Annual Report 2010/2011

DEPARTMENT OF
ELECTRICAL ENGINEERING

ELECTRICAL ENGINEERING

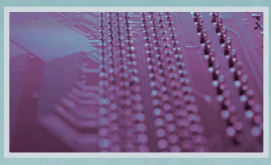
KAIST

TABLE OF CONTENTS

Annual Report 2010/2011

DEPARTMENT OF ELECTRICAL ENGINEERING


Department of
Electrical
Engineering



In the beginning of 2009, Information and Communication University (ICU) was merged into KAIST. Given that nearly half of the studies at ICU focused on electrical engineering, the major contribution of ICU joined our department, the Department of Electrical Engineering (EE) at KAIST.

Message from the Department Head

The Electrical Engineering (EE) department has successfully expanded our research areas to include the fields of brain engineering, network security, and network computing. This expansion is a necessary fundamental step in implementing our long-term goal, which is to become a world-leading department in the field of information technology.

We have experienced many fast and drastic changes in the last five years, such as changes in the faculty tenure system and the tuition policy for undergraduate and graduate students, having all of the undergraduate lectures in English, and integrating new admission standards for prospective undergraduate students. Most of the changes have adapted well to our system and we did our best to integrate the new policies successfully, which has made us stronger in the field of worldwide competition. However, we still have some tasks and policies that need to be refined. We do believe that we have the strength and ability to improve the policies and make changes ourselves.

Currently, the EE department at KAIST is the largest department in Korea with 87 professors, more than 1,200 students (approximately 400 undergraduate and 800 graduate students), and 20 administrative and technical staff members.

This annual report highlights the various activities undertaken in 2010 and in the first half of 2011 by our faculty members, students, and staff. This year, we made great progress and produced outstanding research results. Our research centers worked closely with the government and various industries. We also strengthened our national research laboratories gained a considerable amount of research funding. All of these achievements would not have been possible without the efforts of every member of the KAIST EE department.

We know we have a lot of things to do to realize our vision of becoming the best EE department in the world. Everyone at the Department of Electrical Engineering at KAIST is ready to listen to your suggestions and ideas that may improve the Department of Electrical Engineering. I would like all of you to remain interested in the Department of Electrical Engineering at KAIST and watch us become one of the best departments in the world.

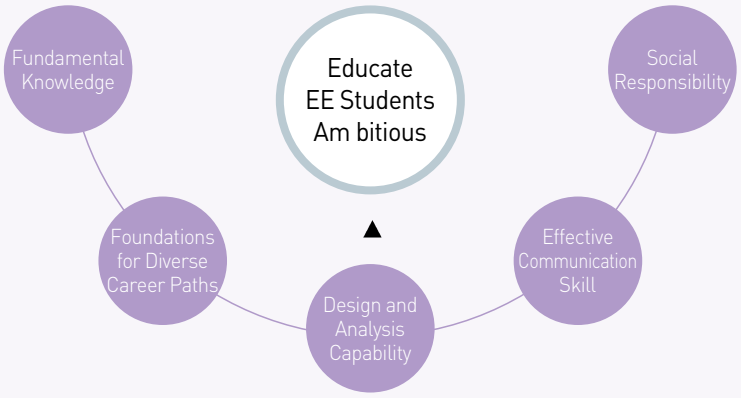
June 2011

Joungho Kim

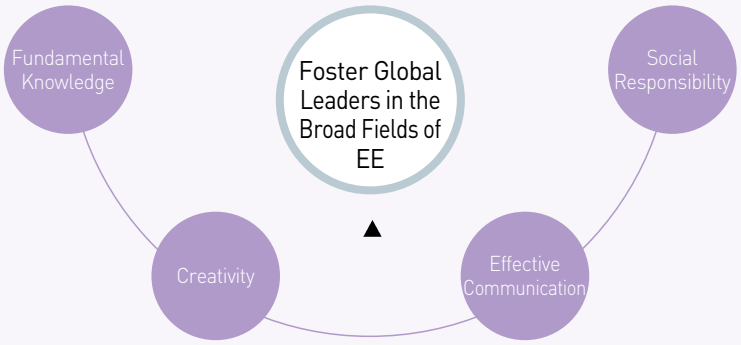
Professor and Department Head
Department of Electrical Engineering

EE vision

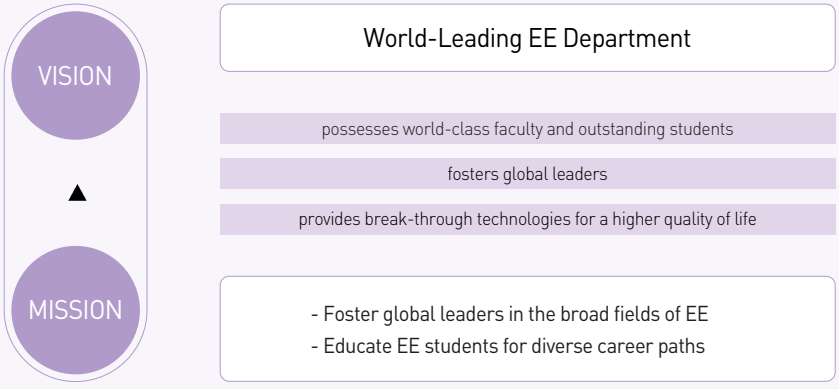
- Mission Statements (Undergraduate)



- Mission Statements (Graduate)

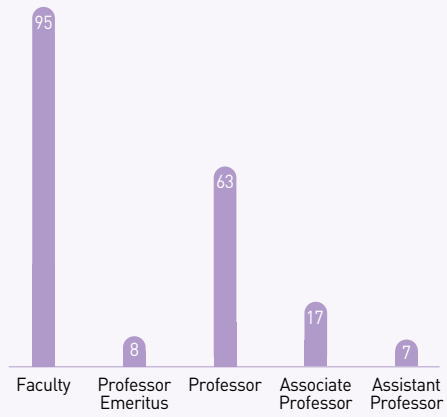


- Vision Statements

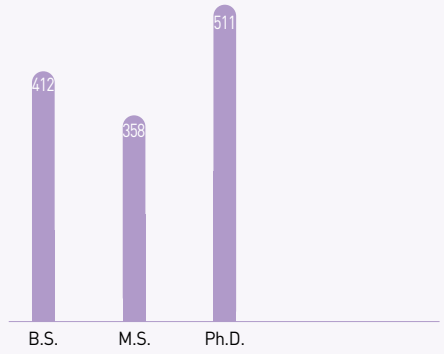


Overview

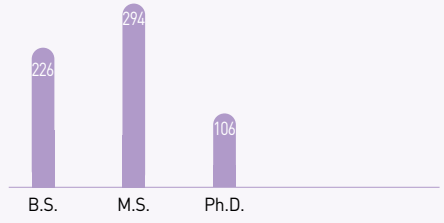
• Faculty (Apr. 2011)



• Student Enrollment (Apr. 2011)



• Degrees Awarded (Feb. 2010 - Feb. 2011)



FACILITIES

7 Buildings
3 Research Groups
87 Laboratories
37 Research Centers

RESEARCH FUND (2010)

$55.95 Million

DEPARTMENT SCHOLARSHIP

- Creative Activity Prize -
  donated by the families of EE graduate students
- Distinguished Thesis Prize -
  established by the trust fund of Prof. Song-Bae Park
- Augustinus Han Chul Hee Scholarship -
  donated by Prof. Chul Hee Han & his students
- Hwang Yoon-Ho Scholarship -
  donated by Mr. Yoon-Ho Hwang
- Il-Soo Scholarship -
  donated by the father of Prof. Young-Se Kwon
- Kim Choong-Ki Scholarship -
  donated by Dr. Hyung-Kyu Lim
- Lee Min-Hwa Scholarship -
  donated by Dr. Min-Hwa Lee
- No Yop Scholarship -
  donated by No Yop Culture Foundation
- Sang-Ae Scholarship -
  donated by Sang-Ae Foundation
- So-Chun Scholarship -
  donated by the father of Prof. Myung Joong Youn
- Suk Rim Scholarship -
  donated by Suk Rim Academic Foundation
- Un Chong-Kwan Scholarship -
  donated by Prof. Chong-Kwan Un

Brief History

1970's

1971
- Establishment of Korea Advanced Institute of Science (KAIS) at Hongneung, Seoul
- **Profs. KunMo Chung and Jung-Woong Ra joined the Department**

1973
- **Profs. Jae-Kyoon Kim and Song-Bae Park joined the Department**
- First entrance ceremony for the master program

1975
- **Prof. Choong-Ki Kim joined the Department**
- First graduation ceremony for the master program
- First entrance ceremony for the PhD program

1977
- **Profs. Zeungnam Bien and Chong-Kwan Un joined the Department**

1978
- **Profs. Zang-Hee Cho and Sang-Yung Shin joined the Department**
- Development of adaptive delta modulation system for defense applications (Prof. Chong-Kwan Un)
- Development of facsimile machine (Prof. Jae-Kyoon Kim)

1979
- **Prof. Young-Se Kwon joined the Department**
- Development of KAISEM, a 4 dof robot-arm manipulator (Prof. Zeungnam Bien)

1980's

1980
- Establishment of Korea Advanced Institute of Science and Technology (KAIST), merged with KIST
- Development of LPC vocoder (Prof. Chong-Kwan Un)

1981
- First graduation ceremony for the PhD program
- Development of 512-bits mask-programmable ROM (Prof. Choong-Ki Kim)

1982
- Development of statistical time-division multiplexer (Prof. Chong-Kwan Un)

1983
- **Profs. Gyu-Hyeong Cho, Myung Jin Chung, Myunghwan Kim, Chong-Min Kyung, Hwang Soo Lee, Kyu Ho Park, and Myung Joong Youn joined the Department**

1984
- Establishment of Korea Institute of Technology (KIT) starting the undergraduate program
- **Prof. Seong-Dae Kim joined the Department**
- **Profs. Choon Gil Kim, Joon Soo Kim, Ju-Jang Lee, Koeng Su Lim, and Byung Cheol Shin joined KIT**
- Development of turret servo drive system (Prof. Myung Joong Youn)

1985
- Profs. Soon Dal Choi, Kwang-Ho Yim, and Dong-Jo Park joined KIT
- Development of 2-Tesla nuclear magnetic resonance imaging system (Prof. Zang-Hee Cho)
- Development of packet switching equipment, KORNET (Prof. Chong-Kwan Un)

1986

- **Profs. Kwyro Lee and Soo-Young Lee joined the Department**
- **Profs. Byung Kook Kim, Hyung-Myung Kim, Noh-Hoon Myung, and Dan Keun Sung joined KIT**
- First entrance ceremony for KIT
- Development of ultrasonic imaging system (Prof. Song-Bae Park)

1987

- **Prof. Jong Beom Ra joined the Department**
- **Profs. Chul Hee Han and Sang Woo Kim joined KIT**

1988

- **Prof. Iickho Song joined the Department**
- **Profs. Jong-Hwan Kim and Jong-Tae Lim joined KIT**
- Implementation of two-dimensional optical neural network (Prof. Sang-Yung Shin)
- Development of 45-Mbps video codec (Prof. Jae-Kyoon Kim)
- Development of vertically integrated AlGaAs laser and JFET (Prof. Young-Se Kwon)

1989

- KIST separated from KAIST
- KAIST merged with KIT and moved to Daejeon
- Former faculty members of KIT joined the Department as of September 1, 1989.
- **Prof. Yong Hoon Lee joined the Department**
- **Profs. Hyo Joon Eom, Songcheol Hong, Yoon Kyu Jhee, and Hee Chul Lee joined KIT**
- Development of 4-legged robot (Prof. Zeungnam Bien)
- Development of KAICUBE-I, a parallel computer (Prof. Myunghwan Kim)

1990's

1990
- First graduation ceremony for the undergraduate program
- Detected the fourth infiltration tunnel excavated by North Korea (Prof. Jung-Woong Ra)

1991
- **Prof. Tag Gon Kim joined the Department**

1992
- **Profs. Joohwan Chun, In So Kweon, and Cheol Hoon Park joined the Department**
- Launched the satellite KITSAT-1 into orbit (Prof. Soon Dal Choi)
- Development of HDTV encoder (Prof. Jong Beom Ra)

1993
- **Profs. Lee-Sup Kim and HyunWook Park joined the Department**
- Launched KITSAT-2 into orbit (Prof. Soon Dal Choi)
- Prof. Choong-Ki Kim was awarded a Hoam Prize

1994
- **Profs. Yun Chur Chung and Beom-Seop Kim joined the Department**
- Development of KAICUBE Hanbit-1, a 2-Gflops parallel computer (Prof. Kyu Ho Park)
- Profs. Soon Dal Choi, Choong-Ki Kim, Jae-Kyoon Kim, and Song-Bae Park were elected Members of Korean Academy of Science and Technology (KAST)

1995
- Development of digital adaptive equalizer ASIC (Prof. Chong-Min Kyung)
- Development of wireless IR printer-sharing unit (Prof. Sang-Yung Shin)
- Prof. Choong-Ki Kim was elected a Fellow of the Institute of Electrical and Electronics Engineers (IEEE)
- Prof. Zang-Hee Cho was awarded a Korea Engineering Award

1996
- **Profs. Joungho Kim, In-Cheol Park, Hyung Cheol Shin, and Eui-Sik Yoon joined the Department**
- Prof. Song-Bae Park was awarded a In-Chon Academic Award

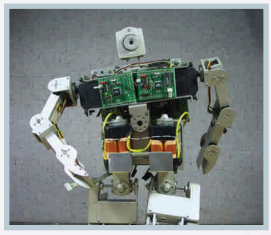
1997
- Establishment of Information and Communications University (ICU)
- **Prof. Chang Hee Lee joined the Department**
- **Profs. Sang-Gug Lee, Seong-Ook Park, Yong Man Ro, Giwan Yoon, and Chan-Hyun Youn joined ICU**
- Development of 50-MHz Pentium chip (Prof. Chong-Min Kyung)
- Development of intelligent wheelchair (Prof. Zeungnam Bien)
- Prof. Jong-Hwan Kim founded the Federation of International Robot-Soccer Association
- Prof. Choong-Ki Kim was awarded an Order of Civil Merit (Mo-Ran)

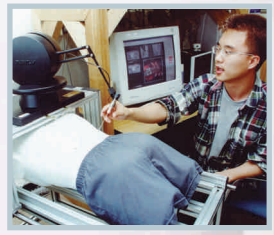
1998
- **Profs. Dong-Ho Cho, Daeyoun Park, and Hoi-Jun Yoo joined the Department**
- **Profs. Hae-Wook Choi, Jun Kyun Choi, Minsoo Hahn, Youngnam Han, Man Seop Lee, Hyo-Hoon Park, Hong-Shik Park, Sin-Chong Park, Yong Hyub Won, and Hyung-Joun Yoo joined ICU**

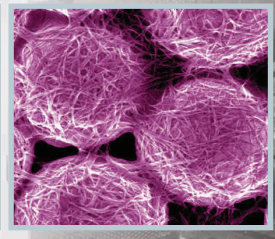
- First entrance ceremony for the graduate program of ICU
- Development of room-temperature IR sensor (Prof. Songcheol Hong)
- Development of fiber back-haul network for wireless CDMA service (Prof. Yun Chur Chung)
- Development of sign-language translation system (Prof. Zeungnam Bien)
- Prof. Zeungnam Bien was elected a Member of KAST
- Prof. Song-Bae Park was elected a Member of the National Academy of Engineering of Korea (NAEK)
- Prof. Jae-Kyoon Kim was awarded an Order Civil Merit (Suk-Ryu)

1999

- **Profs. Yoon Heung Baek, Kyounghoon Yang, and Chang Dong Yoo joined the Department**
- **Profs. Minho Kang, Joongsoo Ma, and Chul Soon Park joined ICU**
- First graduation ceremony for the graduate program of ICU
- Launched KITSAT-3 into orbit (Prof. Dan Keun Sung)
- Development of 3-dimensional integrated inductor (Prof. Choong-Ki Kim)
- Profs. Young-Se Kwon and Sang-Yung Shin were elected Members of KAST
- Prof. Jung-Woong Ra was awarded an Order of Civil Merit (Mo-Ran)







2000's

2000

- **Profs. Song Chong and Gun-Woo Moon joined the Department**
- **Profs. Hoi Rin Kim and Hyuckjae Lee joined ICU**
- Development of CMOS oscillator for cellular systems (Prof. Beom Seop Kim)
- Development of medical diagnosis simulator based on 3-dimentional virtual reality image (Prof. Jong Beom Ra)
- Development of all-optical WDM network testbed with 4 optical cross-connects (Prof. Yun Chur Chung)
- Prof. Sang-Yung Shin and Myung Joong Youn were elected Members of NAEK
- Prof. Song-Bae Park was awarded a Korea Engineering and Technology Award
- Prof. Chong-Min Kyung was awarded an Order of Civil Merit (Suk-Ryu)
- Prof. Iickho Song was awarded a Young Scientists Award from KAST

2001

- **Profs. Jin Sik Choi and Munchurl Kim joined ICU**
- Development of 0.25-micron standard cell library (Prof. Chong-Min Kyung)
- Development of bluetooth baseband chip (Prof. In-Cheol Park)
- Demonstration of Tbps fiber-optic transmission (Prof. Yun Chur Chung)
- Development of speech-recognition phone conversation recorder (Prof. Kwyro Lee)
- Prof. H. Eom was elected a Member of KAST

2002

- **Prof. Jun-Bo Yoon joined the Department**
- **Profs. Hyuncheol Park, Kye Yonug Park, and Mincheol Shin joined ICU**
- First entrance ceremony for the undergraduate program of ICU
- Development of active robot vision camera system (Prof. Myung Jin Chung)
- Prof. Jung-Woong Ra was elected a Member of KAST

2003

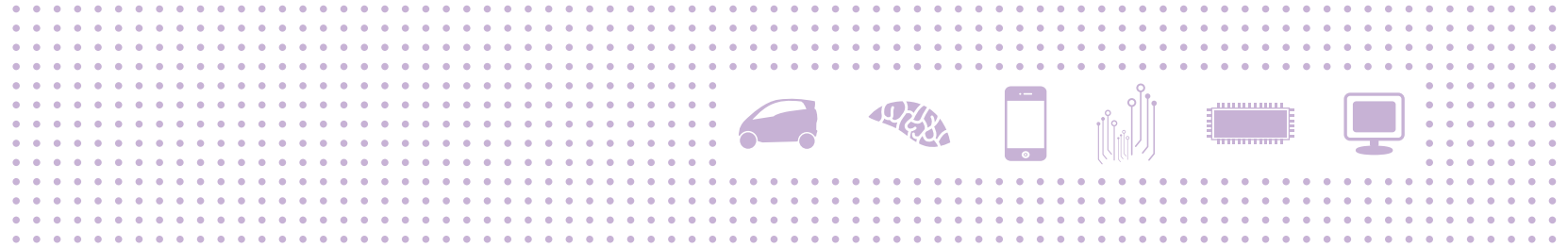
- **Profs. Joonhyuk Kang and Desok Kim joined ICU**
- Launched STSAT-1 designed for the astronomic studies into orbit (Prof. Jong-Tae Lim)
- Development of prototype radio in compliance with IEEE 802.15.4 standard for wireless personal area network (Prof. Kwyro Lee)
- Prof. Kwyro Lee was elected a Member of NAEK
- Prof. Zeungnam Bien was awarded an Order of Science and Technology Merit (Hyeoksin Medal)

2004

- **Profs. SeongHwan Cho, Yang-Kyu Choi, Youngsoo Shin, and Jong-Won Yu joined the Department**
- **Prof. Jeongseok Ha joined ICU**
- Foundation of the National Nanofab Center
- Development of low-noise CMOS-based 13-GHz distributed oscillator (Prof. Eui-Sik Yoon)
- Development of RITY, a robot with gene and chromosome (Prof. Jong-Hwan Kim)
- Prof. Chong-Min Kyung was elected a Member of KAST
- Profs. Yun Chur Chung and Chong-Min Kyung were elected Members of NAEK
- Prof. Jae-Kyoon Kim was awarded an Order of Service Merit (Ok-Jo Geun-Jung)
- Prof. Jong-Tae Lim was awarded an Order of Science and Technology Merit (Doyak Medal)

2005

- **Profs. Kyung Cheol Choi and Sae-Young Chung joined the Department**



- **Profs. Changick Kim and June-Koo Kevin Rhee joined ICU**
- 1000th Ph.D. graduated from the Department
- Development of tactile sensor imitating human skin (Prof. Eui-Sik Yoon)
- Prof. Iickho Song was elected a Member of KAST
- Prof. Ju-Jang Lee was elected a Fellow of the Society of Instrument and Control Engineers (SICE)

2006

- **Prof. Seunghyup Yoo joined the Department**
- **Prof. P. N. Kondekar joined ICU**
- Development of the world smallest 3-nm transistor (Prof. Yang-Kyu Choi)
- Development of the system-in-chip RFID reader (Prof. Jong-Hwan Kim)
- Demonstration of low-power communication through human body (Prof. Hoi-Jun Yoo)
- Prof. Yun Chur Chung was elected a Fellow of IEEE
- Prof. Iickho Song was awarded an Achievement Award from the Institution of Engineering and Technology (IET)

2007

- **Profs. Byung Jin Cho and Youngchul Sung joined the Department**
- **Profs. Wan Choi and Seung-Tak Ryu joined ICU**
- Development of 8-nm flash memory device (Prof. Yang-Kyu Choi)
- Development of prototype technologies for highly efficient PDP lighting (Prof. Kyung Cheol Choi)
- Prof. Yun Chur Chung was elected a Member of KAST
- Prof. Jung-Woong Ra was elected a Member of NAEK
- Prof. Zeungnam Bien was elected a Fellow of IEEE

2008

- **Prof. Yung Yi joined the Department**
- Development of HanSaRam-VIII, a humanoid robot (Prof. Jong-Hwan Kim)
- Development of quantum-effect based multiplexer IC (Prof. Kyounghoon Yang)
- Prof. Jung-Woong Ra was elected a Member of the National Academy of Sciences (NAS)
- Profs. Ju-Jang Lee and Hoi-Jun Yoo were elected Fellows of IEEE

2009

- Merger of KAIST and ICU
- Former faculty members of the ICU joined the Department as of March 1, 2009.
- **Profs. Hyeon-Min Bae, Dae-Shik Kim, Junmo Kim, and Jaekyun Moon joined the Department**
- **Prof. Soo-Young Lee re-joined the Department**
- Prof. Yong Hoon Lee and Dan Keun Sung were elected Members of NAEK
- Profs. Jong-Hwan Kim, Chong-Min Kyung, and Iickho Song were elected Fellows of IEEE
- Prof. Jung-Woong Ra was awarded a Korea Engineering Award

2010

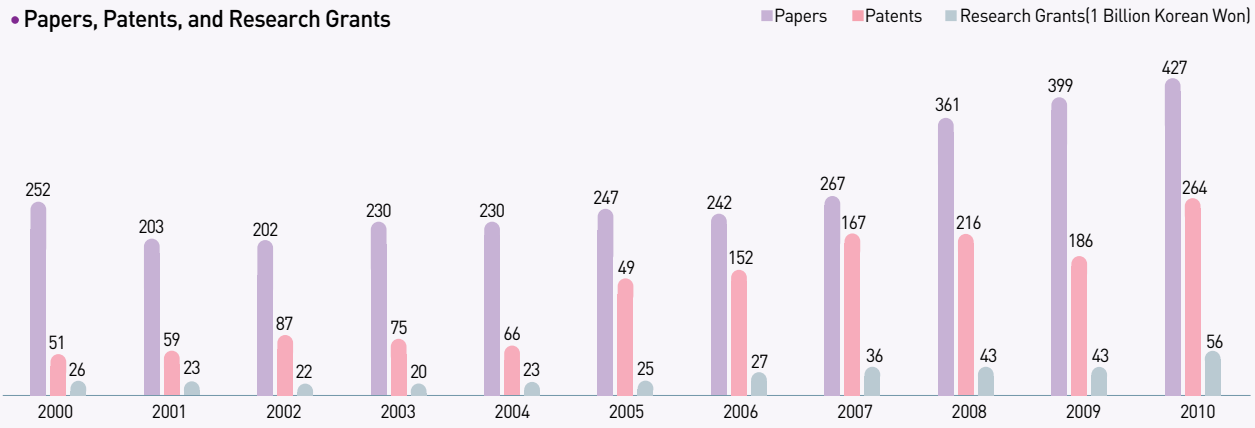
- **Profs. Seok-Hee Lee, KyoungSoo Park, and Kyoungsik Yu joined the Department**
- **Prof. Chang Hee Lee was elected a Fellow of IEEE**

2011

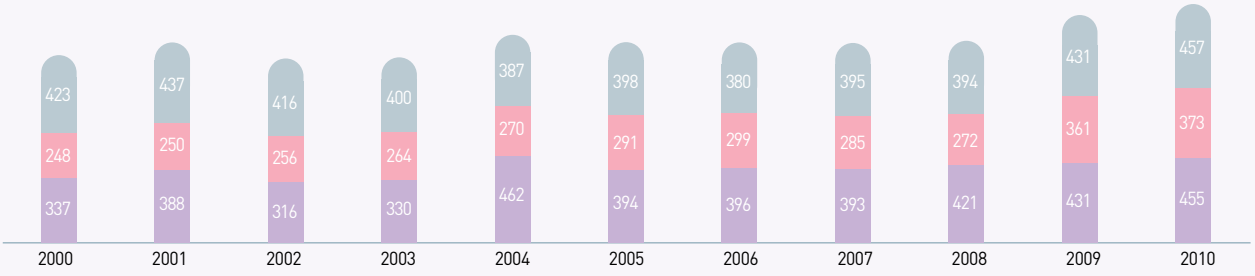
- **Prof. Yong Hoon Lee was appointed as the vice president of KAIST ICC.**
- **Prof. Sung Dae Kim was appointed as the 41st president of IEEK.**
- **Prof. Minsoo Hahn was appointed as the president of Korean Society of Speech Sciences**
- **Profs. Kyung Cheol Choi and Sae-Young Chung were appointed as the Chair Professors by KAIST.**
- Development of a smart household polysomnography (PSG) system (Prof. Hoi-Jun Yoo)
- Development of internet porn filter (Prof. Hoi-Rin Kim)

Statistics 2010/2011

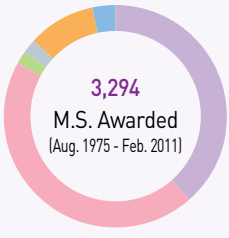
• Papers, Patents, and Research Grants



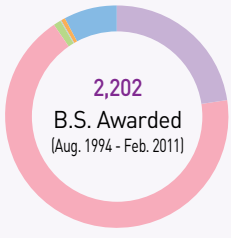
• Student Enrollment



- Industries 883
- Gocernment Agencies 18
- Educational Institutes 148
- Research Institutes 327
- Others 46



- Industries 1267
- Advanced to Higher-Degree Programs 1,494
- Gocernment Agencies 61
- Educational Institutes 69
- Research Institutes 322
- Others 111



- Industries 498
- Advanced to Higher-Degree Programs 1,494
- Gocernment Agencies 24
- Educational Institutes 3
- Research Institutes 13
- Others 170

Professors Emeritus

Bien, Zeungnam
Professor Emeritus

- Ph.D., University of Iowa (1975)
- Automation System, Intelligent Fuzzy Control, Service Robotics
- zbien@ee.kaist.ac.kr

Choi, Soon Dal
Professor Emeritus

- Ph.D., Stanford University (1969)
- Satellite Communication, Remote Sensing
- sdchoi@ee.kaist.ac.kr

Kim, Choong-Ki
Professor Emeritus and Distinguished Professor

- Ph.D., Columbia University (1970)
- Semiconductor Engineering, Infrared Detecting Device Development
- ckkim58@kaist.ac.kr

Kim, Jae-Kyoon
Professor Emeritus

- Ph.D., University of Southern California (1971)
- Video Coding, Visual Communication Systems
- kimjk@ee.kaist.ac.kr

Kwon, Young-Se
Professor Emeritus

- Ph.D., University of California, Berkeley (1977)
- Opto Electronic Integrated Circuit(OEIC) Monolithic Microwave Integrated Circuit(MMIC)
- kwon@ee.kaist.ac.kr

Park, Sin-Chong
Professor Emeritus

- Ph.D., University of Minnesota (1979)
- Wireless Communications SoC
- scpark@ee.kaist.ac.kr

Park, Song-Bae
Professor Emeritus

- Ph.D., University of Minnesota (1968)
- Ultrasonic Systems
- sbpark@ee.kaist.ac.kr

Ra, Jung-Woong
Professor Emeritus

- Ph.D., Polytechnic Institute of Brooklyn (1971)
- Scattering of EM Waves by Dielectric Wedge, Inverse Scattering, Underground Tomogram
- rawoong@ee.kaist.ac.kr

Research Groups

Brain and Smart Systems

Conventional Von Neumann style programmable systems have achieved spectacular success in the past half century. They are in fact one of the cornerstones of our present way of life. It is increasingly evident, however, that many of the mankind's emerging problems are characterized by exceedingly high degree of complexity and uncertainty, necessitating a quantum jump in our ability to capture such problems in a computationally efficient way.

With 50 million neurons and several hundred kilometers of axons terminating in almost one trillion synapses for every cubic centimeter, yet consuming only about 12 watts energy for the entire cortex, the brain is arguably one of the most efficient information processing systems specifically designed to solve complex, real-world problems. The Brain and Smart Systems Group aims to reverse engineer the basic principles of operation and architecture of the brain in order to design new generations of smart systems optimized for solving complex real-world problems for our societal needs.

The group consists of a multidisciplinary circle of investigators experienced in a vast number of areas from circuit design to neuroscience. Some of the major expertise of the group include: 1) Circuit research team with world-class digital/analog circuit design capabilities; 2) Display research team consisting of industry leaders in cutting-edge display systems; 3) Image and signal processing team experienced in sophisticated analyses of biomedical and multi-modal data; 4) Control team made up of world experts in advanced robotics systems.

Bae, Hyeon-Min	Assistant Professor
Cho, SeongHwan	Associate Professor
Choi, Hae-Wook	Professor
Chung, Myung Jin	Professor
Hahn, Minsoo	Professor
Kim, Byung Kook	Professor
Kim, Changick	Associate Professor
Kim, Dae-Shik	Professor
Kim, Hoi-Rin	Associate Professor
Kim, Jong-Hwan	Professor
Kim, Junmo	Assistant Professor
Kim, Lee-Sup	Professor
Kim, Munchurl	Associate Professor
Kim, Seong-Dae	Professor
Kweon, In So	Professor
Kyung, Chong-Min	Professor
Lee, Ju-Jang	Professor
Lee, Soo-Young	Professor
Lim, Jong-Tae	Professor
Moon, Gun-Woo	Professor
Park, HyunWook	Professor
Park, In-Cheol	Professor
Ra, Jong Beom	Professor
Ro, Yong Man	Professor
Shin, Youngsoo	Associate Professor
Yoo, Chang Dong	Professor
Yoo, Hoi-Jun	Professor
Youn, Myung Joong	Professor

Bae, Hyeon-Min

Assistant Professor

Ph.D., University of Illinois, Urbana-Champaign (2004)
hmbae@ee.kaist.ac.kr
http://nais.kaist.ac.kr

Nanoscale Advanced Integrated Systems Laboratory

The research of Nanoscale Advanced Integrated Systems Lab. (NAIS) focuses on System aware Mixed mode IC design and 100Gb/s broadband IC design for next generation broadcasting networks.

System level performance driven adaptive reconfigurable mixed mode IC design technique. In this design, the system level signatures of the underlying physical artifacts will be monitored and processed using adaptive and statistical signal processing to determine optimal strategies for error-compensation, reconfiguration and adaptation of architectural and circuit level parameters. A mixed mode IC designed with such scheme can also overcome the fundamental performance trade-offs existing in non-adaptive conventional mixed mode communication ICs and ultimately improve the baseline performance. As this technique would enable a complete system IC to operate as an evolving organism, self-healing capability would be a valuable byproduct of this scheme.

The steady growth in demand for bandwidth is facing the data-rates in the 100s of Gb/s in optical communications. Such high-speed systems suffer from impairments such as dispersion, noise, and process non-idealities. Due to the difficulty in implementing multi-Gb/s transmitters and receivers in silicon, conventionally, high-speed links were implemented primarily with simple analog circuits employing minimal signal processing. However, the relentless scaling of feature sizes exemplified by Moor's law has enable the application of sophisticated signal processing techniques to overcome such problems prevalent in complex transceivers operating at 100s of Gb/s. Newly developed 100Gb/s CAUI receiver has met all the stringent and complex specifications while mitigating inherent circuit level issues through a variety of innovations at the algorithmic, architectural and circuit levels

KEY ACHIEVEMENTS

[1] H.-M. Bae, J. Ashbrook, J. Park, N. Shanbhag, A. Singer, and S. Chopra, "An MLSE receiver for electronic dispersion compensation of OC-192 fiber links," *IEEE J. Solid-State Circuits*, vol. 41, no. 11, pp. 2541-2544, Feb. 2006.
Selected for the Best Paper of the Year Award For 2006, IEEE J. Solid-State Circuits. Nov, 2006.

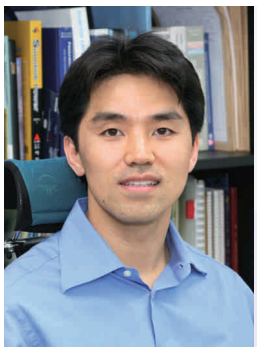
[2] A. Singer, N. Shanbhag, and H.-M. Bae, "Electronic dispersion compensation : Signal processing for fiber optical links," *IEEE Signal processing magazine*, vol. 25, no. 6, pp. 110-130, Nov. 2008.

[3] H.-M. Bae, J. Ashbrook, N. Shanbhag, and A. Singer, "A fast power transient management for WDM add/drop networks," *IEEE J. solid state circuits*, vol. 43, no. 12, pp. 2958-2966, Dec. 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] H. M. Bae et al, *Phase detector utilizing analog-to-digital converter components*, USA, 12/039424, July 6, 2010.

[2] H. M. Bae et al, *Variable gain amplifier having variable gain DC offset loop*, USA, 11/856,680, Apr. 13, 2010.



Cho, SeongHwan

Associate Professor

Senior Member, IEEE

Ph.D., Massachusetts Institute of Technology (2002)
chosta@ee.kaist.ac.kr
http://sites.google.com/site/kaistccs/

Communication Circuits and Systems Laboratory

Communication Circuits and Systems Group explores emerging technologies for various high-performance, low-power wired and wireless communication systems. Our main area of focus is in the design and implementation of analog and mixed-signal integrated circuits with multiple layers of system abstraction in mind, from communication protocols and system architectures to circuit techniques. Our recent research topics include low power communication circuits, digital transceiver and bio-sensor network.

As a key building block of low power communication system, we demonstrated a state-of-the-art ultra low power frequency synthesizer, and also proposed a state-of-the-art digitally-controlled injection-locked frequency divider. For the implementation of digital receivers, we proposed a digital PLL (DPLL) architecture with novel sub-feedback loop which reduces the effect of quantization. We also proposed a low power time-based ADC architecture that can directly digitize the RF signal without any use of large passive devices such as inductors, which is attractive solution for direct RF sampling in deep-submicron processes (Fig.(a)). In addition, we have proposed a novel low-power digital-friendly transmitter architecture which does not use mixers or DACs. In the bio-sensor area, we are investigating a novel magnetic-stimulation-based bio-sensor and a novel bio-impedance measurement system. (Fig. (b)).

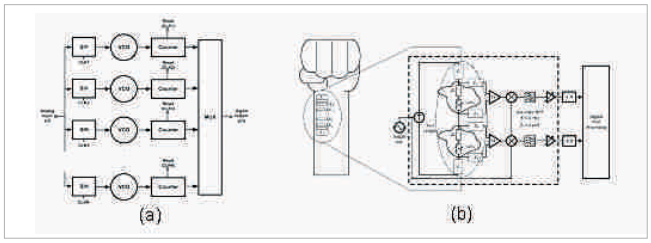


Fig. 1

KEY ACHIEVEMENTS

[1] Y.-G. Yoon, J. Kim, T. K. Jang, and S. H. Cho, "A time-based bandpass ADC using time-interleaved voltage-controlled oscillators," *IEEE Tr. Circuits and Systems I,* vol. 55, no. 11, pp. 3571-3581, Dec. 2008.
2009 IEEE Circuits and Systems Society Guillemon-Cauer Best Paper Award (IEEE Tr. Cir. & Syst. I Best Paper), IEEE Circuits and Systems Society, May 2009.

[2] J. Kim, W. Yu and S.H. Cho, "A digital-intensive receiver front-end using VCO-based ADC with an embedded 2nd-order anti-aliasing sinc filter in 90nm CMOS," IEEE International Solid-State Circuits Conference (ISSCC), 2011.

[3] J. Kim, T.-K. Jang, Y.-G. Yoon and S. H. Cho, "Analysis and design of voltage-controlled oscillator-based analog-to-digital converter" *IEEE Tr. Circuits and Systems I,* vol. 57, no. 1, pp. 18-29, Jan. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] J. Lee, S. Park, and S. H. Cho, "A 470-uW 5-GHz digitally controlled injection-locked Multi-Modulus Frequency Divider with an In-Phase Dual-Input Injection Scheme", *IEEE Tr. Very Large Scale Integrated Systems,* vol. 19, no. 1

[2] J. H.Lee and S.H. Cho "A 201nW 29.3 ppm/°C 0.7V voltage reference with a temperature range of -50 to 130°C in 0.13um CMOS," *IEEE Symp. on VLSI Cir.,* June 2011

[3] J. Lee, J. Kim and S. H. Cho, "A 1.8 to 2.4-GHz 20mW digital-intensive RF sampling receiver with a noise-canceling bandpass low-noise amplifier in 90nm CMOS," *IEEE RFIC Symposium,* 2010.

Choi, Hae-Wook

Professor

Member, IEICE

Ph.D., National Polytechnic Institute of Grenoble (1984)
hwchoi2@ee.kaist.ac.kr
http://ee005.kaist.ac.kr

System VLSI Laboratory

Main research topics of the System VLSI Lab (SVL) include reconfigurable core IP design for important system algorithms, MPSoC based Intelligent NoC design, and energy harvesting sensor/actuator network design for IT convergence systems.

Reconfigurable Core IP Design for Important System Algorithms : One of the big issues in advanced system design is how to effectively implement its complex algorithms with real-time and low-power requirements. The System VLSI Lab's approach is to thoroughly analyze the system algorithms and devise some optimal architectures that meet conflicting system requirements. These architectures are system algorithm core IPs (Intellectual Properties). System algorithms of interest in the lab are those of cryptography, 3D-multimedia and Mobile communication. Currently, we are focusing on core IP design for elliptic curve cryptography (ECC) algorithm.

MPSoC based Intelligent NoC Design : 'Small, Green and Smart' is today's keyword. To achieve this, the lab, SVL, is conducting research on MPSoC based intelligent NoC (network-on-chip). An NoC is composed of MPSoC, i.e., many microprocessors and/or DSPs, memories, and on-chip network (OCN). It is very small, consumes low energy and analyzes very complex phenomena. MPSoC based Intelligent NoC design includes parallel processing, energy calculation methodology, network parameter evaluation and modeling, and SoC design methodology. Main application areas of interest are noisy video and audio signal processing.

Energy Harvesting Sensor/Actuator Network Design for IT Convergence Systems : A world wide issue is 'IT Convergence'. That is to apply well advanced IT technologies to science and engineering. In this regard, the System VLSI Lab is focusing on Energy Harvesting Convergence Sensor/Actuator Network Design in the ocean and fishery science/engineering and plant science. The electric energy is obtained by conversion from the sun, wind, wave, & movement. The science and engineering requirement adapted sensors and actuators are properly applied to the system in question and optimally networked. The R&D is to be done in cooperation with the KAIST Digital Media Lab (DML) that has long been conducting advanced multi-disciplinary media projects. At present, we are conducting an IT convergence project with the National Fishery Research and Development Institute (NFRDI) on processing technologies of marine facilities caused pollution sources.

KEY ACHIEVEMENTS

[1] V.-D. Ngo, H.-N. Nguyen, Y. Bae, H. Cho, and H.-W. Choi, "Throughput aware mapping for network on chip design of H.264 decoder," *LNCS (Springer-Verlag)*, vol. 4331, pp. 709-802, Dec. 2006.

[2] V.-D. Ngo, H.-N. Nguyen, and H.-W. Choi, "The optimized tree-based network on chip topologies for H.264 decoder design," *IEEE Conf. Computer Engineering and Systems*, pp. 62-65, Cairo, Egypt, Nov. 2006. (Best Student Award)

[3] D. Kim and H.-W. Choi, "Advanced constant multiplier for multipath pipelined FFT processor," *Electron. Lett.*, vol. 44, no. 8, pp. 518-519, Apr. 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] H.-S. Kang, M.-L. Hwang, J. Lee, S.-K. Lee, H.-W. Choi, and S.-C. Park, "A calibration scheme for delay mismatch compensation in OFDM-based polar transmitter," *IEICE Tr. Comm.*, vol. E93-B, no.10, pp. 2791-2794, Oct. 2010.

[2] H.-W. Choi, *A food supply system for fish-farm*, 10-2010-0117181, Korea, Nov. 24, 2010.

Chung, Myung Jin

Professor

Senior Member, IEEE

Ph.D., University of Michigan (1983)
mjchung@ee.kaist.ac.kr
http://cheonji.kaist.ac.kr

Robotics Research Laboratory

Robotics Research Laboratory (RRLAB) has mainly focused on developing robot systems for human-robot interaction, 3D world modeling and localization.

Studies for robot to have an integrated emotion generation and expression system have been achieved to increase the effectiveness of the emotional interaction between human and robot. For the emotion generation study, Energy, Entropy, and Homeostasis are being considered. For the emotion expression, new version of robot hardware development and research for auto gesture expression are in progress.

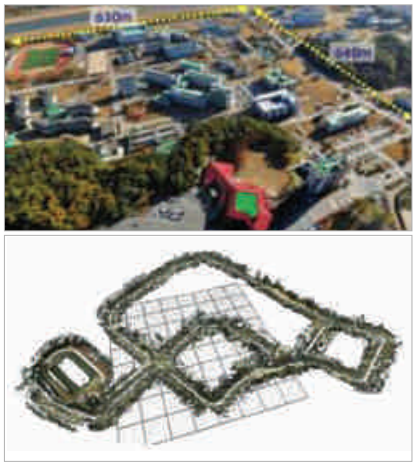


Fig. 1 3D World Modeling

The environment perception is a fundamental capability for many applications of robots. Our mobile platform, which equips multiple sensors for 3D outdoor world modeling. The data from GPS and IMU on the platform are fused to provide vehicle pose on the ground. The laterally installed LRFs(Laser Range Finder) on each side of the vehicle give environment perception information. The data from the LRFs are fused with cameras in order to make colored LRF points. With these multiple sensors, we have successfully built spatio-temporal integrated 3D world models of outdoor environments. We focus on developing localization component using ceiling vision, Monte Carlo Localization and Simultaneous Localization and Map building component technique for implementation of mobile robot navigation.

Fig. 2 Mobile Robot Navigation

KEY ACHIEVEMENTS

[1]H. S. Lee, J. W. Park, and M. J. Chung, "A linear affect-expression space model and control points for mascot-type facial robot," *IEEE Tr. Robotics,* vol. 23, no. 5, pp. 863-873, Oct. 2007.

[2] J. H. Kim and M. J. Chung, "Absolute motion and structure from stereo image sequences without stereo correspondence and analysis of degenerate cases," *Pattern Recognition,* vol. 39, Issue 9, pp. 1649-1661, Sep. 2006.

MAJOR ACHIEVEMENTS in 2010/2011

[1] W. H. Kim, J. W. Park, W. H. Lee, and M. J. Chung, "Robot's emotional expression generation based on context information and combination of behavior database," *IEEE Int. Symp. Robot and Human Interactive Communication,* Viareggio, Italy, Sep. 2010.

[2] K. H. An and M. J. Chung, "Robust unified stereo-based 3D head tracking and Its application to face recognition," *IEEE Int. Conf. Robotics and Automation,* Anchorage, Alaska, USA, May 2010.

Hahn, Minsoo

Professor

Member, KSPSST

Ph.D., University of Florida (1989)
mshahn@ee.kaist.ac.kr
http://sail.kaist.ac.kr

Speech and Audio Information Laboratory

The research areas of Speech and Audio Information Laboratory (SAIL) cover the speech, audio, and bio signal processing. Our research has been focused on noise reduction for speech interfaces, HMM-based speech synthesis, multi-channel/multi-object audio coding.

Noise reduction : The performance of speech interfaces tend to severely degraded by interfering noises. Thus, beamforming algorithms have been suggested for non-stationary noise reduction. The beamforming is spatial filtering to estimate the target signal arriving from a desired direction. For the performance improvement, SAIL has developed a probabilistic adaptation mode controller and an efficient channel mismatch compensator.

HMM-based speech synthesis (HTS) : HTS is the suitable text-to-speech system for embedded applications because it shows high synthetic speech quality for very small-size DB and requires low computational power. In HTS, speech parameters are statistically modeled by context-dependent HMMs. We have proposed a novel two-band excitation model to improve the synthetic speech quality.

Multi-channel/multi-object audio coding : The demand for multi-channel audio services has been increased. Multi-channel audio signals cab be represented by using mono or stereo downmix signal and the side information. SAIL has proposed a residual coding technique, which is efficient mastering signal processing for audio quality improvement with small increase of bit-rate.

The others : We have also studied on the automatic classification method of pathological and normal voice using higher-order statistics, and the technique for automatic arterial stiffness diagnosis using a photoplethysmogram.

KEY ACHIEVEMENTS

[1] J. Jung, H. Park, S. Kang, S. Lee, and M. Hahn, "Measurement of initial motion of a flying golf ball with multi-exposure images for screen-golf," *IEEE Tr. Con. Elec.,* vol. 56, no. 2. pp. 516-523, May 2010.

[2] S, Han, J. Hong, S. Jeong, and M. Hahn, "Robust GSC-based speech enhancement for human machine interface," *IEEE Tr. Con. Elec.,* vol. 56, no.2, pp. 965-970, May 2010.

[3] J. Hong, S. Han, S. Jeong, and M. Hahn, " Adaptive microphone array processing for high-performance speech recognition in car environment," *IEEE Tr. Con. Elec.,* vol. 57, no. 1, pp. 260-266, Feb. 2011.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S. Han, J. Hong, S. Jeong, and M. Hahn, "Probabilistic adaptation mode control algorithm for GSC-based noise reduction," *IEICE Tr. Fund. of Elec., Comm. and Comp. Sciences.* vol. E93-A, no. 3, pp. 627-630, Mar. 2010.

[2] H. Sang Cho, T. Yamazaki and M. Hahn, "AERO: extraction of user's activities from electric power consumption data," *IEEE Tr. Con. Elec.,* vol. 56, no. 3, pp. 2011-2018, Aug. 2010.

[3] J. Lee, S. Jeong, M. Hahn, A. J. Sprecher, and J. J. Jiang, "An efficient approach using HOS-based parameters in the LPC residual domain to classify breathy and rough voices," *Biomedical Signal Proc. and Control,* vol. 6, no. 2, pp. 186-196, Apr. 2011.

Kim, Byung Kook

Professor

Member, IEEK / Member, KIEE / Member, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (1981)
bkkim@ee.kaist.ac.kr
http://rtcl.kaist.ac.kr

Real Time Control Laboratory

Researches in Real-Time Control Lab(RTCL) have been focussing on the followings, two main research groups, Real-Time Control System and Robot Control System. Real-Time control systems area includes Reliable process control system, Real-time systems, and Automotive control. Robot Control System area includes Mobile robot sensing, Navigation, Localization and Manipulator control.

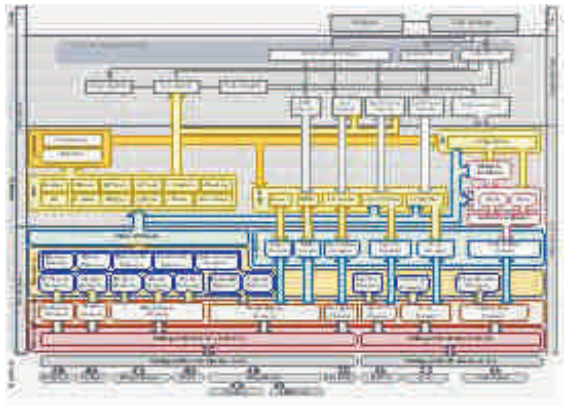


Fig. Structure Design of a Real-Time Control System

More specific, we are researching various optimal mobile robot control topics. For example, a research for the optimal control of mobile robot. It is a essential area of battery-powered robot. This topic includes main problems like energy-constraint, time-constraint and so on. Additionally, we are researching localization for mobile robot. It is also a fundamental research in multi-task mobile robot to recognize where it is and where to go. Since many sensors have used for this area, this topic includes sensor-fusion, sensor information processing and so on. Furthermore, we have on going project, Human Resources Development Program (HRDP) for Convergence Robot Specialist. This is one of the future leading industries supported by Ministry of Knowledge Economy.

From our main researches, we have developed various control systems. For example, we have developed an intelligent powered wheelchair with ultrasonic distance measuring system to meet the needs of users. Also, we have developed technologies for unmanned NBC (Nuclear, Bio, and Chemical) reconnaissance system. Including these technologies, we are making a great contribution for high control technologies and human welfare.

KEY ACHIEVEMENTS

[1] C. J. Seo and B. K. Kim, "Robust and reliable h-Infinity control for linear-systems with parameter uncertainty and actuator failure", *Automatica,* vol. 32, no. 3, pp. 465-467, 1996

[2] B. J. Choi, S. W. Kwak, and B. K. Kim, "Design of a single-input fuzzy logic controller and its properties,", *Fuzzy Sets and Syst.,* vol. 109, no. 3, pp. 299-308, Sep. 1999.

[3] B. J. Choi, S. W. Kwak, and B. K. Kim, "Design and stability analysis of single-input fuzzy logic controller". *IEEE Tr. Syst, Man, and Cybernetics,* vol. 30, no. 2, pp. 303-309, Apr. 2000.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S. J. Kim, and B. K. Kim, "An Accurate Hybrid Global self-Localization Algorithm for Indoor Mobile Robots with 2-D Isotropic Ultrasonic Receivers", *IEEE Tr. Instrumentation and Measurement,* vol. no. pp. Apr. 2011.

[2] Student Paper Award, International Conference on Control, Automation and Systems, Oct. 2011.

Kim, Changick

Associate Professor

Member, IEEK / Senior Member, IEEE

Ph.D., University of Washington (2000)
cikim@ee.kaist.ac.kr
http://cilabs.kaist.ac.kr

Computational Imaging Laboratory

The Computational Imaging Laboratory is performing innovative research work in the areas of image understanding, pattern recognition, computer vision, and 3D image processing. The current research topics are categorized into three groups like the below.
Depth map up sampling and rendering: In order to enhance the quality of the depth map which is often low resolution and noisy, we are studying depth map up-sampling and noise reduction method. Additionally, DIBR (Depth Image Based Rendering), hole filling, and boundary matching methods are researched to reduce the visual fatigue and generate the high quality stereo images.

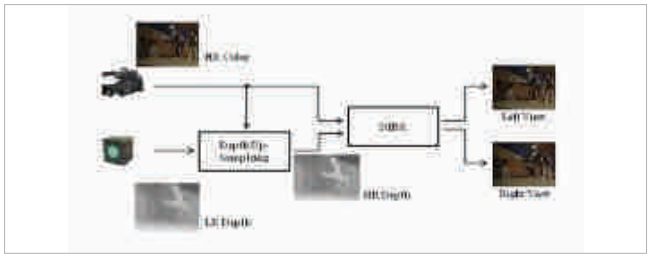


Fig. 1

2D-to-3D conversion: A real-time 3D conversion algorithm for 2D video and still image is being studied to apply in 3D TV. Our system is composed of modules such as object extraction, geometric context understanding, motion analysis, inpainting, region-based graph cut segmentation, and global scene structure understanding.

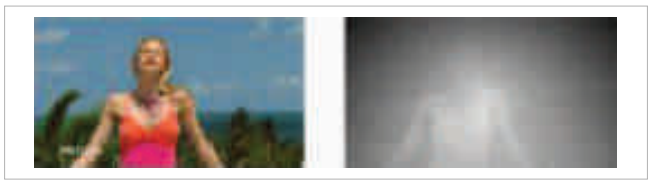


Fig. 2

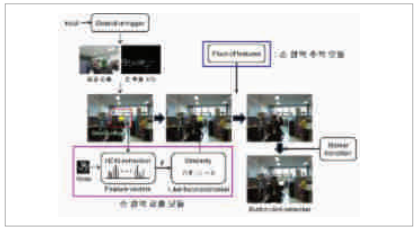


Fig. 3

Human Computer Interaction: Human action and gesture recognition algorithms for HCI (Human Computer Interaction) are being developed eagerly. We have developed a real time gesture recognition algorithm to provide a smart way of TV user interface and a hand interaction system which is robust to illumination changes and complex or cluttered backgrounds.

KEY ACHIEVEMENTS

[1] C. Kim and J.-N. Hwang, "An integrated scheme for object-based video abstraction," *in Proc. ACM Int. Multimedia Conf. 2000,* LA, USA, Oct. 2000.
[2] C. Kim and J.-N. Hwang, "Fast and automatic video object segmentation and tracking for content-based applications," *IEEE Tr. Circuits and Syst. for Video Technology,* vol. 12, no. 2, pp. 122-129, Feb. 2002.
[3] C. Kim and B. Vasudev, "Spatio-temporal sequence matching for efficient video copy detection," *IEEE Tr. Circuits and Syst. for Video Techn.,* vol. 15, no. 1, pp. 127-132, Jan. 2005.

MAJOR ACHIEVEMENTS in 2010/2011

[1] C. Jung and C. Kim, "Segmenting clustered nuclei using H-minima transform based market extraction and contour parameterization," *IEEE Tr. Biomedical Engineering.,* vol. 57, no. 10, pp. 2600-2604, Oct. 2010.
[2] W. Kim, C. Jung, and C. Kim, "Spatiotemporal saliency detection and its applications in static and dynamic scenes," *IEEE Tr. Circuits and Systems for Video Technology.,* vol. 21, no. 4, pp. 446-456, Apr. 2011.

Kim, Dae-Shik

Professor

Ph.D., Max-Planck-Institute for Brain Research (1994)
dskim@ee.kaist.ac.kr
http://brain.kaist.ac.kr

Brain Reverse Engineering & Imaging Laboratory

With 50 million neurons (processing elements) and several hundred kilometers of axons (wires) terminating in almost on trillion synapses (connections) for every (!) cubic centimeter, and consuming only about 12 watts energy for the entire cortex, the brain is arguably one of the most complex and densely packed, yet highly efficient information processing systems known. It is also the seat of sensory perception, motor coordination, memory, and creativity - in short, what makes us humans to humans.

The Goal of our lab is straight forward, yet anything but easy: to understand how our brain works! Not in 100 years; not in 1000 years, but within the next 20 years! How are we going to achieve such an ambitious goal? We believe that recent advances in brain imaging, hierarchical recurrent temporal memory, complex brain network theory, and neuro-robotics in conjuction with the gargantuous corpus of experimental data lay foundation to a perfect storm towards a first release candidate of a correct theory of brain mechanisms. This future Theory of Natural Automata will have to satisfy von Neumann's observation of the brain as a cognitive engine that combines minimum logical depth with maximum logical breadth.

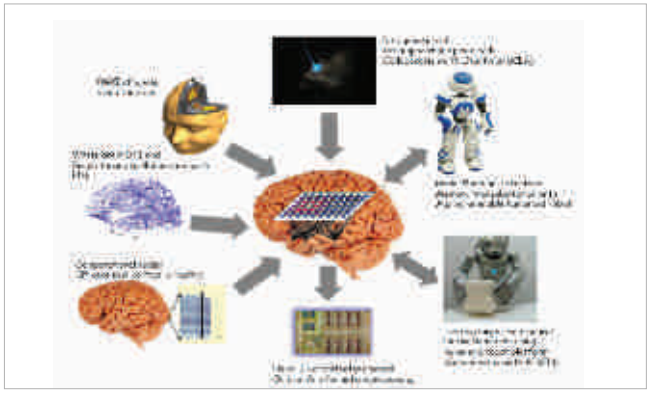


Fig. 1

〈 Research interests 〉

- Systems, Developmental, and Computational Neurosciences
- Functional and Connectivity Mapping of the Human Brain
- Modeling Mini-column Lattices
- Brain Reading & Writing
- Optogenetics
- Massively Parallelized Connectivity Analysis
- Neuro-Robotics
- Hierarchical Neural Models
- Brain-like Smart Phone
- Kinect based Gesture Recognition

KEY ACHIEVEMENTS

[1] D. S. Kim and T. Bonhoeffer, "Reverse occlusion leads to a precise restoration of orientation preference maps in visual cortex," *Nature,* vol. 370, no. 6488, pp. 370-372, Aug. 1994.

[2] D. S. Kim, T. Q. Duong, and S. G. Kim, "High-resolution mapping of Iso-orientation columns by fMRI", *Nature Neuroscience,* vol. 3, no. 2, pp. 164-169, Feb. 2000.

[3] J. H. Lee, R. Durand, V. Gradinaru, F. Zhang, I. Goshen, D. S. Kim, L. E. Fenno, C. Ramakrishnan, and K. Deisseroth, "Global and local fMRI signals driven by neurons defined optogenetically by type and wiring," *Nature,* vol. 465, no. 7299, pp. 788, June 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] J. H. Lee, R. Durand, V. Gradinaru, F. Zhang, I. Goshen, D. S. Kim, L. E. Fenno, C. Ramakrishnan, and K. Deisseroth, "Global and local fMRI signals driven by neurons defined optogenetically by type and wiring", *Nature,* vol. 465, no. 7299, pp. 788, June 2010.

[2] J. H. Lee, R. Durand, V. Gradinaru, F. Zhang, I. Goshen, D. S. Kim, L. E. Fenno, C. Ramakrishnan, and K. Deisseroth, "Bold claims for optogenetics," *Nature,* vol. 468, no. 7323, pp. E3, Nov. 2010.

Kim, Hoi-Rin

Associate Professor

Member, ASK / Member, IEEK / Member, KSSS / Member, IEEE / Member, IEICE

Ph.D., Korea Advanced Institute of Science and Technology (1992)
hrkim@ee.kaist.ac.kr
http://srtlab.kaist.ac.kr

Speech Recognition Technology Research Laboratory

The Speech Recognition Technology Laboratory (SRT-Lab) has focused on developing speech and audio signal processing systems related to speech recognition, speaker identification & verification, keyword spotting, audio indexing & retrieval, music retrieval, and multi-modal interface.
Speech recognition refers to the process of translating the input speech signal obtained from a microphone or telephone into a word or a sentence. The recognition results can be used to command or control a system, or they can be used as an input to a system which understands speech. As a result, speech recognition technology has enabled human beings to communicate more naturally with computers or machines. Recently, speech recognition as one of tools for advanced user interface has become a part of our lives such as mobile device user interface, web search, car navigation, robot interface, home automation systems, and assistance device for disabilities. In addition, audio indexing & retrieval is an emerging technology including music summarization, musical instrument identification, music recommendation, music genre classification, mood classification, and many other audio information processing techniques.
The recent research activities are as follows.

- Unified works for feature compensation and model adaptation methods based on histogram equalization were performed for robust speech recognition.
- Emotion classification methods by voice were proposed for human sensibility processing, and the key idea was on how to extract discriminative features on arousal axis and on valence axis.
- Feature extraction methods based on time-frequency analysis were proposed for automatic detection of harmful speech.
- Assessment methods of dysarthric speech were proposed for the design of individually customized speech recognizer for disabled persons with dysarthria.
- Robust speaker recognition methods were proposed for the use in home robot systems, and the idea is based on filtering in autocorrelation domain and sub-band feature recombination.
- A speaker diarization method of telephone dialogue was proposed for automatically splitting telephone speech into segments and clustering the segments to their corresponding speakers.

KEY ACHIEVEMENTS

[1] Y.-J. Suh, M.-K. Ji, and H.-R. Kim, "Probabilistic class histogram equalization for robust speech recognition," *IEEE Signal Process. Lett.*, vol. 14, no. 4, pp. 287-290, Apr. 2007.
[2] M.-K. Ji, S.-T. Kim, H.-R. Kim, and H.-S. Yoon, "Text-independent speaker identification using soft channel selection in home robot environments," *IEEE Tr. Consumer Electron.*, vol. 54, no. 1, pp. 140-144, Feb. 2008.
[3] Y.-J. Suh and H.-R. Kim, "Environmental model adaptation based on histogram equalization," *IEEE Signal Process. Lett.*, vol. 16, no. 4, pp. 264-267, Apr. 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S.-T. Kim, M.-K. Ji, and H.-R. Kim, "Robust speaker recognition based on filtering in autocorrelation domain and sub-band feature recombination," *Pattern Recogn. Lett.*, vol. 31, issue 7, pp. 593-599, May 2010.
[2] Y.-J. Suh and H.-R. Kim, "Histogram equalization to model adaptation for robust speech recognition," *EURASIP J. Adv. Sig. Pr.*, vol. 2010, article ID 628018, 8 pages, May 2010.

Kim, Jong-Hwan

Professor

Fellow, IEEE

Ph.D., Seoul National University (1987)
johkim@rit.kaist.ac.kr
http://rit.kaist.ac.kr

Robot Intelligence Technology Laboratory

Robot Intelligence Technology (RIT) Lab. has been researching Cyber-Physical Robot Systems (CPRS) including ubiquitous robot and genetic robot, bio-inspired robots such as humanoid roobts, robotic fish, robotic head, etc., and Multi-agent systems (MAS) based on Intelligence Technology (IT). Our vision is to build Robots That Thinks (RTT) using IT.

- Intelligence Technology (IT): IT is to build RTT with cognitive intelligence, social intelligence, behavioral intelligence, ambient intelligence, collective/swarm intelligence and genetic intelligence. To develop such RTT, the Degree of Consideration-based Mechanism of Thought (DoC-MoT) has been proposed along with cognitive architecture.

- Bio-inspired Robots: A humanoid robot HSR (HanSaRam) has been developed since 2,000. Recently, a robotic fish Fibo has been developed for entertainment and education purpose. It can swim like a fish based on localization and obstacle avoidance navigation.

- Ubiquitous Robot & Genetic Robot: Rity and Geney are software robots and have their own personality and internal state such as motivation, homeostasis and emotion. Evolutionary Generative Process for an Artificial Creature's Personality (EGPP) has been proposed to create an artificial genome. Bear-type intelligent robot, GomDoll, which endows hardware robot with the genome code, has been developed.

- Multi-agent System (MAS): For FIRA robot soccer, a univector field navigation method using the position and velocity vectors of robot has been proposed. To achieve high mobility in RoboSot soccer game, omni-directional platform with three omniwheels has been developed. HSR has been participating in the HuroCup, FIRA.

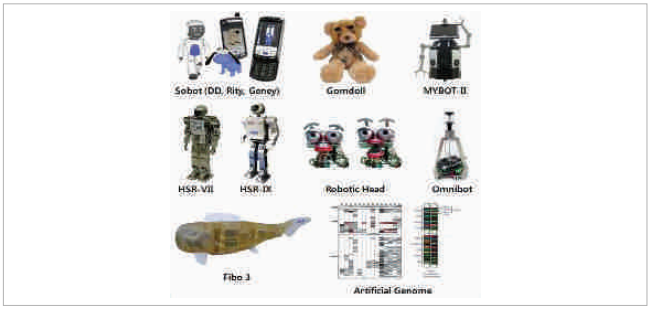


Fig. 1

KEY ACHIEVEMENTS

[1] K.-H. Han and J.-H. Kim, "Quantum-inspired evolutionary algorithm for a class of combinatorial optimization," *IEEE Tr. Evolutionary Computation,* vol. 6, no. 6, pp. 580-593, Dec. 2002.

[2] J.-H. Kim, D.-H. Kim, Y.-J. Kim, and K.-T. Seow, "Soccer robotics (springer tracts in advanced robotics)," *Springer Verlag,* 3540218599, 326, Sep. 2004.

[3] J.-M. Yang and J.-H. Kim, "Sliding mode control for trajectory tracking of nonholonomic wheeled mobile robots," *IEEE Tr. Robotics and Automation,* vol. 15, no. 3, pp. 578-587, Jun. 1999.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y.-D. Hong, B.-J. Lee, and J.-H. Kim, "Command state-based modifiable walking pattern generation on an inclined plane in pitch and roll directions for humanoid Robots," *IEEE/ASME Tr. Mechatronics,* (accepted), Dec. 2010.

[2] J.-H. Kim, J.-H. Han, Y.-H. Kim, S.-H. Choi, and E.-S Kim, "Preference-based solution selection algorithm for evolutionary multiobjective optimization," *IEEE Tr. evolutionary computation,* (accepted), Dec. 2010.

Kim, Junmo

Assistant Professor

Ph.D., Massachusetts Institute of Technology (2005)
junmo@ee.kaist.ac.kr
http://siit.kaist.ac.kr

Statistical Inference and Information Theory Laboratory

The researches of the Statistical Inference and Information Theory Laboratory focus on development of theoretical methods which can be applied to image processing, computer vision, pattern recognition, and machine learning. The key research contributions are introduced below.

Image Segmentation and Statistical Analysis of Shapes
A nonparametric statistical methods have been applied to an image segmentation problem, where this problem is formulated as a maximization of the mutual information between a binary label indicating foreground/background and pixel intensity. This work has unified several existing statistical approaches to image segmentation, enlarging the class of images that can be well segmented and has inspired many extensions, such as colored and/or textured image segmentation techniques.

In addition, we have been working on the problem of statistical analysis of shapes. In particular, we proposed a framework to learn and model a prior distribution in a space of shapes based on available example shapes. This problem involves many challenging issues such as representation of the shape, analysis of resulting Riemannian structure of the shape space, and definition of probability density functions in the shape space. We proposed viable estimates of the probability density functions in the Riemannian space without having to compute the Riemannian metric, namely the geodesic distance.

Face Recognition
Illumination variation is one of the main obstacles for face recognition as face images change significantly under illumination change. We proposed a method of preprocessing input images so that the output images are much less sensitive to illumination change. We also proposed a classifier fusion method for constructing a stronger classifier out of multiple individual classifiers. We also proposed a face recognition system based on extended curvature Gabor filter banks to extract large amount of feature candidates by adding a spatial curvature term to the traditional Gabor filters.

KEY ACHIEVEMENTS

[1] J. Kim, J. Fisher III, A. Yezzi, Jr., M. Cetin, and A. Willsky, "A nonparametric statistical method for image segmentation using information theory and curve evolution," *IEEE Tr. Image Process.*, vol. 14, no. 10, pp. 1486-1502, Oct. 2005.

[2] J. Kim, M. Cetin, and A. Willsky, "Nonparametric shape priors for active contour-based image segmentation," *Signal Processing*, vol. 87, no. 12, pp. 3021-3044, Dec. 2007.

[3] Best Paper Award, European Association for Signal Processing, Aug. 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] W. Hwang, H. Wang, H. Kim, S.-C. Kee, and J. Kim, "Face recognition system using multiple face model of hybrid Fourier feature under uncontrolled illumination variation," *IEEE Tr. Image Process.*, vol. 20, no. 4, pp. 1152-1165, Apr. 2011.

[2] W. Hwang, X. Huang, K. Roh, and J. Kim, "Face recognition system using extended curvature Gabor classifier bunch for low-resolution face image," *IEEE Comp. Vision, Pattern Recogn. Workshop*, Colorado Springs, USA, June 2011.

Kim, Lee-Sup

Professor

Senior Member, IEEE

Ph.D., Stanford University (1990)
lskim@ee.kaist.ac.kr
http://mvlsi.kaist.ac.kr

Multimedia VLSI Laboratory

Multimedia VLSI Lab. (MVLSI) focuses on energy-efficient multimedia processor design including core architectures for parallel processing, algorithms for media applications, thermal management in workload-intensive many core systems, and various digital/analog circuit designs for chip interfaces such as high-speed CMOS transceiver embedded in DRAM devices or flat panel display devices.

Those researches are classified into two topics: Multimedia processor design and Interface circuit design.

Multimedia processor design team focuses on low-power/high-performance embedded processor design for various media applications such as 3D graphics, computer vision, 3D display and augmented reality. Media applications require high computing power based on data-intensive operations, so we are also interested in vertically stacked IC (3D-IC) design.

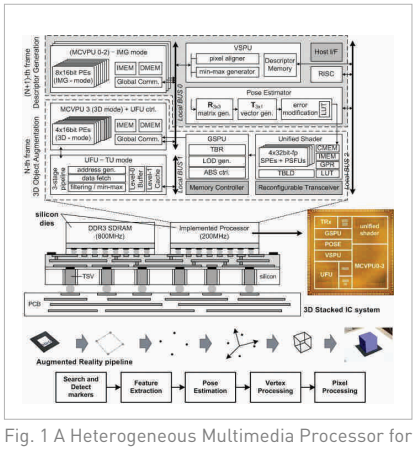


Fig. 1 A Heterogeneous Multimedia Processor for IC-Stacking on Si-Interposer

High-speed serial link transceiver design is important because the required data for multimedia processing tremendously increases recently. Interface circuit design team researches on high-speed/low-power CMOS IO design such as Clock & Data Recovery (CDR) circuit and Phase/Delay Locked Loop (PLL/DLL) for DRAM and display interfaces.

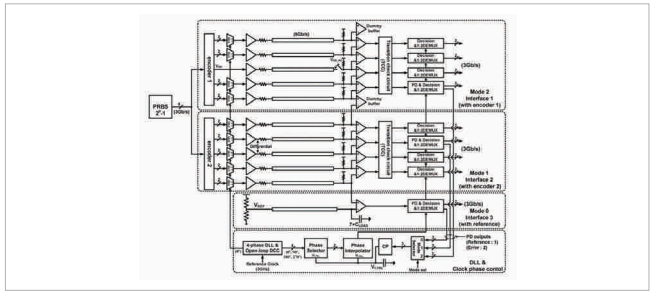


Fig. 2 A Forwarded-Clock I/O Receiver with a Weak Injection-Locked Oscillator

KEY ACHIEVEMENTS

[1] D.-H. Kim and L.-S. Kim, "A floating- point unit for 4D vector inner product with reduced latency," *IEEE Tr. Computers*, vol. 58, no. 7, pp. 890-901, July 2009.

[2] K.-S. Ha, et al., "A 0.13-um CMOS 6 Gb/s/pin memory transceiver using pseudo-differential signaling for removing common-mode noise due to SSN," *IEEE J. Solid-State Circuits*, vol. 44, no. 11, pp. 3146-3162, Nov. 2009.

[3] S.-H. Kim, et al., "A 116fps/74mW heterogeneous 3D-media processor for 3D display applications," *IEEE J. Solid-State Circuits*, vol. 45, no. 3, pp. 652-667, Mar. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] H.-Y. Joo and L.-S. Kim, "A data-pattern-tolerant adaptive equalizer using the spectrum balancing method," *IEEE Tr. Circuits and Systems-II*, vol. 57, no. 3, pp. 228-232, Mar. 2010.

[2] H.-E. Kim, et al., "A 275mW heterogeneous multimedia processor for IC-Stacking on Si-Interposer," *IEEE Int. Solid-State Circuits Conf.*, San Francisco, USA, Feb. 2011.

Kim, Munchurl

Associate Professor

Member, IEEE / Member, SPIE

Ph.D., University of Florida (1996)
mkim@ee.kaist.ac.kr
http://mccb.kaist.ac.kr

Laboratory for Multimedia Computing, Communications and Broadcasting

Laboratory for Multimedia Computing, Communications and Broadcasting (MCCB Lab) currently conducts research in the areas of 2D/3D video coding, pattern recognition and machine learning, image analysis and understanding, and perceptual visual quality human assessments on 3D video contents. The research being carried out in MCCB Lab has aims at looking forwards future applications with Ultra High Definition TV (UHDTV) and 3DTV from next-generation video coding research, smart surveillance from image analysis and understanding, personalized (IP)TV program recommender and scheduler (as TV app store engine) based on statistical learning theory, perceptual visual quality modeling for stereoscopic and multi-view video contents.

The MCCB Lab enlarges its research activities on next-generation video coding, which is High Efficiency Video Coding (HEVC), in conjunction with ISO/IEC MPEG and ITU-T VCEG international standardization activities. The research outcomes are proposed to the international standardization bodies and the active standardization efforts is then made on the technical proposals of MCCB Lab to be adopted as international standards. Research on user preference reasoning for automatic (IP)TV recommendation is to enhance the use accessibility and interaction to the (IP)TV program contents and their related contents from Web such as YouTube. This is a knowledge based smart user interface technology distinguished from the SW based graphical user interface. Intelligence is involved in automatic and personalized reasoning for (IP)TV program recommendation on user preference by using pattern recognition and machine learning technologies.

KEY ACHIEVEMENTS

[1] Houari Sabirin, Munchurl Kim, Hui Yong Kim, Han Kyu Lee, Minkyu Park, and Yong Han Kim, "DMB Application format for mobile multimedia Services," *Accepted for publication in IEEE Multimedia,* Apr. 19, 2011.

[2] Houari Sabirin and Munchurl Kim, "The MPEG musical slide show application format to enrich MP3 experience," *Accepted for publication in IEEE Signal Processing Magazine,* 2011.

[3] International Standard (IS) of ISO/IEC 23000-9 DMB Application Format, Aug. 2008 (Main contributor to this MPEG standard).

MAJOR ACHIEVEMENTS in 2010/2011

[1] Bumshik Lee and Munchurl Kim, "A low complexity mode decision method for spatial scalability coding of SVC," *IEEE Tr. Circuits and Systems for Video Technology,* vol. 21, no. 1, pp. 88-95, Jan. 2011.

[2] Hendry and Munchurl Kim, "A selective protection scheme based on dependency coding structure of SVC," *Accepted for publication as a regular paper in IEEE Tr. Circuits and Systems for Video Technology,* 2011.

Kim, Seong-Dae

Professor

Member, IEEK / Member, KICS / Senior Member, IEEE

Dr.Ing., L'Institut National Polytechnique de Toulouse (1983)
sdkim@ee.kaist.ac.kr
http://sdvision.kaist.ac.kr

Visual Communications Laboratory

Visual Communications Laboratory (VCL), a member of Information Systems Group (ISG), was established in 1984. The research area of VCL covers image/video processing, 2D/3D computer vision, pattern recognition, and image/video coding. Specifically, we are focusing on: 1) image-based rendering of 3D objects; 2) development of pattern recognition systems for faces, industrial parts, military vehicles, etc.; 3) data compression of 3D information for transmission, storage, reconstruction, or retrieval of the data; and 4) development of key algorithms (e.g. 3A and ISP) for digital cameras.

Main aim of the research into 3D reconstruction is to be able to reconstruct and extract 3D shape and surface of an object from images taken from multiple point-of-views and thereby produce an image from a desired viewpoint by the user. This includes research into recovery and store of 3D geometry and texture data, and generation of an intermediate view image. The 3D reconstruction technology, with advancement in 3D display and computer graphics technologies, is seen as core technology in producing a more realistic and interactive scene.

Pattern recognition is another key research topic at VCL. Entire pattern recognition field is researched on, from feature extraction to classifier construction. Creation of recognition systems that could be used in various applications such as face recognition and face detection would be attempted with the result of the research.

Also, researches related to video coding, another key research topic in this lab, include established general purpose video coding and also on coding of 3D geometry and texture data for efficient 3D video coding. It is expected that these research will play vital role in bringing about Ultra Definition Television (UDTV), 3DTV or others that will be flourishing in near future.

In addition, researches are being done on visual surveillance, image enhancement and etc. Advancement from researches at VCL may be used not only for the corresponding research field but the three key research topics compensate each other and consequently may bring out new technologies such as intelligent visual surveillance, 3D video coding, 3D face recognition and so on.

KEY ACHIEVEMENTS

[1] W. Kim, J. Kim, and S.-D. Kim, "A bit allocation method based on the picture activity for the still image coding," *IEEE Tr. Image Processing,* vol. 8, no. 7, pp. 974-977, July 1999.

[2] H. Lee and S.-D. Kim, "Rate-driven key frame selection using temporal variation of visual content," *Electronic lett,* vol. 38, no. 5, pp. 217-218, Feb. 2002.

[3] H. Lee and S.-D. Kim, "Iterative key frame selection in the rate-constraint environment," *Signal Processing :Image Communication,* vol. 18, pp. 1-15, Jan. 2003.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S.-Y. Park, and S.-D. Kim, "Efficient Depth Compression Based on Partial Surface for 3-D Object Represented by Layered Depth Image," *IEEE Signal Processing Letters,* vol. 17, no. 10, pp. 839-842, Oct. 2010.

[2] S. Kim, H.-D Kim, W.-J Kim and S.-D Kim, "Fast Computation of a Visual Hull," *Asian Conference on Computer Vision,* Queenstown, New Zealand, Nov. 2010

Kweon, In So

Professor

Ph.D., Carnegie Mellon University (1990)
iskweon@ee.kaist.ac.kr
http://rcv.kaist.ac.kr

Robotics and Computer Vision Laboratory

The research of the Robotics and Computer Vision Laboratory (RCV Lab) focuses on developing computer vision systems for robotic vision and multimedia applications. The research topics include object recognition, 3D reconstruction and optimization, mobile robot SLAM navigation, sensor fusion for mega city modeling, robust feature extraction and matching, and others from the related field.

Recently, a novel method for metric reconstruction of a projected plane from an uncalibrated camera has been developed. It estimates the plane parameters in 3D space using the images taken by a camera with unknown camera parameters. The proposed method makes use of the geometric properties of vanishing points that are orthogonal to the plane. By using a vanishing point and a rectangle which are easily detectable, the metric reconstruction of 3D shape of an artificial planar object is possible without explicit camera calibration.

For 3D reconstruction and optimization problems, we have also proposed several methods for bundle adjustment to achieve the fastest computational time as well as to show the same, if not better, performance of the optimization of a very large datasets. We have also developed a hand-held fusion sensor system for the calibration, motion estimation, and accumulated error reduction for 3D reconstruction. The proposed method consists of four cameras and two 2D laser scanners to obtain a wide field-of-view. This new approach allows boosting the advantages of two sensor systems and complements the weaknesses of the two. In addition, we are working on various tasks related to national defense and developing vision systems in cooperation with many companies, including multimedia industries.

KEY ACHIEVEMENTS

[1] J. Kim, P. Gurdjos, and I. Kweon, "Geometric and algebraic constraints of projective concentric circles and their applications to camera calibration," *IEEE Tr. Pattern Analysis, Machine Intell.*, vol. 27, no. 4, pp. 637-342, Apr. 2005.

[2] K. Yoon and I. Kweon, "Adaptive support-weight approach for correspondence search," *IEEE Tr. Pattern Analysis, Machine Intell.*, vol. 28, no. 4, pp. 650-656, Apr. 2006.

[3] S. Kim and I. Kweon, "Scalable representation for 3D object recognition using feature sharing and view clustering," *Pattern Recogn.*, vol. 41, no. 2, pp. 754-773, Feb. 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y. Jeong, D. Nister, D. Steedly, R. Szeliski, and I. Kweon, "Pushing the envelope of modern methods for bundle adjustment," *IEEE Conf. on Computer Vision, Pattern Recog.*, June 2010.

[2] J. Kim and I. Kweon, "Metric reconstruction of planes utilizing off-the-plane features," *Computer Vision and Image Understanding*, vol. 115, issue 1, pp. 1-7, Jan. 2011.

Kyung, Chong-Min

Professor

Fellow, IEEE / Fellow, KAST / Member, NAEK

Ph.D., Korea Advanced Institute of Science and Technology (1981)
kyung@ee.kaist.ac.kr
http://vswww.kaist.ac.kr

Smart Sensor Architecture Laboratory

The research of Smart Sensor Architecture Laboratory is exciting and rewarding, and focuses on two items: design of energy-aware smart camera and 3D IC. We design smart camera system based on the Energy-Rate- Distortion Optimization (ERDO) considering the whole process from event detection, encoding to transmission/ recording. We also design 3D IC platform for low-energy applications supporting optimal task and data assignment while minimizing energy consumption with constraints in power, execution time, and temperature.

Energy-Aware smart camera system : One of the most important problems in a battery-operated smart camera is simple : extending the lifetime. Therefore, ERDO is crucial for detection, capture, encoding and transmission/storage. We propose bit-rate allocation method to maximize the lifetime of the memory-constrained black-box camera system based on ERDO of the whole system. The proposed method prolongs the lifetime by up tp 136% compared with an existing bit-rate allocation method. In addition, we proposed the method for energy-aware encoding operation considering the non-linear battery characteristics to maximize the image quality under the limited battery capacity. The proposed scheme provides 2.24~3.78dB improvement in the image quality.

3D IC platform : With surging cost for advanced lithography in IC manufacturing, 3-dimensional IC has become a must for any further integration of storage as well as data processing functions in a small available footprint. Due to the high power density of 3D IC, however, energy consumption and performance need to be co-optimized by considering the chip temperature and leakage. We develop algorithms for both energy-minimal and performance-maximal 3D multi-core architectures in the system-level design stage. Cache data mapping algorithms are proposed to minimize system energy consumption and maximize the system performance. Temperature-aware dynamic power management algorithms based on the DVFS (dynamic voltage and frequency scaling) which judiciously exploits temperature slacks to maximize the overall system performance are also proposed.

KEY ACHIEVEMENTS

[1] Y. Lee, J. Kim, and C.-M. Kyung, "Energy-aware video encoding for minimal distortion in battery-operated surveillance camera," *IEEE Tr. Very Large Scale Integration Syst.,* vol. PP, no. 99, pp. 1-10, Jan. 2011.

[2] S. Na, G. Kim, and C.-M. Kyung, "Lifetime maximization of wireless blackbox surveillance Camera," *IEEE Int. conf. Multim. Expo.,* Barcelona, Spain, July 2011. (accepted for publication)

[3] K. Kang, J. Kim, S. Yoo, and C.-M. Kyung, "A runtime method to power management in 3D multi-core architectures under peak power and temperature constraints," *IEEE Tr. Computer-Aided Design Integr. Circuits, Syst.,* (accepted for publication, Sep. 2010)

MAJOR ACHIEVEMENTS in 2010/2011

[1] J. Jongpil, K. Kang, and C.-M. Kyung, "Design and management of 3D-stacked NUCA cache for chip multiprocessors," *Proc. of the 20th symposium on Great lakes symposium on VLSI,* Lausanne, Switzerland, May 2011. (accepted for publication)

[2] T. Kim, J. Kim, G. Kim and C.-M. Kyung, "An energy-aware hierarchical event detection in battery-operated wireless video surveillance systems," *IEEE Int. conf. Multim. Expo.,* Barcelona, Spain, July 2011. (accepted for publication)

Lee, Ju-Jang

Professor

Fellow, IEEE / Fellow, ICROS / Fellow, SICE

Ph.D., University of Wisconsin (1984)
jjlee@ee.kaist.ac.kr
http://iliad.kaist.ac.kr

Future of Beyond Human Intelligence Laboratory

The Future of beyond Human Intelligence Laboratory (FHI) has been focusing on development of intelligent control theories and their application to the real robotic systems. The research topics also include machine learning and soft computation, vision based control, intelligent transportation system, mobile robotics, rehabilitation robot, evolutionary emotional robot, construction of emotional model and ubibot in the ubiquitous environment, genetic algorithm, chaos control, sensor system, and variable structure control. Recently, the research projects based on the intelligent control technology for robot system are studied as follows: (i) Unmanned Ground Vehicle (UGV) for the military application (ii) development of sound localization, object recognition and visual servoing for explosive removal and security area patrol.

In UGV project, we have developed the unified hierarchical path planning algorithm which consists of global and local path planner. For global path planning, we convert the given DEM, FDB and risk map to the mobility (velocity) map and search the optimal path of the unmaned vehicle in an outdoor environment. For local path planning, we have newly developed Virtual Tangential vector (VTV) algorithm and Emergency Level Around (EMA) using LMS. VTV is similar to VFF, but it can generate mode smooth and short trajectories. ELA is a simple but powerful obstacle avoidance technique.

In the project of the sound localization, object recognition and visual servoing, we
develope intelligent algorithm for an explosive removal and security area patrol. The sound localization algorithm finds location where the abnormal source is originated from and the information is used for target position of a robot to patrol. The object recognition algorithm recognizes an object based on an image taken by a camera on a robot. The recognized object is picked and moved to a safe location using visual servoing technology.

KEY ACHIEVEMENTS

[1] M.-S. Kim, C.-H. Kim, and J.-J. Lee, "Evolving compact and interpretable Takagi-Sugeno fuzzy models with a new encoding scheme," *IEEE Tr. Syst., Man, Cybern., Part B,* vol. 36, no. 5, pp. 1006-1023, Oct. 2006.

[2] J. J. Lee, K. H. Seo, and C. M. Oh, *A intelligent bed robot with a pressure sensor attached mattress and supporting robot arm having grippers,* 10-0815245-0000, Korea, Mar. 13, 2008.

[3] Best Paper Award, IEEE International Conference on Industrial Informatics, July 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] T.-Y. Choi and J.-J. Lee, "Control of manipulator using pneumatic muscles for enhanced safety," *IEEE Tr. Industrial Electron.,* vol. 57, no. 8, pp. 2815-2825, Aug. 2010.

[2] B.-S. Choi and J.-J. Lee, "Sensor network based localization algorithm using fusion sensor-agent for indoor service robot," *IEEE Tr. Consumer Electron.,* vol. 56, no. 3, pp. 1457-1465, Aug. 2010.

Lee, Soo-Young

Professor

Ph.D., Polytechnic Institute of New York (1984)
sylee@kaist.ac.kr
http://cnsl.kaist.ac.kr

Computational NeuroSystems Laboratory

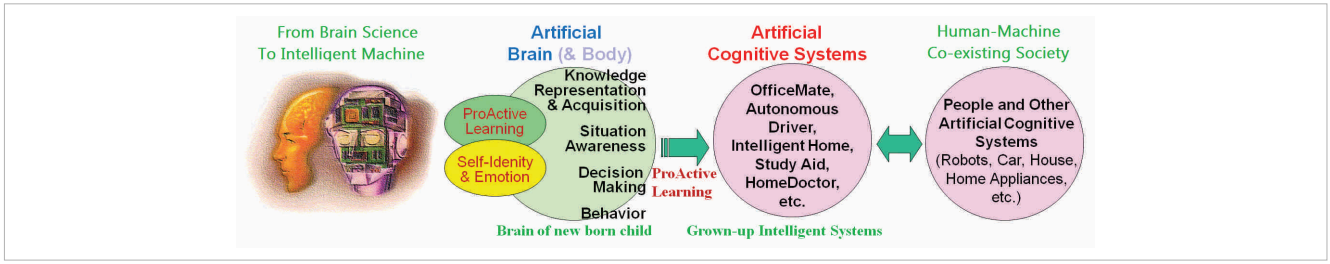


Fig. 1

Computational NeuroSystems Laboratory (CNSL), in collaboration with Brain Science Research Center, has worked on computational models of brain information processing mechanism and their applications for brain-like intelligent system, such as the artificial brain (ABrain).
The main achievements include (a) auditory models for speech feature extraction (b) sound localization and blind signal separation (c) top-down selective attention model for robust recognition and audio-visual integration (d) feature extraction, selection and adaptation for diverse applications (e) neuromorphic chips such as silicon cochlea and learning chips.
Based on these works, an ABrain has been developed as a testbed of human-like intelligent systems, and demonstrated the role of artificial secretary.
The new extension in this direction includes ICA-based signal enhancement and discriminant feature extraction for the recognition of subtle differences in emotional speeches and EEG signals.
Recently, CNSL is further extending its research toward higher-level cognitive functions for artificial cognitive systems, which will serve as the closest friend and secretary. Computational models of active learning, knowledge development, situation awareness, explicit and implicit human intention, and decision making are also being investigated. Furthermore, the next-generation human-machine interfaces are under development using acceleration sensors, eye-gaze, and dry-electrode EEG headset (in collaboration with NeuroSky Inc., USA).

KEY ACHIEVEMENTS

[1] D. S. Kim, S.-Y. Lee, and R. M. Kil, "Auditory processing of speech signals for robust speech recognition in real-world noisy environments," *IEEE Tr. Speech, Audio Process.*, vol. 7, no. 1, pp. 55-69, Jan. 1999.
[2] T. S. Kim, H. Attias, S.-Y. Lee, and T.-W. Lee, "Blind source separation exploiting higher-order frequency dependencies", *IEEE Tr. Audio, Speech, Language Process.*, vol. 15, no. 1, pp. 70-79, Jan. 2007.
[3] APNNA Outstanding Achievement Award, Asia-Pacific Neural Network Assembly, Dec. 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] J. H. Lee and S.-Y. Lee, "Learning the dynamical system behind sensory data," *Neural Compu.*, vol. 22, no. 6, pp. 1615-1645, June 2010.
[2] ICA Unsupervised Learning Pioneer Award, The Society of Photo-Optical Instrumentation Engineers, Apr. 2010.

Lim, Jong-Tae

Professor

Member, IEEK / Member, KIEE / Member, IEEE

Ph.D., University of Michigan (1986)
jtlim@ee.kaist.ac.kr
http://stcon.kaist.ac.kr

System Theoretic Analysis and Control Laboratory

The aim of System Theoretic Analysis and Control Lab is to study the theoretical aspect of nonlinear control systems and communication systems, and to develop the network scheduler in multiuser diversity system and task planning algorithms for service robots.

Study of nonlinear control systems has focused on analyzing the stability of nonlinear systems and stabilizing the singularly perturbed systems based on the Lyapunov function approach.

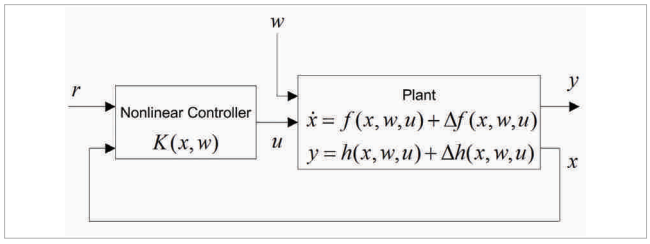


Fig. 1 Block diagram for nonlinear system

Study of communication systems has focused on improving the performance of congestion control for power efficiency, dynamic scheduling for quality of services (QoS) and multiuser diversity, and channel estimation over time-varying channels.

Development of the high performance scheduler using multiuser diversity in wireless network has focused on performance analysis of feedback protocol, feedback load reduction, and queueing analysis with adaptive modulation and coding (AMC).

Development of the task planning algorithm for service robots has focused on cost efficient task planning without degrading the quality of service. Specifically, we employ the technology based on automaton, discrete event systems (DES) and supervisory control.

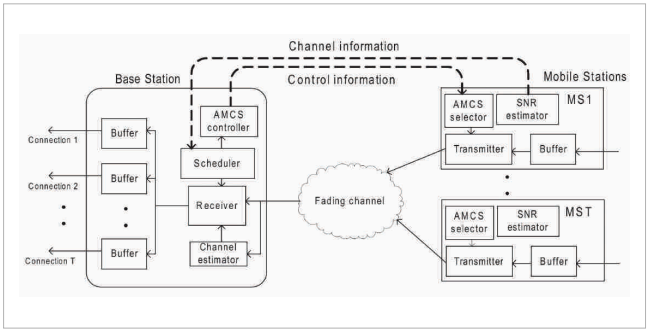


Fig. 2 Multiuser diversity system

KEY ACHIEVEMENTS

[1] S.-H. Lee, T.-H. Kim, and J.-T. Lim, "A new stability analysis of switched systems," *Automatica,* vol. 36, no. 6, pp. 917-922, June 2000.

[2] W.-G. Song and J.-T. Lim, "Pilot-symbol aided channel estimation for OFDM with fast fading channels," *IEEE Tr. Broadcast.,* vol. 49, no. 4, pp. 398-402, Dec. 2003.

[3] H.-L. Choi and J.-T. Lim, "Global exponential stabilization of a class of nonlinear systems by output feedback," *IEEE Tr. Autom. Control.,* vol. 50, no. 2, pp. 255-257, Feb. 2005.

MAJOR ACHIEVEMENTS in 2010/2011

[1] M.-S. Koo, H.-L. Choi, and J.-T. Lim, "Global regulation of a class of uncertain nonlinear systems by switching adaptive controller," *IEEE Tr. Autom. Control,* vol. 55, no. 12, pp. 2822-2827, Dec. 2010.

[2] T.-J. Kim and J.-T. Lim, "Queuing analysis in multiuser diversity system with adaptive modulation and coding scheme," *IEEE Tr. Veh. Technol.,* vol. 60, no. 1, pp. 338-342, Jan. 2011.

Moon, Gun-Woo

Professor

Ph.D., Korea Advanced Institute of Science and Technology (1996)
gwmoon@ee.kaist.ac.kr
http://angel.kaist.ac.kr

Display Power Circuit Laboratory

Fig. 1 applications based on power electronics

Display Power Circuit Lab (DPCL) has focused on the developing high efficiency, high power density conversion systems for the following applications: information display system, automotive electronics, server power system, and IT computing devices.

LED Driver System for LCD TV : To reduce the power consumption and realize high efficiency and low cost LED Driver system, DPCL newly proposed a two dimensional channel driving employing X-Y channel driving technique for 46" LCD TVs.

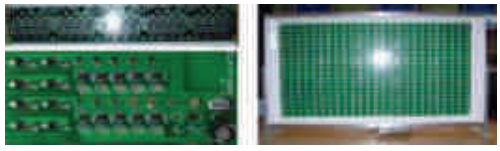


Fig. 2 prototype of LED Backlight Unit

High Efficiency and Power Density Platform for Server Power and Adapter : To realize the high power density and high efficiency of server power and adapter, DPCL proposed new topologies employing the low conduction loss, low switching loss, and reduced size.

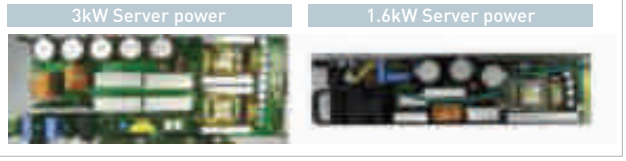


Fig. 3 prototype of sever power

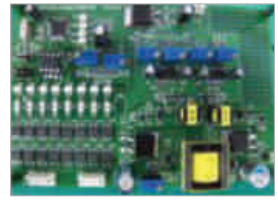


Fig. 4 Prototype of battery charge equalizer

Battery charge equalizer for V2G (Vehicle to Grid) : To realize the power management system for lithium-ion battery of vehicle, DPCL proposed and implemented the protection circuits and equalizer circuit for a V2G.

KEY ACHIEVEMENTS

[1] S. Lee, S. Choi, and G. Moon, "High efficiency active clamp forward converter with transient current build-up (TCB) ZVS technique," *IEEE Tr. Ind. Electron.*, vol. 54, no. 1, pp. 310-318, Feb. 2007.

[2] H. Park, C. Kim, C. Kim, G. Moon, and J. Lee, "A modularized charge equalizer for an HEV lithium-ion battery string," *IEEE Tr. Industrial Electronics.*, vol. 56, no. 5, pp. 1464-1476, Sep. 2006.

[3] W. Lee and G. Moon, "A new PWM-controlled quasi-resonant converter for a high efficiency PDP sustaining power module," *IEEE Tr. Power Electron.*, vol. 23, no. 4, pp. 1782-1790, July 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] I. Cho, K. Yi, K. Cho, and G. Moon, "High-efficient multilevel half-bridge converter," *IEEE Tr. Power Electron.*, vol. 25, no. 4, pp. 943-951, Apr. 2010.

[2] B. Kim, K. Park, C. Kim, B. Lee, and G. Moon, "LLC resonant converter With adaptive link-voltage variation for a high-power-density," *IEEE Tr. Power Electron,* vol. 25, no. 9, pp. 2248-2252, Sep. 2010.

Park, HyunWook

Professor

Member, IEEK / Senior Member, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (1988)
hwpark@kaist.ac.kr
http://athena.kaist.ac.kr

Image Computing Systems Laboratory

Research field of Image Computing Systems Laboratory (ICSL) has been focused on medical imaging, video coding, stereo image processing, and automatic target recognition. One of the medical imaging area is the brain functional studies by detecting causations between spatial pattern in the functional magnetic resonance imaging (fMRI) data. The removal algorithm of the ballistocardiac artifact in electroencephalogram (EEG) recorded in MR system has been also developed for the analysis of epilepsy using fMRI and EEG data. In addition, we have designed RF coil for effectively receiving NMR signals and RF circuit for improving SNR.

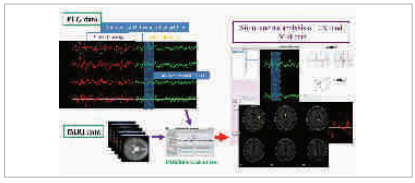


Fig. 1

The study of stereo image processing has mainly focused on 2D to 3D conversion techniques. The proposed 2D to 3D conversion method generate accurate multiple views from single-view sequences.

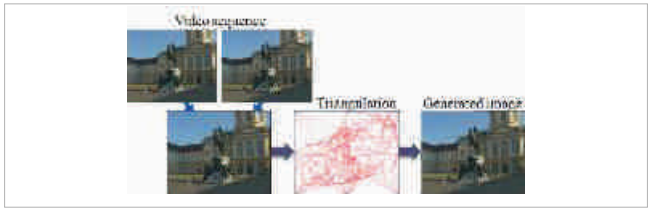


Fig. 2

Frame rate up-conversion is also our interesting research field. In order to generate an intermediate frame between successive frames, the proposed method utilizes a symmetric motion estimation, which is our own pixel-wise motion estimation method for intermediate frame interpolation.

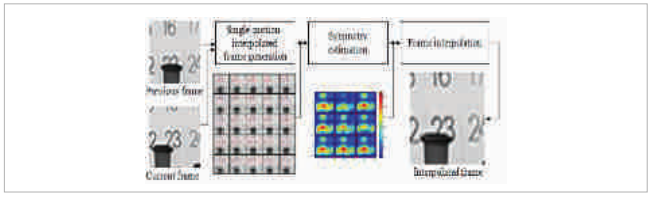


Fig. 3

KEY ACHIEVEMENTS

[1] H.W. Park and H.S. Kim, "Motion estimation using low-band-shift method for wavelet-based moving-picture coding," *IEEE Tr. Image Process.*, vol. 9, no. 4, pp. 577-587, Apr. 2000.

[2] Y.L. Lee, H.C. Kim, and H.W. Park, "Blocking effect reduction of JPEG images by signal adaptive filtering," *IEEE Tr. Image Process.*, vol. 7, no. 2, pp. 229-234, Feb. 1998.

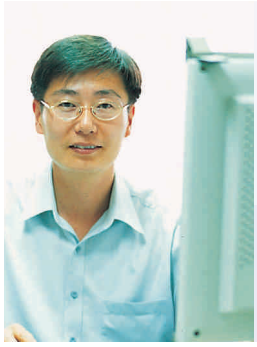
[3] S.D. Yun, S.S. Oh, Y.J. Han and H.W. Park, "High-resolution fMRI with higher-order generalized series imaging and parallel imaging techniques (HGS-Parallel)," *J. Magn. Reson. Imaging*, vol. 29, no. 4, pp. 924-936, Jan. 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] D.S. Jun and H.W. Park, "An efficient priority-based reference frame selection method for fast motion estimation in H.264/AVC," *IEEE Tr. Circ. Syst. Video Tech.*, Vol. 20(8), pp. 1156-1161, 2010.

[2] Y. Piao and H.W. Park, "Adaptive Interpolation-based Divide-and-Predict Intra Coding for H.264/AVC," *IEEE Tr. Circ. Syst. Video Tech.*, vol. 20, no. 12, pp.1915-1921, Jan. 2010.

[3] J.H. Lee, and H.W. Park, "A new distortion measure for motion estimation in motion-compensated hybrid video coding," *Signal processing: Image comm.* vol. 26, pp. 75-84, 2011.



Park, In-Cheol

Professor

Member, KIEE / Senior Member, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (1992)
icpark@ee.kaist.ac.kr
http://ics.kaist.ac.kr

Integrated Computer Systems Laboratory

The researches performed in Integrated Computer Systems (ICS) LAB have been focused on the design of embedded processors and computationally intensive function blocks for multimedia, communication systems.

The design of microprocessors : Many kinds of processors have been developed such as Intel-486 and Pentium-compatible processors, Audio Processor, Single-chip programmable SoC Platform, Multithreaded VLIW processor and Multithread Embedded processor. A 32-bit embedded processor including on-chip bus suitable for developing embedded systems has been developed together with its corresponding development environment such as compiler, assembler and debugger.

VLSI design for multimedia signal processing : ICS lab has mainly focused on high-performance architectures and low complexity algorithms. An efficient approach to accelerate the context-based adaptive binary arithmetic coding (CABAC) decoding for H.264/AVC and efficient hardware structure for JPEG 2000 have been proposed. Real-time efficient hardware for making stereo vision from two images has been proposed, and an efficient image signal processing structure for CMOS image sensors has been developed to achieve high image quality with one third of data by moving color correction and white balancing to the front of the demosaic.

VLSI design for communication systems : we have proposed new synchronization architectures, fast Fourier transform and turbo decoder for WiMAX systems. For the coarse time synchronization and the fractional carrier frequency offset estimation, a disjoint architecture is proposed to reduce the hardware complexity and power consumption. We proposed an efficient method to jointly estimate the fine symbol timing offset and the integer carrier frequency offset as well. The proposed FFT algorithm can reduce the table size to half while retaining the simple structure. An energy-efficient SISO decoder based on border metric encoding, which is especially suitable for the non-binary circular turbo decoding.

KEY ACHIEVEMENTS

[1] H. Choi, J. S. Kim, C. W. Yoon, I. -C. Park, and C. -M. Kyung, "Synthesis of application specific instructions for embedded DSP software," *IEEE Tr. Computers,* vol. 48, no. 6, pp. 603-614, June 1999.

[2] H. J. Kang, H. Kim, and I. -C. Park, "FIR filter synthesis algorithms for minimizing the delay and the number of adders," *IEEE Tr. Circuits and Systems II : Analog and Digital Signal Processing,* vol. 48, no. 8, pp. 770-777, Aug. 2001.

[3] S. -H. Kang and I. -C. Park, "Loosely coupled memory-based decoding architecture for low density parity check codes," *IEEE Tr. Circuits and Systems I : Regular Papers* vol. 53, no. 5, pp. 1045-1056, May 2006.

MAJOR ACHIEVEMENTS in 2010/2011

[1] T. Kim and I. -C. Park, "High-throughput and area-efficient MIMO symbol detection based on modified Dijkstra's search," *IEEE Tr. Circuits and Systems I:Regular Papers,* vol. 57, no. 7, pp. 1756-1766, July 2010.

[2] J. Song and I. -C. Park, "Spur-free MASH delta-sigma modulation," *IEEE Tr. Circuits and Systems I:Regular Papers,* vol. 57, no.9, pp. 2426-2437, Sep. 2010.

Ra, Jong Beom

Professor

Senior Member, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (1983)
jbra@ee.kaist.ac.kr
http://www-isl.kaist.ac.kr

Image Systems Laboratory

The research in the Image Systems Laboratory (ISL) focuses on image processing. The research field includes image and video processing, medical image processing, and 3D visualization systems. Some research topics recently conducted in ISL are as follows.

First, to improve the spatial resolution in PET images, we develop a super-resolution method in the sinogram space. The conventional methods usually apply super-resolution in the image domain. The proposed method is an alternative approach for improving the spatial resolution while reducing the computational complexity.

Second, in order to solve the image degradation problem in the coding standards, we aim to develop a post processing algorithm in low bit rate coded images. Since current coding standards rely on block based processing, reconstructed images include horizontal and vertical grid noise along the block boundaries. This image degradation, called blocking artifacts, is mainly caused due to the quantization process of discrete cosine transform (DCT) coefficients. In order to reduce these blocking artifacts, we propose a novel framework based on the correction of quantized DCT coefficients.

Third, we are working on a challenging problem in fast optical flow estimation. Since optical flow can be applied to a variety of video processing algorithms, a real-time optical flow estimation is an essential issue. To accelerate optical flow estimation, we develop a fast estimation algorithm based on a graphic processing unit (GPU). For parallel processing in GPU, we propose and successfully implement a block-based optical flow estimation algorithm.

Finally, in order to improve the resolution of infrared (IR) image, we develop a new framework based on the high-resolution visible image information. In this framework, high frequency patches for IR edge pixels are estimated by utilizing the local intensity correlation between two images. In addition, a reconstruction-based constraint is adopted to improve regions where visible image information is not available. Thereby, we can improve image quality compared to the existing up-sampling algorithms.

KEY ACHIEVEMENTS

[1] S. D. Kim, J. Yi, H. M. Kim, and J. B. Ra, "A deblocking filter with two separate modes in block-based video coding," *IEEE Tr. Circuits Syst. Video Technol.*, vol. 9, no. 1, pp. 156-160, Feb. 1999.

[2] Y. S. Kim, J. H. Lee, and J. B. Ra, "Multi-sensor image registration based on intensity and edge orientation information," *Pattern Recognition,* vol. 41, issue 11, pp. 3356-3365, Nov. 2008.

[3] D. -G. Kang, D. C. Suh, and J. B. Ra, "Three-dimensional blood vessel quantification via centerline deformation," *IEEE Tr. Med. Imag.,* vol. 28, no. 3, pp. 405-414, Mar. 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] J. H. Lee, Y. S. Kim, D. Lee, D. -G. Kang, and J. B. Ra, "Robust CCD and IR image registration using gradient-based statistical information," *IEEE Signal Processing Letters,* vol. 17, no. 4, pp. 347-350, Apr. 2010.

[2] D. Lee, W. H. Nam, J. Y. Lee, and J. B. Ra, "Non-rigid registration between 3D ultrasound and CT images of the liver based on intensity and gradient information," *Physics in Medicine and Biology,* vol. 56, no. 1, pp. 117-137, Jan. 2011.

Ro,Yong Man

Professor

Member, IEEK / Member, KIISC / Senior Member, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (1992)
ymro@ee.kaist.ac.kr
http://ivylab.kaist.ac.kr

Image and Video Systems Laboratory

The Image and Video Systems Lab (IVY Lab), founded in 1997, conducts research in the area of multimedia processing and communication. The main research topics of IVY Lab are summarized below.

Image/video analysis and exploring social media : Multimedia processing for online social media applications has recently emerged as an area of intense research and development. IVY Lab developed an effective application for annotating social images and a novel system for detecting near-duplicate video clips.

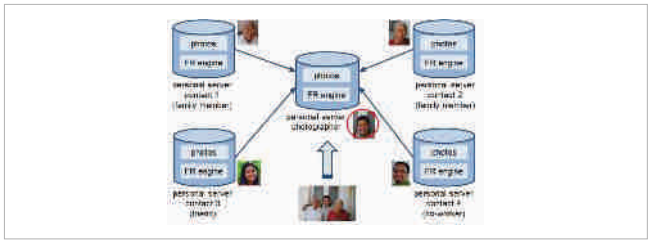


Fig. 1 Collaborative face indexing and search

Face recognition and biometric security : Face recognition is an active area of research, having significant application potential. IVY Lab developed novel techniques for color-based face recognition in both image and video content. These techniques are highly robust to severe changes in illumination, low spatial resolutions, high compression, and blurring.

3D video processing : 3D video processing has emerged as an important research topic. IVY Lab performs research on human 3D perception to guarantee a comfortable viewing experience. We have developed 3D visual comfort metrics, considering depth, motion, and binocular perception.

Medical image processing : Computer-Aided Diagnosis (CAD) assists doctors in the interpretation of medical images. IVY Lab developed techniques to automatically classify lesions as benign or malignant. Further, we proposed an enhanced segmentation method for Multiple Energy X-ray Absorptiometry (MEXA) images that guarantees accurate Bone Mineral Density (BMD) measurement.

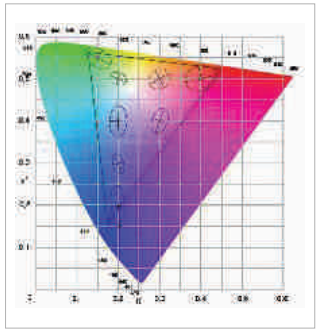


Fig. 2 Binocular color fusion limit for non-spectral colors

KEY ACHIEVEMENTS

[1] Y. M. Ro, et. al., "Visual content adaptation according to user perception characteristics," *IEEE Tr. Multimedia,* vol.7, no.3, pp.435-445, June 2005.

[2] Y. M. Ro et al., "Color face recognition for degraded face images," *IEEE Tr. System Man, and Cybernetics part-B,* vol.39, no.5, Mar. 2009.

[3] Y. M. Ro et al., "Semantic home photo categorization," *IEEE Tr. Circuits and Systems for Video Technology,* vol. 17, no. 3, pp. 298-312, Mar. 2007.

MAJOR ACHIEVEMENTS in 2010/2011

[1] J. Y. Choi, Y. M. Ro, and K. N. Plataniotis, "Boosting color feature selection for color face recognition," *IEEE Tr. Image Processing,* vol. 20, no. 5, pp.1425-1434, May 2010.

[2] H. S. Sohn, W. De Neve, and Y. M. Ro, "Privacy protection in video surveillance systems : analysis of subband-adaptive scrambling in JPEG XR," *IEEE Tr. Circuit and System for Video Technology,* vol. 21, no. 2, pp. 170-177, Feb. 2011.

Shin,Youngsoo

Associate Professor

Member, ACM / Senior Member, IEEE

Ph.D., Seoul National University (2000)
youngsoo@ee.kaist.ac.kr
http://dtlab.kaist.ac.kr

VLSI Design Technology Laboratory

VLSI (Very Large Scale Integration) chips are virtually everywhere now; in cell phones, in iPods and MP3s, in game consoles, etc. It is VLSI design technology that enabled an amazing innovation. We focus on a broad range of VLSI design technology (tools and methodologies) topics, and include performing world class research, which, at the same time, has an industrial impact. Our recent works and interests include low-power and low-leakage circuits and their designs (power-gating, body bias, dual-Vt, and dual-Vdd), high performance designs (pulsed-latch circuits and dual-edge-triggered circuits), structured ASICs (mask reuse methodology and selectively patterned masks), statistical design (yield analysis and latch design), temperature aware design, and high-level synthesis (latch architecture, dual-Vdd architecture, and power-gated circuits).

Power gating has become one of the most widely used circuit design technique for reducing leakage current. We surveyed power-gated circuit design and looked at the best practice within industry and academia. Topics include output isolation and data retention, current switch design and sizing, and physical design issues such as power networks, increases in area and wirelength, and power grid analysis.

Pulsed latch can offer the simple timing model of flip-flops while retaining superior design parameters of latches, which makes it an ideal sequencing element for achieving both high-performance and lower-power designs. To achieve higher performance, we formulated the problem of allocating pulse widths and scheduling of clock skews to minimize the clock period of pulsed-latch circuits. To achieve lower power consumption, we proposed clock gating of pulsed-latch circuits, called pulser gating, to reduce the clocking power of pulsed-latch circuits.

In recent scaled technologies, thermal aware design is becoming even more important as the impact of power consumption densities on the circuit performance is increasing. We sturdied methods to analyze temperature distribution on the design fast and then applied our analyzer to the floorplanning process.

KEY ACHIEVEMENTS

[1] Y. Shin and K. Choi, "Power conscious fixed priority scheduling for hard real-time systems," *Design Automation Conf.,* New Orleans, USA, June 1999.

[2] Y. Shin, K. Choi, and T. Sakurai, "Power optimization of real-time embedded systems on variable speed processors," *Int. Conf. Computer-Aided Design,* San Jose, USA, Nov. 2000.

[3] Y. Shin and T. Sakurai, "Coupling-driven bus design for low-power application-specific systems," *Design Automation Conf.,* Las Vegas, USA, June 2001.

MAJOR ACHIEVEMENTS in 2010/2011

[1] H. Lee, S. Paik, and Y. Shin, "Pulse width allocation and clock skew scheduling: optimizing sequential circuits based on pulsed latches," *IEEE Tr. CAD of Integr. Circuits and Syst.,* vol. 29, no. 3, pp. 355-366, Mar. 2010.

[2] Y. Shin, J. Seomun, K. Choi, and T. Sakurai, "Power gating: circuits, design methodologies, and best practice for standard-cell VLSI designs," *ACM Tr. Design Auto. of Electro. Syst.,* vol. 15, no. 4, article 28, pp. 28:1-28:37, Sep. 2010.

Yoo, Chang Dong

Professor

Member, IEEK / Member, IEEE

Ph.D., MIT (1996)
cdyoo@ee.kaist.ac.kr
http://slsp.kaist.ac.kr

Statistical Learning for Signal Processing Laboratory

Statistical Learning for Signal Processing (SLSP) Laboratory is interested in the application of state-of-the-art machine learning theories and novel signal processing techniques to various signals such as image, text, speech, audio, video, EEG and financial data for long-standing and emerging applications.

For various computer vision applications, a superpixel based higher-order correlation clustering algorithm for image/scene segmentation that outperforms all existing algorithms has been developed. This novel higher-order correlation clustering improves clustering in the presence of local boundary ambiguities by taking into account higher-order cluster relationships over a hypergraph, and furthermore, fast inference and effective parameter learning are possible.

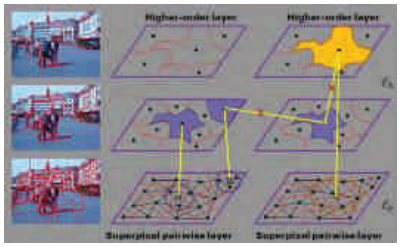


Fig. 1

For music retrieval and plagiarism detection, a melody extraction algorithm based on a dynamic Bayesian model following two uncoupled first-order Markov process has been developed, and experimental results show that the performance of the consider algorithm is better than or comparable to those of other well known melody extraction algorithms in terms of the raw pitch accuracy (RPA) and the raw chroma accuracy (RCA).

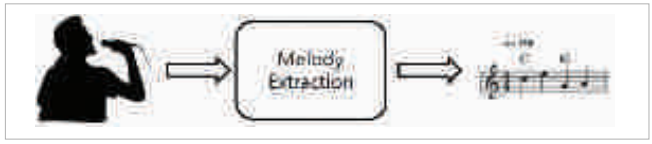


Fig. 2

SLSP Lab. has extensive experience in the development of robust audio/video fingerprinting system, music/image plagiarism detection system, large vocabulary continuous speech recognition system, speech based emotion recognition system, speech based human-computer conversation system, humming-based music retrieval system, singing voice synthesis system, face tracking system, simple free viewpoint video system, etc.

KEY ACHIEVEMENTS

[1] J. Seo, J. A. haitsma, T. Kalker, and C.D. Yoo, "A robust image fingerprinting system using the random transform," *Signal Process,: Image Comm.*, vol. 19, no. 4, pp. 325-339, Apr. 2004.

[2] C.D. Yoo and S. Lee, *Method for reversible image watermarking based on integer-to-integer wavelet transform*, 0898329, Korea, May 12, 2009.

[3] S. Kim and C.D. Yoo, "Underdetermined blind source separation based on subspace representation," *IEEE Tr. Signal Process.*, vol. 57, no. 7, pp.2604-2614, July 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S. Jo and C.D. Yoo, "Psychoacoustically constrained and distortion minimized speech enhancement," *IEEE Tr. Audio, Speech and Language Process.*, vol. 18, no. 8, pp. 2099-2110, Nov. 2010.

[2] D. Jang, C.D. Yoo, and T. Kalker, "Distance metric learning for content identification," *IEEE Tr. Info. Forensics and Security*, vol. 5, no. 4, pp. 932-944, Dec. 2010.

Yoo, Hoi-Jun

Professor

Fellow, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (1988)
hjyoo@ee.kaist.ac.kr
http://ssl.kaist.ac.kr

Semiconductor System Laboratory

The research of Semiconductor System Laboratory (SSL) focuses on developing system on chip (SoC) design. The research topics include analog and digital circuit and system design. Humanistic design is the theme of SSL. We are developing SoCs for the health of human beings and for helping people to live creative lives. The research direction of SSL is divided into 2 part.

1) **Humanistic Intelligence Systems :** Recently, object recognition has been widely used for various applications such as robot vision system, autonomous vehicle control and natural human-machine interfaces. The object recognition applications are characterized by complex and data-intensive computations, which make it difficult to achieve real-time performance even on today°Øs state-of-the-art processors. Especially, real-time performance and low-power consumption are important requirements for embedded systems and programmability is also considered to deal with various recognition targets and algorithms. Such requirements of the mobile robot vision system motivate our research to design a real-time object recognition processor with low-power consumption. The purpose of our research is to develop a mobile robot vision system with real-time object recognition processor as a key component.

2) **Wearable Healthcare :** Recently, as the average span of a man's life becomes longer and the concern of healthcare increases more and more, the researches on bioelectronic applications have been activating. Due to the increasing demands for various kind of health-aids for everyone at anytime, and because the high cost and complex-functional devices cannot satisfy one's need, high performance and low cost bioelectronic applications must be developed. Therefore, we have been studying the convergence of biology and electronics for well-being in human life and have significantly considered three research areas for designing bio microsystems: Bioelectronics, Health Care, and Consumer Electronics. With these considerations, we have developed a microsystem for health care applications which mean complete system from external surrounding to internal organs for one's ability to sense getting enhance, especially in hearing ability. Ultimately, we will make the study of bio microsystems applicable to consumer electronics.

KEY ACHIEVEMENTS

[1] 이달의 과학기술자상, Ministry of Education, Science and Technology, Dec. 2010.
[2] Fellow Certification, The institute of Electrical and Electronics Engineering, Jan. 2008.
[3] Hoi-Jun Yoo, Chris van Hoof, Bio-Medical CMOS ICs, Springer, 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S. Lee, K. Kim, J. Y. Kim, M. Kim, and H.-J. Yoo, "Familiarity based unified visual attention model for fast and robust object recognition," *Pattern Recoginition,* vol. 43, pp. 1116-1128, 2010.
[2] L. Yan, J. Bae, S. Lee, T. Roh, K. Song, and H.-J. Yoo, "A 3.9mW 25-electrode reconfigured sensor for wearable cardiac monitoring system," *IEEE J. Solid-State Circuits,* vol. 46, no. 1, pp. 353-364, Jan. 2011.

Youn, Myung Joong

Professor

Member, KIEE / Member, KIPE / Member, KITE / Senior Member, IEEE / Member, IET

Ph.D., University of Missouri-Columbia (1978)
mmyoun@ee.kaist.ac.kr
http://rainbow.kaist.ac.kr

Power Electronics Laboratory

Power Electronics Lab. (PELab), led by Professor Myung-Joong Youn from 1983, has focused on developing new control algorithms for motor driving system, battery management system, and other power electronics related areas and high efficiency, high density power conversion systems for following applications: display driver circuit, lighting system, and battery management system. Nowadays the research topics and projects are mainly on the digital power systems such as the LCD backlight unit, the LED lighting system, and the server power system.

TFT-LCD needs the light sources called backlight unit (BLU) for the information display. The widely used BLU is a CCFL which is needed more lamps as the screen size is larger. However, due to the characteristic differences of the CCFL the currents which flow each lamp show a deviation error, and it makes the brightness of the screen imbalance. To balance the brightness of the screen, we have developed the digital current balancing technique to make the current of lamps equal. This method does not need analog devices such as current balance transformer which is used for conventional circuits and patented before.

LED has been increasingly used in these days for the lighting system for the reason of eco-friendly device. Also, LED makes various colors, which could be used for the cure of emotional disorder of human beings. To make LEDs give out different lights, driving circuits and color control algorithms are needed. By employing the digital power platforms, the LED Emotional Lighting System has been developed in which one MCU chip controls the driving circuit and color control at the same time.

The last topic is to develop digital controls of high efficiency, high power density power supply for the server computers. The server power supply is mainly divided into two parts: PFC and DC/DC stages. Each stage needs the control ICs for the proper operations and more ICs for the function of server power operations. However, by employing a digital power platform, the whole operations as the server power supply are implemented. Only two MCUs are used to work the server power supply properly.

KEY ACHIEVEMENTS

[1] G. B. Koo, G. W. Moon, and M. J. Youn, "Analysis and design of phase shift full bridge converter with series-connected two transformer," *IEEE Tr. Power Electron.,* vol. 19, no. 2, pp. 411-419, Mar. 2004.

[2] G. B. Koo, G. W. Moon, and M. J. Youn, "New zero-voltage-switching phase-shift full bridge converter with low conduction losses," *IEEE Tr. Ind. Electron.,* vol. 52, no. 1, pp. 228-235, Feb. 2005.

[3] S. K. Han, H. K. Yoon, G. W. Moon, M. J. Youn, Y. H. Kim, and K. H. Lee, "A new active clamping zero-voltage switching PWM current-fed half-bridge converter," *IEEE Tr. Power Electron.,* vol. 20, no. 6, pp. 1271-1279, Nov. 2005.

MAJOR ACHIEVEMENTS in 2010/2011

[1] K. B. Park, C. E. Kim, G. W. Moon, and M. J. Youn, "Three-switch active-clamp forward converter with low switch voltage stress and wide ZVS range for high-input-voltage applications," *IEEE Tr. Power Electron.,* vol. 25, no. 4, pp. 889-898, Apr. 2010.

[2] M. B. Kim and M. J. Youn, "A novel single-stage isolated ac/dc converter with quasi-resonant zero-voltage-switching with a modified forward converter adopting capacitive output filter," *International J. Electron.,* vol. 97, Issue 7, pp. 827-845, July 2010.

Research Groups

Connectivity and Networked Intelligence

The CNI group conducts research and education in the fields of communication, computing and networking. The group's main thrusts are future internet (FI) and unlimited-capacity wireless communication (UCWC). The group's goals are to lay solid theoretical foundations and develop enabling technologies and system components for FI and UCWC.

FI is viewed as a colossal-scale mobile flexible network that integrates wired and wireless communication networks with widely-varying characteristics, constraints and service requirements. The constituent networks include wide area networks, broadband cable networks, ultra-high-speed lightwave networks, wireless local area networks, sensor networks, personal area networks and other future ad-hoc networks geared to MtoM connectivity, body-area networks and military applications. The group's vision of FI embraces green networks, attack-free networks, disaster management, intelligent transport, individually-tailored health-care and real-time environment control. Achieving large-scale, highly dynamic and heterogeneous connectivity will also lead to maximally efficient cloud computing and storage systems with tailored service capabilities.

UCWC is based on the deployment of exceedingly large numbers of relays, small base stations and antennas. In this scenario, each user will likely be served by a large number of base stations and relay nodes, and the environment will be mostly interference-limited. With proper handling of interference, signal-to-noise ratios will be effectively unlimited, allowing extremely high throughput per user. Developing easily deployable miniature base stations with self configuration/maintenance capabilities is critical. Efficient interference-management techniques are also crucial to realizing the vision of UCWC. UCWC research must deal with a myriad of deep theoretical questions as well as numerous practically challenging issues.

The CNI group's research and training addresses all key ingredients of FI and UCWC: security, network and computing infrastructure, emerging software and services, embedded systems and storage architecture, network information theory, multi-user MIMO and interference management, channel-tailored physical layer technologies, innovative resource management, cognitive radio, cooperative communication, energy-efficient communication methods, bio-inspired algorithms, mathematical modeling of discrete event systems and low-complexity coding and signal processing algorithms leading to competitive LSI architectures.

Cho, Dong-Ho	Professor
Choi, Jun Kyun	Professor
Choi, Wan	Associate Professor
Chong, Song	Professor
Chun, Joohwan	Professor
Chung, Sae-Young	Associate Professor
Chung, Yun Chur	Professor
Ha, Jeongseok	Associate Professor
Han, Youngnam	Professor
Kang, Joonhyuk	Associate Professor
Kang, Minho	Professor
Kim, Hyung-Myung	Professor
Kim, Tag Gon	Professor
Lee, Hwang Soo	Professor
Lee, Hyuckjae	Professor
Lee, Man Seop	Professor
Lee, Yong Hoon	Professor
Ma, Joongsoo	Professor
Moon, Jaekyun	Professor
Park, Dong-Jo	Professor
Park, Hong-Shik	Professor
Park, Hyuncheol	Associate Professor
Park, KyungSoo	Assistant Professor
Park, Kyu Ho	Professor
Rhee, June-Koo Kevin	Associate Professor
Song, Iickho	Professor
Sung, Dan Keun	Professor
Sung, Youngchul	Associate Professor
Yi, Yung	Assistant Professor
Youn, Chan-Hyun	Professor

Cho, Dong-Ho

Professor

Member, IEEK / Member, KICS / Member, KISS / Senior Member, IEEE / Member, IEICE

Ph.D., Korea Advanced Institute of Science and Technology (1985)
dhcho@ee.kaist.ac.kr
http://brahms.kaist.ac.kr

Communications and Information Systems Laboratory

The research area of Communications and Information Systems Lab. (CISL) can be divided into three areas, which are 5th generation wireless communication network and protocol including magnetic induction communication, wireless power transfer, and bioinformatics for repetitive element arrangement.

In the research area of 5th generation wireless communication system, hybrid network which consists of ad hoc and cellular network is considered. Resource allocation scheme for beam division multiple access (BDMA) system and self-organizing algorithm (hand-over scheme) for BDMA system have been designed. Also, system level simulator has been developed.

Additionally, we study wireless communication based on polarization diversity and magnetic field. The polarization diversity could be used to improve the capacity of the wireless communication by acquiring additional de-correlated channels. Furthermore, the far-field magnetic communication could be utilized as a way to provide a new dimension for transmitting information through wireless channels.

In Online Electric Vehicle (OLEV) system, we have developed an electric vehicle whose charging is obtained from underground via wireless magnetic resonance power transfer. Especially, magnetic communication technology has been researched for segment operation and location acquisition. At present, shaped magnetic field in resonance(SMFIR) technology based power supply infrastructure and electric vehicle system have been implemented and installed at Seoul Grand Park.

Finally, repetitive element(RE) arrangement over whole genomic sequences has been studied. Existing algorithms or tools for identification of REs have focused on the study for gene and known specific REs. Thus, many REs have not yet been analyzed. Therefore, we hypothesize that highly-ordered RE arrays are associated with evolution and correlated with many biological phenomena. At present, we have verified the hypothesis through the systematic analysis of the DNA sequence including RE array by using various information technologies like searching, signal analysis and modelling .

KEY ACHIEVEMENTS

[1] H. Lee, T. Kwon, and D. H. Cho, "An enhanced uplink scheduling algorithm based on voice activity for VoIP services in IEEE 802.16d/e system," *IEEE Comm. Lett.,* vol. 9, no. 8, pp. 691-693, Aug. 2005.

[2] T. Kwon, H. Lee, S. Choi, J. Kim, and D. H. Cho, "Design and implementation of a simulator based on a cross-layer protocol between MAC and PHY layers in a WiBro compatible IEEE 802.16e OFDMA system," *IEEE Comm. Mag,* vol. 43, no. 12, pp. 136-146, Dec. 2005.

[3] C. Bae and D. H. Cho, "Fairness-aware adaptive resource allocation scheme in multihop OFDMA systems," *IEEE Comm. Lett,* vol. 11, no. 2, pp. 134-136, Feb. 2007.

MAJOR ACHIEVEMENTS in 2010/2011

[1] N. P. Suh, D. H. Cho, and C. T. Rim, "Design of on-line electric vehicle (OLEV)," *CIRP Design Cof,* Nantes, France, Apr. 2010.

[2] J. Kim and D. H. Cho, "A joint power and subchannel allocation scheme maximizing system capacity in indoor dense mobile communication systems," *IEEE Tr. Vehic. Comm.,* vol. 59, no. 9, pp. 4340-4353, Nov. 2010.

Choi, Jun Kyun

Professor

Member, IEEK / Member, KICS / Senior Member, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (1988)
jkchoi@ee.kaist.ac.kr
http://bnlab.kaist.ac.kr

Broadband Network Laboratory

The research of Broadband Network Lab. focuses on New Smart media and Energy Saving Networks related technical issues.

Smart media services : Various media services have been launched that differ from primary simple on-demand video services. The ultimate goal of our study about building new media ecosystem which make people easy to access the data, refine data to information, build knowledge with information and finally distribute the knowledge to the world.

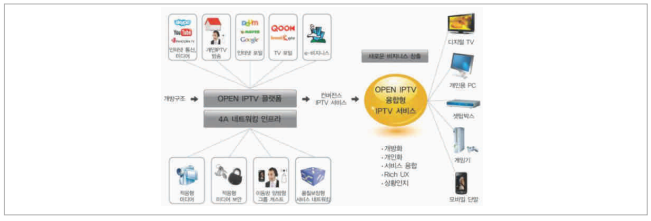


Fig. 1 Open IPTV Research

Energy Saving Networks : Since the past networks have been designed without considering energy efficiency, the current network suffers from low energy efficiency. Thus, we should consider following topics to enhance energy efficiency.

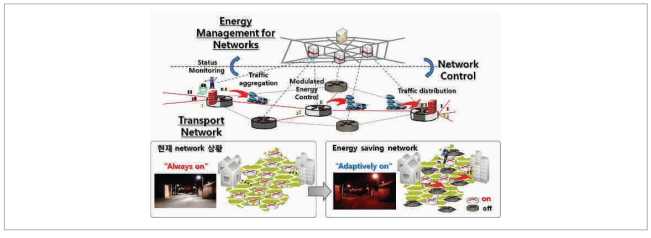


Fig. 2 Overview of Energy Saving Networks

Firstly, existing complex network structure should be redesigned to new network which supports efficient power consumption and energy saving network structure and operating method should be structured.

Secondly, the research which can reduce the network operating cost and maximize the efficiency of overall network operating should be progressed and this technology will be realized by monitoring and controlling of network operating condition.

Technical issues : We firstly study about the Smart Learning System seeks a new network environment to overcome the limits of traditional e-learning services. It includes pure Web based solution, social network service adaptation and other interactive features. Lastly, Web becomes a general platform of whole services. As these trend, Device API and WoO technologies are emerged.

Secondly, we research about Energy Saving Networks to improve energy efficiency in conventional communication networks. The energy modeling scheme is commonly used on wired and wireless network and it researches energy consumption profile and energy condition of each network equipment. Therefore, we study about requirements and technologies in advance.

KEY ACHIEVEMENTS

[1] J. M. Lee, H. J. Park, S. G. Choi, and J. K. Choi, "Adaptive hybrid transmission mechanism for on-demand mobile IPTV over WiMAX," *IEEE Tr. Broadcast.*, vol. 55, no. 2, pp. 468-477, June 2009.

[2] G. M. Lee, C. S. Lee, W. S. Rhee, and J. K. Choi, "Functional architecture for NGN-based personalized IPTV service," *IEEE Tr. Broadcast.*, vol. 55, no. 2, pp. 329-342, June 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y. G. Lee, Y. H. Choi, S. J. Lee, and J. K. Choi, "Performance analysis of OBS networks using the effective bandwidth method," *Photonic Network Comm.*, vol. 21, no. 2, pp. 152-157, Nov. 2010.

Choi, Wan

Associate Professor

Member, IEEK / Member, KICS / Member, IEEE

Ph.D., University of Texas, Austin (2006)
wchoi@ee.kaist.ac.kr
http://wcslab.kaist.ac.kr

Wireless Communication Systems Laboratory

Wireless Communication Systems Lab. (WCSL) carries out advanced research on academic and technological fronts in wireless communications. We identify theoretical capacity and performance limits and thereof rooms to improve, and investigate advanced techniques for the improvement. Our research methodologies exploit many advanced analytical tools in matrix theory, analysis, statistics and probability theory, optimization theory, and information theory. We find our theoretical applications to network MIMO, cooperative communications, compressive sensing, and interference management for the advance of wireless communications. WCSL is led by Prof. Wan Choi who is the recipient of *IEEE Vehi. Techn. Society Jack Neubauer Memorial Award in 2002, IEEE Vehi. Techn. Society Dan Noble Fellowship Award* in 2006, and *IEEE Comm. Society Asia Pacific Young Researcher Award* in 2007. He serves as Editor for IEEE Trans. Wireless Comm. and for IEEE Trans. Vehic. Techn. In 2010-2011, our on-going research progress is summarized as follows:

Cooperative communications : we have studied various strategies for maximizing the benefits of cooperation among communication nodes and reducing losses caused by half duplexing at relay nodes. We have proposed several novel theoretical and practical techniques and identified their ultimate gains.

Compressed sensing (CS) : CS is an emerging field based on the revelation that a small number collection of linear projections of a sparse signal contains enough information for stable, sub-Nyquist signal acquisition. Using the concept of CS, we have proposed new communication systems and investigated the gains obtained from CS.

Limited feedback : the capacity of feedback links is typically limited and shared by multiple users. Using vector quantization theory, we have studied and identified the optimal strategy of feedback capacity sharing in MIMO broadcast channel when feedback capacity is limited.

Interference management : Recognizing that interference management is essential for achieving high spectral efficiency, we have studied interference channel models connected with practical environments. We have developed novel key technologies for interference mitigation and theoretically analyzed their gains.

KEY ACHIEVEMENTS

[1] W. Choi and J. Y. Kim, "Forward-link capacity of a DS/CDMA system with mixed multirate sources," *IEEE Tr. Vehic. Techn,* vol. 50, no. 3, pp. 737-749, May 2001. [IEEE Vehic. Techn. Society Best System Paper Award]

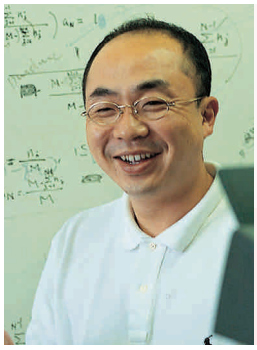
[2] W. Choi and J. G. Andrews, "Downlink performance and capacity of distributed antenna systems in a multicell environment," *IEEE Tr. Wireless Comm.,* vol. 6, no. 1, pp. 69-73, Jan. 2007.

[3] W. Choi, A. Forenza, J. G. Andrews, and R. W. Heath, "Opportunistic space division multiple access with beam selection," *IEEE Tr. Comm.,* vol. 6, no. 12, pp. 2371-2380, Dec. 2007.

MAJOR ACHIEVEMENTS in 2010/2011

[1] W. Choi, D. I. Kim, and B.-H. Kim, "Adaptive multi-node incremental relaying for hybrid-ARQ in AF relay networks," *IEEE Tr. Wireless Comm.,* vol. 9, no. 2, pp. 505-511, Feb. 2010.

[2] J. -P. Hong and W. Choi, "Dynamic reconfigurable relay communications with multiple radio access technologies," *IEEE Tr. Vehic. Tech.,* vol. 59, no. 9, pp. 4608-4614, Nov. 2010.



Chong, Song

Professor

Ph.D., University of Texas, Austin (1995)
song@ee.kaist.ac.kr
http://netsys.kaist.ac.kr

Network Systems Laboratory

Network Systmes(NETSYS) Lab. has been focusing on wireless network research based on broad knowledge gained from wired network research. There are three research groups: Experimentally-driven Design and Evaluation Group, Cellular Network Group, and Mobility-driven Network Group.

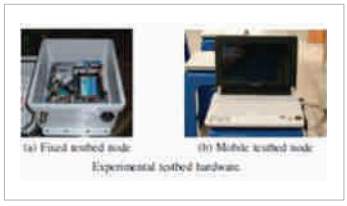


Fig. 1

Experimentally-driven Design and Evaluation Group develops new architecture and protocols for wireless networks from the deep understanding obtained by experimental evaluation. We deployed a world-class wireless mesh network testbed in the undergraduate dormitory area of KAIST. It provides unique experimental experiences on large-scale multi-hop wireless networks and helps to verify the performance of our network protocols. We designed Common Code architecture which gives flexibility for protocol implementation on the mesh testbed.

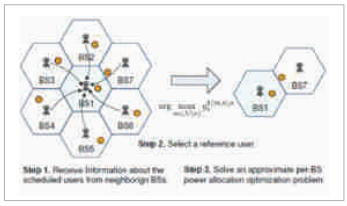


Fig. 2

Cellular Network Group studies resource allocation algorithms to efficiently share scare wireless resources in future mobile networks. We researches interference management and network greening issues in cellular networks.

Mobility-driven Network Group studies human mobility characteristics and their impact on wireless networks including Delay Tolerant Networks(DTN). We designed a novel mobility model called Self-similar Least Action Walk (SLAW) which captures the least action principle in human trip planning.

Fig. 3

KEY ACHIEVEMENTS

[1] K. Lee, Y. Yi, J. Jeong, H. Won, I. Rhee, and S. Chong, "Max-Contribution: On optimal resource allocation in delay tolerant networks," *IEEE INFOCOM 2010,* San Diego, USA, Mar. 2010.

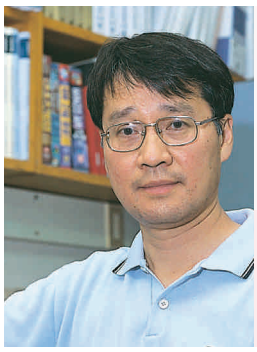
[2] K. Son, S. Chong, and G. De. Veciana, "Dynamic association for load balancing and interference avoidance in multi-cell networks," *IEEE Tr. Wireless Comm.,* vol. 8, no. 7, pp. 3566-3576, July 2009.

[3] K. Son, Y. Yi, and S. Chong , "Adaptive multi-pattern reuse in multi-cell networks," *Wiopt 2009,* Seoul, Korea, June 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Samsung Human Tech 2010 (National Annual Research Paper Award) Silver Prize (2st place in communication & network area)
Paper Title : ExMin: A routing metric for true opportunity gain in delay tolerant networks, Feb. 2011.

[2] Kyunghan Lee, Yoora Kim, Song Chong, Injong Rhee, Yung Yi, "Delay-capacity tradeoffs for mobile networks with Levy walks and Levy flights," *IEEE INFOCOM 2011,* Shanghai, China, Apr. 2011.



Chun, Joohwan

Professor

Member, IEEK / Member, KCS / Senior Member, IEEE

Ph.D., Stanford University (1989)
chun@sclab.kaist.ac.kr
http://sclab.kaist.ac.kr

Scientific Computing Laboratory

Scientific Computing Laboratory has been working on development of algorithms and fundamental techniques in wireless communication and radar systems. However we have expanded our interest in much wider range of areas including satellite image processing and infrared image processing.

Radar subgroup: Our research topic ranges from the classical beam synthesis problem to the recent topic such as a distributed and multi-static radar system. We have been developing an active radar system with a cylindrical multi-array.

Synthesized infrared scene generator

The goal of this research is to develop a synthesized infrared scene generator which involves integration and development of different types of modules; parser module which enables to process various format of images such as 3D objects or backgrounds images, thermal module that is used to model temperature of an object and lastly atmospheric transmission module modelling environmental parameters. The latter two modules are integrated to calculate the infrared radiance which is then applied to the image from parser module. Through this procedure we expect to be able to generate synthesized image.

IR image processing

When acquiring IR images from a satellite a number of environmental factors should not be neglected such as atmosphere, distance and the satellite motion. Additionally because modelling special material characteristics that are not considered in EO image is necessary in IR range, a distinctive image generation method should be developed. It can start with generating synthesized image in infrared range and use it in calibration process of the real image. Through this research we hope to achieve an advance of real satellite IR image processing and to acquire various informations about the image which were not possible in a visible spectrum range.

Satellite image data restoration algorithm development

The research involves analyzing degradation factors in KOMPSAT-2 and removes or mitigate its effect to the acquired image by developing a new restoration algorithm. In order to reconstruct MTFC of image, many of different image filtering techniques are sought out including the optimal Wiener filter and based on these technique bring forth the optimal filtering method for a specific KOMPSAT-3 application.

MAJOR ACHIEVEMENTS in 2010/2011

[1] N. Lee, J. Lim and J. Chun, "Degrees of freedom of the MIMO Y Channel: signal space alignment for network coding," *IEEE Tr. Inform. Theory,* vol. 56, no. 7, pp. 3332-3342 July 2010.

[2] H. J. Yang, Y. Choi, and J. Chun, "Modified high-order PAMs for binary coded physical-layer network coding," *IEEE Comm. Lett.,* vol. 14, no. 8, pp. 689-691, Aug. 2010.

[3] H. J. Yang, J. Chun, and A. Paulraj, "Asymptotic capacity of the separated MIMO two-way relay channel," to appear in *IEEE Tr. Inform. Theory.*

[4] J. Park, J. Chun and F.T. Luk, "Lattice reduction aided MMSE decision feedback equalizers," *IEEE Tr. Signal process.,* vol. 59, no. 1, pp. 436-441 Jan 2011.

[5] B. W. Jung, R. S. Adve, J. Chun, and M. C. Wicks, "Detection performance using frequency diversity with distributed sensors," to appear in *IEEE Tr. Aerosp. Electron. Syst.*

Chung, Sae-Young

Associate Professor

Senior Member, IEEE

Ph.D., Massachusetts Institute of Technology (2000)
sychung@ee.kaist.ac.kr
http://wicl.kaist.ac.kr

Wireless Communications Laboratory

Our main research focus is on information theory and its applications to wireless communications. Specifically, we characterize the fundamental limits of various wireless and wireline communication channels including the broadcast channel, relay channel, interference channel, wireless ad hoc networks, and flash memory. Based on this, we develop schemes that can approach the limits closely. For example, we develop some key technologies for the next generation wireless systems including dirty paper coding, network coding, rateless coding, and new cooperation strategies for relay networks. Some of our recent results include:

- Capacity characterization for a class of multicast tree networks: Information-theoretic capacity is characterized for the first time for a non-trivial class of noisy networks with an arbitrary number of nodes. Invited presentation at Information Theory and Applications Workshop, San Diego, CA, USA, Feb. 2010.
- Noisy network coding: Full information theoretic generalization of network coding for noisy relay networks. Includes as special cases many celebrated classical results such as the max-flow min-cut theorem, network coding, approximate capacity characterization for Gaussian relay networks, and compress-and-forward relaying. Joint work with Young-Han Kim (UCSD) and Abbas El Gamal (Stanford). Invited presentation at IEEE Information Theory Workshop, Cairo, Jan. 2010.
- Approximate capacity characterization for multi-source relay networks: Approximate capacity is characterized for multi-source multi-hop networks for the first time. Joint work with Syed A. Jafar (UC Irvine). Invited presentation at Allerton Conference on Communication, Control, and Computing, Monticello, IL, USA, Sep. 2009.

KEY ACHIEVEMENTS

[1] S.-Y. Chung, G. D. Forney, Jr., T. J. Richardson, and R. Urbanke, "On the design of low-density parity-check codes within 0.0045 dB of the Shannon limit," *IEEE Comm. Lett,* vol. 5, no. 2, pp. 58-60, Feb. 2001.

[2] S.-Y. Chung, T. J. Richardson, and R. L. Urbanke, "Analysis of sum-product decoding of low-density parity-check codes using a Gaussian approximation," *IEEE Tr. Inf. Theory,* vol. 47, no. 2, pp. 657-670, Feb. 2001.

[3] W. Nam, S.-Y. Chung, and Y. H. Lee, "Capacity of the Gaussian two-way relay channel to within 1/2 bit," *IEEE Tr. Inf. Theory,* vol. 56, no. 11, pp. 5488-5494, Nov. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S.-W. Jeon, S.-Y. Chung, and S. A. Jafar, "Approximate capacity of a class of multi-source Gaussian relay networks," *IEEE Tr. Inf. Theory,* vol. 57, no. 5, May 2011.

[2] S. H. Lim, Y.-H. Kim, A. El Gamal, and S.-Y. Chung, "Noisy network coding," *IEEE Tr. Inf. Theory,* vol. 57, no. 5, May 2011.

Chung, Yun Chur

Professor

Fellow, IEEE / Fellow, KAST / Fellow, OSA

Ph.D., Utah State University (1987)
ychung@ee.kaist.ac.kr
http://optolab.kaist.ac.kr

Lightwave Systems Research Laboratory

In our laboratory, we work on various aspects of lightwave communication systems and related technologies. In particular, we endeavor to identify the fundamental limitations imposed on the lightwave systems and discover new practical solutions to overcome such limitations. Our research activities include both experimental and theoretical works. We have a well-equipped laboratory to support these activities with state-of-the-art test gears and various types of advanced components. Recently, we have been working on ultrahigh-speed (>100 Gb/s) transmission systems, digital coherent detection techniques, multi-level modulation formats, optical performance monitoring techniques, WDM passive optical networks, and high-speed (>10 Gb/s) MMF systems.

The followings are our core competence, mission, applications, and major achievements.

- Core Competence:
  - Lightwave systems technology
- Mission:
  - To create a world-leading knowledge base in lightwave communication systems, subsystems, networks, and related technologies
- Applications:
  - High-capacity all-optical core networks
  - Ultrahigh-speed transmission systems
  - Metropolitan area networks
  - Broadband access networks
  - Fiber backhaul networks for wireless application
- Major achievements:
  - 5 Tb/s WDM transmission system
  - >100 Gb/s transmission technology
  - KAIST all-optical network (KAON) testbed
  - Broadband FTTH network
  - WDM passive optical network (PON)
  - Passive optical network for microcellular CDMA services
  - High-speed (>10 Gb/s) LAN
  - Multi-purpose fiber-optic access network
  - Optical performance monitoring techniques
  - Optical cross-connects & optical add/drop multiplexers
  - Spectrum-sliced light source
  - New fiber design for high-capacity WDM systems

KEY ACHIEVEMENTS

[1] J. S. Lee and Y. C. Chung, "Spectrum- sliced fiber amplifier light source for multi- channel WDM applications," *IEEE Photonics Techn. Lett.*, vol. 5, no. 12, pp. 1458. Dec. 1993.

[2] D. K. Jung, S. K. Shin, C. H. Lee, Y. C. Chung, "Wavelength-division-multiplexed passive optical network based on spectrum -slicing techniques," *IEEE Photonics Techn. Lett.*, vol. 10, no. 9, pp. 1334, Sep. 1998.

[3] J. H. Lee, D. K. Jung, C. H. Kim, and Y. C. Chung, "OSNR monitoring technique using polarization-nulling method," *IEEE Photonics Techn. Lett.*, vol. 13, no. 1, pp. 88, Jan. 2001.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Young Scientist Award, Optoelectro and Communications Comm. Conf. 2010, Sapporo, Japan, July 2010.

[2] K. Y. Cho, K. Tanaka, T. Sano, S. P. Jung, J. H. Chang, Y. Takushima, A. Agata, Y. Horiuchi, M. Suzuki, and Y. C. Chung, "Long-reach coherent WDM PON employing self-polarization-stabilization technique," *IEEE/OSA J. Lightwave Techn,* vol. 29, no. 4, pp. 456-462, Feb. 2011.

Ha, Jeongseok

Associate Professor

Member, KICS / Member, IEEE

Ph.D., Georgia Institute of Technology (2003)
jsha@ee.kaist.ac.kr
http://ccit.kaist.ac.kr

Coding, Communications, and Information Theory Laboratory

The research interests of coding, communications, and information theory (CCIT) Lab. include the general areas of communications, error-control coding, and information theory. CCIT Lab. has been working on challenging problems in physical layer security, secure network coding, and error-control coding (ECC) for solid state drives (SSDs). These works are sponsored by NRF, MKE, etc.

Physical Layer Security : Due to the broadcast nature of wireless mediums, it is essential to address inherent security weakness in wireless networks. The nature of wireless mediums can also be advantageous for securing wireless network. We exploit physical layer resources to secure wireless networks, which may supplement or replace conventional security systems. As a part of the research activities, we have been studying secure wireless sensor networks which guarantee the unconditional (perfect) security with limited computing power. We have also been actively investigating secret key extraction techniques from physical layer resources. Our works are collaborated with Georgia Tech, and Swansea University.

Secure Network Coding : Network coding is a way to achieve multicast capacity by allowing packets to be algebraically combined at intermediate nodes. However, the packet combining results in many security issues. The problems have attracted considerable attention in recent years. We investigate universal, i.e. network topology independent, error control schemes based on extensions of theories of algebraic codes.

ECC for SSDs : Solid-State Drives (SSDs) are considered as one of the next-generation mass storage devices. It employs NAND FLASH memories with single-level cells (SLCs) or multi-level cells (MLCs). Although the cost efficiency of the MLCs makes SSDs based on MLC technology more preferable to the market, more errors are likely to happen in MLCs, and thus demands on customized error-control coding (ECC) for the SSD have been ever growing. CCIT Lab. investigates theoretic limits of bit density of SSDs, customized ECCs for SSDs with MLCs and their encoder/decoder structures with lower complexity. These works are collaborated with partners in industries and academia.

KEY ACHIEVEMENTS

[1] J. Ha and S. W. McLaughlin, "Low-density parity-check codes over Gaussian channels with erasures," *IEEE Tr. Inf. Theory,* vol. 49, no. 7, pp. 1801-1809, July 2003.

[2] J. Ha and S. W. McLaughlin, "Rate-compatible puncturing of low-density parity-check codes," *IEEE Tr. Inf. Theory,* vol. 50, no. 11, pp. 2824-2836, Nov. 2004.

[3] J. Ha, J. Kim, D. Klinc, and S. W. McLaughlin, "Rate-compatible punctured low-density parity-check codes with short block lengths," *IEEE Tr. Inf. Theory,* vol. 52, no. 2, pp. 728-738, Feb. 2006.

MAJOR ACHIEVEMENTS in 2010/2011

[1] H. Jeon, J. Choi, H. Lee, and J. Ha, "Channel-aware energy efficient transmisiion strategies for large wireless sensor networks," *IEEE Sig. Process. Lett,* vol. 17, no. 7, pp. 643-646, July 2010.

[2] H. Jeon, N. Kim, J. Choi, H. Lee, and J. Ha, "Bounds on secrecy capacity over correlated ergodic fading channels at high SNR," *IEEE Tr. Inf. Theory,* vol. 57, no. 4, pp. 1975-1983, Apr. 2011.

Han, Youngnam

Professor

Senior Member, IEEE

Ph.D., University of Massachusetts (1992)
ynhan@ee.kaist.ac.kr
http://wit.kaist.ac.kr

Wireless Innovative Technologies Laboratory

The research of wireless innovative technologies laboratory (wit) focuses on wireless communication and networking. wit is conducting research to improve the wireless network performance and design innovative and efficient algorithms for current and next wireless communication systems. The research direction of wit is mainly radio resource management (RRM) that will be the main issue of the future wireless network due to the lack of wireless resources such as frequency, power, space, code, and so on.
The main objectives in radio resource management is how we utilize limited wireless radio resources optimally. Since the radio resource management scheme is positively necessary in any wireless technologies, therefore, recently radio resource management researches are recently noticeable by attaching up-to-date technologies such as MIMO-OFDM, Multicell Coordination, Cooperative network, Network coding, Cognitive Radio, etc. Currently wit is conducting the survey on optimal radio resource allocation method for IEEE 802.16m, 3GPP HSPA and LTE system investigation with ETRI and Samsung. In addition, for the prior occupation of next generation wireless communnication technologies wit is working on the study for 5G key technologies with SKT. As well as commercial wireless network, wit is performing the research on designing MIMO radar with the National Defense and Science Institute (ADD) to detect unidentified aircraft using commercial wireless network for increasing detection probability without any suspicious of detection to enemy. In addition, in ITRC-BcN center, wit is working on the study related on wired and wireless convergence network. As well as wired and wireless convergence network, currently we are working on heterogeneous wireless network which consists of diverse network topology such as macro, micro, pico, femto cells, etc. for future network environment. Since heterogeneous network is more complicated environments than homogeneous network from the point of view of interference, scheduling, power allocation, handoff, we are working on challenging problems in heterogeneous network.

KEY ACHIEVEMENTS

[1] H. Kim and Y. Han, "An opportunistic channel quality feedback scheme for proportional fair scheduling," *IEEE Comm. Lett.*, vol.11, no.6, pp. 501-503, June 2007.
[2] J. Oh, J. Hwang, J. Kim, and Y. Han, "Efficient CQI feedback via network coding for wireless relay network," *IEEE Comm. Lett.*, vol. 13, no. 10, pp. 758-760, Oct. 2009.
[3] S. Han, H. Kim, Y. Han, and John M. Cioffi, "Efficient power allocation schemes for nonconvex sum-rate maximization on gaussian cognitive MAC," *IEEE Tr. Comm.*, vol. 58, no. 3, pp. 753-757, Mar. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] T. Kim, S. Han, and Y. Han, "A QoS-aware vertical handoff algorithm based on service history information," *IEEE Comm. Lett.*, vol. 14, no. 6, pp. 527-529, June 2010.
[2] Y. Choi, H. Kim, S. Han, and Y. Han, "Joint Resource Allocation for parallel multi-radio access in heterogeneous wireless networks," *IEEE Tr. Wireless Comm.*, vol. 9, no. 11, pp. 3324-3329, Nov. 2010.

Kang, Joonhyuk

Associate Professor

Member, IEEE / Member, IEICE

Ph.D., University of Texas, Austin (2002)
jhkang@ee.kaist.ac.kr
http://artlab.kaist.ac.kr

Advanced Radio Technology Laboratory

The research of Advanced Radio Technology (ART) lab focuses on the digital communication techniques for advanced wireless communication systems. The research topics include Multiple-Input Multiple-Output (MIMO), smart antenna, orthogonal frequency division multiplexing (OFDM), collaborative signal processing and spectral estimation. We apply these technologies to the various applications such as 4G wireless, indoor localization, sensor networks and cognitive radio.

Theory for OFDM : Orthogonal frequency-division multiplexing (OFDM) is a transmission technique based upon the idea of frequency-division multiplexing (FDM). Its robustness and efficiency are important advantages for transmitting data at high data rates required by future broadband applications.

Theory for MIMO : Recently, multiple-input multiple-output (MIMO) techniques has received attention since they increase link reliability and spectral efficiency over wireless fading channels without more expending time and bandwidth. Multi-antenna technique has been adopted to many standards such as mobile WiMAX and 3GPP LTE.
Theory for Cooperative communication: Cooperative communication systems, such as multi-cell coordinated system and relay based system, provide reliable data transmission that satisfies user's QoS. Related standards are 3GPP LTE-Advanced, IEEE 802.16j, and .16m.

Theory for Localization (Ranging) : Ranging technique provides various services such as location-based services and GPSless geolocation system. IEEE 802.15.4a is the standard considering ranging technology.

KEY ACHIEVEMENTS

[1] M. Torlak, S, -Y. Kim, J. Kang, G. Xu, and H. Li, "Performance of MC-CDMA system using antenna arrays," *Signals, Systems, and Computers Conf. Record of the Thirty Asilomar,* CA, USA, vol. 1, Oct. 1999.

[2] K. Lee, Y. Kim, and J. Kang, "A simple adaptive switching scheme between STBC-OFDM and SFBC-OFDM systems," *IEICE Tr. on Comm.,* vol. E92-B, no. 11, pp. 3546-3549, Nov. 2009.

[3] J. Cha, Y. Kim, H. Lee, and J. Kang, "An efficient ZJ-based decoding algorithm for space-time trellis codes in slow rayleigh fading channel," *IEEE Tr. on Comm.,* vol. 59, no. 2, pp. 337-342, Feb. 2011.

MAJOR ACHIEVEMENTS in 2010/2011

[1] C. Yoon, H. Lee, and J. Kang, "Combined ML and DFE decoding for coded Double STBC-OFDM System," *IEEE Comm. Lett.,* vol. 14, no. 12, pp. 1164-1166, Dec. 2010.

[2] J. Cha, Y. Kim, H. Lee, and J. Kang, "An efficient ZJ-based decoding algorithm for space-time trellis codes in slow Rayleigh fading channel," *IEEE Tr. Comm.,* vol. 59, no. 2, pp. 337-342, Feb. 2011.

[3] C. Yoon, H. Lee, and J. Kang, "Performance evaluation of space-time block codes from coordinate interleaved orthogonal designs in shadowed fading channels," *IEEE Tr. Vehic. Techn,* vol. 60, no. 3, pp. 1289-1295, Mar. 2011.

Kang, Minho

Professor

Member, NAEK / IEEK / KICS / KIEE / Senior Member, IEEE / Foreign Member, IEICE

Ph.D., University of Texas, Austin (1977)
minkang@ee.kaist.ac.kr
http://line.kaist.ac.kr

Lab. for Integrated Network Engineering (LINE)

Lab. for Integrated Network Engineering (LINE) pursues the goal to make global leader in the area of researching inter-operation of existing IP networks, intelligent optical internet, and wireless networks.
Current research areas of LINE are optical internet, traffic engineering & QoS support mechanism, FTTH networks, home network, broadband convergence networks, wired/wireless integration, and the next generation wireless network technology.
We take an Optical Internet Research Center (OIRC) project in which the main goal "Research of optical packet router architecture" is actively studied. Currently, we focus on the control plane architecture of next generation optical internet in terms of organization of architecture and QoS mapping for seamless service. Moreover, we treat a hot issue, convergence of optical and wireless networks including the studies for wireless environment such as QoS mapping, enhanced mobility for converged networks, and power management is being currently studied.

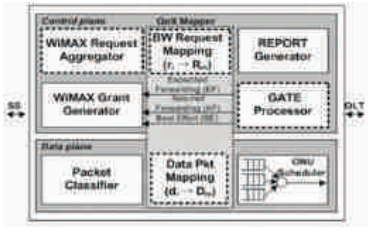


Fig. 1 Hybrid ONU-BS function block for Qos

Another research area is the network coding technologies based on advanced passive optical network (PON) that is one of solution to bottleneck problem in network routing area. Network coding technologies is good for bandwidth limitation problem and security problem. It is also good for multicast service with good QoS.
We are also studying the convergence network such as optical Internet technology and wireless Internet technology including WiBro and WiMAX in BcN project of ITRC.

KEY ACHIEVEMENTS

[1] S. Oh, H. Hong, and M. Kang, "A data burst assembly algorithm in optical burst switching networks," *ETRI J.* vol. 24, no. 4, pp. 311-322, Aug. 2002.
[2] N. Kim and M. Kang, "Traffic shared-based multicast scheduling for broadcast video delivery in shared WDM-PONs," *IEEE J. Lightwave Techn,* vol. 25, no. 9, pp. 2814-2827, Sep. 2007.
[3] M. Kim, J. Choi, and M. Kang, "Adaptive power saving mechanism considering the request period of each initiation of awakening in the IEEE 802.16e system," *IEEE Comm. Lett,* vol. 12, no. 2, pp. 106-108, Feb. 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] M. Kim, G. Shen. J. Choi, B. Jung, H. Park, and M. Kang, "Distributed antenna-based EPON-WiMAX integration and its cost-efficient cell planning," *IEEE J. Sel. Areas in Comm.,* vol. 28, no. 6, pp. 808-817, Aug. 2010.
[2] B. Jung, J. Choi, Y. Han, M. Kim, and M. Kang, "Centralized scheduling mechanism for enhanced end-to-end delay and QoS support in integrated architecture of EPON and WiMAX," *IEEE J. Lightwave Techn,* vol. 28, no. 16, pp. 2277-2288, Aug. 2010.

Kim, Hyung-Myung

Professor

Member, KICS / Member, KISS / Member, KITE / Senior Member, IEEE

Ph.D., University of Pittsburgh (1985)
hmkim@ee.kaist.ac.kr
http://csplab.kaist.ac.kr

Communications Signal Processing Laboratory

The Communications Signal Processing Laboratory (CSPLAB) has researched on wireless communications, image processing, and radar signal processing. Especially, a variety of research topics in wireless communications are studied in the CSPLAB. In orthogonal frequency division multiplexing (OFDM) systems, the research on the frequency offset estimation and inter-carrier interference cancellation is ongoing.

In ad-hoc relay networks over IEEE 802.16 orthogonal frequency division multiple access (OFDMA) systems, the ranging protocol and call admission control are studied.

In wireless multi-input multi-output (MIMO) relay systems, the source and relay precoder design problems with partial channel state information (CSI) such as mean and covariance information of channels are investigated. The partial CSI schemes are essential for the practical communication systems with a limited feedback rate.

Recently, the cognitive radio and femtocell systems have gained a lot of interest from the researchers for the efficient use of limited resources. In a cognitive radio system which includes a primary user (spectrum licensed user) and a cognitive user (spectrum unlicensed user), spectrum sensing, cognitive user resource allocation, and cognitive relay network related topics are studied. In a femtocell, which is a small cellular base station designed for use in residential or small business environments, the channel and power allocation for femtocell users is studied.

A number of other research projects have been completed and there are also ongoing projects in the CSPLAB: A project on the precoder design in MIMO relay systems and a project on the UWB radar signal processing for discrimination between human and animals.

The research is much more concentrated on theoretical and academic studies rather than practical device experiments in the CSPLAB.

Above all, the research topics are open. Every student studies their own topics and improves their research capabilities through laboratory seminars and group studies with all the laboratory members.

KEY ACHIEVEMENTS

[1] T. S. Kang and H. M. Kim, "Optimal beam subset and user selection for orthogonal random beamforming," *IEEE Comm. Lett,* vol. 12, no. 9, pp. 636-638, Sep. 2008.

[2] W. G. Ahn and H. M. Kim, "An improved ranging algorithm for ad-hoc relay networks over IEEE 802.16 ofdma systems," *IEEE Comm. Lett,* vol. 13, no. 5, pp. 357-359, May. 2009.

[3] C. Jeong and H. M. Kim, "Precoder design of non-regenerative relays with covariance feedback," *IEEE Comm. Lett,* vol. 13, no. 12, pp. 920-922, Dec. 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] D. H. Kim and H. M. Kim, "MMSE precoder design for a non-regenerative MIMO relay with covariance feedback," *IEEE PIMRC,* Istanbul, Turkey, Sep. 2010.

[2] K. H. Kim and H. M. Kim, "An ICI suppression scheme based on the correlative coding for Alamouti SFBC-OFDM system with phase noise," *IEEE Tr. Wireless Comm.,* 2011 (accepted)

Kim, Tag Gon

Professor

Member, HKN / Member, IEEK / Member, KSS / Senior Member, IEEE / Fellow, SCS

Ph.D., University of Arizona (1988)
tkim@ee.kaist.ac.kr
http://sim.kaist.ac.kr

Systems Modeling and Simulation Laboratory

Fig. 1

Systems Modeling and Simulation (SMS) Lab is devoted to researching on theory and applications of modeling, simulation and analysis of discrete event systems. The modeling framework in our research is DEVS (Discrete Event Systems Specification) formalism which supports specification of discrete event models in a hierarchical modular manner. Research emphasis is given to two areas: methodology and tools for (1) systems analysis at a high level and for (2) simulators development and their interoperation. The first area is to develop a new framework for the efficient analysis of complex systems, such as application-specific digital systems, using discrete event system M&S. The framework includes a DEVS specification language, realization of the DEVS formalism in MATLAT/Simulink, an operation and interconnection sharing algorithm for reconfiguration overhead reduction using static partial reconfiguration.

The second area is mainly aimed at the development of HLA-compliant military wargame simulators. Such simulators should be interoperable with other simulators through HLA (High Level Architecture) / RTI (Run Time Infrastructure). SMS lab has developed a set of tools for development of simulators which meet the standard: DEVSim++, KHLAAdaptor, and KComLib. The tools set has been used to develop 3 major military wargame simulators in Korea such as Navy's Chunghae Simulator, Air Force's Changkong Simulator and Marine's Chunjabong Simulator (shown in the figure above).

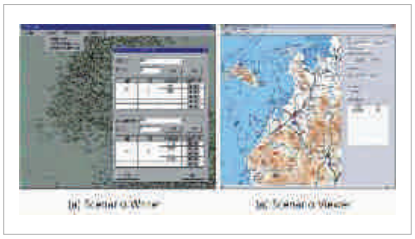


Fig. 2

KEY ACHIEVEMENTS

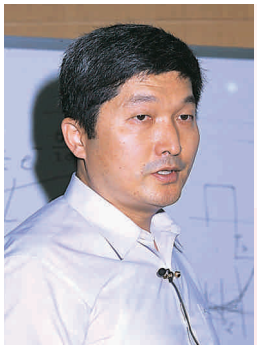
[1] Ki Jung Hong and Tag Gon Kim, "DEVSpecL-DEVS specification language for modeling, simulation and analysis of discrete event systems," *Inf. and Software Techn,* vol. 48, no. 4, pp. 221 - 234, Apr., 2006.

[2] Tag Gon Kim, Chang Ho Sung, Su-Youn Hong, Jeong Hee Hong, Chang Beom Choi, Jeong Hoon Kim, Kyung Min Seo, and Jang Won Bae, "DEVSim++ toolset for defense M&S and interoperation," *J. Defense Modeling and Simulations,* Published online before print November 29, 2010, DOI: 10.1177/1548512910389203

MAJOR ACHIEVEMENTS in 2010/2011

[1] Jang Won Bae and Tag Gon Kim, "DEVS based plug-in framework," *Spring Simulation Multi-Conf.,* Orlando, FL, USA, pp. 147-153, Apr., 2010.

[2] Kyung-Min Seo, Jeong Hee Hong and Tag Gon Kim, "DEVS-based underwater warfare simulation development for effectiveness analysis," *Summer Simulation Multi-Conf,* Ottawa, Canada, July 11-15, 2010.



Lee, Hwang Soo

Professor

Member, KICS / Member, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (1983)
hwanglee@ee.kaist.ac.kr
http://mcl.kaist.ac.kr

Mobile Communications Laboratory

Our research covers two major areas: wireless communication networks. and image signal processing.
In the area of wireless communication networks, we are doing research on

1. Cognitive radio network - traffic pattern based scheduling and implementation
2. Sensor network - lifetime analysis of sensor network and algorithm for enhancing sensor network lifetime
3. IEEE 802.11ac system - enhanced MAC algorithm and MU-MIMO performance analysis
4. Moving cell network - IEEE 802.16j-based mobile cell implementation and capacity enhancement
5. Vehicular network - IEEE 802.11p-based performance analysis and modeling for vehicular traffic control

For image signal processing area, we consider implementation of real applications and integration with IP networks. The area covers,

1. Codec system - scalable image encoding and information transmission
2. Surveillance system - image detection and tracking algorithm
3. Real time image streaming - RTSP and integration with IP network

KEY ACHIEVEMENTS

[1] B. C. Kim and H. S. Lee, "Performance comparison of route metrics for wireless mesh networks," *IEICE Tr. Comm.*, vol. 89, no. 11, pp. 3124-3127, Nov. 2006.
[2] J. Y. Lee and H. S. Lee, "A performance analysis model for IEEE 802.11e EDCA under saturation condition," *IEEE Tr. Comm.*, vol. 57, no. 1, pp. 56-63, Jan. 2009.
[3] W. S. Lee, M. V. Nguyen, A. Verma, and H. S. Lee, "Schedule unifying algorithm extending network lifetime in S-MAC-based wireless sensor networks," *IEEE Tr. Wireless Comm.* vol. 8, no. 9, pp. 4375-4379, Sep. 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S. B. Lee and H. S. Lee, "Analysis of network lifetime in cluster-based sensor networks," *IEEE Comm. Lett,* vol. 14, no. 10, pp. 900-902, Oct. 2010.
[2] M.-V. Nguyen, J. Yoon, J. Lee, and H. S. Lee, "Scheduling in cellular cognitive radio network," *IEEE WCNC 2011,* Cancun, Mexico, Mar. 2011.

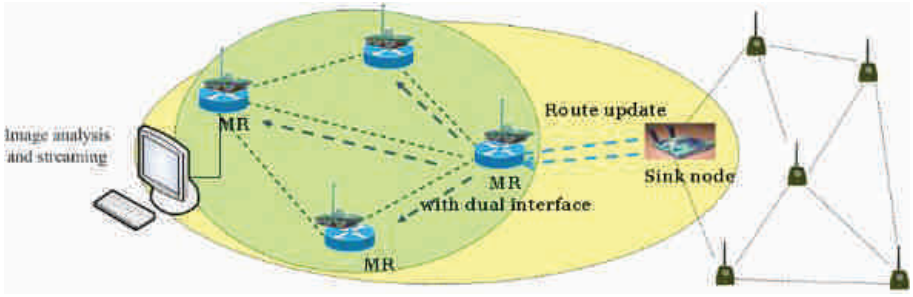
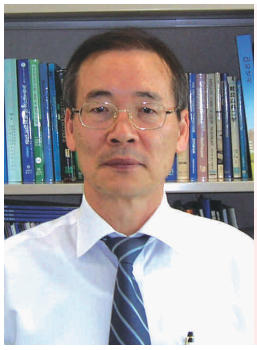


Fig. 1



Lee, Hyuckjae

Professor

Member, IEEK / Member, KEES / Member, KICS / Member, IEEE

Ph.D., Oregon State University (1983)
hjlee@ee.kaist.ac.kr
http://rclab.kaist.ac.kr

Radio and Communications Laboratory

Research interests in Radio and Communications Laboratory (RCLab) include fundamentals of wireless communications and 4G related communication systems such as Cognitive Radio (CR), Dynamic Spectrum Access (DSA), Wireless Channel Modeling, and Radio Frequency IDentification (RFID).

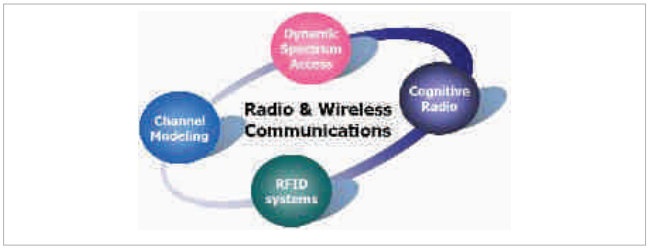


Fig. 1

Cognitive Radio (CR): CR technology utilizes unused frequency bands in licensed bands by using fine spectrum sensing techniques. RCLab has studied on spectrum sensing technology and carried out the research for standardization in IEEE 802.22 WRAN. Recently, issues on CR control channel or rendezvous in CR networks are interesting research topics to us.

Dynamic Spectrum Access (DSA): While demand for the limited spectrum resource is causing the spectrum scarcity, DSA has recently received a great attention due to the ability to improve spectrum utilization. RCLab is working on political and engineering issues related to DSA such as public safety spectrum management, interference management.

Wireless Channel Modeling: To guarantee reliable performance measurement of next generation wireless communication systems, practical observation and modeling about wireless channel need to be established. We aim at developing a novel wireless channel model of cooperative communications based on IMT-Advanced system.

Radio Frequency IDentification (RFID) : RFID is one of the key technologies for ubiquitous communications, which use RF waves to identify, track, or categorize object. We are researching new protocols for the arrangement of efficient RFID system, especially which considers anti-collision among various types of readers.

KEY ACHIEVEMENTS

[1] J. Choi, D. Lee, and H. Lee, "Query tree-based reservation for efficient RFID tag anti-collision," *IEEE Comm. Lett.*, vol. 11, no. 1, pp. 85-87, Jan. 2007.

[2] H. Kim, S. Park, J. Seo, H. Eum, Y. Lee, S. Lee, and H. Lee, "Modulation and pre-equalization method to minimize time delay in equalzation digital on-channel repeater," *IEEE Tr. on Broadcast*, vol. 54, no. 2, pp. 249-256, June 2008.

[3] H. Jeon, N. Kim, J. Choi, H. Lee, and J. Ha, "Bounds on secrecy capacity over correlated ergodic fading channels at high SNR," *IEEE Tr. Inf. Theory*, vol. 57, no. 4, pp. 1975-1983, Apr. 2011.

MAJOR ACHIEVEMENTS in 2010/2011

[1] H. Jeon, J. Choi, H. Lee, and J. Ha, "Channel-aware energy efficient transmission strategies for large wireless sensor networks," *IEEE Sig. process. lett*, vol. 17, no. 7, pp. 643-646, July 2010.

[2] H. Jeon, N. Kim, J. Choi, H. Lee, and J. Ha, "Bounds on secrecy capacity over correlated ergodic fading channels at high SNR," *IEEE Tr. Inf. Theory*, vol. 57, no. 4, pp. 1975-1983, Apr. 2011.

Lee, Man Seop

Professor

Member, KIEE / Member, KSLP / Member, IEEE / Member, OSA / Member, SPIE

Ph.D., Korea Advanced Institute of Science and Technology (1991)
leems@ee.kaist.ac.kr
http://vega.kaist.ac.kr/~rainbow/

Photonics Application Laboratory

We fabricated various micro/nanostructures on glass by changing the various laser parameters of a Ti:sapphire femtosecond laser to find the interaction of femtosecond laser with glass material. It was found that regular and closely joined spherical nano-structures were increased with the increase of speed of the translation stage. Nanostructures down to 16 nm was fabricated on glass material. The size of the micro lines were decreased with the decrease of laser energy per pulse. As the pulse duration was increased, the number of structures (holes, micro- and nano-structures) was more when the laser was applied twice (forward and backward) compared to one time laser shine. Due to the rapid growth of Internet with new generation of services and applications, demand for faster and cheaper access network has been rising. Mostly, time division multiplexed (TDM)-PON is deployed in all parts of the world. In order to mitigate the future demand, some next generation PON systems have been investigated by the researchers. In this paper, we examine the current status of PONs and investigate the probable future PONs. We also explain the smooth migration process from the current status to the future technologies. Architecture of a self-restored tree-type hybrid wavelength division multiplexed/ TDM-PON (WDM/TDM-PON) has been proposed, for migrating from TDM to WDM-PON. The proposed architecture has the ability to provide the networking support to multiple WDM-PON and TDM-PON simultaneously. Due to the restorable capacity of the architecture, the availability of the system is increased. In addition, cost analysis of different PON architectures are performed and compared with the cost of the proposed architecture. It is found that, the proposed architecture provides more cost effective solution.

We studied the temperature effects on anomalous radio duct propagation in Korean coastal area. It was found that atmospheric radio ducts can trap VHF/UHF radio waves and propagate them over long distances. 284.4625 MHz Japanese radio wave signal measurements show that the radio waves are propagated to Korea coastal regions when ground temperatures exceed 10°.... This paper discusses the reasons for the existence of this critical temperature threshold.

KEY ACHIEVEMENTS

[1] Md. S. Ahsan, M. S. Lee, S. H. S. Newaz, and S. Md. Asif, "Migration to the next generation passive optical network," *ICCIT 2009*, Dhaka, Bangladesh, Dec. 2009.

[2] Md. Shamim Ahsan, Yeong Gyu Kim, Man Seop Lee, "Formation mechanism of nanostructures in soda-lime glass using femtosecond laser," *J. Non-Crystalline Solids,* vol. 357, no. 3, pp. 851, Nov. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Md. Shamim Ahsan, Yeong Gyu Kim, and Man Seop Lee, "Colorizing of the stainless steel surface by single-beam direct femtosecond laser writing," *Photonic West 2011,* Jan. 2011.

[2] Yeong Gyu Kim, Md. Shamim Ahsan, and Man Seop Lee, "Polyimide surface processing depend on Z-location using femtosecond laser," 레이저가공학회 추계 학술 발표대회 논문집 pp. 78, Dec. 2010.

Lee, Yong Hoon

Professor

Member, NAEK / Member, IEEK / Member, KICS / Senior Member, IEEE

Ph.D., University of Pennsylvania (1984)
yohlee@ee.kaist.ac.kr
http://kalman.kaist.ac.kr

Digital Communications Laboratory

Digital Communications Laboratory (DCL) actively conducts research on physical layer design and signal processing for various communication systems including next generation mobile communication and military communication systems. DCL has been collaborated with other laboratories in KAIST to design overall communication systems and to implement signal processing techniques. Its research activities are being funded by the Ministry of Knowledge Economics, Agency for Defense Development and private companies such as LIG Nex1. Some highlights of the research are described as follows.

Next generation mobile communication systems: Various techniques for increasing capacities of wireless network are being investigated. Recently proposed techniques include Beam Division Multiple Access (BDMA), which is a simple but effective location based service for cellular downlink, pre-nullification for full-duplex relaying, cooperative cognitive radio for cellular uplink, multi-way relaying, some modifications of interference alignment and digital pre-distortion schemes for wide-band power amplifiers supporting dynamic frequency allocation. In this research we collaborate with professors D. H. Cho, S.-Y. Chung and Y. Sung.

Military communication systems: A hybrid of cellular and ad-hoc network is investigated to support high data rate, yet flexible and secure communications.

KEY ACHIEVEMENTS

[1] I. Kim, I.-S. Park, and Y. H. Lee, "Use of linear programming for dynamic subcarrier and bit allocation in multiuser OFDM," *IEEE Tr. Vehic. Techn*, vol. 55, no. 4, pp. 1195-1207, July 2006.

[2] J. Joung and Y. H. Lee, "Regularized channel diagonalization for multiuser MIMO downlink using a modified MMSE criterion," *IEEE Tr. Sig. Process,* vol. 55, no. 4, pp. 1573-1579, Apr. 2007. (Gold prize in the 2006 student paper contest (sponsored by Intel))

[3] W. Chang, S.-Y. Chung, and Y. H. Lee, "Achievable rate for cognitive radios opportunistically permitting excessive secondary-to-primary interference," *IEEE Tr. Wireless Comm,* vol. 9, no. 2, pp. 674-683, Feb. 2010. (Silver prize in the 2008 Humantech paper contest (sponsored by Samsung))

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y.-U Jang, E.-R. Jeong, and Y. H. Lee, "A two-step approach to power allocation for OFDM signals over two-way amplify-and-forward relay," *IEEE Tr. Sig. Process,* vol. 58, no. 4, pp. 2426-2430, Apr. 2010.

[2] W. Nam, S.-Y. Chung, and Y. H. Lee, "Capacity of the gaussian two-way relay channel to within 1/2 bit," *IEEE Tr. Inf. Theory,* vol. 56, no. 11, pp. 5488-5494, Nov. 2011.

Ma, Joongsoo

Professor

Member, KICS / Member, IEEE

Ph.D., University of Massachusetts (1978)
jsma@ee.kaist.ac.kr
http://mmlab.kaist.ac.kr

Mobile Multimedia Laboratory

The Mobile Multimedia Laboratory (MMLAB) has focused on designing wireless communications network architectures, protocols, and evaluating network performance. Currently, we are developing communication protocols and algorithms to service a large number of real-time traffic flows efficiently in a multi-hop wireless mesh network. Our target real-time traffic includes voice, video and sensed data. Our particular emphasis is placed on developing expandable multi-channel multi-radio medium access and routing protocols that easily adjust to geographically differing traffic densities. We are also developing congestion and admission control policies that produce a high capacity while satisfying a given quality of service. We are building simulation programs and prototype systems to verify the performance and the ultimate usability.

KEY ACHIEVEMENTS

[1] M. Seo and J. Ma, "Dynamic channel selection with snooping for multi-channel multi-hop wireless networks," *IEICE Tr. Comm.,* vol. E91B, no. 8, pp. 2752-2756, Aug. 2008.

[2] S. Kim, J. Cha, and J. Ma, "Design and theoretical analysis of throughput enhanced spatial reuse distributed coordination function for IEEE 802.11," *IET Comm.,* vol. 3, no. 12, pp. 1934-1947, Dec. 2009.

[3] Y. Kim, M. Seo, M. Ji, and J. Ma, "Novel interface failure tolerant schemes for wireless mesh networks," *J. Inf.,* vol. 13, no. 2, pp. 239-251, Mar. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y. Kim, M. Seo, M. Ji, and J. Ma, "Novel interface failure tolerant schemes for wireless mesh networks," *J. Inf.,* vol. 13, no. 2, pp. 239-251, Mar. 2010.

[2] Y. Kim, D. Jung, J. Ma, Y. Kim, H. Ko, S. Cho, S. Shin, and J. Ihm, *Method and apparatus for estimating amount of external interference in wireless mesh network,* 10-2010-0127010, Korea, Dec. 13, 2010.

Moon, Jaekyun

Professor

Fellow, IEEE

Ph.D., Carnegie Mellon University (1990)
jmoon@kaist.edu
http://comstolab.kaist.ac.kr

Communications and Storage (ComSto) Laboratory

The ComSto Lab (Communications and Storage Lab) has its origin in the CDS Lab (Communications and Data Storage Lab) that was founded by Prof. Jaekyun Moon at the the University of Minnesota, USA, back in 1990, as he was joining the ECE Department there as an Assistant Professor. The lab has since been well-recognized in the international community for its innovative research and commercialization efforts in signal processing and coding related to achieving high-density storage and high-rate communications.

The maximum transition run length (known as the MTR code in industry) code invented in the lab, for example, had become widely used in high-density disk drives through late 90's and early 2000's as an effective means to pack bits more densely in thin film recording disks. In 2009, the MTR patent also has become a part of the patent pool for technologies that are essential for manufacturing BluRay optical storage devices. In 2001, Prof. Moon co-founded, partly based on the technologies developed in his lab, a wireless chip start-up Bermai, Inc. in the Silicon Valley to design and manufacture chips and systems to enable fast wireless access in local area networks. The wireless technologies developed by Bermai are now a part of wireless homenetworking products manufactured and marketed by DSPG, a publicly-traded company.

In 2009, Prof. J. Moon relocated his lab to the EE department at KAIST, renaming it as "ComSto Lab", as he joined KAIST as a Professor. At KAIST, Prof. Moon continue research in the general area of high-speed communication and high-density storage.

The ComSto Lab's current research emphasis is on how to design coding and equalization geared to known or partially-known interference. Interference-dominant channels are an important current trend in many crucial communication systems including high-speed computer buses, wireless Femto cells, high-density Flash memory, high-density hard disk drives, multi-giga networks and underwater communications.

ComSto's interests cover a broad spectrum of disciplines ranging from mathematical theory to low-complexity FPGA/VLSI architecture solutions, all with applications to communication and storage in mind.

KEY ACHIEVEMENTS

[1] J. Moon and B. Brickner, "Maximum transition run codes for data storage systems," *IEEE Tr. Magn.,* vol. 32, no. 5, pp. 3992-3994, Sep. 1996.

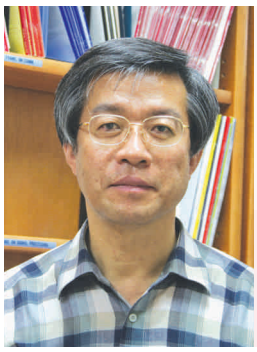
[2] J. Moon and J. Park, "Pattern-dependent noise prediction in signal-dependent noise," *IEEE J. Sel. Areas in Comm.,* vol. 19, no. 4, pp. 730-743, Apr. 2001.

[3] J. Park and J. Moon, "Error-pattern-correcting cyclic codes tailored to A prescribed set of error cluster patterns," *IEEE Tr. Inf. Theory,* vol. 55, no. 4, pp. 1747-1765, Apr. 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] H. AlHussien and J. Moon, "An iteratively decodable tensor product code with application to data storage," *IEEE J. Sel. Areas in Comm.,* vol. 28, no. 2, pp. 228-239, Feb. 2010.

[2] H. AlHussien and J. Moon, "The error-pattern-correcting turbo equalizer: spectrum thinning at high SNRs", *IEEE Tr. Inf. Theory,* vol. 57, no. 2, pp. 953-971, Feb. 2011.



Park, Dong-Jo

Professor

Member, IEEE

Ph.D., University of California, Los Angeles (1984)
djpark@ee.kaist.ac.kr
http://armi.kaist.ac.kr

Information Processing and Systems Laboratory

Information processing and systems laboratory (IPSL) is led by professor Dong-Jo Park. IPSL is focusing on two major parts: wireless communication and image processing systems. Research topics on wireless communication include synchronization, channel estimation, channel coding, pre-coding, and interference management for future wireless communication systems. Image processing areas include video coding, target detection and tracking.

Wireless communication systems: One of the promising candidates for the 4G wireless communication system is LTE-advanced organized by 3GPP. LTE-advanced systems can improve spectral efficiency of whole cell users and especially for cell-edge users by coordinate multiple transmission/reception. In one of our lab projects, we are proposing patents for LTE-advanced systems and for beyond 4G systems. Especially, we expect that the transmitter and the receiver are closer to each other to increase the system capacity of a wireless link. In this environment, system performance is dominated by interference rather than noise so that interference management (e.g. interference alignment (IA), dirty paper coding (DPC), multi-user beam-forming and etc.) is the most important problem to increase system capacity.

Image processing topics: Motion estimation via the block matching algorithm (BMA) has been adopted in all the video coding standards. Although the full-search algorithm (FSA) is the best BMA when it comes to motion estimation accuracy, its high computational load limits its practical usage. Therefore, we study a novel candidate position sub-sampling technique (CPST) and a fast template matching scheme using integral image. In the video analytics, we are interested in developing a system which can detect and track moving objects automatically. Since information from a single camera is limited, the performance of the tracking system is degraded as moving objects approach each other. In order to tackle this occlusion problem, we are researching detection and tracking algorithms that can deal with input sequences from multiple cameras simultaneously.

KEY ACHIEVEMENTS

[1] M. K. Oh, H. M. Kwon, D. J. Park, and Y. H. Lee, "Iterative channel estimation and LDPC decoding with encoded pilots," *IEEE Tr. Vehic. Techn,* vol. 57, no. 1, pp. 273-285, Jan. 2008.

[2] Y. H. Kwon, M. K. Oh, and D. J. Park, "Optimal erasure selection for errors and erasures decoding in M-ary PAM signalling," *IEEE Tr. Comm.,* vol. 56, no. 12, pp. 938-950, Dec. 2008

[3] J. H. Jung, H. S. Lee, J. H. Lee, and D. J. Park, "A novel template matching scheme for fast full-search boosted by an integral image," *IEEE Sig. Process. Lett,* vol. 17, no. 1, pp. 107-110, Jan. 2010

MAJOR ACHIEVEMENTS in 2010/2011

[1] H. S. Lee, J. H. Jung, and D. J. Park, "2:1 candidate position subsampling technique for fast optimal motion estimation," *IEEE Tr. Circuits and Systems for Video Techn,* vol. 20, no. 7, pp. 1052-1056, July 2010.

[2] S. Kim, S. Choi, and D. J. Park, "Optimal beamforming with combining for the non-orthogonal amplify-and-forward (NAF) protocol in cooperative communication systems," *IEEE Tr. Wireless Comm.,* vol. 10, no. 4, pp. 1038-1043, Apr. 2011.

Park, Hong-Shik

Professor

Member, IEEE / Member, IEICE

Ph.D., Korea Advanced Institute of Science and Technology (1995)
parkhs@ee.kaist.ac.kr
http://mtel.kaist.ac.kr

Multimedia Traffic Engineering Laboratory

Multimedia Traffic Engineering Laboratory is interested in the technologies for Future Network and Next Generation Network, such as Quality-of-Service provisioning technology, traffic and congestion control technology, traffic engineering technology for resource management and construction of reliable communication network, next generation router technology, high-speed switching and routing technology, IP forwarding technology, and protocol engineering technology for open network which are necessitated for the next generation router and broad-band switching system.
Recently, we are focusing on the bio-inspired traffic engineering, service application classification, high link speed measurement, and network coding.
Bio-inspired network engineering is one of the recent key issues in traffic engineering, which is a strategy for efficient and scalable networking under uncertain conditions, e.g., for autonomic organization in largely distributed systems. In fact, when we look carefully into nature, it is clearly observed that the dynamics of many biological systems and laws governing them are based on a surprisingly small number of simple generic rules which yield collaborative yet effective patterns for resource management and task allocation, social differentiation, synchronization (or de-synchronization) without the need for any externally controlling entity. We are mainly focusing on ant colony optimization based self-organizing QoS framework, swarm intelligence based energy saving routing, and bio-inspired synchronization for wireless network.
Service application classification and high link speed measurement is the basis of the traffic engineering to guarantee the network service quality. we are researching the traffic classification for guaranteeing QoS, a methodology of the network performance measurement of super broadband service, bandwidth measurement with minimized probing traffic, and bandwidth measurement for wired/wireless network.
Network coding is an in-network data processing technique in order to increase the capacity or the throughput of the network. We are interested in network coding node placement mechanism for wire/wireless networks and network coding mechanism for reducing channel zapping time of IPTV.

KEY ACHIEVEMENTS

[1] I. Han and H. Park, "An integrated home server for communication, broadcast reception, and home automation," *IEEE Tr. Consum. Electr.,* vol. 52, no. 1, pp. 104-109, Feb. 2006.
[2] M. Kim, G. Shen, J. Choi, B. Jung, H. Park, and M. Kang, "Distributed antenna-based EPON-WiMAX integration and its cost-efficient cell planning," *IEEE J. Sel. Area. Comm.,* vol. 28, no. 6, pp. 808-817, Aug. 2010.
[3] S. Lee, I. Hwang, and H. Park, *Void-filling in an optical burst switching system using constant offset,* 7684393, US, Mar. 23. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y. Han, I. Hwang, J. Kim, and H. Park, "A new attainable TCP throughput measurement tool for long distance high speed networks," *IEEE Comm. Lett.,* vol. 14, no. 10, pp. 990-992, Oct. 2010.
[2] Y. Kim, E. Lee, and H. Park, "Ant colony optimization based self-organizing QoS framework in IP networks," *IEEE Comm. Lett.,* vol. 13, no. 11, pp. 1074-1076, Nov. 2010.

Park, Hyuncheol

Associate Professor

Member, IEEK / Member, KICS / Member, IEEE / Member, IEICE

Ph.D., Georgia Institute of Technology (1997)
hcpark@ee.kaist.ac.kr
http://lit.kaist.ac.kr

Laboratory for Information Transmission

The Laboratory for Information Transmission (LIT) has been focused on design and analysis of modern wireless communication systems. The main research areas are: multi-user MIMO communications, multicarrier transmission on fast fading channel, link adaptation, Binary space-time code, visible light communications.

Multi-cell, Multi-user MIMO on Spatially Correlated Channel : We investigate the effects of spatial correlation on several multiple antenna schemes in multiuser environments. We quantify the interaction among spatial correlation, spatial diversity, spatial multiplexing and multiuser diversity. Analytical and simulation results have shown that spatial correlation imposes positive impacts on spatial diversity techniques if multiuser scheduling is employed although spatial correlations have been considered drawbacks in point-to-point communications. However, a spatial multiplexing scheme with multiuser scheduling is still degraded by spatial correlation.

Binary Space-Time Codes : We introduce a simple bit-interleaved binary space-time code for a coded MIMO system to obtain additional throughput and power gains, where two transmit and two receive antennas are used. Maximum additional throughput gain of 1.5 is achieved when a mother code rate goes to 0, while maintaining the diversity order for coded MIMO system. Moreover, we show that maximum power gain of 1.76dB can also be obtained. The proposed scheme is highly flexible, in other words, any types of binary channel codes and space-time codes can be concatenated, and outer iteration can be used to improve the performance further.

Visible Light Communications : Visible light communication (VLC) is a short-range optical wireless communication utilizing LED lighting, so the LED lights can provide both illumination and communication. First, we present indoor multipath dispersion characteristics for VLC. Second, we propose a multiple pulse position modulation (MPPM) to offer both functions of modulating data-stream and controlling the brightness at the same time.

KEY ACHIEVEMENTS

[1] K. Bang, N. Cho, J. Cho, D. Hong, K. Kim, and H. Park, "A coarse frequency offset estimation in an OFDM system using the concept of the coherence phase bandwidth," *IEEE Tr. Comm.,* vol. 49, no. 8, pp. 1320-1324, Aug. 2001.

[2] H. Park and J. Barry, "Trellis-coded multiple-pulse-position modulation for wireless infrared communications," *IEEE Tr. Comm.,* vol. 52, no. 4, pp. 643-651, Apr. 2004.

[3] N. Kim, Y. Lee, and H. Park, "Performance analysis of MIMO system with linear MMSE receiver," *IEEE Tr. Wireless Comm.,* vol. 7, no. 11, pp. 4474-4478, Nov. 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y. Lee, N. Kim, and H. Park, "Performance of MC-CDM systems with MMSEC over Rayleigh fading channels," *IEEE Tr. Vehic. Tech.,* vol. 59, no. 6, pp. 3126-3130, July 2010.

[2] K. Lee, H. Park, and J. Barry, "Indoor channel characteristics for visible light communications," *IEEE Comm. Lett.,* vol. 15, no. 2, pp. 217-219, Feb. 2011.

Park, KyoungSoo

Assistant Professor

Ph.D., Princeton University (2007)
kyoungsoo@ee.kaist.ac.kr
http://www.ndsl.kaist.edu

Networked and Distributed Computing Systems Research Laboratory

Networked and Distributed Computing Systems Research Lab (NDSL) focuses on the performance, reliability, scalability and security issues in the design and implementation of modern networked computing systems. Main research topics include scalable content distribution networks (CDNs), high-performance network server design, delay-tolerant network infrastructure for wireless Internet access, and networked systems security. The goal of our research is to find the fundamental design principles in building innovative computer systems that would improve the quality of our daily computing life.

Delay-tolerant network infrastructure for wireless Internet access : Recent smart phone revolution accelerates the demands for wireless Internet access, yet the current and future wireless phone access technologies will not be able to meet the increasing capacity requirements. We are designing a novel network infrastructure that transparently offloads ever-growing wireless network demands to existing high-capacity wireless networks (e.g., Wi-Fi). Drawing and applying the techniques from delay-tolerant networking, we hope to satisfy the majority of wireless network demands with intelligent store-and-forward delivery infrastructure.

Scalable networked systems on commodity computer hardware : PC-based commodity systems provide inexpensive platforms for flexible packet processing that reflects modern network traffic demand. We have been building one of the fastest software routers and a scalable SSL accelerator proxy on a regular PC. By designing and building these networked systems, we re-define the role of batching, pipelining, and parallel processing in the context of innovative new hardware. Graphics processing units (GPUs), multi-core CPUs, and high-speed network cards and interconnects all contribute to the scalability and performance of these systems, and we study how we expose them in the design of novel networked systems.

Secure network framework : We are looking into the various issues in networked systems security. Using secure hardware chips such as Trusted Platform Module (TPM), we are building a network framework to eliminate security attacks such as DDoS, click frauds, spamming, etc.

KEY ACHIEVEMENTS

[1] K. Park, V. Pai, L. Peterson, and Z. Wang, "CoDNS: improving DNS performance and reliability via cooperative lookups," *USENIX Sympo. Operating Systems Design, Implem.* San Francisco, USA, Dec. 2004.

[2] K. Park and V. Pai, "Scale and performance in the CoBlitz large-file distribution service," *USENIX Sympo. Networked Systems Design, Implem.* San Jose, USA, May 2006.

[3] K. Jang, S. J. Han, S. Y. Han, S. Moon, and K. Park, "SSLShader: cheap SSL acceleration with commodity processor," *USENIX Sympo. Networked Systems Design, Implem.* Boston, USA, Mar. 2011.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S. J. Han, K. Jang, S. Moon, and K. Park, "PacketShader: a GPU-accelerated software router," *ACM Special Interest Group on Data Communication.* New Delhi, India, Aug. 2010.

[2] K. Jang, S. J. Han, S. Y. Han, S. Moon, and K. Park, "SSLShader: cheap SSL acceleration with commodity processor," *USENIX Sympo. Networked Systems Design, Implem.* Boston, USA, Mar. 2011.

Park, Kyu Ho

Professor

Member, KISS / Member, KIT / Member, ACM / Member, IEEE / Member, IEICE

Dr.Ing., Paris XI University (1983)
kpark@ee.kaist.ac.kr
http://www-core.kaist.ac.kr

Computer Engineering Research Laboratory

Computer Engineering Research (CORE) Laboratory has been contributed to (1) Manycore and Next-Generation Memory Computing System, (2) Cloud Computing System, and (3) Ubiquitous Computing System. We have developed several techniques (static core partitioning, NUMA-aware core scheduling, reference-pattern based memory balancing etc.) for manycore computing system. We have also developed memory management technique (selective data allocation, dynamic page migration and culling, etc) for hybrid main memory architecture. In addition, we have developed page caching algorithm for hybrid main memory architecture. We constructed a cloud R&D testbed (600 core, 1.3TB Memory, 300TB Storage) at KAIST. In this testbed, research institutes (SNU, Univ. and KAIST) and companies (KT, Daum, KBS) utilize our testbed for research on security, semantic search engine, searchable media broadcasting service, and even platform itself. Finally, we also developed an energy-efficient network protocol (CONET) for the ubiquitous environment. In addition, we have studied various user interfaces for a wearable computer, future museum, etc.

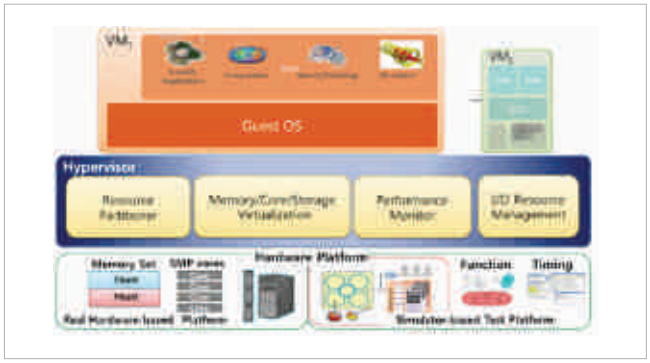


Fig. 1 Overall Architecture of MN-MATE

KEY ACHIEVEMENTS

[1] S. Lim and K. H. Park, "An efficient NAND flash file system for flash memory storage," *IEEE Tr. Comp.*, vol. 55, no. 7, pp. 906-912, July 2006.

[2] . H. Baek and K. H. Park, "Matrix-stripe-cache-based contiguity transform for fragmented writes in RAID-5," *IEEE Tr. Comp.*, vol. 56, no. 8, pp. 1040-1054, Aug., 2007. (IEEE ToC Featured Article)

[3] J.-W. Yoo and K. H. Park, "A cooperative clustering protocol for energy saving of mobile devices with WLAN and Bluetooth interfaces", *IEEE Tr. Mobile Comp.*, vol. 10, no. 4, pp. 491-504, Apr. 2011. (IEEE TMC Spotlight Paper)

MAJOR ACHIEVEMENTS in 2010/2011

[1] K.-W. Park, S. K. Park, J. S. Han, and K. H. Park, "THEMIS: towards mutual-verifiable billing transaction for cloud computing environment", *IEEE CLOUD,* Miami, Florida, USA, July 2010.

[2] K. H. Park, Y. Park, W. Hwang, and K-W. Park, "MN-Mate: resource management of manycores with DRAM and nonvolatile memories", *IEEE HPCC Conf.,* Melbourne, Australia, Sep. 2010

Rhee, June-Koo Kevin

Associate Professor

Member, KICS / Member, IEEE / Member, OSA

Ph.D., University of Michigan (1995)
rheejk@ee.kaist.ac.kr
http://cane.kaist.ac.kr

Convergence and Advanced Network Engineering Laboratory

Convergence and Advanced Network Engineering Laboratory (CANE LAB.) has been established with a vision to educate and train world-class scholars and engineers in the area of networks and communications. We have two important philosophies: Create the first new ideas and be the first in market applications. The lab has been producing sophisticated research results in the worldwide community. The main research area of CANE Lab focuses on ubiquitous wireless networks and broadband convergence networks beyond traditional wireless and optical networks. In the area of wireless networks, our researches mainly focus on routing, scheduling and network coding for network utility maximization. As one of outstanding researches, we have introduced physics inspired network routing called ALFA (Autonomous Load-balancing Filed-based Anycast routing), and the testbed which consists of one hundred commercial APs (Access Points) as a result of ALFA research will raise our competitiveness in this field. Recently, we have been investigating cross layer optimization for further enhancement of network capacities by combining back-pressure algorithm and network coding.

In the area of optical networks, we investigate Ethernet networks and packet-optical networks. Especially, CANE Lab is recognized as one of the world leaders in developing ERP (Ethernet Ring Protection) technology, providing key solutions for the framework design, switching behaviour, and multi-ring protection. Meanwhile, we are actively participating the standard organization such as IEEE and ITU-T by presenting more than 10 consents at the organizations. As a result, we have accomplished the world first commercialization of the ERP technology by joint research with ETRI and a venture company, Actus Networks, in 2009.

In optical networks, we have introduced all-optical OFDM transmission theory for high data rate transmission, which is one of the strongest candidate for 100 Gbps or higher data rate transmission, coping with optical transmission penalties such as due to optical non-linearity and chromatic dispersion. We proposed a framework of all-optical DFT/IDFT processor for the first time, and now we are actively co-working with NICT for experimental studies of all optical OFDM system of 20X10.7 Gbps.

KEY ACHIEVEMENTS

[1] J.-K. K. Rhee, D. Chowdhury, K. Sing Cheng, and U. Gliese, "DPSK 32x10 Gb/S transmission modeling on 5x90 km terrestrial system," *IEEE Photon. Techn. Lett.,* vol. 12, no. 12, pp.1627-1629, Dec. 2000.

[2] K. Lee, C. T.D. Thai, and J.-K. K. Rhee, "All optical discrete Fourier transform processor for 100 Gbps OFDM transmission," *Opt. Express,* Vol. 16, No. 5, pp.4023-4028, Mar. 2008.

[3] J. Ryoo, H. Long, Y. Yang, M. Holness, Z. Ahmad, and J.-K. K. Rhee, "Ethernet ring protection for carrier ethernet networks," *IEEE Comm. Mag.,* Vol. 46, Issue 9, pp.136-143, Sep. 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S. Jung, J. Sung, Y. Bang, K. Malaz, H. Kim, and J.-K. K. Rhee, "Greedy local routing strategy for autonomous global load balancing based on three-dimensional potential field," *IEEE Comm. Lett.,* vol. 14, no. 9, pp. 839-841, Sep. 2010.

[2] C. Lee, and J.-K. K. Rhee, "Add-drop Benes network for scalable optical packet networks" *Opt. Express,* vol. 19, issue. 9, pp. 8632-8640, Apr. 2011.

Song, lickho

Professor

Fellow, IEEE / Fellow, KAST / Member, ASK / Member, IEEK / Member, KICS / Fellow, IET

Ph.D., University of Pennsylvania (1987)
i.song@ieee.org
http://bungae.kaist.ac.kr

Statistical Signal Processing Laboratory

Research activities in the Statistical Signal Processing Laboratory have mainly been on the fundamental theory and applications of various communication/signal processing techniques. Particularly, we have focused on the studies related to the weak signal detection, code acquisition, frequency synchronization, and multiple-input multiple-output system, and have obtained various interesting results. Recently, we have investigated the following quintessential techniques: ① spectrum sensing scheme for cognitive radio and ② identification of finite state automata.

1. Spectrum sensing scheme for cognitive radio:
   Employing the generalized likelihood ratio test detector on each antenna branch and exploiting nonlinear diversity combining strategies, we have proposed a class of spectrum sensing schemes for cognitive radio with receive diversity. The performance characteristics of the proposed scheme have been analyzed in comparison with those of conventional schemes in Gaussian and non-Gaussian noises with various fading conditions.
2. Identification of finite state automata:
   We have proposed a new class of recurrent neural networks capable of identifying any discrete-time dynamical system. The proposed network has been trained by the hybrid greedy simulated annealing with a modified cost function to identify finite state automata. The identification with the proposed network exhibits generally better performance than conventional identification schemes.

The research results have been recognized in its significance and originality, having been published in internationally reputable journals. The results are theoretically interesting, and at the same time, practically applicable in many areas. Currently, we are working on challenging problems in feature extraction and cooperative cognitive radio networks. Specifically, we are studying a complexity reduced scheme for the feature extraction method of linear discriminant analysis with small sample size problems. In cooperative cognitive radio networks, based on the nonlinear schemes, we are investigating a cooperative spectrum sensing scheme with improved performance under non-Gaussian noise circumstances.

KEY ACHIEVEMENTS

[1] Y. H. Kim, I. Song, S. Yoon, and S. R. Park, "An efficient frequency offset estimator for OFDM systems and its performance characteristics," *IEEE Tr. Vehic. Techn.,* vol. 50, no. 5, pp. 1307-1312, Sep. 2001.

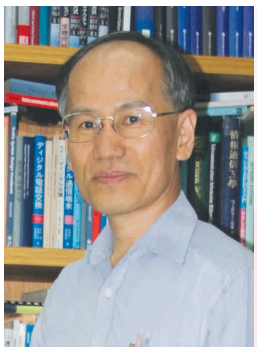
[2] I. Song, J. Bae, and S. Y. Kim, *Advanced Theory of Signal Detection,* Springer, 2002.

[3] I. Song, H. G. Kang, and T. An, *A novel complexity reduced maximum likelihood decoding method for multi-input multi-output systems,* GB 2442075, UK, Oct. 15, 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S. H. Won, I. Song, S. Y. Lee, and C. H. Park, "Identification of finite state automata with a class of recurrent neural networks," *IEEE Tr. Neural Netw.,* vol. 21, no. 9, pp. 1408-1421, Sep. 2010.

[2] H. G. Kang, I. Song, S. Yoon, and Y. H. Kim, "A class of spectrum sensing schemes for cognitive radio under impulsive noise circumstances: structure and performance in non-fading and fading environments," *IEEE Tr. Vehic. Techn.,* vol. 59, no. 9, pp. 4322-4339, Nov. 2010.



Sung, Dan Keun

Professor

Member, NAEK / Member, KICS / Member, KISS / Senior Member, IEEE / Member, IEICE

Ph.D., University of Texas, Austin (1986)
dksung@ee.kaist.ac.kr
http://cnr.kaist.ac.kr

Communication Networks Research Laboratory

The research activities at Communication Networks Research (CNR) Lab. have focused on radio resource management for next generation mobile communication networks, quality of service (QoS) guarantee for communication networks, and energy-efficient networks design.

We studied resource management for machine-to-machine (M2M) communications and smart grid networks. Since the number of M2M devices will be much larger than that of mobile users and the size of packets is smaller than that of conventional communications, we need to investigate core technologies to efficiently support M2M communications in future cellular networks and M2M random access networks.

We have proposed an Orthogonal Resource Hopping Multiplexing (ORHM) scheme in downlink and an Orthogonal Resource Hopping Multiple Access (ORHMA) scheme in uplink. The ORHM scheme yields a statistical multiplexing gain in downlink and the ORHMA scheme provides a new multiple access technique to improve the uplink capacity of mobile communication networks.

As next generation networks should support various types of traffic such as voice over IP, FTP, and web browsing, QoS requirements of packets arriving at the networks are diverse. The systemneeds to efficiently classify them and differentiate resource scheduling mechanisms. We apply new technologies such as hybrid automatic repeat and request (HARQ), link adaptation, data aggregation to those scheduling mechanisms and optimize in order to efficiently support various QoS requirements.

The design concepts of current Internet and telecommunication networks are not focusing on energy efficiency. The energy consumption in communication networks is drastically increasing due to exponential growth in network size, especially with explosion of wireless data traffic. To significantly reduce the energy consumption of the current networks, new network architectures with newly emerging enabling technologies are needed. We have carried out several researches for energy-efficient wireless network communications such as energy saving in small cell environments and a new energy-aware cellular architecture.

KEY ACHIEVEMENTS

[1] S. M. Shin, C. H. Cho, and D. K. Sung, "Interference-based channel assignment for DS-CDMA cellular systems," *IEEE Tr. Vehic. Techn.*, vol. 48, no. 1, pp. 233-239, Jan. 1999.

[2] D.K. Kim, and D. K. Sung, "Characterization of soft handoff in CDMA systems," *Tr. Vehic. Techn.*, vol. 48, no. 4, pp. 1195-1202, July 1999.

[3] S. Park and D.K. Sung, "Orthogonal code hopping multiplexing," *IEEE Comm. Lett*, vol. 6, no. 12, pp.529-531, Dec. 2002.

MAJOR ACHIEVEMENTS in 2010/2011

[1] H. Jin, C. Cho, N. Song, and D. K, Sung, "Optimal rate selection for persistent scheduling with HARQ in time-correlated Nakagami-m fading channels," *IEEE Tr. Wireless Comm.*, vol. 10, no. 2, pp. 637-647, Feb. 2011.

[2] S. M. Kim, W. Choi, T. W. Ban, and D. K. Sung, "Optimal rate adaptation for hybrid ARQ in time-correlated Rayleigh fading channels," *IEEE Tr. Wireless Comm.*, vol. 10, no. 3, pp. 968-979, Mar. 2011.

Sung, Youngchul

Associate Professor

Member, IEEK / Member, KICS / Senior Member, IEEE

Ph.D., Cornell University (2005)
ysung@ee.kaist.ac.kr
http://wisrl.kaist.ac.kr

Wireless Information Systems Research Laboratory

The research of Wireless Information Systems Research Lab. (WISRL) focuses on signal processing, statistical inference and communication theory with applications to next generation wireless networks and related fields. The research direction of WISRL is two-fold. First, WISRL is trying to advance the fundamental understanding of large signal and information processing networks that will be the main issue of the system area in the future. Second, WISRL is conducting research to improve the performance and devise innovative methods for current and next wireless communication systems.

Next Generation Wireless Networks : In this area, WISRL is conducting research on wireless communication systems and networks from the perspective of commercial applications such as 3G, 3G LTE/4G and Beyond 4G. We are trying to come up with new wireless communication methods or architectures with significant performance improvement. Currently, we are working on challenging problems in multi-user communication systems, and the research achievements include 1) the invention of real-time adaptive algorithms for interference alignment, 2) establishing the relationship among various beamformer design methods for multiuser MIMO interference channels, 3) suggesting a new framework for linear Gaussian relay problem, and 4) invention of a new receiver in-between zero-forcing and MMSE type receivers with superior adaptive performance, etc. (4 is together with Prof. M. Yukawa in Niigata University.)

Theory for Large Information Processing Networks : One of the most important and long-standing open problems in the field of communications and networking is the lack of general theory of large networks. This open problem is closely related to design and commercialization of many types of important wireless networks such as sensor networks, smart grid, etc. In this area, we investigate the possibility of the development of new abstractions and general theory capturing the essence of multi-node large networks. Recently, Youngchul Sung and his colleague investigated large ad hoc sensor networks deployed for statistical inference under 2D stochastic field model using large deviations principle, and obtained the fundamental trade-offs among information, energy and density for such networks to provide guidelines for sensor network design for statistical inference.

KEY ACHIEVEMENTS

[1] Y. Sung, H. V. Poor, and H. Yu, "How much information can one get from a wireless ad hoc sensor network over a correlated random field," *IEEE Tr. Inf. Theory,* vol. 55, no. 6, pp. 2827-2847, June 2009.

[2] Y. Sung, X. Zhang, L. Tong, and H. V. Poor, "Sensor configuration and activation for field detection in large sensor arrays," *IEEE Tr. Sig. Process.,* vol. 56, no. 2, pp. 447-463, Feb. 2008.

[3] J. Lee, H. Yu, Y. Sung and Y. H. Lee, "Adaptive beam tracking for interference alignment in time-varying MIMO interference channels: Conjugate gradient approach," *IEEE. ICASSP, Prague, Czech, May 2011.*

MAJOR ACHIEVEMENTS in 2010/2011

[1] H. Yu and Y. Sung, "Least squares approach to joint beam design for interference alignment in multiuser multi-input multi-output interference channels," *IEEE Tr. Sig. Process.,* vol. 58, no. 9, pp. 4960-4966, Sep. 2010.

[2] J. Park, Y. Sung and H. V. Poor, "On beamformer design for multiuser MIMO interference channels," submitted to *IEEE Tr. Inf. Theory,* Nov. 2010

Yi, Yung

Assistant Professor

Member, KIISE / Member, ACM / Member, IEEE

Ph.D., University of Texas, Austin (2006)
yiyung@ee.kaist.ac.kr
http://lanada.kaist.ac.kr

Laboratory of Network Architecture, Design, and Analysis

The Laboratory of Network Architecture, Design, and Analysis (LANADA in short) was established in August of 2008 by Prof. Yung Yi. LANADA has performed research on futuristic communication networking systems with the theme of starting from fundamental theories and transferring it to practice. Nowadays the communication networking systems have been changed vertically and horizontally at an alarming scale and speed. Horizontally, various network infrastructures such as broadband access networks, wireless cellular/ad-hoc networks, wired core networks, and overlay networks have been evolved and combined together, and also vertically, the division of each layer has become more ambiguous and cross-layer network designs are becoming more and more preferable. LANADA has focused on developing algorithmic and practical solutions of important networking problems, their performance evaluation and analysis over various communication networking systems. We try to start to look at many problems fundamentally from theories and transfer them to practice by developing theory-driven algorithms and protocols.

Recently, we also increase our interest in economic aspects in communication networking systems, and network greening, which start to receive significant attentions these days, and are challenging due to its necessity to view problems from various angles and tools such as stochastic theory, control theory, economic theory, optimization theory, and even biological theory. LANADA has established strong collaboration with other research groups inside and outside Korea, such as SK Telecom, Korea Telecom, North Carolina University, Princeton University, University of Texas at Austin, Microsoft Research lab, and Chinese University of Hong Kong, and strongly recommends the students in our group to visit and jointly research with them. Our lab consists of one postdoctoral research associate, 5 PhD, 7 MS, also a lot of domestic and international collaborators. Our recent research publications appear at various top conferences and journals, such as IEEE Infocom, ACM Mobihoc, ACM Sigmetrics, and IEEE/ACM Transactions on Networking.

KEY ACHIEVEMENTS

[1] Y. Yi and S. Shakkottai, "Hop-by-hop congestion control over a wireless multi-hop network," *IEEE/ACM Tr. Netw,* vol. 15, issue 1, pp. 133-144, Feb. 2007.

[2] Y. Yi and S. Shakkottai, "On the elasticity of marking functions in an integrated network," *IEEE Tr. Auto. Confrol,* vol. 54, issue 2, pp. 323-336, Feb. 2009.

[3] Y. Yi, G. D. Veciana, and S. Shakkottai, "MAC scheduling with lowover heads by learning neighborhood contention patterns," *IEEE/ACM Tr. Netw,* vol. 18, issue 5, pp. 1637-1650, Oct. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] K. Lee, Y. Kim, S. Chong, I. Rhee, and Y. Yi, "Delay-capacity tradeoffs for mobile networks with levy walks and levy flight," *IEEE Info com,* Shanghai, China, Apr. 2011.

[2] K. Son, S. Lee, Y. Yi, and S. Chong, "REFIM: a practical interference management in heterogeneous wireless access networks," *IEEE J. Sel. Areas in Comm.,* vol. 29,no. 6,June 2011.

Youn, Chan-Hyun

Professor

Member, KICS / Member, IEEE

Ph.D., Tohoku University (1994)
chyoun@ee.kaist.ac.kr
http://ancl.kaist.ac.kr

Advanced Network and Computing Laboratory

Advanced Network and Computing Lab. (ANCL), a founder of Grid Middleware Research Center, has been focusing on advanced computing middleware and development of service management system in advanced networks, e.g. next generation network and future Internet. Especially, Grid PQRM (Policy Quorum-based Resource Management) developed through ITRC project for the past 4 years was evaluated as one of the best research projects by the government, Ministry of Education, Science and Technology in 2008. Recently, for developing cloud collaboration technologies, we are studying optimal cloud resource management technologies with dynamic workflow management mechanism: 1) Cloud collaboration for supporting multidisciplinary applications and 2) Mobile cloud technology for providing device- and provider-transparent development infrastructure (Fig. 1). In addition, we are developing collaborative work management that enable transaction processing, job management, and resource monitoring for workflow profile in multi-cloud environment.

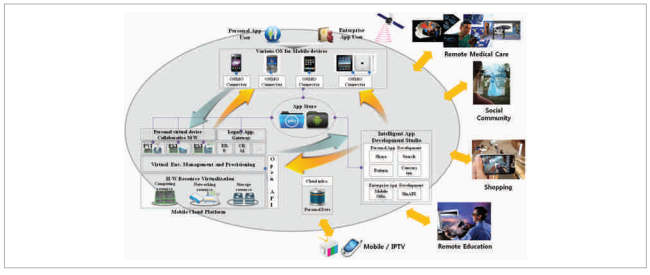


Fig. 1 Mobile Cloud System

As for P3DigiCar, which targets a user-defining car with free installations of CarApp and CarHW, we are developing a middleware which can support resource partitioning technology and verification functions to control the distributed devices and for guaranteeing reliability as well.

We focus on Plug & Play Middleware to control distributed devices (ECUs) in the digital electric car. Especially, ANCL and CORE Lab. (Prof. Kyu Ho Park) are collaborating to develop the Hot-Plug-supported middleware framework and the unified interface which will realize a user-defining car by offering a portable application environment.

KEY ACHIEVEMENTS

[1] C.-H. Youn, E. B. Shim, S. Lim, Y. M. Cho, H. K. Hong, Y. S. Choi, H.-D. Park, and H. K. Lee, "A cooperative metabolic syndrome estimation with high precision sensing unit," *IEEE Tr. Biomedical Eng,* vol. 58, no. 3, pp.809-8013, Mar. 2011.

[2] Y. Han and C.-H. Youn, "A new grid resource management mechanism with resource-aware policy administrator for SLA constrained applications," *Future Generation Comp. Syst.,* vol. 25, no. 7, pp. 768-778, July 2009.

[3] Uk Bin Im, Soon Sung Kwon, Kiwoong Kim, Yong Ho Lee, Yong Ki Park, Chan-Hyun Youn, Eun Bo Shim, "Theoretical analysis of the magnetocardiographic pattern for reentry wave propagation in a three-dimensional human heart model," *Progress in Biophysics and Molecular Biology Elsevior*-Vol 96, pp339 ~ 356, 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y. Moon and C.-H. Youn, "Integrated approach towards adaptive state-tracking job migration for maximizing performance benefit," *Electr. Lett,* vol. 46, no. 25, Dec. 2010.

[2] Xiaohu Ge, Jinzhong Hu, Cheng-Xiang Wang, Chan-Hyun Youn, Jing Zhang, and Xi Yang, "Energy efficiency analysis of MISO-OFDM communication systems considering power and capacity constraints," *Mobile Netw. and Appli,* published online, Feb. 2011.

Research Groups

Emerging Device

The Emerging Device Group investigates new devices and systems that can have significant social and industrial impacts. The group strives to come up with creative and innovative ideas through interdisciplinary research activities involving physics, chemistry, materials science, and the biological sciences. Research activities include six focused fields of research: Nano devices and circuits, bio electronic devices, displays and lighting, green energy devices, lightwaves and optics, and electromagnetic waves and RF.

Through creative and interdisciplinary research, the group is discovering revolutionary new technologies that meet the social needs of such key future-oriented fields as information technology, energy and green environment, and healthcare. Furthermore, the group fosters groundbreaking, futuristic research with the aim of developing the most cutting-edge technologies in its fields of expertise, and in the process is producing elite minds capable of competing at the topmost levels around the world.

Cho, Byung Jin	Professor
Cho, Gyu-Hyeong	Professor
Choi, Kyung Cheol	Professor
Choi, Yang-Kyu	Professor
Eom, Hyo Joon	Professor
Hong, Songcheol	Professor
Kim, Desok	Assistant Professor
Kim, Joungho	Professor
Lee, Chang Hee	Professor
Lee, Hee Chul	Professor
Lee, Kwyro	Professor
Lee, Sang-Gug	Professor
Lee, Seok-Hee	Associate Professor
Lim, Koeng Su	Professor
Myung, Noh-Hoon	Professor
Park, Chul Soon	Professor
Park, Hyo-Hoon	Professor
Park, Seong-Ook	Professor
Ryu, Seung-Tak	Assistant Professor
Shin, Mincheol	Associate Professor
Shin, Sang-Yung	Professor
Won, Yong Hyub	Professor
Yang, Kyounghoon	Professor
Yoo, Hyung-Joun	Professor
Yoo, Seunghyup	Associate Professor
Yoon, Giwan	Professor
Yoon, Jun-Bo	Associate Professor
Yu, Jong-Won	Associate Professor
Yu, Kyuoungsik	Assistant Professor

Cho, Byung Jin

Professor

Member, IEEK / Senior Member, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (1991)
bjcho@ee.kaist.ac.kr
http://nit.kaist.ac.kr

Nano IC Technology Laboratory

Nano IC Technology (NIT) Laboratory has been launched in 2007 by Prof. Byung Jin Cho. Our Research is focused on the development of new technologies for future IC devices based on nano technology. Recent research activities include near term solutions for DRAM and FLASH technology as well as long term solutions for future nano-IC devices such as graphene-based devices and nano energy devices.

For the researches on the near term solution, we developed La doped cubic structured-HfO2 (HfLaO) as a new high-K material which has the highest K value among HfO2 based dielectrics. Together with ZrO2, planar cell capacitors which satisfy 30nm DRAM technology specification were developed. It can be directly applicable to DRAM manufacturing. New La2O3-doped trapping layer for charge trap type Flash memory device was also developed, demonstrating highly improved charge retention property.

Fig. 1 inch size monolayer graphene substrate

For the graphene based electronics, we focus on synthesis of large area high quality graphene and development of device fabrication process. Now, we has world-top level graphene synthesis technology. Other technologies to realize graphene based integrated circuit are being actively studied, including the interaction between graphene and dielectrics, hybrid (organic/inorganic) gate dielectrics, novel graphene field effect device structure, etc.

And, we are developing flexible thin-film thermoelectric module which converts the thermal energy to electric energy, using low-cost thermoelectric materials and a screen printing technique. The performance of the module is comparable to that of commercial module in aspect of cost per watt. In addition, new model was developed to evaluate the thermal conductivity of thick or thin-film thermoelectric materials using by screen printing technique.

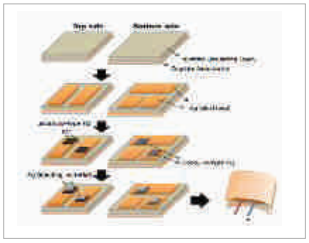


Fig. 2 Flexible thermoelectric module fabricated by screen printing method

KEY ACHIEVEMENTS

[1] B. J. Kang, J. H. Mun, C. Y. Hwang and B. J. Cho, "Mono-layer graphene growth on sputtered thin film platinum" *J. Appl. Phys.*, vol. 106. no. 10, pp. 104309-1-6, Nov. 2009.

[2] National research lab., KOSEF, Sep. 2010.

[3] S. K. Hong, Samsung Human Tech. Award, Samsung electronics, Feb. 2011.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y. Park, J. K. Park, M. H. Song, S. K. Kim, J. S. Oh, M. S. Joo, K. Hong, and B. J. Cho, "Structural and compositional dependence of gadolunum-aluminum oxide for the application of charge-trap-type non-volatile memory devices," *Appl. Phys. Lett.*, vol. 96, no. 7, 052907, Feb. 2010.

[2] S. K. Hong, J. E. Kim, S. O. Kim, S.-Y. Choi, and B. J. Cho, "Flexible resistive switching memory device based on graphene oxide", *IEEE El. Dev. Lett.*, vol. 31, no. 9, pp 1005-1007, Sep. 2010.

Cho, Gyu-Hyeong

Professor

Member, IEEK / Senior Member, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (1981)
ghcho@ee.kaist.ac.kr
http://circuit.kaist.ac.kr

Circuit Design And System Application Laboratory

Circuit Design and System Application Laboratory is established in KAIST in 1984. 9 master course students and 15 doctoral course students in our laboratory are currently enrolled in the list of the graduate course of KAIST. The research and administrative members in our laboratory are led by professor Gyu-Hyeong Cho. Major research areas are focused in designing Analog IC, Power Management IC, Display driver IC and Bio-Chip.

1. Power Management IC (DC-DC Converter)

IC is important in portable electronic devices which get their operation powers from batteries. Power management technology can generate various controlled voltages from a battery which are required for the sub-circuits in the device. SIMO can generate multiple controlled voltages from a single battery with single inductor, which can reduce the size and cost of the DC to DC converters.

2. Class-D Audio Amplifier & Envelop Modulator for polar RF transmitter

Class-D audio amplifier has significant advantages in many applications.(lower power dissipation, circuit board space and cost, extends battery life) Moreover, the combination of class-D, which is the extension of DC/DC converter, and class-AB has been successfully implemented in envelope modulator for polar RF transmitter suitable for EDGE communicational standard by extending the operation speed.

3. Data Drivers for LCD and AMOLED Displays

Our researches in data driver ICs for displays are mainly focused on high resolution and low power-consumption in driving schemes. Another special interest in our research is aiming at AMOLED displays. Innovative driving schemes and dedicated circuits for AMOLED drivers have been developed for fast and accurate AMOLED data driver ICs.

4. Bio-Chip for a biological molecule

In order to analyze a bio-molecule in experiment laboratory currently, complex processes are required. These processes require much time and cost, large size of equipments and work places. Thus our researches are focused on design Diagnosis chip using antigen-antibody reaction, impedance detection chip and FET sensor using surface.

KEY ACHIEVEMENTS

[1] S. T. Ryu, Ray. S, B. S. Song, G. H. Cho, and Bacrania. K, "A 14-b linear capacitor self-trimming pipelined ADC," *IEEE J. Solid-State Circuits,* vol. 39, no. 11, pp. 2046-2051, Nov. 2004.

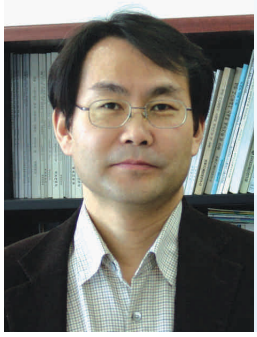
[2] T. W. Kwak, M. C. Lee, and G. H. Cho, "A 2W CMOS hybrid switching amplitude modulator for EDGE polar transmitters," *IEEE J. Solid-State Circuits,* vol. 42, no. 12, pp. 2666-2676, Dec. 2007.

[3] H. P. Le, C. S. Chae, K. C. Lee, S. W. Wang, G. H. Cho, and G. H. Cho, "A single-inductor switching DC-DC converter with 5 outputs and ordered power-distributive control," *IEEE J. Solid-State Circuits,* vol. 44, no. 2, pp. 509-524, Feb. 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y. J. Jeon, J. Y. Jeon, Y. S. Son, J. H, and G. H. Cho, "A high-speed current-mode data driver with push-pull transient current feedforward for full-HD AMOLED displays," *IEEE J. Solid-State Circuits,* vol. 45, no. 9, pp.1881-1895, Sep. 2010.

[2] K. H. Lee, J. O. Lee, M. J. Sohn, B. H. Lee, S. H. Choi, S. K. Kim, J. B. Yoon, and G. H. Cho, "One-chip electronic detection of DNA hybridization using precision impedance-based CMOS array sensor," *Biosensors and Bioelectronics,* vol. 25, no. 4, pp. 1373-1379, Dec. 2010.



Choi, Kyung Cheol

Professor

Member, KIDS / Member, IEEE / Member, MRS / Member, SID

Ph.D., Seoul National University (1993)
kyungcc@ee.kaist.ac.kr
http://adnc.kaist.ac.kr

Advanced Display and Nano Convergence Laboratory

The Advanced Display & Nano Convergence Lab. (ADNC) is focusing its research on new technologies for displays, especially flexible and transparent photoluminescent display devices.

The evolution of information display devices is one of our core research fields. We expect to see huge demand in the near future for new display devices, particularly transparent displays and flexible displays.

Fig. 1 Flexible transparent photoluminescent display

We have fabricated a prototype of a flexible transparent photoluminescent plasma display, and we are undertaking more research on the detailed design structures and development of the fabrication process in order to improve the device's reliability and electrical performances.

Fig. 2 Transparent barrier ribs for the flexible substrate

Incorporating nanotechnology into next- generation displays is one of our key objectives. Surface plasmon resonance (SPR) which occurs in sub-wavelength scaled metal structures, is a promising new nano- technology. Our studies have confirmed that nanoscale metal structures can improve conventional displays and, for that reason, we are currently researching the use of SPR in novel display modes.

Two research centers associated with ADNC Lab are assisting with these studies, and there is greater opportunity for wider industrial collaboration. The center for Advanced Flexible Display Convergence (CAFDC) was chosen as an engineering research Center by the National Research Foundation of Korea (NRF). And the KAIST-LG Display center was established in September 2010 with the aim of developing next generation displays.

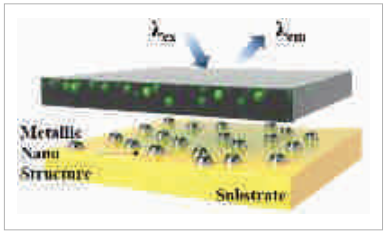


Fig. 3 Light enhancement by LSPR, Appl. Phys. Lett. 2010

Fig. 4 Surface plasmon mediated Photoluminescence

KEY ACHIEVEMENTS

[1] K. Y. Yang, K. C. Choi, and C. W. Ahn, "Surface plasmon-enhanced energy transfer in an organic light-emitting device structure," *Opt. Express,* vol. 17, no. 14, pp. 11495-11504, July 2009.
(selected for Technology Focus in Nature Photonics, vol. 3, p443, Aug. 2009)

[2] K. Y. Yang, K. C. Choi, and C. W. Ahn, "Surface plasmon-enhanced spontaneous emission rate in an organic light-emitting device structure: cathode structure for plasmonic application," *Appl. Phys. Lett.,* vol. 94, no. 173301, pp. 173301, Apr. 2009.

[3] S. H. Kim, C. Jang, K. J. Kim and K. C. Choi, "Improvement of reliability of a flexible photoluminescent display using organic-based material," *IEEE Tr. Elec. Dev.* 2010, vol. 57, no.10, pp. 2644-2650, Oct. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S. M. Lee and K. C. Choi, "Enhanced photoluminescence of BaMgAl10O17:Eu2+ by localized surface plasmon resonance of silver particles," *Optics Express,* vol. 18, no. 12, pp. 109-112, June 2010.

[2] K. H. Cho, S. I Ahn, S. M. Lee, and K. C. Choi, "Surface plasmonic controllable enhanced emission from the intrachain and interchain excitons of PLEDs," *Appl. Phys. Lett.,* vol. 97, no. 19, pp. 193306-1-3, Nov. 2010.

Choi, Yang-Kyu

Professor

Ph.D., University of California, Berkeley (2001)
ykchoi@ee.kaist.ac.kr
http://nobelab.kaist.ac.kr

Nano-Oriented-Bio-Electronics Laboratory

Nano-Oriented Bio-Electronics Laboratory (NOBEL) mainly focuses on two different branches; 1) research for fusion of nano- and bio-technology and 2) development of exploratory devices.

In the field of bio research, a silicon nanowire field effect transistor (FET) mounted with a double-gate structure was demonstrated for biosensor applications. The separated double-gates, G1 (primary) and G2 (secondary), allow for independent voltage control in modulating the channel potential. Therefore, the detection sensitivity was enhanced by the use of G2. By applying a weak positive bias to G2, the sensing window was significantly broadened compared to the conventional case where only G1 is employed. The charge effect arising from biomolecules was also analyzed. Double-gate nanowire FET can pave the way for electrically operating biosensors without labeling processes.

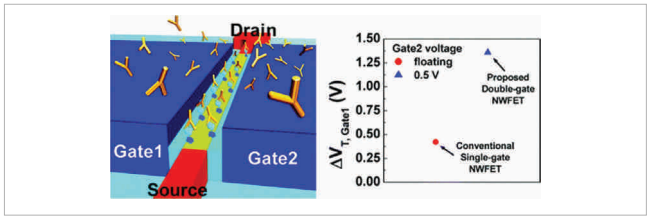


Fig. 1 Schematic of the double-gate nanowire biosensor and its bio-sensing characteristics

NOBEL has also focused on developing Si-based exploratory devices. We demonstrated a transformable silicon nanowire (SiNW) field effect transistor (FET) through a wafer-scale top-down approach. By successfully taking advantage of the proposed electrostatic SiNW-FET with mechanically movable SiNWs, we have learned that all essential logic gates, including address decoders, can be monolithically integrated into a single device. The integration of various functional devices, such as pn-diodes, FETs, logic gates, and address decoders, can eliminate the complex fabrication issues associated with nanoscale integrations. The above results represent a step toward the creation of multifunctional and flexible nanoelectronics.

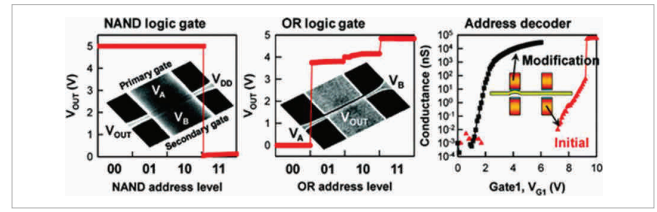


Fig. 2 Schematic of the transformable functional SiNW-FET and its logic operations (NAND, OR, and decoder)characteristics

KEY ACHIEVEMENTS

[1] Y.-K. Choi, N. Lindert, P. Xuan, S. Tang, D. Ha, E. Anderson, T.-J. King, J. Bokor, and C. Hu, "Sub-20nm CMOS FinFET technologies," *IEEE Int. Elec. Devices Meeting*, Washington, USA, Dec. 2001.

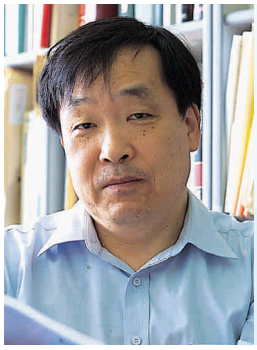
[2] Y.-K. Choi, T.-J. King, and C. Hu, "Nanoscale CMOS spacer FinFET for the terabit era," *IEEE Electron Device Lett.*, vol. 23, no. 1, pp. 25-27, Jan. 2002.

[3] H. Im, X.-J. Huang, B. Gu, and Y.-K. Choi "A dielectric-modulated field-effect transistor for biosensing," *Nat. Nanotechnol.*, vol. 2, pp. 430-434, June 2007.

MAJOR ACHIEVEMENTS in 2010/2011

[1] J.-H. Ahn, S.-J. Choi, J.-W. Han, T. J. Park, S. Y. Lee, and Y.-K. Choi, "Double-gate nanowire field effect transistor for a biosensor," *Nano Lett.*, vol. 10, no. 8, pp. 2934-2938, July 2010.

[2] S.-J. Choi, J.-H. Ahn, J.-W. Han, M.-L. Seol, D.-I. Moon, S. Kim, and Y.-K. Choi, "Transformable functional nanoscale building blocks with wafer-scale silicon nanowires," *Nano Lett.*, vol. 11, no. 2, pp. 854-859, Jan. 2011.



Eom, Hyo Joon

Professor

Fellow, KAST / Member, IEEK / Senior Member, IEEE

Ph.D., University of Kansas (1982)
hjeom@ee.kaist.ac.kr
http://eom.kaist.ac.kr

Electromagnetic Wave Laboratory

The Electromagnetic Wave Laboratory is aimed at the development of new analytic solutions to electromagnetic problems. Our research activities cover a wide range of electromagnetics and microwave engineering. The research topics include electromagnetic wave scattering, antennas, and waveguides.

We are mainly interested in the study of electromagnetic scattering, diffraction, and radiation problems. We solve the problems by using the Fourier transform and mode matching technique. We are also interested in the area of electromagnetic interference and compatibility (EMI/EMC), electrostatic/magnetostatic problems, and acoustic problems.

We have been performing various projects supported by govermental organizations. We analyzed the radiation properties of the leaky wave antennas and Vivaldi slot antennas. We developed the solution tool of EMI problems. Also we worked on the project of the corrugated circular waveguide and EMI software supported by various government research establishment. The development of a new mathematical technique for wave scattering and diffraction is the goal of the Electromagnetic Wave Laboratory.

KEY ACHIEVEMENTS

[1] H. H. Park and H. J. Eom, "Electromagnetic penetration into a rectangular cavity with multiple rectangular apertures in a conducting plane," *IEEE Tr. Electromagn. Compat.*, vol. 42, no. 3, pp. 303-307, Aug. 2000.

[2] J. K. Park, J. N. Lee, D. H. Shin and H. J. Eom, "A full-wave analysis of a coaxial waveguide slot bridge using the Fourier transform technique," *J. Electromagn. Waves Applic.*, vol. 20, no. 2, pp. 143-158, Feb. 2006.

[3] Y. H. Cho and H. J. Eom, "Analysis of a ridge waveguide using overlapping T-blocks," *IEEE Tr. Microwave Theory Tech.*, vol. 50, no. 10, pp. 2368-2373, Oct. 2002.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y. S. Lee and H. J. Eom, "Field penetration into a circular aperture pierced by a long cylinder," *IEEE Tr. Antennas Propagat.*, vol. 58, no. 11, pp. 3734-3737, Nov. 2010.

[2] H. J. Eom, J. J. Kim, and J. S. Ock, "Higher-order modes for broadside-coupled striplines in a shield," *Radio Science*, vol. 45, RS4002, July 2010.

Hong, Songcheol

Professor

Ph.D., University of Michigan (1989)
schong@ee.kaist.ac.kr
http://weis.kaist.ac.kr

Wave Embedded Integrated Systems Laboratory

Research area of WEIS(Wave Embedded Integrated Systems) Laboratory covers RF transceiver for wireless communication and RADAR systems. There are two groups that dedicate to each research topic: FT(Future Transceiver) and SOAC(System-On-A-Chip).
The main topics of FT group are a CMOS power amplifier and digital-RF transmitter, which are the most important issue that determines the performance of various mobile handset applications. Recently, many efforts have been made to improve the efficiency of a power amplifier which consequently affects the life-time of a cell-phone battery. Digital-RF transmitter is the new research area which will lead to the increased flexibility, programmability and better tolerance against PVT variation.

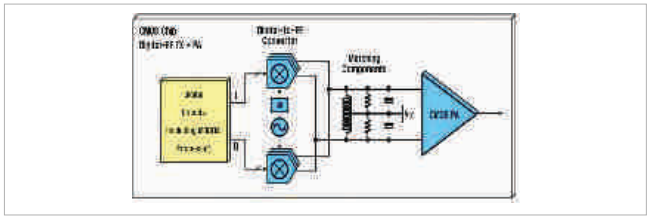


Fig. 1

Another research group, SOAC, focuses on sensor system using miniaturized RADAR. This group has pursued studies of RADAR systems, which can be applied to various industries, based on the Si semiconductor design technology. SOAC group is mainly interested in RF front-end of miniaturized RADAR. RADAR sensor system detects the position(range, angle) and the velocity of an target by echo signal returning from the target. This group has been studied remote bio-sensor which extracts heart-beat and respiration signals and image sensor which can get the information of distance and shape of an object for the application of the robot vision.

Fig. 2

KEY ACHIEVEMENTS

[1] D. Hah, E. Yoon, and S. Hong, "A low-voltage actuated micromachined microwave switch using torsion springs and leverage," *IEEE Tr. Microw. Theory and Tech.*, vol. 48, no. 12, pp. 2540-2545, Dec. 2000.

[2] T. Song, H. Oh, E. Yoon, and S. Hong, "A low-power 2.4-Ghz current-reused receiver front-end and frequency source for wireless sensor network," *IEEE J. of Solid-State Circuits*, vol. 42, issue 5, pp. 1012-1022, May 2007.

[3] D. Baek, S. Ko, J. Kim, D. Kim, and S. Hong, "Ku-band InGaP-GaAs HBT MMIC VCOs with balanced and differential topologies," *IEEE Tr. Microw. Theory and Tech.*, vol. 52, no. 4, pp. 1353-1359, Apr. 2004.

MAJOR ACHIEVEMENTS in 2010/2011

[1] B. Ku and S. Hong, "6-bit CMOS digital attenuators with low phase variations for X-band phased array systems," *IEEE Tr. Microw. Theory and Tech.*, vol. 58, no. 7, pp. 1651-1663, Aug. 2010.

[2] J. Paek and S. Hong, "A 29dBm 70.7% PAE injection locked CMOS power amplifier for PWM digitized polar transmitter," *IEEE Microw. Wireless Compon. Lett.*, vol. 20, no. 11, pp. 637-639, Nov. 2010.

Kim, Desok

Assistant Professor

Member, IEEE

Ph.D., University of North Carolina (1993)
kimdesok@ee.kaist.ac.kr
http://vega.kaist.ac.kr/~kimdesok

Quantitative Medical Imaging and Analysis Laboratory

Our research mainly focuses on the development of quantitative techniques for medical images and signals. We have been improving clinical diagnosis techniques that conventionally rely on the visual interpretation of digital images or signals from subjects. Research techniques include signal/image processing, feature calculation, and pattern recognition that can be eventually applicable to the development of novel computer aided diagnosis or detection (CAD).

Due to the advancement of automated microscopes, a whole histologic tissue slide can be digitized within several tens of minutes, producing vast amount of image data. Since the visual interpretation of these large images by pathologists can be tiresome and costly, a fully automated analysis of these images is highly anticipated. Recently, we have developed images analysis methods that successfully identified malignant tissue areas from prostate or breast cancer slides at the accuracy greater than 90%.

Bone implant integration has been actively investigated to design a better dental implant. Histologic analysis is a common method to validate a new implant design that involves the animal experimentation. We have shown the early changes of bone intensity and complexity using longitudinally obtained intraoral X-ray images of implant patients. Based on this result, we are developing three dimensional image analysis methods to obtain more comprehensive bone healing information from computed tomography. Our approach became feasible due to the recent development of an experimental implant that does not create the X-ray beam hardening artifact.

Stroke is the number one cause of elderly disability. Prior to clinical stroke attacks, a patient may have several transient "mini strokes" that should affect the parts of the brain that regulates heart rates. Thus, the long term variation of heart rates or their associated patterns may indicate the increased chance for having a stroke among elderly subjects with stroke risk factors such as cardiac diseases or high blood pressures. Through implementation of a mobile healthcare system that consists of an ECG sensor, a smart phone, and a data server, we are tying to improve the long term monitoring of abnormal heart rhythms.

KEY ACHIEVEMENTS

[1] D. Choi, W. Lee, D. Kim, and B. Lee, "Radiologic study of the healing process of the extracted socket of beagle dogs using cone beam CT," *Kor. Acad. Oral M. Radiol.*, vol. 39, pp. 19-25, 2009.

[2] J. Kim, W. Lee, K. Kim, Y. Roh, D. Kim, and B. Lee, "Quantitative analysis of periapical lesions on cone beam computed tomograph and periapical radiograph," *Kor. Acad. Oral M. Radiol.*, vol. 39, pp. 41-49, 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Desok Kim, Hyekyung Jeong, Minjin Kim, Changick Kim, Byung-Do Lee, "Multiscale Image Analysis for the Quantitative Evaluation of Periapical Lesion Healings," CISP'10-BMEI'10, October 16-18, 2010, Yantai, China.

[2] Minjin Kim, Hyekyung Jeong, Wonjun Kim, Han Kyul Kim, Desok Kim, and Byung-Do Lee, "Radiographic Analysis of Peri-Implant Trabecular Bones After Implant Placement," CISP'10-BMEI'10, October 16-18, 2010 , Yantai, China.

Kim, Joungho

Professor

Ph.D., University of Michigan (1993)
joungho@ee.kaist.ac.kr
http://www.tera.ac.kr

Terahertz Interconnection and Package Laboratory

The research of Terahertz Interconnection and Package Laboratory (TERA Lab.) focuses on Three-dimensional Integrated Circuit (3-D IC) system. Interconnection and I/O density have dramatically increased, as the demands of high performance and small electronic devices increase. Therefore, it is getting more important to integrate various functional ICs in one small united system. 3-D IC using vertical interconnection is powerful solution to increase packaging density and system performance simultaneously. Also, Through Silicon Via (TSV) is a core technology which provides a vertical interconnection with greatly reduced interconnect length among stacked dies as shown in Figure 1.

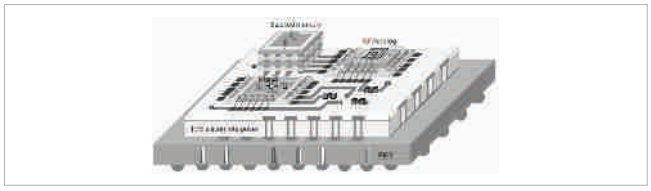


Fig. 1 TSV silicon interposer of 3-D IC

The research of 3-D IC design has three main directions. First, 3-D IC design is focusing on Signal Integrity (SI) with considering Loading effect, Reflection, crosstalk and jitter. Second, 3-D IC system is design for Power Integrity (PI). Because simultaneous switching noise causes insufficient power, power integrity has an effect on consumption of power. Finally, in view of EMI, 3-D IC designs. In vertical connection between dies, the problem of EMI coupling comes up. Also, 3-D IC designs with considering routability for interconnects and thermal reliability issues.

Especially, because of capacitive and lossy characteristic of TSV, TERA Lab. conducts research to aspects of SI. and PI. TERA Lab has focused on electrical modeling of TSV and analysis of crosstalk issues. Achievement of TERA Lab. in 2010-2011 were proposing TSV model and analyzing TSV channel and TSV effect on power distribution network (PDN) in 3-D IC to guarantee SI. and PI. By using these achievements, TERA Lab. developed design methodologies for advanced 3-D IC design.

KEY ACHIEVEMENTS

[1] J. W. Lee, Y. J. Park, M. H. Kim, C. Yun, J. H. Kim and K. H. Kim, "System-on-package ultra-wideband transmitter using CMOS impulse generator," *IEEE Tr. Microwave Theory and Techniques*, vol. 54, no. 4, pp. 1667-1674, June 2006.

[2] J. B. Park, H. S. Kim, Y. C. Jeong, J. O. Kim, J. S. Park, D. G. Kam and J. H. Kim, "Modeling and measurement of simultaneous switching noise coupling through signal via transition," *IEEE Tr. Advanced Packaging.*, vol. 29, no. 3, pp. 548-559, Aug. 2006.

[3] D. G. Kam and J. H. Kim, "40-Gbps package design using wire-bonded plastic ball grid array," *IEEE Tr. Advanced Packaging*, vol. 31, no. 2, pp. 258-266, May 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] J. H. Kim, J. H. Cho, and J. H. Kim, "TSV modeling and noise coupling in 3D IC," *Electronics System Integration Technology Conference ESTC 2010 in Berlin.*, Berlin, Germany, Sep. 2010.

[2] J. S. Park, J. H. Kim, J. H. Cho, H. G. Kim, and J. H. Kim, "Electrical performance of 3D TSV channel and 3D stacked PDN based on hierarchical models," *2011 Design, Automation & Test in Europe Conference.*, Grenoble, France, Mar. 2011.

Lee, Chang Hee

Professor

Fellow, IEEE / Member, IEEK / Member, KICS / Member, OSA

Ph.D., Korea Advanced Institute of Science and Technology (1989)
chl@ee.kaist.ac.kr
http://photonet.kaist.ac.kr

Photonics Networks Research Laboratory

Quadruple play services, converged service of voice, data, wireless, and video will play a key role in the future access networks. The quality of video information improves continuously, such as HD(High Definition) and 3D video. Hence information to each person or home is increasing dramatically and consistently. To accommodate this large amount of bandwidth, a new optical communication system like fiber-to-the home(FTTH) based on a passive optical network(PON) is required. A WDM (Wavelength Division Multiplexing)-PON is considered to be the ultimate goal of the access networks, since it can deliver almost unlimited dedicated bandwidth with protocol transparency.
Photonic Networks Research Laboratory (PNRL) has been focusing on investigating enabling technologies for optical access network such as WDM-PON including high-speed WDM-PON based on wavelength-locked Fabry-Perot Laser Diodes. The world first commercial WDM-PON was suggested by PNRL, and adopted to Korea, USA and Europe. To make WDM-PON reliable and field deployable, protection methods and the low noise BLS based on mutually injected F-P LDs with RF modulation were investigated. We also proposed an evolution scenario from the existing Time Division Multiplexing-PON (TDM-PON) to WDM-PON with video overlay and a remotely reconfigurable remote node (RN) to provide next generation services (WDM-PON) from legacy services (TDM-PON). Moreover, we derived theoretical model of wavelength-locked F-P LD to understand physical mechanism clearly.
PNRL has succeed 2.5Gb/s transmission, and keep researching to transmit 5Gb/s and 10Gb/s without additional signal processing. Recent research topics are development of low noise multi-wavelength, light source, noise suppressed transmission, and increase of the number of channels. In additions, broadcasting in WDM-PON is actively investigated. Finally, plug and play with tunable laser is studying for very high speed of long reach WDM-PON.

KEY ACHIEVEMENTS

[1] H. D. Kim, S.-G. Kang, and C.-H. Lee, "A low-cost WDM source with an ASE injected Fabry-Perot semiconductor laser," *IEEE Photonics Technology Letters,* vol. 12, no. 8, pp. 1067-1069, Aug. 2000.
[2] S.-J. Park, C.-H. Lee, K.-T. Jeong, H.-J. Park, J.-G. Ahn, and K.-H. Song, "Fiber-to-the-home services based on wavelength-division-multiplexing passive optical network," *IEEE J. Lightwave Technology,* vol. 22, no. 11, pp. 2582-2591, Nov. 2004.
[3] C.-H. Lee, W. V. Sorin, and B. Y. Kim, "Fiber to the home using a PON infrastructure," *IEEE J. Lightwave Technology,* vol. 24, no. 12, pp. 4568-4583, Dec. 2006.

MAJOR ACHIEVEMENTS in 2010/2011

[1] H.-K. Lee, H.-S. Cho, J.-Y. Kim, and C.-H. Lee, "A WDM-PON with an 80 gb/s capacity based on wavelength-locked Fabry-Perot laser diode," *Opitcs Express,* vol. 18, no. 17, pp. 18077-18085, Aug. 2010.
[2] J.-Y. Kim, H.-S. Cho, S.-G. Mun, H.-K. Lee, and C.-H. Lee, "High capacity DWDM-PON using triple contact F-P LDs," *IEEE Photonics Technology Letters,* vol. 23, no. 2, pp. 127-129, Jan. 2011.

Lee, Hee Chul

Professor

Member, IEEE / Member, JJSAP

Ph.D., Tokyo Institute of Technology (1989)
hclee@ee.kaist.ac.kr
http://irislab.kaist.ac.kr

Infrared Image Sensor Laboratory

Infrared Detector is the main research theme of IRIS (InfraRed Image Sensor) LAB. We focused on the cooled type infrared sensor before 2005, and transition to the uncooled type has been made after then. Our research result has led to the beginning of an infrared camera venture company, I3system, whose CEO is the 1st Ph.D. alumni of IRIS LAB.

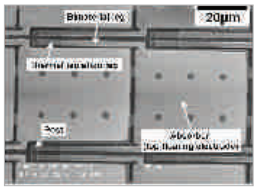


Fig. 1 IRIS Capacitive IR Sensor

Now, we are focusing on the uncooled infrared detectors which are expected to be used more widely than the cooled one for their low price and reasonable performance. Currently, the infrared sensor team in our laboratory is studying about the novel bolometer material and the micro-cantilever type capacitive IR sensor which uses bi-material effect (fig.1). The former is under brisk researches whereas the latter is at the finishing step.
Along with our IR sensor research, the packaging team in our laboratory is focusing on the vacuum package for infrared sensor. To prevent thermal loss and to enhance the responsivity of infrared sensor, the vacuum packaging becomes a key technology. Besides, the packaging is the most expensive part of the infrared sensor fabrications. Thus we are studying about wafer level vacuum package with high IR transmission and high vacuum level for low cost sensor package.
IRIS Lab. also researches the radiation hardness for aerospace electronics. Radiation damage on integrated circuit due to an incident energetic particle causes functional failure of the electronic device and bit flip in memory device. The radiation hardening of Si integrated circuit for aerospace electronics is investigated through consideration of radiation TID(Total Ionizing Does) damage and SEE(Single Event Effect) damage by a cosmic ray or particles in van Allen belt. To minimize the radiation damage, the hardening work should be performed at both cell level and circuit level. We are researching device simulations for evaluating effectiveness of a proposed rad-hard MOSFET structure designed by layout modification technique, and circuit design solutions for high performance rad-hard ICs.

KEY ACHIEVEMENTS

[1] J. K. White, C. A. Musca, HC. Lee, and L. Faraone, "Hydrogenation of ZnS passivation on narrow-band Gap HgCdTe," *Appl. Phys. Lett.,* vol. 76, no. 17, Arp. 2000.
[2] YH. Kim, TS. Kim, D.A. Redfern, C.A. Musca, HC. Lee and CK. Kim, "Characteristics of gradually doped LWIR diodes by hydrogenation," *J. Electronic Materials,* vol. 29, no. 6, pp. 859-864, June 2000.
[3] BH. Kim and HC. Lee, "Smart TDI Readout Circuit for Long-wavelength IR Detector," *Electronics Lett.,* vol. 38, no. 16, pp. 854-855, Aug. 2002.

MAJOR ACHIEVEMENTS in 2010/2011

[1] WY. Kim, DY. Ka, DS. Kim, IW. Kwon, SY. Kim, YS. Lee, and HC. Lee, "Internal bias field in ferroelectric polymer thin film for nonvolatile memory applications," *IEEE Electron Device Lett.,* vol. 31, no. 5, pp. 482-484, May 2010.
[2] DS. Kim, IW. Kwon, YS. Lee, and HC. Lee, "The bolometric characteristic of thermally oxidized thin nickel film for an uncooled infrared image sensor," *Infrared Physics and Technology,* vol. 54, pp.10-12, Jan. 2011.

Lee, Kwyro

Professor

Member, NAEK / Member, IEEK / Senior Member, IEEE

Ph.D., University of Minnesota (1983)
krlee@ee.kaist.ac.kr
http://wpcl.kaist.ac.kr

Wireless PHYsical layer COMmunication Laboratory

The research of Wireless PHYsical layer COMmunication Lab. (WPCL) focuses on wireless physical layer communication system, which includes both the RF and baseband analog/digital circuitry, specifically the low power CMOS circuit design. In addition to R&D, we are highly emphasizing high-tech entrepreneurship.
The recent R&D topic is the development of multi-band / multi-mode programmable radio receivers and SAW-less RF transceiver for SDR (software defined radio). Modern cellular phone is supposed to have more than 10 radios, composed of several cellular, several mobile TV, and WLAN, Bluetooth, RF-ID, and so forth. The above technology is possible when the challenges of broadband matching, wide band selectivity/sensitivity, a sufficient gain with wide bandwidth, a high linearity, a small noise is settled nicely. It is a great challenge to provide this with acceptable performance with the smallest form factors and cost. To provide solution for the several challenges, based on double-conversion TV tuner IC development using silicon BiCMOS in early 1990°Øs, Kwyro Lee and his colleagues have invented many novel ideas such as, highly linear CMOS circuits using multiple gated transistor (MGTR) technique, CMOS complementary parallel push-pull (CCPP) amplifier, polylithic integration of SAW reference oscillator, and image rejection with digital compensation, etc. Our research team have successfully developed a 2.4GHz single-chip transceiver radio for ZigBee / IEEE 802.15.4 applications among wireless personal area network (WPAN) standards, and the developed radio chip is utilized to implement a health monitoring MICROS system. Our recent research includes user interface (UI) technology for a mobile information device in the future. Touch sensors, sensing algorithms and modeling, and feedback techniques are the main issues. Using mutual capacitive sensing method, we have developed the high performance CMOS touch sensor read-out IC (ROIC).

KEY ACHIEVEMENTS

[1] P. Choi, H. Park, S. Kim, S. Park, I. Nam, T. Kim, S. Park, S. Shin, M. Kim, K. Kang, Y. Ku, H. Choi, S. Park, and K. Lee, "An experimental coin-sized radio for extremly low-power WPAN (IEEE 802.15.4) application at 2.4 GHz," *IEEE J. Solid-State Circuits,* vol. 38, no. 12, pp. 2258-2268, Dec. 2003.

[2] T. Kim, B. Kim, and K. Lee, "Highly linear receiver front-end adopting MOSFET transconductance linearization by multiple gated transistor," *IEEE J. Solid-State Circuits,* vol. 39, no. 1, pp. 223-229, Jan. 2004.

[3] K. Lee, I. Nam, I. Kwon, J. Gil, K. Han, S. Park, and B. Seo, "The impact of semiconductor technology scaling on CMOS RF and digital circuits for wireless applications," *IEEE Tr. Electronic Devices,* vol. 52, no. 7, pp. 1414-1422, July 2005.

MAJOR ACHIEVEMENTS in 2010/2011

[1] E. Kim, K. Lee, and J. Ko, "An isolator-less CMOS RF front-end for UHF mobile RFID reader," in Proc. *IEEE Int. Solid-State Circuits Conf. Tech. Dig. Tech. Papers,* San Francisco, CA, Feb. 2011, pp. 456-458.

[2] D. Im, I. Nam, and K.Lee, "A CMOS active feedback balun-LNA with high IIP2 for wideband digital TV receivers," *IEEE Tr. Microw. Theory Tech.,* vol. 58, no. 12, pp. 3566-3579, Dec. 2010.

Lee, Sang-Gug

Professor

Member, IEEK / Member, KICS / Member, IEEE

Ph.D., University of Florida (1992)
sglee@ee.kaist.ac.kr
http://u-radio.kaist.ac.kr

Micro-Radio Laboratory

Micro-Radio Laboratory (μ-Radio LAB) has focused on CMOS Integrated Circuit design since 1998. The main research area consists of RF front-end, Baseband analog, Mixed-mode(Synthesizer, ADC/DAC), High speed optical circuits and Digital calibration techniques. The Lab's research topics include DTV tuner, Impulse-Radio UWB (IR-UWB) radar, Wake-up receiver, mobile communication, Digital RF system, Display semiconductor, Energy harvesting, THz device etc. Some of the research details are as follows.

[Digital TV Tuner] In line with digital convergence on video and TV technology, u-Radio laboratory has made persistent effort in DTV tuner IC development and developed DVB-T/DVB-H dual band tuner and ISDB-T tuner. Now the research phase moves to multi-standard DTV tuner development which covers ATSC, DVB-T, DVB-C, and Open-Cable.

[Impulse Radio UWB Radar] μ-Radio laboratory developed low-power IR-UWB transceiver for IEEE 802.15.4a standard and low-power, low-cost, and low-complexity IR-UWB radar for movement detection.

[Wake-Up Receiver] Low power consumption is one of major design issues in wireless sensor networks due to the limited battery. The key issues are ultra-low power consumption, extremely short latency, and reliability. μ-Radio laboratory has developed a few μA current consumption Wake-up receiver passing by three-time design experiences.

[THz Device] THz devices is difficult to implement neither in electronic nor in photonic. However, the importance of THz technology is getting higher because of its unique characteristic and wide application to medical, environment, communication, etc. μ-Radio laboratory develops CMOS THz device such as THz VCO, Schottky Barrier Diode, Plasma wave detector, transmission line, etc.

[Energy Harvesting] The dependence on the battery as the only power source is putting an enormous burden in applications such as wireless micro-sensor network, implantable medical electronics due to size, weight, safety or lifetime constraints. μ-Radio laboratory research about vibration energy harvesting from the environment and transforming into electrical energy.

KEY ACHIEVEMENTS

[1] J.P. Hong and S.G. Lee, "Low phase noise Gm-boosted differential gate-to-source feedback colpitts CMOS VCO," *IEEE J. Solid-State Circuits,* vol. 44, no.11, pp.3079-3091, Nov. 2009.

[2] H.L. Thai, H.H. Nguyen, H.N. Nguyen, H.S. Cho, J.S. Lee, and S.G. Lee, "An IF band-pass filter based on a low distortion transconductor", *IEEE J. Solid-State Circuits,* vol.45, no.11, pp. 2250-2261, Nov. 2010.

[3] J.P. Hong and S.G. Lee, "Gm-boosted differential drain-to-source feedback colpitts CMOS VCO," to be appeared in *IEEE Tr. Microwave Theory and Techniques,* 2011.

MAJOR ACHIEVEMENTS in 2010/2011

[1] H.H. Nguyen, H.N. Nguyen, J.S. Lee, and S.G. Lee, "A high-linearity low-noise reconfiguration-based programmable gain amplifier", *ESSCIRC,* pp. 166-169, Sep. 2010.

[2] Y. Sun, C.J. Jeong, I.Y. Lee, J.S. Lee, and S.G. Lee, "A 50-300-MHz low power and high linear active RF tracking filter for digital TV tuner ICs", *IEEE Custom Integrated Circuits Conference,* Sep. 2010.

Lee, Seok-Hee

Associate Professor

Ph.D., Stanford University (2001)
seokheelee@ee.kaist.ac.kr
http://ndl.kaist.ac.kr

Nano Devices Laboratory

Nano Devices Lab. (NDL) focuses on nano scaled CMOS devices and processing. The research topics include high mobility channel device, 22nm Logic transistor device/ processing development, DRAM cell transistor, thermoelectric and spintronics. Ultimately, NDL pursues the realization of high performance transistors with extremely small feature size, which can lead the worldwide technological trend.

Beyond 22nm technology : Nowadays, conventional Si-based planar devices cannot provide high-enough performance because of its intrinsic limitations. 3-D structure, FinFET & nanowire, and germanium channel devices are under research in NDL to improve electronic performances such as mobility and gate controllability issues.

DRAM Cell transistor : Conventional planar DRAM has weakness on integration due to the limit on reduction of cell size. Recently, vertical cell structure has been proposed. But there is a problem related with the floating-body effect(FBE) which originates from substrate contact. NDL is currently investigating the FBEs on DRAM vertical transistor and our ultimate goal is to make a new model which includes these FBEs in vertical transistor and improving these effects.

Thermoelectric : Because of energy depletion & environment pollution, thermoelectric devices have become a big issue. Thermoelectric effect is the direct conversion of temperature differences to electric voltage and vice versa. We attempt to use top-down process on manufacturing silicon nanowire thermoelectric devices because the silicon nanowire has ZT value that is larger than that of bulk silicon.

Spintronics : Spintronics has been regarded as the future generation technology. Conventional semiconductor technology only considers electron charge as the information storage unit. However, electron spin can be used as a new unit of information storage and spintronics is the research area that explores this topic. Using spintronics, we can make devices which consumes lower power and higher performance.

KEY ACHIEVEMENTS

[1] C. Jan, S. Lee, Y. Zhang, and P. Bai, "A 32nm SoC platform technology with 2nd generation high-k/metal gate transistors optimized for ultra low power, high performance, and high density product applications," Tech. Dig. *IEEE Intern. Elec. Dev. Meet.,* Baltimore, MD USA, p.647-650, Dec. 2009.

[2] P. Packan, S. Lee, Y. Luo, S. Natarajan, "High performance 32nm logic technology featuring 2nd generation high-k + metal gate transistors," *Tech. Dig. IEEE Intern. Elec. Dev. Meet.,* Baltimore, MD USA, p.659-662, Dec. 2009.

[3] S. Pae, S. Lee, A. St. Amour, and B. Woolery, "Reliability characterizations of 32nm high-k and metal-gate logic transistor technology," *IEEE Intern. Rel. Phys. Symp., Anaheim,* CA USA, pp.287-292, May 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y. Shin, K. Min, S. Lee, S. Lim, J. Oh, K. Lee, K. Hong, and B. Cho, "Crystallized HfLaO embedded tetragonal ZrO2 for dynamic random access memory capacitor dielectrics," *Applied Physics Letter,* vol. 98, no. 173505, Mar. 2011.

[2] J. Park, Y. Park, S. Lee, S. Lim, J. Oh, M. Joo, K. Hong, and B. Cho, "Mechanism of date retention improvement by high temperature annealing of Al2O3 blocking layer in flash memory device", *Japanese J. Applied Physics,* vol. 50, no. 4, Apr. 2011.

Lim, Koeng Su

Professor

Ph.D., Tokyo Institute of Technology (1984)
kslim@ee.kaist.ac.kr
http://ultrasolar.kaist.ac.kr

Semiconductor Energy Laboratory

The research of Semiconductor Energy Lab (SEL) has been focused on the developing and analyzing new and efficient photo-voltaic devices, low cost solar cell module fabrication methods, transparent conductive oxide, new texturing method and its application. Transparent resistive random access memory (TRRAM) is also investigated.
For the high efficiency thin film solar cell, design of tandem structure is very important. We have protocrystalline silicon solar cell technologies, which show low-degradation characteristics. In the tandem solar cell, the protocrystalline silicon cell could be used as top cell.
For the low-cost thin film silicon solar cell module fabrication, new integration method are developed without laser scribing. We have cluster multiplicity systems for integrated solar cell mini module. With developed new integration method, silicon solar cell layer are not air exposed in the fabrication process, so that we can expect the low-cost high- efficiency solar cell module fabrication.
The fabrication of a fully transparent resistive random access memory (TRRAM) device based on an ITO (indium tin oxide)/ZnO/ITO capacitor structure and its resistive switching characteristics are investigated. The fabricated TRRAM has a transmittance of 81% (including the substrate) in the visible region and an excellent switching behavior under 3 V.
Also, We report the room temperature fabrication of highly transparent and flexible resistive random access memory devices on a flexible substrate. The ITO/Ag/ITO multilayered bottom electrode provides superior flexibility as well as high transparency compared to devices with ITO single bottom electrode during repetitive bending tests. The devices exhibit a high transmittance and the excellent reliability of data retention. Moreover, they show consistent memory performance, even under thermal stress. The results of this study provide a breakthrough solution for the era of transparent and flexible electronic systems in the near future.

KEY ACHIEVEMENTS

[1] S. Myong, S. Kwon, M. Konagai, M. Kondo, and K. Lim, "Inclusion of nanosized silicon grains in hydrogenated protocrystalline silicon multilayers and its relation to stability," *Applied Physics Letters*. vol. 88, No. 8, pp. 083118-083120, Feb. 2006.
[2] J. Kwak, S. Kwon, S.l Park, and K. Lim, "Highly and quickly stabilized p-i-n/p-i-n type protocrystalline silicon multilayer tandem solar cells," *Solar Energy Materials and Solar Cells*, vol. 92, no. 9, pp. 1067-1070, Sep. 2008.
[3] J. Seo, J. Park, J. Yang, S. Kang and K. Lim, "Transparent resistive random access memory and its characteristics for nonvolatile resistive switching," *Applied Physics Letters*, vol. 93, no. 22, pp. 223505-223507, Dec. 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] L. Fang, S. Baik, K. Lim, S. Yoo, M. S대, S. Kang, J. Seo, "Tungsten oxide as a buffer layer inserted at the SnO2 /p-a-SiC interface of pin-type amorphous silicon based solar cells," *Applied Physics Letters*, vol. 96, no. 19, pp. 193501-193504, May 2010.
[2] J. Im, S. Park, J. Jeon, and K. Lim, "Fabrication of microcrystalline silicon solar cells on a SnO2 coated substrate using seed layer insertion," *Solar Energy Materials & Solar Cells*, vol. 95, no. 1, pp. 150-153, May 2010.

Myung, Noh-Hoon

Professor

Ph.D., The Ohio State University (1986)
nhmyung@ee.kaist.ac.kr
http://ett.kaist.ac.kr

Electromagnetic Theory & Technology (ETT) Laboratory

ETT laboratory's main research activities are divided into two groups, electromagnetic wave theory and RF system development.

In the electromagnetic wave theory research group, research topics include development of wave propagation prediction model for next generation mobile system and DTV broadcasting, hybrid analysis technique for wave scattering by inlet geometries, RCS modeling and analysis, target recognition inclusive of radar signal processing. Analysis of electromagnetic signal interference and jamming effect is also one of the main topics in this group.

In the RF system development group, research activities are development of the dual polarized array antenna, active phased array antenna without phase shifter, oscillator design using EBG (electromagnetic band gap), new type of RFID tag antennas, meta-material issues and high integrity wideband SAR front-end.

Representative research topics are following.

- -Development of electromagnetic environment prediction model
- -RCS modeling and analysis
- -Target recognition and motion compensation techniques
- -Active phased array antenna without phase shifters

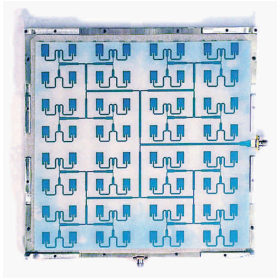


Fig. 1 8 by 8 DBS array antenna

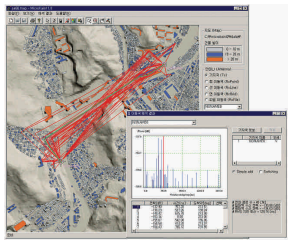


Fig. 2 DRT simulator for 3D ray tracing

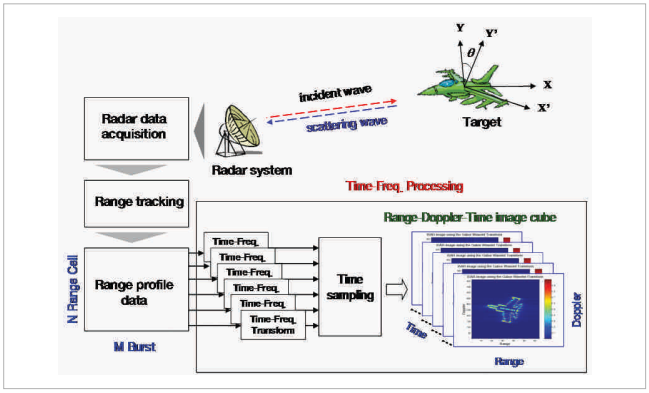


Fig. 3 Motion compensation for ISAR image

KEY ACHIEVEMENTS

[1] H. W. Son and N. H. Myung, "A deterministic ray tube method for microcellular wave propagation prediction model," *IEEE Tr. AP,* vol. 47, no. 8, Aug. 1999.

MAJOR ACHIEVEMENTS in 2010/2011

[1] H. Lim and N. H. Myung, "A novel hybrid AIPO-MoM technique for jet engine modulation analysis," *Progress In Electromag. Research,* vol. 104, pp. 85-97, 2010.

[2] S. H. Lim, J. H. Han, S. Y. Kim and N. H. Myung, "Azimuth beam pattern synthesis for airborne SAR system optimization", *Progress In Electromag. Research* , vol. 106, pp. 295-309, 2010.

Park, Chul Soon

Professor

Ph.D., Korea Advanced Institute of Science and Technology (1985)
parkcs@ee.kaist.ac.kr
http://microlab.kaist.ac.kr

Microwave and Microsystems Laboratory

The Microwave and Microsystems Laboratory (MICROLAB) has focused on researching micro (millimeter) wave circuits and systems. The primary studies being undertaken by the laboratory are the design of RFICs for intelligent radio and millimeter-wave circuits for Gbps high data rate wireless communications, and their implementation to radio systems. These are also the major research objectives of the IREC (Intelligent Radio Engineering Center), which is supported as an ERC (engineering research center), a center-of-excellence program, by MEST (Ministry of Education, Science and Technology) and NRF (National Research Foundation of Korea) since 2005.

An intelligent radio can autonomously adapt its frequency, bandwidth, and modulation to the communication environment; this capability is a core solution for software-defined radio and cognitive radio. The ultimate aim of Microlab's current line of research is to arrive at a universal radio solution with unlimited connectivity in a single CMOS chip. Our research is focused on three major areas: 4G and backward compatibility research for a reconfigurable mobile radio transmitter; a digital radio receiver with low-cost, easy-to-use terminals; and a 60 GHz wireless transceiver with a low-power ultrahigh capacity.

In 2010, we began preliminary research on a digital radio with embedded digital-analog circuits. We successfully demonstrated a reconfigurable transmitter test bed for next-generation wireless communications and a test bed for a wideband RF receiver. In addition, our millimeter-wave CMOS OOK receiver, which is packaged on a LTCC with a patch antenna, was used successfully in a video streaming test with a GaAs OOK transmitter SoP . We are also about to test a CMOS OOK transmitter SoP.

In other initiatives, we have integrated CMOS technology with SOC in the design of a multimode envelope amplifier and a multiband power amplifier for a reconfigurable transmitter. We have also investigated a new band pass delta sigma receiver with a high-speed RF digital-to-analog converter and comparator for use in a digital radio receiver designed with 90 nm CMOS technology. Finally, we are currently researching and designing a single millimeter-wave CMOS chip T/Rx and PLL for use with 90 nm CMOS technology

KEY ACHIEVEMENTS

[1] D. Y. Jung, W. Chang, K. C. Eun, and C. S. Park, "60 GHz system-on-package transmitter integrating sub-harmonic frequency amplitude shift keying modulator," *IEEE Tr. Microw. Theory Tech,* vol. 55, no. 8, pp. 2227-2232, Aug. 2007

[2] Y. S. Noh and C. S. Park, "An intelligent power amplifier MMIC using a new adaptive bias control circuit for W-CDMA applications", *IEEE J. Solid-Stats Circuits,* vol. 39 no. 6, pp. 967-970, 2004

[3] J. H. Kim, J. H. Kim, Y. S. Noh, and C. S. Park, "An InGaP/GaAs HBT MMIC smart power amplifier for W-CDMA mobile handsets", *IEEE J. Solid-Stats Circuits,* vol. 38, no. 6, pp. 905-910, June 2003.

MAJOR ACHIEVEMENTS in 2010/2011

[1] C. W. Byeon, J. J. Lee, K. C. Eun, and C. S. Park, "A 60 GHz 5 Gb/s gain-boosting OOK demodulator in 0.13㎛ CMOS", *IEEE Microw. Wireless Compon. Lett,* vol. 21, no. 2, pp. 101-103, Feb. 2011

[2] S. Y. Kang, J. Y. Jang, I. Y. Oh, and C. S. Park, "A 2.6 mW low power digitally-controlled variable gain amplifier," *IEEE Microw. Wireless Compon. Lett,* vol. 20, no. 3, pp. 172-174, Mar. 2010.

Park, Hyo-Hoon

Professor

Senior Member, IEEE / Senior Member, SPIE

Ph.D., Korea Advanced Institute of Science and Technology (1985)
parkhh@ee.kaist.ac.kr
http://pcs.kaist.ac.kr

Photonic Computer Systems Laboratory

Photonic Computer Systems Laboratory studies to achieve next generation computers in which high speed data are transmitted through photons, instead of electrons. Our research requires creative challenges in wide areas, including design of new architecture for photon-interfaced computer, signal protocol for high speed data transmission between MPU and memory, development of electro-optic hybrid boards, design of low-power consumption interface ICs for electron-photon signal conversion, compact integration of optoelectronic devices, and low cost packaging of optical modules.

We have demonstrated various optical-link platforms based on the electro-optic hybrid boards for computer applications. Optical links of FPGA MPU-to-memory, PCI Express-to-MPU, optical USB-to-MPU were first demonstrated in our laboratory. Signal protocol for optical link between PCI Express and MPU above 5Gb/s was proposed in coorperation with ETRI. Also, first developed the 10Gb/s-level interface ICs possessing versatile functions of bidirectional data transmission, clock distribution and recovery, serialization and deserialization of digital photon signals etc. PCB-compatible electro-optic hybrid boards and cost-effective packaging schemes were developed, incooperation with LG Innotek. From this scheme, we recorded the lowest optical loss below -1dB in the photon-data-transmission through the hybrid board. Based on these achievements, we now move to implement nanophotonics-based computer systems. Especially, Si-photonics-based interface modules and nanophotonic circuits are studied. For practical system applications, we also develops the wireless and optical interconnect combined high speed transmission systems, such as intra-building security networks using HD camera systems.

KEY ACHIEVEMENTS

[1] T.-H. Ngo, T.-W. Lee, and H.-H. Park, "4.1 mW 50dBOhm 10 Gbps transimpedance amplifier for optical receivers in 0.13 μm CMOS," *Microwave and Opt. Tech. Lett.,* vol. 53, no. 2, pp. 448-451, Feb. 2011.

[2] I.-K. Cho, J.-H. Yun, M.-Y. Jeong, H.-H. Park, "Optical chip-to-chip link system by using optical wiring method for reducing EMI," *IEEE Tr. Adv. Packaging,* vol. 33, no. 3, pp. 722-728, Aug. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] J. Sangirov, I. A. Ukaegbu, T.-W. Lee, M.-H. Cho, and H.-H. Park, "Low-power high-speed SerDes with new dynamic latch and flip-flop for optical interconnect in 180 nm CMOS technology," *SPIE Photonics West,* San Francisco, California, USA, Jan. 2011.

[2] I. A. Ukaegbu, J. Sangirov, T.-H. Ngo, .W. Lee, and H.-H. Park, "Design of simultaneous bidirectional CMOS transceiver with a resistor-transconductor hybrid for optical chip-to-Chip interconnects," *SPIE Photonics West* 2011, San Francisco, California, USA, Jan. 2011.

Park, Seong-Ook

Professor

Ph.D., Arizona State University (1997)
sopark@ee.kaist.ac.kr
http://ma.kaist.ac.kr

Microwave and Antenna Laboratory

Microwave and Antenna Laboratory research activities cover the electromagnetic theory including antenna analysis, reconfigurable antenna, small antenna using nano materials, precision antenna measurement techniques and radar system.

Electromagnetic Phenomena Analysis : We are studying the analytical and numerical techniques of electromagnetic theory focusing on new material antenna and electromagnetic properties of radiators, using method of moment(MoM), FDTD, and the spectral domain integral equation approach.

Electromagnetic theory and analysis of antennas using nano material and structure lead an exotic physical phenomena, it can be combined to achieve high efficient, electrically small antenna, and lead to the medical treatment application.

Small antenna with nano-materials : The creative antenna techniques using interdisciplinary nature for nano-materials are investigated for ultra-small antenna design in space-limited mobile handset. The high-efficiency ultra-small antenna structures applied to the mobile phone are implementing by using new and nano-materials. The design and development of sophisticated and reliable solutions for freely two beam generation are pursued by enhancing the mobile call quality, the creative structure of antenna itself, new antenna measurement techniques, and the mutual coupling constraints of space-limited mobile handset.

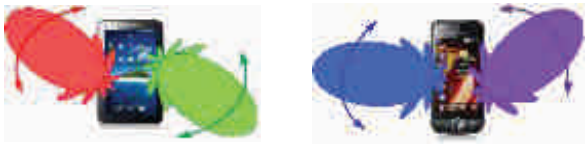


Fig. 1

Portable multi-function Radar System for Surveillance : MA Lab research the channel and vital signal measurement radar systems using FMCW and Chirp-Pulse. We are studying the design of active and array antenna. All this researches are integrated to application of finding the non-invasive vital signal and measuring target data(distance, velocity) for surveillance system.

KEY ACHIEVEMENTS

[1] K. Li, S.O. Park, and H.Q. Zhang, "Electromagnetic field over the spherical Earth coated with N-layered dielectric," *Radio Science,* vol. 39, issue 2, RS2008, Mar. 2004.

[2] R.A. Bhatti and S.O. Park, "Hepta-band internal antenna for personal communication handsets," *IEEE Tr. A.P.,* vol. 55, no.12, pp. 3398-3403, Dec. 2007.

[3] J.H. Lee, J.M. Hwang,and S.O. Park, "Noninvasive biosignal detection radar system using circular polarization," *IEEE Tr. Information Tech. in Biomedicine,* vol. 13, issue 3, pp. 400-404, May 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] J.H. Choi and S.O. Park, "Exact Evaluation of Channel Capacity Difference of MIMO Handset Antenna Arrays," *IEEE Antenna and Wireless Propagation Lett.,* vol. 9, pp. 219-222, Mar. 2010.

[2] J.H. Choi and S.O. Park, "Generation of Rayleigh/Rician fading channels with variable RMS delay by changing boundary conditions of the reverberation chamber," *IEEE Antenna and Wireless Propagation Lett.,* vol. 9, pp. 510-516, May 2010.

Ryu, Seung-Tak

Assistant Professor

Member, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (2004)
stryu@ee.kaist.ac.kr
http://msicl.kaist.ac.kr

Mixed Signal Integrated Circuits Laboratory

The Mixed-Signal Integrated Circuits Laboratory (MSICL) is working on analog and mixed-mode circuits design with emphasis on data converters. Currently, low-power and high speed data converters are being actively studied in MSICL. Many of the low power analog-to- digital converters (ADCs) being researched in our lab are based on successive approximation architecture (SAR). Based on our own high-speed operational algorithm for SAR ADC, ADEC algorithm, we have designed a 12b 500K/s 300uW ADC in 0.5um CMOS process for low power touch sensor application. The estimated FoM of the ADC is 200fJ/cs, and the number is the state-of-the-art performance for the given technology. Bio-medical applications and micro energy harvesting systems require ultra low power ADCs. For such applications, we have designed a 10nW 10b 2.5KS/s SAR ADC by finding an optimum conditions for leakage current and switching power consumption and by applying asynchronous clocking scheme. Ultimate speed realization with SAR ADC was also tried. By applying reference switching and non-binary digital errror correction technique, we have designed a 10b 120MS/s ADC with the estimated power consumption of 3mW.

High speed data converters being researched in MSICL are targeting UWB and 60GHz WPAN. For a 60GHz system, a 6b 4GS/s flash ADC was designed. We got rid of power-hungry preamplifiers and, instead, invented a time-domain latch interpolation scheme with offset calibration for low power consumption. Hybrid architectures able high speed low power design. Based on our own flash-SAR architecture with time-interleaving scheme, we are developing a 6b 2GS/s ADC. A compact 2b/cycle SAR ADC architecture is in development for 7b 600MS/s target with FoM of 50fJ/cs. The design employes a new non-binary digital error correction and high speed latches for fast decision loop. High speed DAC for 60GHz system was developed with 6b 3GS/s specification. The design suggests a new high speed DAC design strategy to achieve maximum signal bandwidth by minimizing parasitic capacitance.

Research topics in MSICL also includes high resolution ADC and other analog circuits. A digital LMS calibration algorithm is studied for SAR and pipelined ADC. Capacitive sensing circuits for touch screen and low power filters are also in our research interest.

KEY ACHIEVEMENTS

[1] S. H Cho, "A 50fJ/step 10b 50MS/s SAR ADC," Bronze prize, The 10th Semiconductor Design Contest, Korean Intellectual Property Office, Nov. 2009.

[2] Hun-Do Shin and Seung-Tak Ryu, "Spectre-Matlab Co-design Methodology for Bandwidth-Power Ratio Maximized Filter Design" Best paper, IDEC CAD & Design Methodology 2011.

[3] S. H. Cho, C. K. Lee, J. K. Kwon, and S. T. Ryu, "A 550μW 10b 40MS/s SAR ADC with multistep addition-only digital error correction," accepted to *IEEE J. Solid-State Circuits,* Aug.2011.

MAJOR ACHIEVEMENTS in 2010/2011

[1] S. H. Cho, C. K. Lee, J. K. Kwon, and S. T. Ryu, "A 550μW 10b 40MS/s SAR ADC with Multistep Addition-only Digital Error Correction," *IEEE Custom Integrated Circuits Conference,* Sep. 2010.

[2] Huy-Binh Le, Sang-gug Lee and Seung-Tak Ryu, "A regulator-free 84dB DR audio-band ADC for compact digital microphones," *IEEE Asian Solid-State Circuits Conference* 2010, pp.365-368.

Shin, Mincheol

Associate Professor

Member, KPS / Member, IEEE

Ph.D., Northwestern University (1992)
mcshin@ee.kaist.ac.kr
http://cnl.kaist.ac.kr

Computational Nanotechnology Laboratory

In the Computational Nanotechnology Lab (CNL), our main research activity lies in developing in-house nano-electronic device simulators based on the quantum mechanical principles. Our developed tools are aimed to be deployed in Web-based simulation portals such as nanoHUB for public access.

We have been keeping expanding the functionality of our in-house k·p simulator. The Schottky barrier contacts have been implemented at the source/drain and channel interfaces so the p-type Schottky barrier MOSFETs could be explored. Efforts have been given to add the strain effects to the k·p simulator and to expand the backbone k·p Hamiltonian with 8 bands to the one with 14/30 bands so that the off-Γ valleys in the conduction band can be included. Our full-fledged k·p simulator which is to roll out soon will be a very versatile tool capable of simulating not only Si but Ge and III-V materials with strain effects in 1D, 2D, or 3D structures.

We have made some meaningful progress in our research project which is aimed at developing a multi-scale simulation framework linking first-principles calculations with device-level simulations. In a collaboration with a research group specialized in the ab-initio calculations, the band gap profiles and dielectric constants along the $Si/SiO_2/HfO_2$ interface of a MOS device were calculated based on the density functional theory. The interface model was combined with the device simulation based on the non-equilibrium Green's function to accurately assess the device performance. A key result in our recent work is that the suboxide interlayer between Si and HfO_2 can be ignored in device simulations, if the dielectric constant and effective mass of HfO_2 layer are modified in a systematic way.

We have recently started a new research project in the field of the green nanotechnology; modeling and simulation of silicon-based hetero-junction nanowire thermoelectric device. Using the non-equilibrium Green's function approach, phonon dispersion in nanowires and phonon propagation in heterojunction nanowires are calculated, along with the electrical conductivity.

KEY ACHIEVEMENTS

[1] M. Shin, "Multi-gate nanowire FET," *Simulation tool on nanoHUB,* DOI:10254/nanohub-r2704, May 2008. https://www.nanohub.org/tools/mgnanowirefet (Accumulated users: 340, Jobs: 7696.)

[2] M. Shin, "Quantum simulations of ballistic nanowire field effect transistors", *Encyclopedia of Complexity and Systems Science in Meyers, Robert (Ed.),* Springer New York, June 2009 (Invited Article).

[3] M. Shin, S. Lee and G. Klimeck, "Computational study on the performance of Si nanowire pMOSFETs based on the k·p method," *IEEE Tr. Electron Devices*, vol. 57, no. 9, pp. 2274-2283, Sep. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] M. Shin, "Effect of channel orientation in p-type nanowire Schottky barrier Metal- Oxide-Semiconductor Field-Effect-Transistors," *Appl. Phys. Lett.,* vol. 97, no. 9, pp. 092108-1-092108-3, Aug. 2010

[2] M. Shin, Y. Park, K.-J. Kong, and H. Chang, "Interface model for HfO_2 gate stack from first principles calculations and its application to nanoscale device simulations", *Appl. Phys. Lett.,* vol. 98, no. 17, pp.173501-173501-3, Apr. 2011.

Shin, Sang-Yung

Professor

Fellow, KAST / Member, NAEK / Member, IEEK / Senior Member, IEEE / Member, OSA

Ph.D., Polytechnique Institute of New York (1976)
syshin@ee.kaist.ac.kr
http://eolab.kaist.ac.kr/eolabdream

Electro-Optics Laboratory

Electro-Optics Laboratory (EOL) is engaged in the experimental and theoretical studies of integrated optical waveguide devices for optical communications, optical signal processing and optical sensing. Current research interests are silicon photonic devices, surface plasmon polariton (SPP) devices and polymer optical waveguide devices.
Silicon photonic devices: Conventional silica or polymeric planar lightwave circuits are not compatible with electric ICs on the same substrate, and their elements are relatively large since the refractive index difference between the core and the cladding is small. In order to overcome these problems, a silicon optical waveguide with a high index contrast has been actively investigated. Thus silicon photonic wires attract much attention recently. With rich experiences in working on polymeric optical waveguide devices, we have successfully demonstrated new silicon photonic wire devices such as an ultra-short polarization splitter (PS) and a long period grating (LPG) filter.
Surface plasmon polariton (SPP) : For the development of submicron optical devices, the SPP waveguide device is one of promising solutions due to its submicron mode size. The dielectric-embedded metal structure for SPP modes, as in the metal-insulator-metal optical waveguide, makes it possible to overcome the diffraction limit. However, the SPP waveguide has large propagation loss, though the long range surface plasmon polariton (LRSPP) waveguide with relatively low propagation loss has been reported. To investigate coupling between the SPP waveguide and silicon photonic nanowire, we design and fabricate a hybrid directional coupler between the SPP waveguide and the conventional silicon waveguide.

KEY ACHIEVEMENTS

[1] G. H. Song and S. Y. Shin, "Design of corrugated waveguide filters by the Gel'Fand-Levitan-Marchendo inverse scattering method," *J. Opt. Soc. Am. A,* vol. 2, no. 11, pp. 1905-1915, 1985.
[2] C. H. Lee, T. H. Yoon, and S. Y. Shin, "Period doubling and chaos in a directly modulated laser diode," *Appl. Phys. Lett.* vol. 46, no. 1, pp 95 -97, Jan. 1985
[3] J. S. Jang, S. W. Jung, S. Y. Lee, and S. Y. Shin, "Optical implementation of the hopfield model for two-dimensional associative memory," *Optics Letters,* vol. 13, no. 3, pp. 248 - 250, Mar. 1988.

MAJOR ACHIEVEMENTS in 2010/2011

[1] J. T. Kim, J. J. Ju, S. t. Park, M. S. Kim, S. K. Park, and S. Y. Shin, "Hybrid plasmonic waveguide for low-loss lightwave guiding," *Opt. Express.,* vol. 18, no. 3, pp. 2808-2813, Feb. 2010.
[2] J. S. Shin, M. S. Kwon, and S. Y. Shin, "Design and analysis of a vertical directional coupler between a three-dimensional plasmonic slot waveguide and a silicon waveguide," accepted for publication in *Optics Comm.*

Won, Yong Hyub

Professor

Member, IEEK / Member, KICS / Member, IEEE

Ph.D., Cornell University (1990)
yhwon@kaist.ac.kr
http://code.kaist.ac.kr

Convergence Optoelectronic Device Engineering Laboratory

The Convergence Optoelectronic Device Engineering [CODE] Laboratory has primarily focused on developing key optical modules for optical networks, hologram ID tags, and 3D display applications.

Next Generation Security Code : Hologram ID Tag System

The novel color computer generated hologram pattern is used for the realization of the next generation high security codes which can potentially be applicable to a wide area of certificates, credit cards, currencies, industrial products, etc. Recently HS-code (high security code) was developed using dual color recognition and amplitude/phase separation method in our lab.

Fig. 1 Application area of Hologram ID

Optofluidic Devices for 3D display application

The development of a 3D display front-panel which is capable of offering clear 3D images without glasses has been done in our lab. This method has critical advantages compared with conventional Barrier and Lenticular methods.

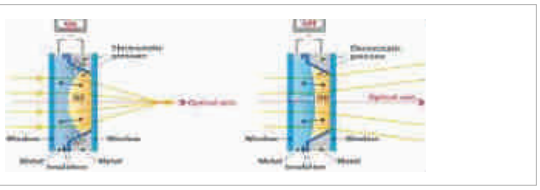


Fig. 2 Electrowetting method for 3D display

Photonic Signal Processing Devices

Our lab is a leading group in the world for the key photonic devices using single-mode Fabry-Perot laser diodes [FP-LD]. The conventional multimode FP-LD was successfully converted to a single-mode FP-LD using a technique of commercial TO-can packages. Wavelength converters and optical flip-flop devices are typical targets using single-mode FP-LDs in our lab.

Fig. 3 A cost effective single-mode FP-LD and its application

KEY ACHIEVEMENTS

[1] Y. Noh, J. Kim, H. Choi, H. Lee, Y. H. Won, and S. Han, "Thermooptic 2X2 asymmetric digital optical switches with zero-voltage operation state," *IEEE Photon. Techn. Lett.*, vol. 16, no. 2, pp. 446-448, Feb. 2004.

[2] Y. Jeong, Y. H. Won, S. Choi, and J. Yoon, "Tunable single-mode Fabry-Perot laser diode using a built-in external cavity and its modulation characteristics," *Optics Lett.*, vol. 31, no. 17, pp. 2586-2587, Sep. 2006.

[3] M. R. Uddin and Y. H. Won, "All-optical wavelength conversion by the modulation of self-locking state of a single mode FP-LD," *IEEE Photon. Tech. Lett.*, vol. 22, no. 5, pp. 290-292, Mar. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] H. R. Kim, K. M. Park, K. W. Jun, H. H. Choi, J. S. Lim and Y. H. Won, "Application of kinoform CGHs to an ID tag system," *IEEE Photon. Journal*, vol.2, no.4, pp.290-292, Aug. 2010.

[2] B. Nakarmi, M. R. Uddin, T. Q. Hoai, and Y. H. Won, "Demonstration of all-optical NAND gate using single mode Fabry-Perot laser diode," *IEEE Photon. Tech. Lett.*, vol. 23, no. 4, pp. 236-238, Feb. 2011.

Yang, Kyounghoon

Professor

Senior Member, IEEE

Ph.D., University of Michigan (1994)
khyang@ee.kaist.ac.kr
http://hsnl.kaist.ac.kr

High Speed Nanoelectronics Laboratory

High Speed Nanoelectronics Lab (HSNL) conducts research in next-generation devices and ICs with focus on high speed and high functional applications. The lab is currently involved in four research categories: (i) Quantum-effect based nano devices and high speed circuits, (ii) InP-based optical detector, (iii) Si-based optoelectronics, and (iv) high frequency, high power devices and MMICs(Monolithic Microwave Integrated Circuit).

In research based on the quantum/nano device, the RTD(Resonant Tunneling Diode) which has the unique negative differential resistance and very high-speed switching characteristics enables us to develop ultra high-speed and extremely low power analog and digital ICs. By using RTD based NDR(Negative Differential Resistance) ICs, it can be achieved to develop next-generation high-speed optical communication system, nano/bio sensor system and artificial neural network system.

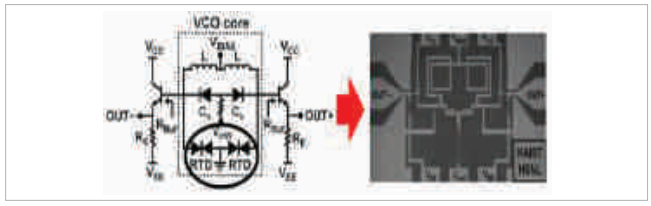


Fig. 1 Extremely Low DC Power RTD VCO IC

The research of optical detectors is focused on developing high-sensitivity SPADs(Single Photon Avalanche Diodes) for the applications of 3D imaging and LADAR(Laser Radar). For the LADAR system, the device technology of InGaAs/InP SPAD arrays is being developed.

Si-based optoelectronic sensors are also being researched for commercial camera applications such as CMOS Image Sensors (CISs) and Si based APD. To improve the performance of the sensors, new photodetector structures are being developed and analyzed. The designed sensors are promising candidates for the cost effective, high performance imaging applications.

High-frequency and high-power MMICs for the next-generation T/R module systems have been developed, by using the InP/InGaAs diodes which have excellent microwave performances such as high breakdown voltage, low insertion loss, high isolation and high cut-off frequency. A BCB-based multi-layer MMIC technology has been established to reduce the size and cost of MMICs. We have also been investigating next-generation high-power GaN-based devices for microwave applications.

KEY ACHIEVEMENTS

[1] S. Choi, Y. Jeong, J. Lee and K. Yang, "A novel high-speed multiplexing IC based on resonant tunneling diodes," *IEEE Tr. Nanotechnology,* vol. 8, no. 4, pp.482-486, July 2009.

[2] Y. Jeong, S. Choi and K. Yang, "A Sub-100uW Ku-band RTD VCO for extremely low power applications," *IEEE Microwave and Wireless Components Letters,* vol. 19, no. 9, pp.569-571, Sep. 2009.

[3] Y. Jeong, S. Choi, and K. Yang, "Novel antiphase coupled RTD microwave oscillator operating at extremely low DC power consumption," *IEEE Tr. Nanotechnology,* vol. 9, no. 3, pp.338-341, May 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] J. Yang, and K. Yang, "Ka-Band 5-bit MMIC phase shifter using InGaAs PIN switching diodes," *IEEE Microwave and Wireless Components Letters,* Vol. 21, no. 3. pp. 151-153 Mar. 2011.

[2] M. Kim, J. Yang and K. Yang, "A switched transmission-line type Q-band 4-bit MMIC phase shifter using InGaAs PIN diodes," *IET Electronics Letters,* Vol. 46, no. 3, pp. 219 -220, Feb. 2010.

Yoo, Hyung-Joun

Professor

Member, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (1994)
hjyoo53@ee.kaist.ac.kr
http://codes.kaist.ac.kr

Communication Devices and Systems Laboratory

The research area of communication devices and systems (CoDeS) laboratory is focused on RF technology for the next generation wireless communications. Various wireless standards, and digital/RF technologies will be merged in the next generation wireless terminals. We will develop technologies of digital RF transceiver for wideband OFDM signals as a core technology of the next generation wireless convergence transceiver. To implement an efficient multi-standard transceiver with a high flexibility, we have been trying to substitute functions of RF blocks for digital circuitry as many as possible with minimizing RF/analog parts. Digitalization of RF function results in a highly efficient system with a high integration, a reduced cost, and a low power consumption.

Our researches are focused on digital RF transmitters and discrete time receivers. The digitally controlled oscillator (DCO) is a vital block of the ADPLL in digital RF transmitter. High frequency resolution of DCO is required for supporting the high data rate system. To increase frequency resolution of DCO, we proposed an oppositely-coupled pMOS pair and apply it to DCO. As a result, the frequency resolution of 14 kHz is obtained at 5.8 GHz and corresponding $\triangle C$ is about 32 atto Farad. Recently, we are trying to analyze the relation between nonlinear capacitance, oscillation amplitude, and frequency resolution in the DCO.

We also are interested in sampler based discrete time receiver. Sampler is a key block of discrete time receiver and perform frequency conversion and filtering. We implemented and confirmed these two functions for basic sampler architectures. We will research on new sampler architecture that has small number of unit capacitors with high order filtering characteristic.

The other research topic is CMOS transceiver for multi-standard RFID reader, which supports various high frequency (HF) band standards, such as 14443-A/B, 15693, and 18000-3, etc. We also try to reduce the analog parts and many of them are substituted by digital counterparts. Since our RFID transceiver does not use any capacitor, the chip area is extremely small and the cost can be minimized.

KEY ACHIEVEMENTS

[1] S.-S. Yoo, Y.-C. Choi, H.-J. Song, and H.-J. Yoo, "A 5.9 GHz LC-based digitally controlled oscillator with high frequency resolution using novel varactor pairs" *IEEE RFIT 2009,* pp. 195-198, Singapore, Dec. 2009.

[2] C.-H. Kim, S.-H. Shin, and H.-J. Yoo, "A low phase noise and low power series coupled quadrature VCO using reconfigurable LC tank," *IEEE RWS 2008,* pp. 395-398, Orlando, FL, USA, Jan. 2008.

[3] Y.-K. Jang, J.-H. Kim, and H.-J. Yoo, "Reconfigurable CMOS mixer for multi-standard applications," *IEICE Tr. Electron.,* vol. E88-C, no. 12, pp. 2379-2381, Dec. 2005.

MAJOR ACHIEVEMENTS in 2010/2011

[1] Y.-H. Kim, Y.-C. Choi, M.-W. Seo, S.-S. Yoo, and H.-J. Yoo, "A CMOS transceiver for a multistandard 13.56-MHz RFID SoC," *IEEE Tr. Ind. Electron.,* vol. 57, no. 5, pp.1563-1572, May 2010.

[2] S.-S. Yoo, Y.-C. Choi, H.-J. Song, S.-C. Park, J.-H. Park, and H.-J. Yoo, "A 5.8-GHz high-frequency resolution digitally controlled oscillator using the difference between inversion and accumulation mode capacitance of pMOS varactors," *IEEE Tr. Microw. Theory Tech.,* vol. 59, no. 2, pp. 375-382, Feb. 2011.

Yoo, Seunghyup

Associate Professor

Ph.D., University of Arizona (2005)
syoo@ee.kaist.ac.kr
http://ioel.kaist.ac.kr

Integrated Organic Electronics Laboratory

Integrated Organic Electronics Lab. (IOEL), established on August, 2006, focuses on developing novel device architectures and integrated systems based on organic semiconductors and conductors in the three major areas: display & lighting, energy, and flexible low-cost electronics. Research on organic light-emitting diodes (OLEDs), attracting a great amount of interest as a basic element for next-generation display & lighting applications, constitutes one of IOEL's top-priority research efforts. Such efforts include a development of (1) flexible/ transparent OLEDs for ultraportable displays and smart windows; (2) high contrast inverted OLEDs for AMOLEDs with n-type TFTs; and (3) "jet-on-demand" organic vapor jet printing as a novel, scalable deposition technique that can lead to reliable large-area organic displays and lighting.

Energy-related research is mainly focused on development of organic solar cells for future use of this innately low-cost organic technology in photovoltaic energy generation, which essentially requires large-area fabrication and affordability. Key efforts are being made in achieving reliable and scalable OPV technologies that are balanced with continual improvement of power conversion efficiences, so that they can finally be deployed in real-world applications.

Fig. 1 Photo of various devices and systems under development by IOEL

Another integral part of IOEL's research efforts is to develop reliable, high performance electronic devices and integrated circuits based on organic or inorganic thin-film transistors (OTFTs), diodes, and memory devices for low-cost and flexible alternatives to existing technologies. They have a potential to be used in printed electronics for flexible electronics which finds applications in emerging technologies like RFIDs and smart electronic labels.

KEY ACHIEVEMENTS

[1] T. -W. Koh, H. -M. Choi, and S. Yoo, "Optical outcoupling enhancement in organic light-emitting diodes: highly conductive polymer as a low-index layer on microstructured ITO electrodes," *Adv. Mater.*, vol. 22, pp.1849-1853, Apr. 2010

[2] S. Han, S. Lim, H. Kim, H. Cho and S. Yoo, "Versatile multilayer transparent electrodes for ITO-free and flexible organic solar cell," *IEEE J. Sel. Topics in Quant. Elect.*, vol. 16, no. 6, pp. 1656-1664, Nov. 2010.

[3] D. Im, H. Moon, M. Shin, J. Kim, and S. Yoo, "Towards gigahertz operation: Ultrafast low turn-on organic diodes and rectifiers based on C60 and tungsten oxide," *Adv. Mater.*, vol. 23, pp.644-648, Feb. 2011

MAJOR ACHIEVEMENTS in 2010/2011

[1] H.Cho, J. -M. Choi, and S. Yoo, "Highly transparent organic light-emitting diodes with a metallic top electrode: the dual role of a Cs2CO3 layer," *Opt. Express.*, vol. 19, no. 2, pp.1113-1121, Jan. 2011

[2] C. Yun, H. Moon, H. W. Kang, M. Kim, H. J. Sung, and S. Yoo, "High-performance pentacene thin-film transistors fabricated by organic vapor-jet printing," *IEEE Electron. Dev. Lett..*, vol. 31, no. 11, pp.1305-1307, Sep. 2010

Yoon, Giwan

Professor

Member, IEEE, KIMICS

Ph.D., University of Texas, Austin (1994)
gwyoon@ee.kaist.ac.kr
http://cel.kaist.ac.kr

Terahertz Nano System Laboratory

Terahertz Nano System Laboratory explores a vision of multi-functional and intelligent devices, systems and algorithms to provide more efficient and seamless information communications. Our research areas of interest include solid-state nano-scale devices, ultra-small intelligent RF devices & systems, and also smart systems & algorithms for future wireless applications.
Recently, our research efforts have been mainly focused on communication hardware and software technologies involving ultra-small RF devices and MIIMO (Multi-input multi-output) algorithms.
More efforts are expected to be made to develop intelligent nano-scale devices based on the modeling, design and fabrication of novel structures.

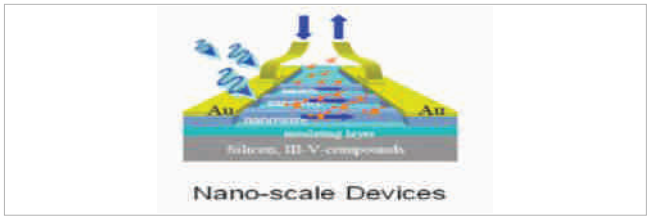


Fig. 1

In addition, we have a keen interest in and are also working on some semiconductor technology-based THz devices, in addition to the intelligent algorithms for smart wireless communications.

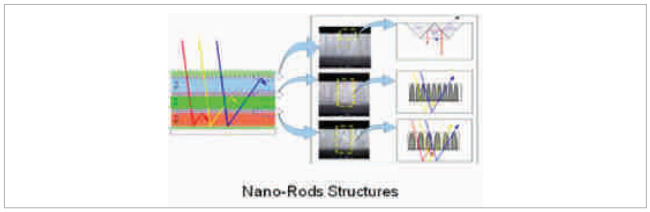


Fig. 2

KEY ACHIEVEMENTS

[1] M. T. Le, V. S. Pham, L. Mai, and G. W. Yoon, "Low complexity maximum likelihood decoder for four-transmit-antenna quasi-orthogonal space-time code," *IEEE Trans. Comm.*, vol. 53, no. 11, pp.1817-1821, Nov. 2005.
[2] M. T. Le, V. S. Pham, L. Mai, and G. W. Yoon, "Efficient algorithm for blind detection of orthogonal space-time block codes," *IEEE Signal Process. Lett.*, vol. 14, no. 5, pp.301-304, May 2007.
[3] L. Mai, J. Y. Lee, V. S. Pham, and G. W. Yoon, "Design and fabrication of ZnO-based FBAR microwave devices for mobile WiMAX applications," *IEEE Microw. Wirel. Compon. Lett.*, vol. 17, no. 12, pp. 867-869, Dec. 2007.

MAJOR ACHIEVEMENTS in 2010/2011

[1] R. Zhang, E. J. Lee, and G. W. Yoon, "Effects of thermal annealing condition on nitrogen [N]-incorporated ZnO films in FBAR devices," *Electron. Lett.*, vol. 46, no. 9, pp. 605-606, Apr. 2010.
[2] J. D. Park, E. J. Lee, and G. W. Yoon, "Average bit-error rate of the alamouti scheme in Gamma-Gamma fading channels," *IEEE Photonics Technol. Lett.*, vol. 23, no. 4. pp. 269-271, Feb. 2011.

Yoon, Jun-Bo

Associate Professor

Member, IEEE

Ph.D., Korea Advanced Institute of Science and Technology (1999)
jbyoon@ee.kaist.ac.kr
http://3dmems.info

3D Micro-Nano Structures Laboratory

3D Micro-Nano Structures Lab. has been focusing on micromachining technologies for 3D structures with micro to nano size and has applied these in Korea-strong fields such as display, memory and wireless telecommunication.

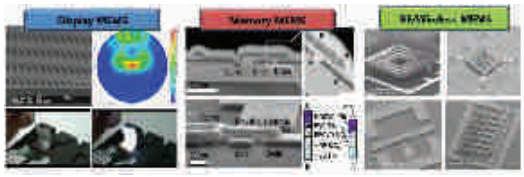


Fig. 1 Korea-strong MEMS/NEMS: Display, Memory and RF/Wireless MEMS

In the Display MEMS, we have researched novel backlight unit (BLU) and flexible front light guide (FLU) unit for display. Our light guides are based on microlens array made by 3D diffuser lithography. The excellence of the proposed system is that the number of optical films can be reduced into just one sheet to improve not only their optical performance but also the manufacturing cost efficiency. We have researched DMD(Digital Mirror Device) with unique and simpler structure than Texas Instruments' DMD. The research on 16 $\mu m \times 16\,\mu m$ DMD was performed for the high resolution and low cost projection display.

In the Memory MEMS, we proposed the mechanical memory which was produced using MEMS/NEMS technology. Nano mechanical memory can overcome the physical limitation of the memory based on CMOS technology. The nano-mechanical memory controls the current level using mechanical movements using electrostatic force instead of electric field same as CMOS devices. We developed 3-terminal NEMS switch with 40 nm-thick beam and 20 nm-thick air-gap with NNFC for high density logic and memory applications.

In RF/Microwave MEMS, passive components such as RF inductor, variable capacitor, and microwave antenna have been researched. Specially, we have gone deeper into study about modeling, design, and fabrication of MEMS inductors for a long time.

KEY ACHIEVEMENTS

[1] J.-B. Yoon, C.-H. Han, E. Yoon, and C.-K. Kim, "Surface micromachined solenoid on-Si and on-Glass inductors for RF applications," *IEEE Electron Device Lett.*, vol. 20, no. 9, pp. 487-489, Sep. 1999.

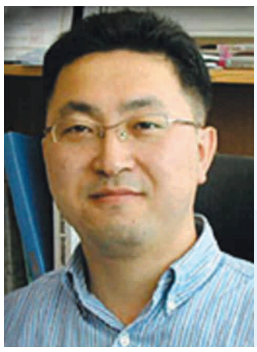
[2] J.-B. Yoon, Y.-S. Choi, B.-l. Kim, Y. Eo, and E. Yoon, "CMOS-compatible surface-Micromachined suspended-spiral inductors for multi-GHz silicon RF ICs," *IEEE Electron Device Lett.*, vol. 23, no. 10, pp. 591-593, Oct. 2002.

[3] W. W. Jang, J.O.Lee, J.-B. Yoon, M.-S. Kim, J.-M. Lee, S.-M. Kim, K.-H. Cho, D.-W. Kim, D. Park, and W.-S. Lee, "Fabrication and characterization of a nanoelectromechanical switch with 15-nm-thick suspension air gap," *App. Phys. Lett.*, vol. 92, no. 10, pp. 1-3, Mar. 2008.

MAJOR ACHIEVEMENTS in 2010/2011

[1] D.-H.Kim, M.-W.Kim, J.-W. Jeon, K.S.Lim and J.-B. Yoon, "A trnas-scaled nanofabrication using 3D diffuser lithography, metal mold and nano-imprinting," *IEEE J. MEMS*, vol. 19, no. 5, pp. 1197-1206, Oct. 2010.

[2] Y.-H.Song, D.-H.Choi, H.-H.Yang, and J.-B. Yoon, "An extreme low contact resistance MEMS relay using meshed drain structure and soft insulating layer," *IEEE J. MEMS.*, vol. 20, no. 1, pp. 204-212, Feb. 2011.



Yu, Jong-Won

Associate Professor

Ph.D., Korea Advanced Institute of Science and Technology (1998)
drjwyu@ee.kaist.ac.kr
http://rfss.kaist.ac.kr

Radio Frequency System Solution Laboratory

The Radio Frequency System Solution Lab (RFSS Lab) primarily focuses on making RF systems more optimal, reliable and efficient for the future wireless environment. Currently, main research areas include hybrid and integrated RF system, minimized and multiband antenna, applications using electromagnetic analysis, etc.

Our 3 main research topics include :

1. Low profile Circular polarized (CP) antenna
2. Optimized beam-forming method
3. Improvement of Hand-Effect in mobile terminal

Low profile Circular polarized (CP) antenna : Conventional CP antennas such as patch antennas have high gain performance but there are some disadvantages such as large size, narrow bandwidth and high manufacturing cost. Our goal in this research is to develop CP antennas which is more compact and has a wider bandwidth with lower manufacturing cost than the conventional CP antenna. Examples for this kind of antenna are quadrifilar helix antenna, wideband helical antenna and dual-band mobile RFID reader Antenna.

Optimized beam-forming method : The motivation for beam-width controllable beam-forming antenna is to implement high efficient communications system. This can increase communication efficiency and eliminate noise in wireless communications. Beam-forming communications method optimized in 60GHz multi-gigabit wireless communication is the aim of this research. The key point of this research is to develop the algorithm which could control the array antennas to make the optimal antenna beam for suitable conditions. Our RFSS lab is also conducting resesarch on designing the 60GHz wide-band antenna employing LTCC (Low temperature co-fired ceramic).

Improvement of Hand-Effect in mobile terminal : Death grip has been a great issue when I Phone 4 was released. This is the phenomenon of the hand-effect. Hand-effect is a effect which makes your antenna out of control since your hand changes the characteristics of the antenna. Our main concentration is to analyze the hand-effect and develop a high speed impedance matching circuit.

KEY ACHIEVEMENTS

[1] W. I. Son, W. G. Lim, M. Q. Lee, S. B. Min and J. W. Yu, "Design of compact quadruple inverted-F antenna with circular polarization for GPS receiver," *IEEE Tr. Antennas and Propagat.,* vol. 58, no. 5, pp. 1503-1510 May 2010.

[2] D. Z. Kim, W. I. Son, W. G. Lim, H. L. Lee and J. W. Yu, "Integrated planar monopole antenna with microstrip resonators having band-notched characteristics," *IEEE Tr. Antennas and Propagat.,* vol. 58, no. 9, pp. 2837-2842, Sep. 2010.

[3] W. G. Lim, H. L. Lee and J. W. Yu, "Transmitter and receiver isolation by concentric antenna structure," *IEEE Tr. Antennas and Propagat.,* vol. 58, no. 10, pp. 3182-3188, Oct. 2010.

MAJOR ACHIEVEMENTS in 2010/2011

[1] W. G. Lim, H. L. Lee and J. W. Yu, "Transmitter and receiver isolation by concentric antenna structure," *IEEE Tr. Antennas and Propagat.,* vol. 58, no. 10, pp. 3182-3188, Oct. 2010.

[2] W. I. Son, M. Q. Lee and J. W. Yu, "Module-Integrated-antenna with circular polarization for mobile UHF RFID reader", *IEEE Tr. Microwave Theory and Technique,* vol. 59, no. 4, pp. 1157-1165, Jan. 2011.

Yu, Kyoungsik

Assistant Professor

Ph.D., Stanford University (2004)
ksyu@ee.kaist.ac.kr
http://yu.kaist.ac.kr

Integrated Nanophotonics Laboratory

The Integrated Nanophotonics Laboratory led by Prof. Kyoungsik Yu focuses on nano- and micro-scale optoelectronic devices and their integration techniques for photonic interconnects, bio/chemical sensing and imaging applications.

Information processing and communication technologies have improved our perception of the world by supplying abundant information and computing power. However, because of power consumption and space constraints, it is becoming more difficult to build high-performance information processing and distribution systems only with electronics. In optical imaging and sensing systems, the engineering trade-off in resolution and throughput has limited our ability to probe small objects and fast phenomena in biology and nanotechnology.

Nanophotonics can provide unique solutions to such important problems by processing optical signals in multiphysics domains. Integrated nanophotonic devices offer exciting opportunities in the generation, control, and detection of photons and their interaction with semiconductor and/or biochemical materials. The range of optical wavelengths useful for most communication and sensing applications is on the order of micrometers, and, therefore, nanofabrication technologies allow us to precisely fabricate features in subwavelength dimensions that can best interact with photons.

An example of our nanophotonic research is the subwavelength metal-optic cavities on active compound semiconductor materials to surpass the size limitation of conventional light sources. Conventional light sources are usually in the micrometer range due to the diffraction limit, whereas the length scale of electronic transistors is currently approaching tens of nanometers with the advance of fabrication technology. Subwavelength-scale light sources and their integration techniques will play important roles for future integration of electronic and photonic devices on a chip-scale platform.

KEY ACHIEVEMENTS

[1] K. Yu, J. Shin, and N. Park, "Wavelength-time spreading optical CDMA system using wavelength multiplexers and mirrored fiber delay lines," *IEEE Photonics Technol. Lett.*, vol. 12, no. 9, pp. 1278-1280, Sep. 2000.

[2] I. Keslassy, S.-T. Chuang, K. Yu, D.A.B. Miller, M. Horowitz, O. Solgaard, and N. McKeown, "Scaling Internet routers using optics," *ACM SIGCOMM,* Karlsruhe, Germany, Aug. 2003.

[3] Z. Fan, H. Razavi, J. Do, A. Moriwaki, O. Ergen, Y.-L. Chueh, P.W. Leu, J.C. Ho, T. Takahashi, L.A. Reichertz, S. Neale, K. Yu, M. Wu, J.W. Ager, and A. Javey, "Three-dimensional nanopillar-array photovoltaics on low-cost and flexible substrates," *Nature Materials,* vol. 8, no. 8, pp. 648-653, Aug. 2009.

MAJOR ACHIEVEMENTS in 2010/2011

[1] K. Yu, A. Lakhani, and M. C. Wu, "Subwavelength metal-optic semiconductor nanopatch lasers," *Optics Express,* vol. 18, no. 9, pp. 8790-8799, Apr. 2010.

[2] A. M Lakhani, K. Yu, and M. C. Wu, "Lasing in subwavelength semiconductor nanopatches," *Semiconductor Science and Technology,* vol. 26, no. 1, pp. 014013, Jan. 2011.

Annual Report 2010/2011

DEPARTMENT OF ELECTRICAL ENGINEERING

http://www.ee.kaist.ac.kr

Research Centers

• Brain Science Research Center (BSRC)
Director: Prof. Soo-Young Lee
Vice Director: Prof. Dae-Shik Kim, Prof. HyunWook Park
Sponsor: National Research Foundation, Ministry of Knowledge Economy
- BSRC has worked on the understanding and computational models of brain information processing mechanisms and their applications to brain-like intelligent systems **(artificial brain and artificial cognitive systems)**. It also operates brain signal measurement facilities such as 3T fMRI, fMRI-compatible EEG, and NIRS.

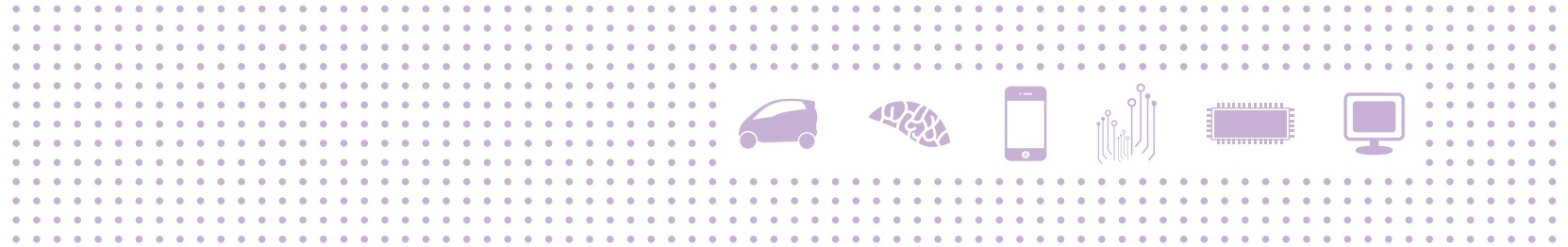
• Broadband Convergence Network(BcN) Engineering Research Center
Director: Prof. Hong-shik Park
Sponsor: Ministry of Knowledge Economy
- Broadband Convergence Network is the Next Generation Network of Korea. To make BcN into the groundwork of IT powerhouse, 11 professors and 70 students of BcN Engineering Research Center research the core BcN engineering technologies, such as end-to-end QoS guaranteeing technology, network optimization technology, overlay network technology, and so on.

• Center for Advanced Flexible Display Convergence (CAFDC)
Director: Prof. Kyung Cheol Choi
Sponsor: National Research Foundation
- CAFDC conducts interdisciplinary convergence of basic research related to next generation flexible display devices, materials, and driving methods. CAFDC has set its aim high to develop display devices in the spirit of Anywhere, Any Size, and Anytime for the approaching ubiquitous era.

• Center for Robot Intelligence Technology (RIT)
Director: Prof. Jong-Hwan Kim
Sponsor: Institute for Information Technology Advancement
- RIT center guides the leadership of technical innovation from 'information technology' (IT) to 'intelligence technology' (IT). The center proposes 6 types of robot intelligence (CI, SI, BI, AI, GI, SI) and realizes each of them through 5 core technologies (EC, FL, NN, DES, ML) and 5 detail technologies (Cognitive Architecture, Voice Recognition, HRI, Task Scheduling, Learning).

• Center for Robot Vision & Perception (CRVP)
Director: Prof. Myung Jin Chung
Sponsor: Ministry of Knowledge Economy
- CRVP consists of 4 professors and 42 students. CRVP is currently focusing on the development of 3D sensing and vision based human/object perception for intelligent robots.

• Display Research Center (DRC)
Director: Prof. Gun-Woo Moon
Sponsor: Samsung Electronics
- DRC consists of 12 professors and 80 students who conduct research in the field of LCD displays.



• IC Design Education Center (IDEC)
Director: Prof. Chong-Min Kyung
Sponsor: Ministry of Knowledge Economy
- IDEC was founded by the Ministry of Commerce, Industry and Energy to cultivate design experts in the field of non-memory IC. IDEC provides each working group(WG) in each university with CAD tools, computing platforms and related technologies. IDEC offers the lectures, CAD tool training classes and CD-ROMs of the open lectures and books relevant to IC design.

• Image Information Research Center (IIRC)
Director: Prof. Jong Beom Ra
Sponsor: Defense Acquisition Program Administration and Agency for Defense Development
- IIRC consists of 20 professors and 19 students conducting research in the field of image information.

• Intelligent Radio Engineering Center (IREC)
Director: Prof. Chul Soon Park
Sponsor: National Research Foundation
- The mission of the Intelligent Radio Engineering Center (IREC) is to acquire the "Universal Radio Solution with Unlimited Connectivity" to cope with convergence among the mobile, WLAN, WPAN, broadcasting, and sensor networks. 14 Professors and more than 100 students are engaged in the IREC.

• Intelligent Robot Vision Systems Research Center (IRVS)
Director: Prof. In So Kweon
Sponsor: Samsung Techwin
- The center is working to develop intelligent robot vision systems using multiple sensors and mobile robots.

• Mobile Media Platform Center (MMPC)
Director: Prof. Hwang Soo Lee
Sponsor: Texas Instruments, Korea Institute for Advancement of Technology
- MMPC consists of 9 professors and 50 students. MMPC was established to develop mobile multimedia platform technology.

• Mobile Multimedia Research Center (MMRC)
Director: Prof. Joong Soo Ma
Sponsor: Ministry of Knowledge Economy
- MMRC consists of 9 professors and 60 students. MMRC is developing fundamental technologies and prototypes for Mobile Tactical Communication System (MOTACS) and Ad Hoc Mesh Network.

• Optical Internet Research Center (OIRC)

Director: Prof. Minho Kang

Sponsor: Korea Science and Engineering Foundation

- OIRC consists of 12 professors and 80 students. OIRC is first aimed to put the invention practice use and get core patents for GMPLS over AOBS. Second, it purpose to investigate for the metro-access architectures and applications in AOBS, and finally conduct researches in the blue ocean of the optical internet.

• Patent Examiners Education Center (PEEC)

Director: Prof. Hae-Wook Choi

Sponsor: Korean Industrial Property Office (KIPO)

- PEEC provides patent examiners of the Korean Industrial Property Office (KIPO) with customized and top-level education of new technologies and their trends about mechanical, metallurgical, civil, chemical, biological, electric, electronic, information, and communication engineering and sciences in order to enhance the efficiency and quality of patent examination.

• Personal Plug&Play DigiCar Center (P3 DigiCar Center)

Director: Prof In So Kweon

Sponsor: Ministry of Education, Science and Technology & National Research Foundation of Korea

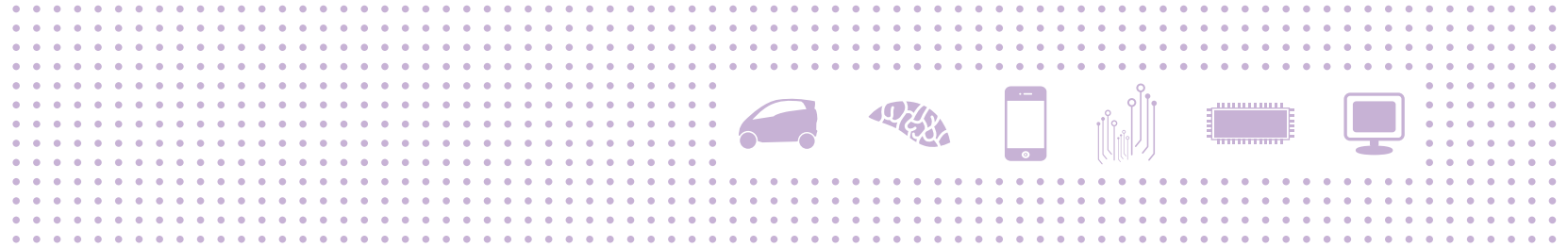
- This center was selected as the National Core Research Center (NCRC) in Sep. 2010 which is supported by Ministry of Education, Science and Technology and National Research Foundation of Korea. The center is founded for fostering experts and developing a novel electronic car called 'Personal Plug&Play DigiCar' (P3 DigiCar) which is the eco-friendly and energy-efficient personal urban vehicle.
  P3 Digicar is the future vehicle of high efficiency, reliability, and comfortable user interface. The center explores three research areas: First, a technology substituting conventional vehicle instruments such as steering, brake system, air-conditioning into electric based ones; Second, an advanced interface technology and signal processing techniques for safe driving; Third, an integrating technology of machinery and IT devices by plugging them into embedded platform to make energy-efficient and comfortable vehicle.

• Power Electronics Research Center (PERC)

Director: Prof. Gun-Woo Moon

Sponsor: Samsung Electro-Mechanics

- PERC consists of one professor and 18 students. PREC is working to develop the best products in the world in the terms of both servers and adapters while collaborating with 12 experts from Samsung Electro-Mechanics.



• Radio Education and Research Center (RERC)
Director: Prof. Hyuckjae Lee
Sponsor: Korea Communications Commission
- Funded by the Korea Communications Commission, Radio Education and Research Center (RERC) has been established to be a major educational center to cultivate students and professionals in the radio technology field and to boost the global competitiveness of radio technology industry through systematic development of new educational materials both online and offline.

• Samsung Research Center (SRC)
Director: Prof. Youngnam Han
Sponsor: Samsung Electronics
- SRC consisted of 7 professors and 40 students who conduct research in the field of uHealth and 4G wireless communication systems. Currently, 2 professors and 6students are invloved in Samsung sponsored research.

• SMD-KAIST OLED Research Center (SORC)
Director: Prof. Seunghyup Yoo
Sponsor: Samsung Mobile Display
- Backed by Samsung Mobile Display (SMD), SORC focuses on developing efficient, reliable organic light-emitting diodes (OLEDs) and cutting-edge displays made thereof. The center embraces participation from interdisciplinary fields, covering innovations in three major aspects: device architecture, material, and novel process.

• SoC Initiative for Ubiquity and Mobility (SoCium)
Director: Prof. Chong-Min Kyung
Sponsor: Samsung Electronics, LG Electronics, Core-Logic, Enter-Tech
- SoCium consists of 14 professors and 100 students. SoCium produces the experts in the field of SoC design and industry.

• System Design Innovation & Application Research Center (SDIA)
Director: Prof. Hoi-Jun Yoo
Sponsor: Institute for Information Technology Advancement
- SDIA focus on the research, development of some platforms and application of intelligent robots, wearable computers and bio systems

• Wireless Technology Center (WTC)
Director: Prof. Songcheol Hong
Sponsor: Samsung Electro-mechanics
- WTC, consisting of 4 professors and 37 students, is working to develop next generation wireless technology. The Center does research on the front-end module and future transmitter system.

Undergraduate Courses

Classification	Subject No.	Subject Name	Lecture:Lab.: Credit (Homework)	Semester	Remark
Mandatory Major Course	EE201	Circuit Theory	3:1:3 (6)	Spring ·Fall	
	EE202	Signals and Systems	3:1:3 (6)	Spring ·Fall	
	EE204	Electromagnetics	3:0:3 (6)	Spring ·Fall	
	EE209	Programming Structure for Electrical Engineering	3:0:3 (6)	Spring ·Falll	
	EE305	Introduction to electronics design Lab	1:6:3 (6)	Fall	
	EE405	Electronics Design Lab.	1:6:3 (6)	Spring	
Elective Major Course	EE205	Data Structures and Algorithms for Electrical Engineering	3:0:3 (6)	Fall	
	EE210	Probability and Introductory Random Processes	3:0:3 (6)	Spring ·Fall	
	EE211	Introduction to Physical Electronics	3:0:3 (6)	Spring ·Fall	
	EE303	Digital System Design	3:1:3 (6)	Spring ·Fall	⁎CS211
	EE304	Electronic Circuits	3:1:3 (6)	Spring ·Fall	
	EE311	Operating Systems and System Programming for Electrical Engineering	3:0:3 (6)	Spring	
	EE312	Introduction to Computer Architecture	3:1:3 (6)	Fall	⁎CS311
	EE321	Communication Engineering	3:0:3 (6)	Spring	
	EE323	Computer Network	3:0:3 (6)	Spring	
	EE324	Network Programming	3:1:3 (6)	Fall	
	EE326	Introduction to Information and Coding Theory	3:0:3 (6)	Fall	
	EE341	Electromagnetic waves and antennas	3:0:3 (6)	Spring	
	EE342	Radio Engineering	3:1:3 (6)	Fall	
	EE362	Semiconductor Devices	3:0:3 (6)	Spring ·Fall	
	EE372	Digital Electronic Circuits	3:0:3 (6)	Fall	
	EE381	Control System Engneering	3:0:3 (6)	Spring	
	EE391	Electronic Control of Electric Machines	3:0:3 (6)	Spring	
	EE401	Communication Skills	2:0:2 (4)	Spring	
	EE402	Future Society and Electrical Engineering	2:0:2 (4)	Fall	
	EE403	Analog Electronic Circuits	3:0:3 (6)	Spring	
	EE411	Switching and Automata Theory	3:0:3 (6)	Spring	
	EE414	Embedded Systems	3:1:3 (6)	Fall	
	EE421	Wireless Communication Systems	3:0:3 (6)	Spring	
	EE425	Wireless Network	3:0:3 (6)	Spring	
	EE432	Digital Signal Processing	3:0:3 (6)	Spring ·Fall	
	EE441	Introduction to Fiber Optic Communication Systems	3:0:3 (6)	Spring	
	EE452	Fundamentals of Photonics	3:0:3 (6)	Fall	
	EE463	Semiconductor IC Technology	3:0:3 (6)	Spring	
	EE464	Electrical Engineering for Green Energy	3:0:3 (6)	Fall	
	EE466	Introduction to Biomedical Electronics	3:0:3 (6)	Fall	
	EE474	Introduction to Multimedia	3:0:3 (6)	Spring	
	EE476	Audio-Visual Perception Model	3:0:3 (6)	Fall	
	EE481	Intelligent Systems	3:0:3 (6)	Spring	
	EE485	Special Topics in Electronic Engineering Ⅰ	1:0:1	Spring ·Fall	
	EE486	Special Topics in Electronic Engineering Ⅱ	2:0:2	Spring ·Fall	
	EE488	Special Topics in Electronic Engineering	3:0:3 (6)	Spring ·Fall	
Research	EE490	B.S. Thesis Research	0:6:3	Spring ·Fall	
	EE495	Individual Study	0:6:1		
	EE496	Seminar	1:0:1	Spring	

Notes. i) 400 level course credits except EE405, EE406 can be counted as master course credits.
ii) " ⁎" mark represents a substitutive subject.

Graduate Courses

Classification	Subject No.	Subject Name	Lecture:Lab.: Credit (Homework)	Semester	Remark
General Course (Select 1 out of 7)	CC010	Special Lecture on Leadership	1:0:0	Fall	
	CC020	Ethics and Safety I	1AU	Spring·Fall	
	CC500	Scientific Writing	3:0:3 (4)	Spring·Fall	
	CC510	Introduction to Computer Application	2:3:3 (10)	Spring·Fall	
	CC511	Probability and Statistics	2:3:3 (6)	Spring·Fall	⁎REE528
	CC512	Introduction to Materials and Engineering	3:0:3 (3)	Spring·Fall	
	CC513	Engineering Economy and Cost Analysis	3:0:3 (6)	Fall	
	CC530	Enterpreneurship and Business Strategies	3:0:3 (6)	Fall	
	CC531	Patent Analysis and Invention Disclosure	3:0:3 (6)	Spring?Fall	
	CC532	Collaborative System Design and Engineering	4:0:4	Spring	
Mandatory Major Course	EE505	Electronics design Lab.	1:6:3 (6)	Spring	
Elective Major Course	EE509	Technical Writing	1:0:1 (2)	Fall	
	EE511	Computer Architecture	3:0:3 (6)	Spring	
	EE512	System Programming	3:0:3 (6)	Fall	
	EE513	Operating Systems for Networked Systems	3:0:3 (6)	Spring	
	EE515	Cryptography and Network Security	3:0:3 (6)	Fall	
	EE516	Embedded Software	1:6:3 (6)	Fall	
	EE520	Telecommunication Networks	3:0:3 (6)	Spring	
	EE522	Communication Theory	3:0:3 (6)	Spring	
	EE525	Networking Technology and Applications	1:6:3 (6)	Spring	
	EE527	Data Communication	3:0:3 (6)	Spring	
	EE528	Engineering Random Processes	3:0:3 (6)	Spring·Fall	
	EE531	Statistical Learning Theory	3:0:3 (6)	Fall	
	EE533	Digital Speech Processing	3:0:3 (6)	Spring	
	EE535	Digital Image Processing	3:0:3 (6)	Spring	
	EE538	Neural Networks	3:0:3 (6)	Spring	
	EE539	Nonlinear Statistical Signal Processing	3:0:3 (6)	Fall	
	EE541	Electromagnetic Theory	3:0:3 (6)	Spring	
	EE542	Microwave Engineering	3:1:3 (6)	Fall	
	EE543	Antenna Engineering	3:1:3 (6)	Spring	
	EE546	Fields and Waves	3:0:3 (6)	Fall	
	EE555	Optical Electronics	3:0:3 (6)	Spring	
	EE561	Introduction to VLSI Devices	3:0:3 (6)	Spring	
	EE563	Display Engineering	3:0:3 (6)	Spring	
	EE565	Modern Physics for Engineers	3:0:3 (6)	Spring	
	EE566	MEMS in EE Perspective	3:0:3 (6)	Fall	
	EE567	Photovoltaic Power Generation	3:0:3 (6)	Spring	
	EE568	Introduction to Organic Electronics	3:0:3 (6)	Spring	
	EE569	Nanobioelectronics	3:0:3 (6)	Spring	
	EE571	Advanced Electronic Circuits	3:0:3 (6)	Spring	
	EE572	Technology Futures and Management strategies: Future New Media	3:0:3 (6)	Fall	
	EE573	Introduction to VLSI Systems	3:0:3 (6)	Spring	
	EE574	Computer Aided Design of VLSI Circuits and Systems	3:0:3 (6)	Fall	
	EE575	Entertainment Platform	3:0:3 (6)	Fall	
	EE581	Linear Systems	3:0:3 (6)	Spring	
	EE582	Digital Control	3:1:3 (6)	Spring	
	EE594	Power Electronics Systems	3:0:3 (6)	Fall	

Notes. i) " ⁎" mark represents a substitutive subject
ii) 500 level course credits except EE505, EE525, EE572 can be counted as bachelor course credits.

Classification	Subject No.	Subject Name	Lecture:Lab.: Credit (Homework)	Semester	Remark
	EE612	Discrete Event System Modeling and Simulation	3:0:3 (6)	Fall	*CS655
	EE613	Distributed Computing Systems	3:0:3 (6)	Spring	
	EE614	Service Oriented Computing Systems	3:0:3 (6)	Spring	
	EE615	Architecture of Systems Problem Solving	3:0:3 (6)	Spring	
	EE617	Parallel Computing Systems and Programming	3:0:3 (6)	Fall	
	EE621	Coding Theory	3:0:3 (6)	Spring	
	EE622	Signal Detection Theory	3:0:3 (6)	Spring	
	EE623	Information Theory	3:0:3 (6)	Fall	
	EE624	Mobile Communication Systems	3:0:3 (6)	Fall	
	EE625	Applied Detection and Estimation	3:0:3 (6)	Spring	
	EE626	Advanced Communication Theory	3:0:3 (6)	Fall	
	EE627	Performance Analysis of Communication Networks	3:0:3 (6)	Spring	
	EE628	Visual Communication Systems	3:0:3 (6)	Fall	
	EE629	Mobile Communication Engineering	3:0:3 (6)	Fall	
	EE631	Advanced Digital Signal Processing	3:0:3 (6)	Fall	
	EE634	Pattern Recognition	3:0:3 (6)	Fall	*CS676
	EE636	Digital Video Processing	3:0:3 (6)	Fall	
	EE637	Speech & Audio Coding Theory	3:0:3 (6)	Spring	
	EE641	Monolithic Microwave Integrated Circuits	3:0:3 (6)	Fall	
	EE643	MMIC Design	3:0:3 (6)	Spring	
	EE645	Wireless Transceiver Systems	3:0:3 (6)	Spring	
	EE647	Nano-Photonics	3:0:3 (6)	Spring	
	EE650	Optimization in Communication Network	3:0:3 (6)	Spring	
	EE651	Digital Switching Engineering	3:0:3 (6)	Spring	
Elective Major Course	EE652	Optical Communication	3:0:3 (6)	Fall	
	EE653	Network Security	3:0:3 (6)	Spring	
	EE654	MIMO Wireless Communications	3:0:3 (6)	Fall	
	EE655	Economics in Communication Network	3:0:3 (6)	Spring	
	EE657	Local Area Network/Metropolitan Area Network (LAN/MAN)	3:0:3 (6)	Spring	
	EE658	Queueing theory with applications	3:0:3 (6)	Fall	
	EE659	Wireless Communication Network	3:0:3 (6)	Spring	
	EE661	Solid State Physics	3:0:3 (6)	Fall	
	EE663	High Frequency Electronic Devices	3:0:3 (6)	Spring	
	EE665	CMOS Front-end Process Technology	3:0:3 (6)	Spring	
	EE666	Optoelectronic Semiconductor Devices and Their Applications	3:0:3 (6)	Fall	
	EE669	Experimental Methods in Biotechnology	3:0:3 (6)	Spring	
	EE676	Analog Integrated Circuits	3:0:3 (6)	Fall	
	EE678	Digital Integrated Circuits	3:0:3 (6)	Fall	
	EE679	Analog and Mixed Signal Circuits for Communication	3:0:3 (6)	Spring	
	EE681	Nonlinear Control	3:0:3 (6)	Fall	
	EE682	Intelligent Control Theory	3:0:3 (6)	Fall	
	EE683	Robot Control	3:0:3 (6)	Fall	
	EE684	Evolutionary Computation	3:0:3 (6)	Fall	
	EE686	Optimization Theory	3:0:3 (6)	Fall	
	EE687	Real-Time Control	3:0:3 (6)	Spring	
	EE688	Optimal Control Theory	3:0:3 (6)	Fall	
	EE690	Overlay Networking	3:0:3 (6)	Fall	
	EE691	Telecom. Network Management	3:0:3 (6)	Spring	
	EE692	Parallel and Distributed Computation in Communication Network	3:0:3 (6)	Fall	
	EE694	Telephone and IP Telephony Network	3:0:3 (6)	Fall	

Classification	Subject No.	Subject Name	Lecture:Lab.: Credit (Homework)	Semester	Remark
Elective Major Course	EE696	Telecommunication Software Design	3:1:3 (6)	Fall	
	EE698	Multimedia Communication Middleware	3:0:3 (6)	Fall	
	EE713	Entertainment Platform	3:0:3 (6)	Spring	
	EE722	Advanced Signal Detection	3:0:3 (6)	Fall	
	EE727	Broadband Network Design and Analysis	3:0:3 (6)	Fall	
	EE731	Adaptive Signal Processing	3:0:3 (6)	Spring	
	EE733	Multirate Signal Processing	3:0:3 (6)	Fall	
	EE734	Image Understanding	3:0:3 (6)	Spring	
	EE735	Computer Vision	3:0:3 (6)	Fall	
	EE737	Medical Imaging Technology	3:0:3 (6)	Spring	
	EE738	Speech Recognition Systems	3:0:3 (6)	Fall	
	EE739	Cognitive Information Processing	3:0:3 (6)	Fall	
	EE741	Radiation and Diffraction of Waves	3:0:3 (6)	Spring	
	EE742	Ray Analysis for Electromagnetic Scattering Problems	3:0:3 (6)	Fall	
	EE745	EMI / EMC Design and Analysis	3:0:3 (6)	Spring	
	EE746	Radar System	3:0:3 (6)	Fall	
	EE748	High-Frequency Passive Devices	3:0:3 (6)	Fall	
	EE755	Advanced Coding Theory	3:0:3 (6)	Fall	
	EE756	Advanced Information Theory	3:0:3 (6)	Fall	
	EE757	Nonlinear Fiber Optics	3:0:3 (6)	Spring	
	EE758	Optical Networks	3:0:3 (6)	Fall	
	EE762	Advanced MOS Device Physics	3:0:3 (6)	Fall	
	EE764	Quantum Engineering for Nanoelectronic Devices	3:0:3 (6)	Fall	
	EE766	Plasma Electronics	3:0:3 (6)	Fall	
	EE772	Electronic Circuits for Green Energy	3:0:3 (6)	Fall	
	EE773	Bio-Medical CMOS IC Design	3:0:3 (6)	Spring	
	EE774	VLSI Design Methodology	3:0:3 (6)	Fall	
	EE775	Communication Core IP Design	3:0:3 (6)	Spring	
	EE783	Adaptive Control Theory	3:0:3 (6)	Spring	
	EE785	Robust Control Theory	3:0:3 (6)	Spring	
	EE788	Robot Cognition and Planning	3:0:3 (6)	Fall	
	EE791	Power Conversion Circuits and Systems	3:0:3 (6)	Spring	
	EE807	Special Topics in Electrical Engineering	3:0:3 (6)	Spring	
	EE808	Special Topics in Electronic Engineering Ⅰ	1:0:1	Spring·Fall	
	EE809	Special Topics in Electronic Engineering Ⅱ	2:0:2	Spring·Fall	
	EE817	Special Topics in Computer Engineering	3:0:3 (6)	Spring	
	EE827	Special Topics in Communication	3:0:3 (6)	Spring	
	EE837	Special Topics in Signal Processing	3:0:3 (6)	Spring·Fall	
	EE838	Special Topics in Image Engineering	3:0:3 (6)	Fall	
	EE847	Special Topics in Electromagnetics	3:0:3 (6)	Spring·Fall	
	EE857	Special Topics in Optical Engineering	3:0:3 (6)	Spring	
	EE867	Special Topics in Physical Electronics	3:0:3 (6)	Spring·Fall	
	EE868	Special Topics in Solid-State Physics	3:0:3 (6)	Fall	
	EE877	Special Topics in Integrated Circuits	3:0:3 (6)	Spring·Fall	
	EE878	Special Topics in VLSI	3:0:3 (6)	Fall	
	EE887	Special Topics in Robotics	3:0:3 (6)	Spring	
	EE888	Special Topics in Control Theory	3:0:3 (6)	Spring·Fall	
	EE897	Special Topics in Power Electronics	3:0:3 (6)	Spring	
	EE898	Special Topics in Intelligent Information Processing	3:0:3 (6)	Fall	
Research	EE960	M.S. Thesis		Spring·Fall	
	EE965	M.S. Individual Study	0:6:1	Spring	
	EE966	M.S. Seminar	1:0:1	Fall	
	EE968	Technical Writing	1:0:1 (2)	Spring·Fall	
	EE980	Ph.D. Thesis			
	EE986	Ph.D. Seminar	1:0:1	Spring	

Global Advisory Committee

Professor
Karen Maex
Katholieke
Universiteit Leuven

Professor
Jasprit Singh
University of Michigan

Professor
Takeo Kanade
Carnegie Mellon
University

Professor
Vahid Tarokh
Harvard University

Special Programs

• Government-Sponsored Program

Brain Korea 21 (BK21)
BK 21 Electronics and Communications Technology Division of KAIST aims to develop a world-class research-oriented graduate program. Specifically, our goal is to improve the graduate program so that its quality reaches a level comparable to that of the top level universities in the world. IT is widely expected to play an essential role in the information-oriented society of the 21st century, and the School of IT is committed to playing a pioneering role in conducting research and educating students who will become leaders in Korea. The Electronics and Communications Technology Division consists of 3 groups with 82 professors, 50 researchers, and 800 graduate students. The average annual budget for the school of Electronics and Communications Technology Division is about 28 million dollars which comes from the government, industry, and KAIST.

• Industry-Sponsored Programs

Cooperative Telecommunication Education Program (CTEP)
CTEP was established to promote education in date transmission, networking and network application. This program provides the participating students with a scholarship and appropriate facilities for IT education. CTEP students are industry-university cooperative scholarship students supported by the companies participating in CTEP such as Dacom, KTF, LG Electronics, and Hanaro Telecom. This program has been started in 1998 as a cooperative educational program in collaboration with the four departments/divisions; Electrical Engineering, Computer Science, Industrial Engineering and Applied Mathematics. Homepage : http://ktep.kaist.ac.kr

Educational Program for Samsung Semiconductor (EPSS)
EPSS at KAIST was founded in August, 2005 to cultivate human resources that will become the pioneers in the semiconductor technology through the world in the 21st century with joint efforts of the five departments (Electrical Engineering, Physics, Biological & Chemical Engineering, Material Engineering, Chemistry) at KAIST and the sponsor of Samsung Electronics. This program makes an effort to produce high quality and multidisciplinary human resources by offering the customized programs and to set a successfully collaborative model with both industry and university. Homepage: http://epss.kaist.ac.kr

KAIST Education Program for Semiconductor Industry (KEPSI)
KEPSI was established in 1996 as a response to the demand of semiconductor industries to foster high qualified semiconductor engineers who can play a leading role in the area of semiconductors and integrated circuits for information technologies. This program is supported by the participating companies, especially Hynix Semiconductor. Homepage: http://kepsi.kaist.ac.kr

LGD Display Education Program (LGenius)
LGenius is a cooperative program between academia and industry established to assist specialists in the display field to combine theory and practice through customized selection and training courses provided by KAIST and LG Display (Ltd). LGenius will provide students with opportunities to gain practical work experience through internships. This program's aim is to jointly train exceptional human resources in a variety of interdisciplinary fields, providing the knowledge and skills needed to the supplement the excellent education provided at KAIST.
- Departments involved: Department of Electrical Engineering, Department of Physics, Department of Chemistry, Division Mechanical Engineering, Department of Chemical & Biomolecular Engineering, Department of Materials Science & Engineering
- Education and research areas: Fields associated with the display devices, materials, processes, circuits, systems, equipment, and software sectors Homepage: http://lgenius.kaist.ac.kr

Admission to Graduate Program

1. Scholarships for Graduate Students

Every graduate student at KAIST is eligible for one of the following scholarships:

A. Government Scholarship (sponsored by the government)
B. KAIST Scholarship (sponsored by the research fund of a faculty member or such industry-funded education programs as CTEP, KEPSI, EPSS, etc.)
C. General Scholarship (sponsored by outside organizations)

2. Advisor Assignment

A. A student with Government Scholarship shall be assigned a faculty member in the Department by the Head.
B. A student with KAIST Scholarship shall be assigned a faculty member who has in advance requested students under the special education programs. The field of the student's research may have been pre-determined if the student is supported by the research fund of a faculty member.
C. A student with General Scholarship shall be assigned a faculty member in the field of research specified by the sponsoring organization.

3. Admissions Process

Once an applicant submits the academic information together with English score (TOEFL, TOEIC, TEPS, IEPS), the Admissions Committee will review the application material and then interview the qualified applicants as necessary. For more information, please visit http://admission.kaist.ac.kr

대학원 입학 안내

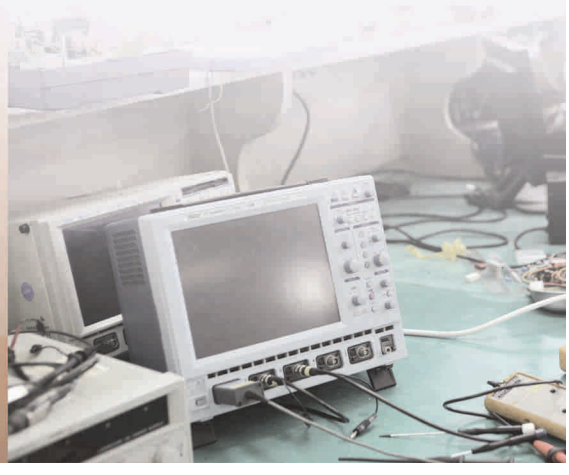
1. 학생구분

- 국비 장학생: 교육경비의 전부 또는 일부를 한국과학기술원이 확보한 정부예산으로 지원 받는 학생.
- 과학기술원 장학생: 교육경비의 전부 또는 일부를 교육 프로그램 (CTEP, KEPSI, EPSS), 한국과학기술원에서 조성한 장학금, 외부출연기금, 교수 수탁과제 연구비, 연구센터 운영비에서 지원 받는 학생 (교수 수탁과제 연구비에서 지원받는 과학기술원 장학생은 해당 과제에 따라 연구 분야가 제한될 수 있음).
- 일반 장학생: 교육경비의 전부 또는 일부를 입학추천기관에서 지원 받는 학생.
- 지원자는 입학 원서에 학생구분을 3지망까지 순위를 매겨 적어 낼 수 있습니다.그 순위를 바탕으로 한국과학기술원이 학생구분을 정해 최종 합격자를 발표하며, 따라서 2지망이나 3지망으로 합격될 수 있음을 참고하시기 바랍니다.

2. 전형방법

- 1차 전형: 서류심사 (영어성적 포함)
- 2차 전형: 면접시험

※ 자세한 사항은 학교 누리집 http://admission.kaist.ac.kr에서 보실 수 있습니다.



Staffs

Lee, Jae Nam (Team Leader)
cowboy@ee.kaist.ac.k
+82-42-350-3499

Cho, Eun Gyeong (International Relations)
kenzosj@ kaist.ac.kr
+82-42-350-3407

Cho, Sun-Young (Financial Management)
scho@ee.kaist.ac.kr
+82-42-350-3406

Je, Sung Ae (Graduate Affairs)
isting@ee.kaist.ac.kr
+82-42-350-3408

Kang, Insoo (Research Fund Management)
iskang@ee.kaist.ac.kr
+82-42-350-3405

Kang, Kyoung-Hwa (Researcher Support, Business Trip)
roodolp@ee.kaist.ac.kr
+82-42-350-7401

Kim, Eun Young (KEPSI Staff)
eykim@ee.kaist.ac.kr
+82-42-350-8585

Kim, Mi Young (BK Staff)
kimmy@kaist.ac.kr
+82-42-350-8505

Ko, Eun Hee (BK Staff)
kkoppoppo@kaist.ac.kr
+82-42-350-8503

Kwag, Bo Ram (BK Staff)
kboram@kaist.ac.kr
+82-42-350-8502

Lee, In Hwan (Server Management)
hwan@ee.kaist.ac.kr
+82-42-350-3409

Lee, Kyu Myung (Facilities Management)
whoo@ee.kaist.ac.kr
+82-42-350-5407

Park, Sang-Hwan (Undergraduate Affairs and Curriculum)
shpark@ee.kaist.ac.kr
+82-42-350-3404

Park, Sunyoung (Alumni Affairs)
heru@kaist.ac.kr
+82-42-350-3402

Seok, Yong-Won (Technical Support for Lab Courses and Assets Management)
ywseok@ee.kaist.ac.kr
+82-42-350-5409

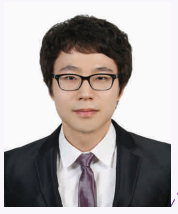
Lee, Kyoung Hee (CTEP, LGenius Staff)
khlee@ee.kaist.ac.kr
+82-42-350-8541

Lee, Seungjun (Technical Support for Lab Courses)
eesj@ee.kaist.ac.kr
+82-42-350-5408

Oh, Kyoung Hee (EPSS Staff)
khgreen@ee.kaist.ac.kr
+82-42-350-8584

Park, Yong-Il (Facilities Management)
pyi@ee.kaist.ac.kr
+82-42-350-3496

Song, Chae Bin (Graduate Admissions)
songshan@ee.kaist.ac.kr
+82-42-350-3403



Yun, Guk Young (Technical Management)
gyyun@kaist.ac.kr
+82-42-350-3497

Location

E3 Information and Electronics

· East Campus Map

E1 • Main Gate
E2 • Industrial Engineering and Management
E3 • Information and Electronics
1 Department of Computer Science
2 Department of Electrical Engineering
3 Image Processing
4 Semiconductor
E4 • KAIST Institutes
E5 • Faculty Hall
E6 • Natural Science
E7 • Biomedical Research Center
E8 • Sejong Hall
E9 • KAIST Library
E10 • Storehouse
E11 • Creative Learning
E12 • Energy Plant
E13 • Satellite Technology Research Center
E14 • Main Adminstration
E15 • Auditorium
E16 • ChungMoonSoul
E17 • Stadium
E18 • Bio Model System Park
E19 • National Nano Fab Center
E20 • KyeRyong Hall
E21 • Medical Center

· West Campus Map

W1 • Applied Engineering
W2 • Student Center-1
1- International Center
W3 • Galilei Hall
W4 • Heemang Hall, Dasom Hall
W5 • 1,2,3- Married Students Housing
4,5- International Village A/B
W6 • Student Dormitory
W7 • Nanum Hall
W8 • Educational Support
W9 • Outdoor Theater
W10 • Wind Tunnel Laboratory
W11 • KAIST Foreign Professor Residence
W12 • West Energy Plant
W16 • Geotechnical Centrifuge Center

· North Campus Map

N1 • East Gate
N2 • Branch Administration
N3 • Sports Complex
N4 • School of Humanities and Social Science
N5 • Basic Experiement and Research
N6 • Faculty Club
N7 • Mechanical Engineering
N9 • Practice
N10 • KAIST Branch Library
N11 • Cafeteria
N12 • Student Center-2
N13 • Tae Wul Gwan
N14 • Sarang Hall
N15 • Bachelors Housing-2
N16 • Somang Hall
N17 • Seongsil Hall
N18 • Jilli Hall
N19 • Areum Hall
N20 • Silloe Hall
N21 • Jihye Hall
N22 • Alumni Venture Hall
N23 • f/MRI Center
N24 • LG Semicon Hall
N25 • Department of Industrial Design
N26 • CHIPS
N27 • Hi-Tech Venture Hall
N28 • Energy and Environment Research Center
N29 • Center for IT Convergence

한국과학기술원
전기 및 전자공학과
연차보고서 2010/2011

펴낸이 _ 김정호

엮은이 _ 강준혁, 김준모, 윤준보, 조은경, 최 완

꾸민이 _ 모인 (김성룡, 이경연)

펴낸때 _ 2011년 7월

Annual Report 2010/2011

DEPARTMENT OF ELECTRICAL ENGINEERING

KAIST

335 Gwahag-ro, Yuseong-gu, Daejeon 305-701, Republic of Korea
Tel: +82-42-350-3402~8 Fax: +82-42-350-3410 http://www.ee.kaist.ac.kr