

Exhibit 4

U.S. Patent No. 9,980,691



(12) **United States Patent**
Douglas et al.

(10) **Patent No.:** **US 9,980,691 B2**
 (45) **Date of Patent:** **May 29, 2018**

(54) **METHOD AND APPARATUS FOR THREE DIMENSIONAL VIEWING OF IMAGES**

A61B 6/466; A61B 6/467; A61B 6/501; A61B 6/503; A61B 6/504; G02B 27/0172; G02B 2027/0134; G02B 2027/0187; G02B 27/0093; G02B 27/2207; G06T 19/00

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See application file for complete search history.

(72) Inventors: **David Byron Douglas**, Winter Park, FL (US); **Robert E. Douglas**, Winter Park, FL (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days. days.

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(Continued)

(21) Appl. No.: **14/877,442**

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(65) **Prior Publication Data**

US 2016/0026266 A1 Jan. 28, 2016

Jason et al "Pictorial Depth cues for outdoor Augmented Reality", IEEE 2005.*

Related U.S. Application Data

Primary Examiner — Amara Abdi

(63) Continuation-in-part of application No. 12/176,569, filed on Jul. 21, 2008, now Pat. No. 9,349,183, which (Continued)

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(51) **Int. Cl.**
G06K 9/00 (2006.01)
A61B 6/00 (2006.01)

(Continued)

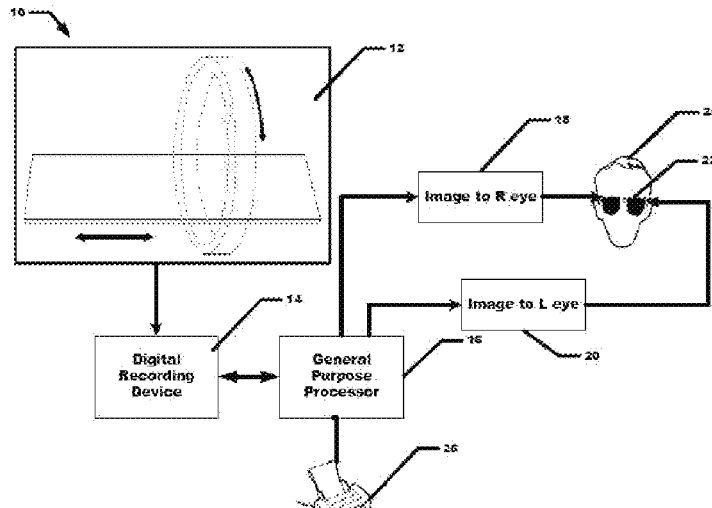
(57) **ABSTRACT**

A method, apparatus and computer program product for three-dimensional viewing of images is presented. Embodiments of the invention provide a process for combining slices generated by medical imaging devices to create a volume of interest and then present this volume in a three-dimensional representation to a head display unit so that the user can obtain a holistic view of the patient. Key image processing techniques are applied which enable the user to rotate and view the volume of interest from alternative viewpoints; to enable tissue subtraction to facilitate unobstructed viewing of a region of interest; to identify differing tissues with color schematics; to zoom in for optimal viewing; and to view a moving image of a volume of interest.

(52) **U.S. Cl.**
 CPC **A61B 6/466** (2013.01); **A61B 5/055** (2013.01); **A61B 6/022** (2013.01); **A61B 6/462** (2013.01); **G02B 27/0172** (2013.01); **G06T 19/00** (2013.01); **A61B 6/467** (2013.01); **A61B 6/501** (2013.01); **A61B 6/503** (2013.01); (Continued)

(58) **Field of Classification Search**
 CPC A61B 5/055; A61B 6/022; A61B 6/462;

21 Claims, 17 Drawing Sheets



US 9,980,691 B2

Page 2

Related U.S. Application Data

- is a continuation-in-part of application No. 11/941, 578, filed on Nov. 16, 2007, now Pat. No. 8,384,771.
- (60) Provisional application No. 60/877,931, filed on Dec. 28, 2006.
- (51) **Int. Cl.**
G06T 19/00 (2011.01)
A61B 6/02 (2006.01)
A61B 5/055 (2006.01)
G02B 27/00 (2006.01)
G02B 27/22 (2018.01)
G02B 27/01 (2006.01)
- (52) **U.S. Cl.**
 CPC *A61B 6/504* (2013.01); *G02B 27/0093* (2013.01); *G02B 27/2207* (2013.01); *G02B 2027/0134* (2013.01); *G02B 2027/0187* (2013.01)

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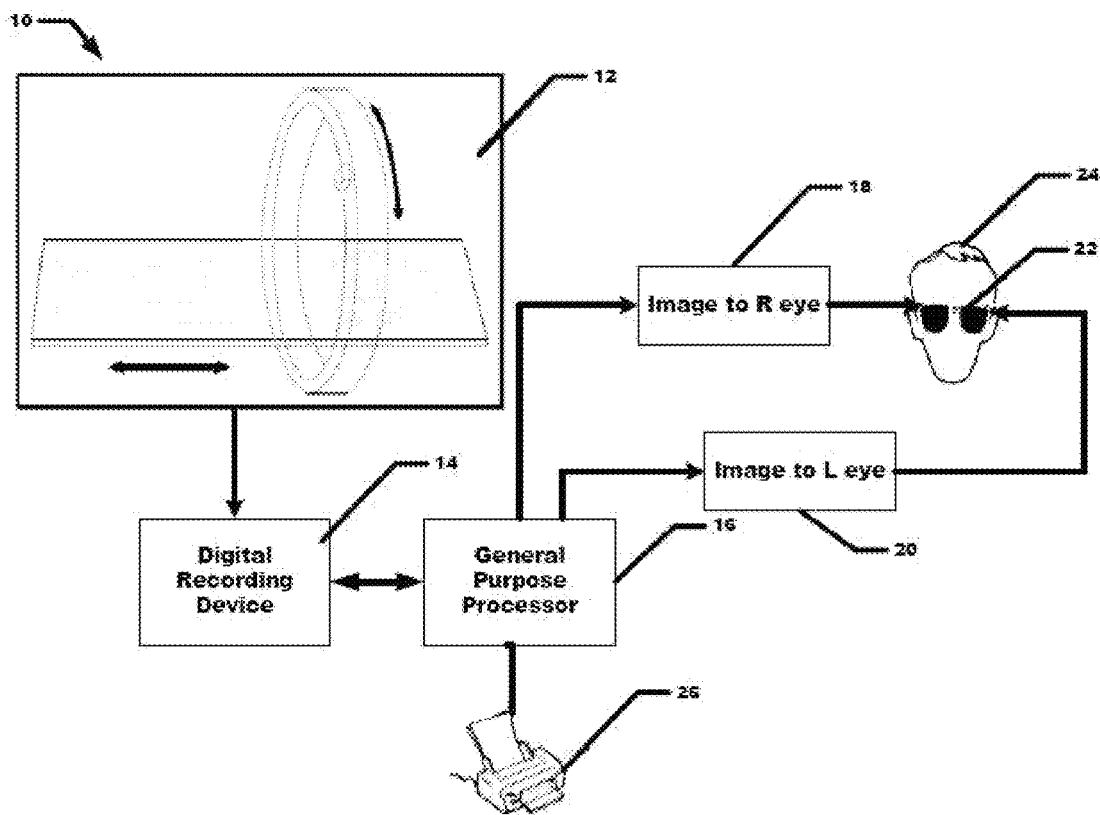


FIGURE 1

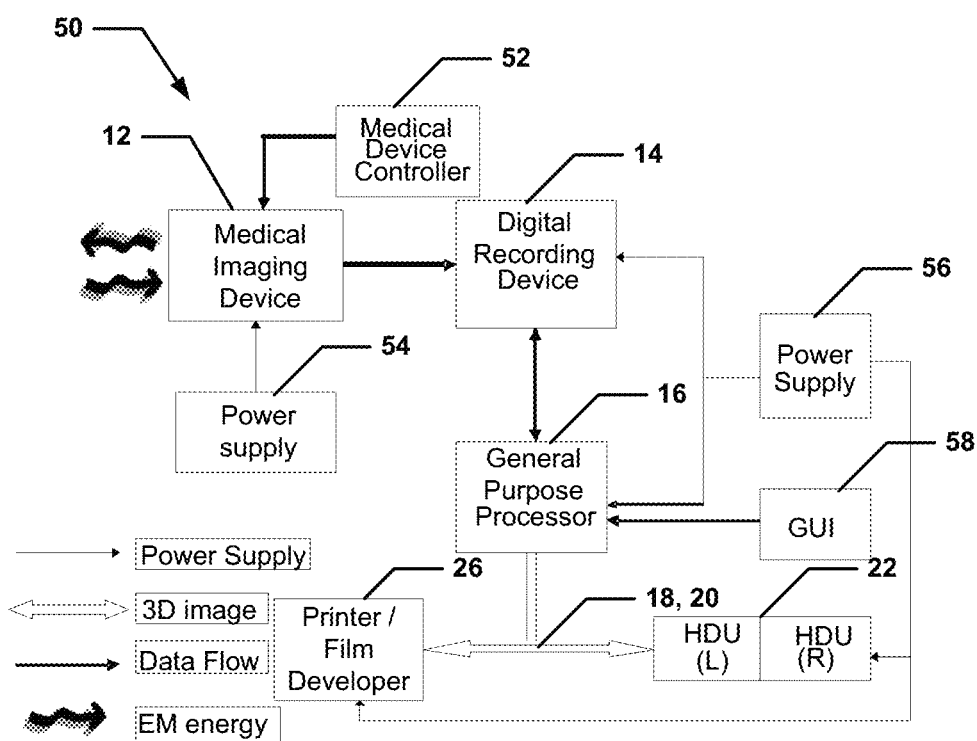


FIGURE 2

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