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(54) **Video signal recording and reproducing apparatus**

Fernsehsignalaufnahme- und -wiedergabeanlage

Appareil d'enregistrement et de reproduction de signal vidéo

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Description

1. Field of the Invention:

[0001] The present invention relates to a video signal recording and reproducing apparatus which can simultaneously record and reproduce a video by using a disk apparatus.

2. Description of the Related Art:

[0002] A video tape recorder (VTR) has heretofore been used as a home-use video recording apparatus. As is well known, a VTR receives a broadcast program transmitted by a broadcasting station via an antenna, records the program and then reproduces the program. That is to say, having once finished the recording operation of a predetermined program, the VTR rewinds the tape on which the program has been recorded and then reproduces the received and recorded program to be watched.

[0003] A currently available VTR cannot record and reproduce a video simultaneously. For example, assuming that a broadcast program which starts at 10 o'clock and ends at 12 o'clock is now being received and recorded by a single VTR, it is impossible to reproduce and watch the broadcast program from the beginning from 11 o'clock on, while continuing receiving and recording the program. It is much less impossible to perform a trick play reproducing operation (e.g., a fast-forward reproducing operation or a backward reproducing operation) of a recorded video of a program which is now being received and recorded. On the other hand, a technique which is called "following reproducing operation" is currently utilized for a live broadcast relayed by a broadcasting station. In accordance with this technique, a video which has been transmitted to a broadcasting station is slightly delayed and then delivered substantially in real time. However, in such a case, it is necessary to use either a plurality of VTRs or an optical disk apparatus of a special type in which a recording head and a reproducing head are separately provided, for simultaneously performing the recording and the reproducing operations. If a plurality of VTRs are simultaneously used, then it becomes adversely complicated to operate these apparatuses. On the other hand, the use of such an optical disk apparatus of a special type disadvantageously increases the costs.

[0004] The document US-A-5 438 423 also discloses a video recording and reproducing apparatus which allows to reproduce a recorded video at a later -time and at a desired rate. A video signal is continuously written into a random access dynamic buffer, such as an optical disk, in a recirculating manner, and may be read out on a random access basis.

SUMMARY OF THE INVENTION

[0005] Thus, the present invention concerns a video signal recording and reproducing apparatus as defined in the appended claims.

[0006] By utilizing the above-described configurations, it is possible to provide an apparatus which can independently perform a trick play reproducing operation (e.g., a fast-forward reproducing operation or a backward reproducing operation) of a recorded part of a broadcast program which is now being received, while compression encoding and recording the broadcast program. As a result, it is possible to start watching a recorded part of a program without waiting for the program to end as is done in the recording and reproducing operations performed by a conventional single VTR. In addition, even when a viewer initially starts watching a program at a time much later than the broadcast start time of the program, the viewer can finish watching the program substantially at the same time as the broadcast end time by additionally utilizing a fast-forward reproducing function in the middle of the reproducing operation.

[0007] According to the present invention, it is possible to provide an apparatus which can perform a normal reproducing operation or a trick play reproducing operation (e.g., a fast-forward reproducing operation or a backward reproducing operation) of a recorded part of a broadcast program which is now being received, while recording the broadcast program by using a universal hard disk apparatus without using a plurality of VTRs or an expensive optical disk apparatus for which a recording head and a reproducing head are separately provided. As a result, it is possible to start watching a recorded part of a program without waiting for the program to end, as is necessary in the recording and reproducing operations performed by a conventional single VTR. In addition, even when a viewer initially starts watching a program at a time much later than the broadcast start time of the program, the viewer can finish watching the program substantially at the same time as the broadcast end time by additionally utilizing a fast-forward reproducing function in the middle of the reproducing operation, so that a considerable amount of time can be saved. Moreover, in the case where a viewer cannot help stopping watching a program in the middle of the program, even if the program still continues when the viewer resumes watching the program, the viewer can reproduce and watch the program from the scene which was broadcast when the viewer left, while continuing recording the program. Furthermore, in the case where a viewer watches a first program while recording a second program on a different channel, it is possible to instantaneously

start watching the second program from the beginning thereof at a time after the first program ends and before the second program ends.

[0008] Thus, the invention described herein makes possible the advantage of providing a video signal recording and reproducing apparatus which can simultaneously record and reproduce a television signal.

[0009] This and other advantages of the present invention will become apparent to those skilled in the art upon reading and understanding the following detailed description with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Figure **1** is a block diagram illustrating a configuration for a video signal recording and reproducing apparatus in a first example of the present invention.

[0011] Figure **2** is a diagram illustrating an operational concept in the first example.

[0012] Figure **3** is a diagram illustrating the contents of a table RAM.

[0013] Figure **4** is a detailed timing chart of peripheral hardware for a hard disk apparatus.

[0014] Figure **5** is a block diagram illustrating a configuration for a video signal recording and reproducing apparatus in a fourth example of the present invention.

[0015] Figure **6** is a block diagram illustrating a configuration for a video signal recording and reproducing apparatus in a sixth example of the present invention.

[0016] Figure **7** is a diagram illustrating a screen synthesis in the sixth example of the present invention.

[0017] Figure **8** is a diagram illustrating a screen separation in the sixth example of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Hereinafter, the embodiments of the present invention will be described with reference to the accompanying drawings.

Example 1

[0019] Figure **1** is a block diagram illustrating a configuration for a video signal recording and reproducing apparatus in a first example of the present invention. In Figure **1**, the reference numeral **1** denotes an antenna; **2** denotes a tuner; **3** denotes a demodulator; **4** denotes an MPEG1 encoder; **5** and **6** denote recording buffer memories; **7** denotes a first switch; **8** denotes a hard disk apparatus; **9** and **10** denote reproducing buffer memories; **11** denotes a second switch; **12** denotes an MPEG1 decoder; **13** denotes a TV monitor; **14** denotes a hard disk controller; **15** denotes a table RAM; **16** denotes a system controller; **17** denotes a timer; and **18** denotes an operator panel.

[0020] First, before describing the operation of the apparatus in the first example with reference to Figure **1**, the operational concepts will be described with reference to Figure **2.** In this example, it is assumed that a viewer wants to watch a program which is to be broadcast from 10 p.m. to 12 p.m. (as shown in portion (**a**) of Figure **2**) but that it is only after 11 p.m. that the viewer can watch the program because of some inconvenience. In such a case, in accordance with the method of this example, while recording the program from 10 p.m. to 12 p.m. (as shown in portion (**b**) of Figure **2**), the viewer can start reproducing the program from the beginning thereof from 11 p.m. (as shown in portion (**c**) of Figure **2**). When a normal reproducing mode is selected, the reproducing operation ends at 1 a.m. which is two hours later than the time when the viewer started watching the program. On the other hand, since a fast-forward reproducing operation can also be performed on a part of the program which has already been recorded as shown in portion (**d**) of Figure **2**, it is also possible to reproduce all of the program at a time slightly later than 12 p.m., that is the time when the broadcasting of the program actually ends.

[0021] Hereinafter, a detailed operation of the video signal recording and reproducing apparatus of the first example will be described with reference to Figure **1.** First, a viewer pre-sets a TV channel, a recording start time and a recording end time of a program to be watched on the operator panel **18**. For example, it is assumed that the viewer sets a program on channel # 6 starting at 10 p.m. In such a case, when it is 10 p.m., the system controller **16** sets the tuner **2** to channel # 6 in accordance with the information supplied from the timer **17** such that the electric waves for the channel # 6 are selected from the electric waves received by the antenna **1**, and the demodulator **3** demodulates the received waves into signals.

[0022] The received signals can be monitored on the TV monitor **13.** The received signals are converted by the MPEG1 encoder **4** into compressed video signals so as to be bit streams having a bit rate of 1.5 Mbps. These signals are transmitted via the first and the second recording buffer memories **5** and **6** having a capacity of 200 Kbytes, for example, and the first switch **7** so as to be written onto the hard disk apparatus **8.**

[0023] This operation will be described in detail later with reference to Figure **3.** The sector information indicating the physical positions of the compressed video signals written on the hard disk and the time information of the written

signals are stored in the table RAM **15** so as to correspond to each other. Such a state is maintained until 11 p.m., when the viewer starts watching the program. When it is 11 p.m., the viewer starts watching the program on the TV monitor **13.** In this case, if the viewer wants to watch the program starting at 10 p.m. (i.e., reserved recording start time) from the beginning thereof, then the viewer has only to push the reproducing button (not shown) on the operator panel **18.**

[0024] In this case, the program starting at 10 p.m. is reproduced from the beginning thereof from 11 p.m. at a normal reproducing speed as shown in portion **(c)** of Figure **2.** The hard disk controller **14** controls the hard disk apparatus **8** in accordance with the information supplied from the table RAM **15,** so that the compressed video signals recorded on the hard disk apparatus **8** are reproduced via the reproducing buffer memories **9** and **10** and the second switch **11.** This operation will be described in detail later with reference to Figure **3.** The reproduced compressed video signals are decoded by the MPEG1 decoder **12** so as to be video signals which are displayed on the TV monitor **13.**

[0025] It is noted that, in this example, the video signals compressed by the MPEG1 encoder **4** are being transmitted via the recording buffer memories **5** and **6** and the first switch **7** so as to be continuously written onto the hard disk apparatus **8** until 12 p.m. during the reproduction of the video signals. When it is 12 p.m., the system controller **16** finishes recording the compressed video signals onto the hard disk apparatus **8** in accordance with the information supplied from the timer **17.** In this case, it is possible to monitor on the TV monitor **13,** the video signals which are being written in parallel with the video signals which are being reproduced by using a technique such as a screen division.

[0026] On the other hand, in performing the reproducing operation, the viewer can reproduce a part of a program to be watched in detail at a slower speed and can reproduce an unnecessary part of the program at a higher speed in accordance with the instructions supplied from the system controller **16** by operating the operator panel **18.** The correspondence between the sector information of the compressed video signals recorded on the hard disk, and the time information of the signals, has been stored in the table RAM **15** for performing these operations.

[0027] The format of this table is shown in Figure **3.** In Figure **3,** the reference numeral **19** denotes the time information represented as a time code and **20** denotes a sector number on the hard disk. In this example, since each of a plurality of successive sectors corresponds to one second, sector addresses are indicated every other second in Figure **3.** In accordance with the operation of the viewer, the hard disk controller **14** reproduces required video signals based on this time information.

[0028] In the case of the MPEG1 standard, an image is generally compressed based on a unit consisting of a plurality of frames. A concept "GOP (group of pictures)" is used as the unit. For example, in the case where 1 GOP = 15 frames, 1 GOP covers a video corresponding to 0.5 second. Thus, in the case of performing a fast forward reproducing operation or a slow reproducing operation, if a decimation or an interpolation is performed on a GOP basis with respect to a video which has been decoded on a GOP basis, the resulting motion of the image is no longer smooth. In order to make the motion smooth, the decimation or the interpolation is required to be performed on a frame basis.

[0029] That is to say, a 10x fast-forward reproducing operation (or a fast-forward reproducing operation performed at a speed ten times as high as a normal reproducing speed) is realized by reproducing one frame out of ten frames. On the other hand, a 1/10x slow reproducing operation is realized by displaying one and the same frame 10 times in succession.

[0030] A time difference between the time when the video which is now being reproduced was recorded (hereinafter, such a time will be referred to as a "video recording time") and the current time, can be calculated by subtracting the video recording time, obtained by using the time information supplied from the table RAM **15,** from the current time. If the time difference is displayed on the TV monitor **13,** the time difference can be monitored. Before this time difference becomes zero, any arbitrary part of the video which has already been recorded can be reproduced. In addition, it is also possible to simultaneously display on the TV monitor **13** both the time corresponding to the output of the demodulator **3** and the time corresponding to the output of the MPEG1 decoder **12** by dividing the screen into two parts. Then, a video which is now being broadcast (and corresponds to the output of the demodulator **3**) and a video which is now being reproduced (and corresponds to the output of the MPEG1 decoder **12**) can be simultaneously watched on the same screen.

[0031] Assuming that the hard disk apparatus has a capacity large enough to record compressed video signals corresponding to two hours, if the viewer does not start watching a program within two hours after the recording start time, the recorded signals are updated from the point of time two hours later than the recording start time, whereby a program corresponding to two hours preceding the time when the viewer starts watching the recorded program can always be covered. On the other hand, an update halt mode may also be selected. In such a case, a video can only be recorded for two hours in the same way as a commonly used VTR.

[0032] Hereinafter, detailed timings of peripheral hardware of the hard disk apparatus **8** will be described with reference to Figure **4.**

[0033] The detailed configuration of the hard disk apparatus **8** is omitted in Figure **1.** A hard disk apparatus which is universally used as a peripheral device for a computer system can be used as the hard disk apparatus **8.** The hard

disk apparatus **8** may include either one disk medium or a plurality of disk media and includes a recording and reproducing head, not a head exclusively used for a recording operation or a reproducing operation.

[0034] Portion **(a)** of Figure **4** represents an output of the MPEG1 encoder **4** and **A1, A2, A3,** ... **A6** indicate the signals obtained by dividing the output by every 1.5 Mbits. Portion **(b)** of Figure **4** represents the operational modes of the recording buffer memory **5** having a capacity of 200 Kbytes and **W** indicates writing a signal onto the memory and **R** indicates reading out a signal from the memory. Thus, **A1-W** means writing a signal **A1** onto the buffer memory and **A1-R** means reading out the signal **A1** from the buffer memory, for example. A signal is written onto the buffer memory in real time simultaneously with the video signals, while the signal is read out from the buffer memory at a high rate in accordance with the transfer rate at which the signal is transferred to the hard disk apparatus **8.**

[0035] Portion (c) of Figure **4** represents the operational modes of the recording buffer memory **6** having a capacity of 200 Kbytes and **W** and **R** indicate the same operations as those in portion (**b**). The buffer memories **5** and **6** operate in pairs. More specifically, while one of the buffer memories **5** or **6** transfers data to the hard disk apparatus **8** via the first switch **7,** the other buffer memory **6** or **5** stores therein a compressed video signal supplied from the MPEG1 encoder **4.**

[0036] Portion (**d**) of Figure **4** represents the seek timings for writing data onto the hard disk apparatus **8.** Portion (**e**) of Figure **4** represents the timings at which data is transferred from the buffer memories **5** and **6** to the hard disk apparatus **8** so as to be written thereon. **A1-W** means writing the signal **A1** onto the hard disk apparatus **8.** Though the time sequence is not specifically shown in Figure **4,** portions (**b**) and (**c**) always precede portion **(e).** For example, the signal **A1** read out by **A1-R** in portion (**b**) is written by **A1-W** in portion **(e).**

[0037] Portion (**f**) of Figure **4** represents the seek timings for reading out data from the hard disk apparatus **8.** Portion (**g**) of Figure **4** represents the timings at which data is read out from the hard disk apparatus **8** and **B1-R** means reading out a signal **B1** from the hard disk apparatus **8,** for example. Portion **(h)** of Figure **4** represents the operational modes of the reproducing buffer memory **9** having a capacity of 200 Kbytes and **B1-W** means writing the signal **B1** onto the buffer memory **9.**

[0038] Portion (**i**) of Figure **4** represents the operational modes of the reproducing buffer memory **10** having a capacity of 200 Kbytes and **W** and **R** indicate the same operations as those described above. The buffer memories **9** and **10** operate in pairs. More specifically, while a signal read out from the hard disk apparatus **8** is written onto one of the buffer memories **9** or **10,** the other buffer memory **10** or **9** reads out a signal, which has been supplied from the hard disk apparatus **8** and stored in the buffer memory **10** or **9,** at a rate of the video signal and then supplies the signal to the MPEG1 decoder **12** via the second switch **11.**

[0039] Portion (**j**) of Figure **4** represents an input to the MPEG1 decoder **12.** As shown in Figure **4,** the input has been extended so as to have the same period as that of the output in portion (**a**) and is continuously reproduced.

[0040] As shown in Figure **4,** for recording and reproducing a video signal simultaneously and continuously, the period of each of the signals **A1, A2, A3,** ... is set to be longer than the following time T:

T = (seek time for preparing to record data onto the hard disk)

+ (time required for writing the data having the

period onto the hard disk)

+ (seek time for preparing to reproduce the data from

the hard disk)

+ (time required for reading out the data having the

period from the hard disk)

[0041] If the total of these times becomes longer than the period of **A1, A2, A3,** ..., then the video cannot be recorded but overflows. Thus, the period is required to be sufficiently longer than the total time. Since the seek time of the hard disk, in particular, largely varies depending upon situations, a maximum seek time is required to be estimated and included in the sum.

[0042] In this case, the period of **A1, A2, A3,** ... is a time during which an MPEG bit stream having a bit rate of 1.5 Mbps is occupied by a buffer memory having a capacity of 200 Kbytes: 200 k + (1.5 M + 8) = about 1 second. Assuming that the data transfer rate of the hard disk is 1 Mbyte per second, the time required for transferring the data is: 200 k + 1 M = 0.2 second. Even when the maximum seek time is estimated to be 100 milliseconds,

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