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PICTURE SIGNAL CODING METHOD, DECODING METHOD AND PICTURE SIGNAL RECORDING MEDIUM

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(71) Applicant(s)
SONY CORPORATION

(72) Inventor(s)
TERUHIKO SUZUKI; YOICHI YAGASAKI; JUN YONEMITSU

(74) Attorney or Agent
SPRUSON & FERGUSON , GPO Box 3898, SYDNEY NSW 2001

(56) Prior Art Documents
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(57) Claim

1. A picture signal recording method, comprising the steps of:

coding an input picture signal to produce a coded picture signal, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals;

dividing the coded picture signal into coded picture signals for high speed reproduction and other coded picture signals, the coded picture signals for high speed reproduction including the intra-frame coded picture signals and at least one of the predictive-coded picture signals;

arranging the coded picture signals for high speed reproduction and the other coded picture signals within each group-of-pictures so that the coded picture signals for high speed reproduction in the group-of-pictures are positioned at the beginning of the group-of-pictures to produce a recording signal; and

recording the recording signal onto a recording medium.

PICTURE SIGNAL CODING METHOD, DECODING METHOD AND PICTURE SIGNAL RECORDING MEDIUM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a picture signal coding method and decoding method and a picture signal recording medium suitable for use to record and reproduce a coded moving picture signal onto and from a recording medium such as, for example, a compact disk or a hard disk.

2. Description of the Related Art

When it is tried to record and reproduce moving picture data, a recording medium having a very high continuous transmission rate is required since they involve a very great amount of information. At present, a video signal, for example, of the NTSC television system, is recorded onto and reproduced from a magnetic tape or an optical disk.

If it is tried to record a video signal for a long time onto a recording medium which has a comparatively small size and has a comparatively information recording capacity, then means is essentially required for coding and recording the video

signal in a high efficiency and decoding a read signal of the thus recorded video signal in a high efficiency. In order to meet the requirement, several high efficiency coding systems which make use of correlations of a video signal have been proposed, and one of the systems is the MPEG (Moving Picture Experts Group) system. Details of the MPEG system are disclosed in AVC-400 TEST MODEL 3, ISO-IEC/JTC1/SC29/WG11, November, 1992. Another system wherein a coded signal is divided into high priority data and low priority data and then the high priority data and the low priority data are transmitted on different carriers from each other is investigated by the ATV of the United States.

In the MPEG system, a difference between picture frames of a video signal is taken first to decrease the redundancy in the time axis direction, and then an orthogonal transformation technique such as discrete cosine transform (DCT) is used to decrease the redundancy in the space axis direction. A video signal is coded efficiently in this manner and recorded onto a predetermined recording medium. Recording of a video signal coded in a high efficiency is disclosed, for example, in U.S. Patent No. 5,140,437, U.S. Patent No.

5,040,061, Japanese Laid-Open Patent No. 3-129979 and Japanese Laid-Open Patent No. 3-78380.

On the other hand, when a recording medium on which a video signal coded in a high efficiency is recorded in this manner is reproduced, the reproduction signal is transformed by inverse orthogonal transformation to decode it in a high efficiency to reproduce the video signal.

By the way, when a recording medium on which a video signal coded in a high efficiency that is recorded in this manner is to be reproduced at a high speed (picture search), decoding is performed after each several frames and the thus decoded signal is outputted at a rate equal to that in ordinary reproduction.

However, in a coding method according to the MPEG system described above, coding is performed based on prediction of motion between frames. Consequently, some frames (P-pictures or B-pictures) cannot be decoded without a coded picture of another frame in the past or in the future with respect to the frame at present. Accordingly, it is not always possible to arbitrarily select frames of a picture signal to reproduce the picture signal at a high speed.

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If only frames (I-pictures) which can be accessed and decoded directly are reproduced, then high speed reproduction of the picture signal is possible without waiting reproduction of some other frame or frames. However, the I-picture (intra-frame coded frame whose decoding is completed within the frame) is normally present by one frame in only each ten and several frames (GOP which will be hereinafter described), and even if only such intra-frame coded frames are reproduced, only high speed reproduction with rough motion can be performed.

For example, a continuously inputted video signal is grouped into a GOP (Group of Pictures) which includes 15 frames. Then, as shown in FIG. 57, the first two frames of a GOP are processed as B-pictures (B0, B1), and then the next frame is processed as an I-picture (I2). Thereafter, coding processing is performed such that P-pictures (P5, P8, P11, P14) may be produced with two B-pictures (B3, B4, B6, B7, B9, B10, B12, B13) interposed between each two adjacent ones of them.

The data coded in this manner are transmitted in the order of I2, B0, B1, P5, B3, B4, P8, B6, B7, P11, B9, B10, P14, B12 and B13 as seen in FIG. 58. This is

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because, since, for example, each of the B-pictures B0 and B1 (or B3 and B4) requires, as a predictive frame, another frame I2 (P5) which appears later in time, it cannot be decoded if the frame I2 (P5) is not prepared in advance.

While high speed reproduction is possible if coding processing is performed at a high speed for all of the frames B0 to P14, this is substantially impossible due to a restriction in software to raise the decoding processing speed by several times.

Therefore, if each I-picture and each P-picture for which another frame preceding in time is used as a predictive frame are reproduced but no B-picture is reproduced as seen from FIG. 58, then finer high speed reproduction can be performed. The high speed reproduction method is disclosed in U.S. Patent Application Serial No. 07/981,178, now U.S. Patent No. 5305113. In this instance, however, so much time is required to effect track jumping to search a next P- or I-picture after another I- or P-picture has been reproduced that the high speed reproduction picture may possibly be interrupted. Further, a method wherein some of P-pictures and B-pictures are used in addition to I-pictures for high speed reproduction is disclosed in U.S. Patent

now U.S. Patent No. 5504585.
Application Serial No. 125,685, Further, a technique wherein an entry packet indicative of an access point upon high speed reproduction is inserted into a bit stream is disclosed in U.S. Patent Application Serial No. 125,573, now U.S. Patent No. 5455684.

Further, an I-picture involves a greater amount of data than P- and B-pictures and consequently data of I-pictures are read out, upon high speed reproduction, at a high frequency than upon ordinary reproduction. Consequently, there is ~~a subject~~ to be solved in that failure to read data of an I-picture sometimes occurs.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a picture signal coding method and decoding method and a picture signal recording medium which allow smooth (fine) high speed forward and reverse reproduction without raising the processing speed required for decoding.

In order to attain the object described above, according to the present invention, a picture signal is first coded, for example, in accordance with the MPEG system, and then data only of an I-picture or of both of an I-picture and a P-picture or P-pictures are treated

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as data for high speed reproduction separately from data of the other P-pictures and B-pictures and are collectively recorded in units of, for example, a GOP and at the top of the GOP or a sector. The data for high speed reproduction may be all of I- and P-pictures or may be those of such I and P-pictures which are comparatively high in priority degree. Consequently, the number of jumping operations can be reduced and time wasted for waiting for inputting of data to be decoded can be reduced. Consequently, a high speed reproduction picture will be interrupted. Further, the reading time for high speed reproduction can be reduced. In addition, when an error has occurred, for example, with the other data, data for high speed reproduction are reproduced at an ordinary speed. Consequently, the loss of a picture can be suppressed.

More particularly, according to a first aspect of the present invention, there is provided a picture signal recording method, comprising the steps of:

coding an input picture signal to produce a coded picture signal, the coded picture signal including intra-frame coded picture signals, predictive coded picture signals, and bi-directional predictive coded picture signals;

dividing the coded picture signal into coded picture signals for high speed reproduction and other coded picture signals, the coded picture signals for high speed reproduction including the intra-frame coded picture signals and at least one of the predictive-coded picture signals;

arranging the coded picture signals for high speed reproduction and the other coded picture signals within each group-of-pictures so that the coded picture signals for high speed reproduction in the group-of-pictures are positioned at the beginning of the group-of-pictures to produce a recording signal; and

recording the recording signal onto a recording medium.

According to a second aspect of the present invention, there is provided a picture signal recording method, comprising the steps of:

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coding an input picture signal to produce a coded picture signal which includes intra-coded picture signals, predictive-coded picture signals, and bi-directionally predictive-coded picture signals;

dividing the coded picture signals into coded picture signals for high speed reproduction and other coded picture signals, the coded picture signals for high speed reproduction including intra-coded picture signals and at least one predictive-coded picture signal;

successively arranging the coded picture signals for high speed reproduction and the other coded picture signals at a predetermined ration to produce a recording signal; and

recording the recording signal onto a recording medium.

According to a third aspect of the present invention, there is provided a picture signal recording method, comprising the steps of:

coding an input picture signal to produce a coded picture signal, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals;

dividing the coded picture signal into coded picture signals of a high priority degree and coded picture signals of a low priority degree, the coded picture signals of a high priority degree including at least portions of the intra-frame coded picture signals and at least portions of at least one of the predictive-coded picture signals and the coded picture signals of a low priority degree including at least other portions of the intra-coded picture signals and at least other portions of the at least one predictive-coded picture signals,

producing a recording signal of a packet construction such that the coded picture signals of a high priority degree and the coded picture signals of a low priority degree are not present in a same packet; and

recording the recording signal onto a recording medium.

According to a fourth aspect of the present invention, there is provided a picture signal reproduction method, comprising the steps of:

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reproducing a coded picture signals from a recording medium on which the coded picture signal is recorded, the coded picture signal including intra-frame coded picture signals, predictive coded picture signals, and bi-directional predictive-coded picture signals and the coded picture signal being recorded on the recording medium such that coded picture signals for high speed reproduction in a predetermined picture unit and other coded picture signals in the predetermined picture unit are disposed so that the coded picture signals for high speed reproduction are positioned at the beginning of the predetermined picture unit, the coded pictures signals for high speed reproduction including the intra-frame coded picture signals and at least one of the predictive-coded picture signals;

separating the coded picture signal into the coded picture signals for high speed reproduction and other coded picture signals;

re-arranging the coded picture signals for high speed reproduction and the other coded picture signals thus separated in a predetermined order to produce a rearranged signal; and

decoding the re-arranged signal to produce a decoded picture for ordinary reproduction.

According to a fifth aspect of the present invention, there is provided a picture signal reproduction method, comprising the steps of:

reproducing, from a recording medium on which a coded picture signal is recorded, only coded picture signals for high speed reproduction, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals and the coded picture signal being recorded on the recording medium such that the coded picture signals for high speed reproduction in a predetermined picture unit, and other coded picture signals in the predetermined picture unit are disposed so that the coded picture signals for high speed reproduction in the predetermined picture unit are positioned at the beginning of the predetermined picture unit, the coded picture signals for high speed reproduction

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including the intra-frame coded picture signals and at least one of the predictive-coded picture signals; and

decoding the coded picture signals for high speed reproduction thus reproduced to produce a decoded picture for high speed reproduction.

According to a sixth aspect of the present invention, there is provided a picture signal reproduction method, comprising the steps of:

reproducing, from a recording medium, a sector of the recording medium to which coded picture signals for high speed reproduction are allocated, a coded picture signal including intra-frame coded picture signals, predictive-coded pictures signals, and bi-directional predictive-coded picture signals recorded on the recording medium such that coded picture signals for high speed reproduction and other coded picture signals are successively arranged on the recording medium at a predetermined ratio and the coded picture signal has a predetermined amount of codes allocated to each sector, the coded picture signals for high speed reproduction including the intra-frame coded picture signals and at least one predictive-coded picture signal;

separating, in response to a signal in a subcode of the sector representative of a beginning address of the coded picture signals for high speed reproduction, the coded picture signals of the sector for high speed reproduction from the other coded picture signals of the sector; and

decoding the thus separated coded picture signals for high speed reproduction to produce a decoded picture for high speed reproduction.

According to a seventh aspect of the present invention, there is provided a picture signal reproduction method, comprising the steps of:

reproducing a coded picture signal from a recording medium, the coded picture signal including intra-frame coded picture signals, predictive coded picture signals, and bi-directional predictive coded picture signals, the coded picture signal recorded on the recording medium having been divided into coded picture signals of a high priority degree and coded picture signals of a low priority degree, the coded picture signals of a high priority degree and the coded picture signals of a low priority degree having been

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recorded on the recording medium in a packet construction such that the coded picture signals of a high priority degree and the coded picture signals of a low priority degree do not exist in a same packet, the coded picture signals of a high priority degree including at least portions of the intra-frame coded picture signals and at least portions of at least one of the predictive-coded picture signals and the coded picture signals of a low priority degree including at least other portions of the intra-coded picture signals and at least other portions of the at least one predictive-coded picture signals;

separating the coded picture signals of a high priority degree and the coded picture signals of a low priority degree from each other in response to an identification signal provided in a header of the packet and that identifies whether the coded picture signals in the packet are the coded picture signals of a high priority degree or the coded picture signals of a low priority degree; and

decoding only the coded picture signals of a high priority degree upon high speed reproduction.

According to an eighth aspect of the present invention, there is provided a picture signal reproduction method, comprising the steps of:

reproducing a coded picture signal from a recording medium, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals, the coded picture signal recorded on the recording medium having been divided into coded picture signals of a high priority degree and coded picture signals of a low priority degree, the coded picture signals of a high priority degree and the coded picture signals of a low priority degree having been recorded on the recording medium in a packet construction such that the coded picture signals of a high priority degree and the coded picture signals of a low priority degree do not exist in a same packet, the coded picture signals of a high priority degree including at least portions of the intra-frame coded picture signals and at least portions of at least one of the predictive-coded picture signals and the coded picture signals of the low priority degree including at least other portions of the intra-coded picture signals and at least other portions of the at least one predictive-coded picture signals;

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separating the coded picture signals of a high priority degree and the coded picture signals of a low priority degree from each other in response to an identification signal provided in a header of the packet and that identifies whether the coded picture signals in the packet are the coded picture signals of a high priority degree or the coded picture signals of a low priority degree;

combining the coded picture signal of a high priority degree and the coded picture signals of a low priority degree in response to a link signal provided in the header of the packet to produce a combination signals; and

decoding the combination signal to produce a decoded picture signal for ordinary reproduction.

According to a ninth aspect of the present invention, there is provided a picture signal recording apparatus, comprising:

coding means for coding an input picture signal to produce a coded picture signal, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals;

division means for dividing the coded picture signal into coded picture signals for high speed reproduction and other coded picture signals, the coded picture signals for high speed reproduction including the intra-frame coded picture signals and at least one of the predictive-coded picture signals;

multiplexing means for arranging the coded picture signals for high speed reproduction and other coded picture signals within each group-of-pictures so that the coded picture signals for high speed reproduction in the group-of-pictures are positioned at the beginning of the group-of-pictures to produce a recording signal; and

recording means for recording the recording signal onto a recording medium.

According to a tenth aspect of the present invention, there is provided a picture signal recording apparatus, comprising:

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coding means for coding an input picture signal to produce a coded picture signal which includes intra-coded picture signals, predictive-coded picture signals, and bi-directionally predictive-coded picture signals;

divisional means for dividing the coded picture signal into coded picture signals for high speed reproduction and other coded picture signals, the coded picture signals for high speed reproduction including intra-coded picture signals and at least one predictive-coded picture signal;

multiplexing means for successively arranging the coded picture signals for high speed reproduction and the other coded picture signals at a predetermined ratio to produce a recording signal; and

recording means for recording the recording signal onto a recording medium.

According to an eleventh aspect of the present invention, there is provided a picture signal recording apparatus, comprising:

coding means for coding an input picture signal to produce a coded picture signal, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals;

division means for dividing the coded picture signal into coded picture signals of a high priority degree and coded picture signals of a low priority degree, the coded picture signals of a high priority degree including at least portions of the intra-frame coded picture signals and at least portions of at least one of the predictive-coded picture signals, and the coded picture signals of the a priority degree including at least other portions of the intra-coded picture signals and at least other portions of the at least one predictive-coded picture signals;

multiplexing means for producing a recording signal of a packet construction such that the coded picture signals of a high priority degree and the coded picture signals of a low priority degree are not present in a same packet; and

recording means for recording the recording signal onto a recording medium.

According to a twelfth aspect of the present invention, there is provided a picture signal reproduction apparatus, comprising:

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reproduction means for reproducing, a coded picture signal from a recording medium on which the coded picture signal is recorded, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals and the coded picture signal being recorded on the recording medium such that coded picture signals for high speed reproduction in a predetermined picture unit and other coded picture signals in the predetermined picture unit are disposed so that the coded picture signals for high speed reproduction are positioned at the beginning of the predetermined picture unit, the coded picture signals for high speed reproduction including the intra-frame coded picture signals and at least one of the predictive-coded picture signals;

separation means for separating the coded picture signal into the coded picture signals for high speed reproduction and the other coded picture signals;

means for re-arranging the coded picture signals for high speed reproduction and the other coded picture signals thus separated in a predetermined order to produce a re-arranged signal; and

decoding means for decoding the re-arranged signal to produce a decoded picture for ordinary reproduction.

According to a thirteenth aspect of the present invention, there is provided a picture signal reproduction apparatus, comprising:

reproduction means for reproducing, from a recording medium on which a coded picture signal is recorded, only coded picture signals for high speed reproduction, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals and the coded picture signals for high speed reproduction including the intra-frame coded picture signals and at least one of the predictive-coded picture signals, the coded picture signal being recorded on the recording medium such that coded picture signals for high speed reproduction in a predetermined picture unit and other coded picture signals in the predetermined unit are disposed so that the coded picture signals for high speed

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reproduction in the predetermined picture unit are positioned at the beginning of the predetermined picture unit; and

decoding means for decoding the coded picture signals for high speed reproduction thus reproduced to produce a decoded picture for high speed reproduction.

According to a fourteenth aspect of the present invention, there is provided a picture signal reproduction apparatus, comprising:

reproduction means for reproducing a coded picture signal from a recording medium on which the coded picture signal is recorded, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals and the coded picture signals for high speed reproduction including the intra-frame coded picture signals and at least one of the predictive-coded picture signals, the coded picture signal being recorded on the recording medium such that the coded picture signals for high speed reproduction and the other coded picture signals are successively arranged at a predetermined ratio and the coded picture signal is allocated for each predetermined amount of codes to each sector, a sector to which the coded picture signals for high speed reproduction are allocated;

separation means for separating, in response to a signal representative of a beginning address of the coded picture signals for high speed reproduction in a subcode of the sector, the coded picture signals for high speed reproduction from the other coded picture signals thus reproduced from the sector; and

decoding means for decoding the thus separated coded picture signals for high speed reproduction to produce a decoded picture for high speed reproduction.

According to a fifteenth aspect of the present invention, there is provided a picture signal reproduction apparatus, comprising:

reproduction means for reproducing a coded picture signal from a recording medium, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals, the coded picture signal recorded on the recording medium having been divided into coded

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picture signals of a high priority degree and coded picture signals of a low priority degree, the

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coded picture signals of a high priority degree and the coded picture signals of a low priority degree having been recorded in a packet construction such that the coded picture signals of a high priority degree and the coded picture signals of a low priority degree do not exist in a same packet;

separation means for separating the coded picture signals of a high priority degree and the coded picture signals of a low priority degree from each other in response to an identification signal provided in a header of the packet and that identifies whether the coded picture signals in the packet are the coded picture signals of a high priority degree or the coded picture signals of a low priority degree; and

decoding means for decoding only the coded picture signals of a high priority degree upon high speed reproduction.

According to a sixteenth aspect of the present invention, there is provided a picture signal reproduction apparatus, comprising:

reproduction means for reproducing a coded picture signal from a recording medium, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals, the coded picture signal recorded on the recording medium having been divided into coded picture signals of a high priority degree and coded picture signals of a low priority degree, the coded picture signals of a high priority degree and the coded picture signals of a low priority degree having been recorded in a packet construction such that the coded picture signals of a high priority degree and the coded picture signal of a low priority degree do not exist in a same packet;

separation means for separating the coded picture signals of a high priority degree and the coded picture signals of a low priority degree from each other in response to an identification signal provided in a header of the packet and which identified whether the coded picture signals within the packet are the coded picture signals of a high priority degree or the coded picture signals of a low priority degree;

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means for combining the coded picture signals of a high priority degree and the coded picture signals of a low priority degree in response to a link signal provided in the header of the packet to produce a combination signal; and

decoding means for decoding the combination signal to produce a decoded picture signal for ordinary reproduction.

According to a seventeenth aspect of the present invention, there is provided a picture signal recording medium, having data recorded thereon formed by the steps of:

coding an input picture signal to produce a coded picture signal, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals;

dividing the coded picture signal into coded picture signals for high speed reproduction and other coded picture signals, the coded picture signals for high speed reproduction including the intra-frame coded picture signals and at least one of the predictive-coded picture signals;

arranging the coded picture signals for high speed reproduction and the other coded picture signals within each group-of-pictures so that the coded picture signals for high speed reproduction in the group-of-pictures are positioned at the beginning of the predetermined group-of-pictures to produce a recording signal; and

recording the recording signal onto the recording medium.

According to an eighteenth aspect of the present invention, there is provided a picture signal recording medium, having data recorded thereon formed by the steps of:

coding an input picture signal to produce a coded picture signal, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals;

dividing the coded picture signal into coded picture signals for high speed reproduction and other coded picture signals, the coded pictures signals for high speed reproduction including the intra-frame coded picture signals and at least one of the predictive-coded picture signals;

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successively arranging the coded picture signals for high speed reproduction and the other coded picture signals at a predetermined ratio to produce a recording signal; and

recording the recording signal onto a recording medium.

According to a nineteenth aspect of the present invention, there is provided a picture signal recording medium, formed by the steps of:

coding an input picture signal to produce a coded picture signal, the coded picture signal including intra-frame coded picture signals, predictive-coded picture signals, and bi-directional predictive-coded picture signals;

dividing the coded picture signal into coded picture signals of a high priority degree and coded picture signals of a low priority degree, the coded picture signals of high priority degree including at least portions of the intra-frame coded picture signals and at least portions of at least one of the predictive-coded picture signals and the coded picture signals of a low priority degree including at least other portions of the intra-coded picture signals and at least other portions of the at least one predictive-coded picture signals;

producing a recording signal of a packet construction such that the coded picture signals for high speed reproduction and the other coded picture signals are not present in a same packet and

recording the recording signal onto a recording medium.

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