DIGITAL RECORDING AND REPRODUCING

The present invention relates to methods of and apparatus for digital recording and reproducing.

When recording a color picture on a magnetic tape, a digital video cassette recorder (VCR) usually uses one of several compressive encoding methods so as to promote recording efficiency. A standard compressive method is a DCT variable-length encoding method in which the number of output bits varies according to picture complexity. However, in recording digital data onto a digital magnetic tape, fixing the number of output bits to a predetermined limit is important. Particularly, this functions as a critical factor during a variable-speed playback operation such as high speed search. Since a playback head scans a plurality of tracks by traversing them during the high speed search, the output gain of the playback head decreases when it passes between the tracks, so that the playback head draws a diamond-shaped envelope waveform. Therefore, in such a conventional method, in order to arrange the minimum required video data to recognize a picture on a region where a playback head scans, i.e. a reproducible region, during a variable-speed playback operation such as a high speed search, video data is mixed to be re-arranged in a track or the re-arranged data of tracks are re-arranged in different tracks. However, in such a conventional method, since the regions where the head scans are different in each track, the format for re-arranging the data should be different for each track, resulting in a complicated re-arrangement algorithm and circuit.

Preferred embodiments of the present invention aim to provide a digital magnetic recording/reproducing method which is capable of improving the

quality of a reproduced image during a variable-speed playback operation such as a high speed search.

Another aim is to provide a digital magnetic recording/reproducing method which facilitates the re-arrangement of video data.

A still further aim is to provide a digital magnetic recording/reproducing apparatus suitable for performing the above methods.

According to one aspect of the present invention, there is provided a digital magnetic recording/reproducing method which compressively encodes video data to reduce a bit rate of the video data, forms the compressed data into sync-block units as minimum units for error-correcting, records the data on a plurality of tracks of a magnetic tape, and reproduces the recorded data, wherein said sync blocks of one picture are recorded such that they are arranged on said plurality of tracks using a line sequential method in the track traversing direction, and said arranged sync blocks are restored to their original locations.

Preferably, each sync block contains a sync code, an ID code, an independently decodable first data code, a first error-correcting code for error correcting said first data code, a second data code decode-dependent on said first data code, and a second error-correcting code for error-correcting said second data code.

Preferably, during variable-speed playback, only said first data code is restored.

According to a further aspect of the present invention, there is provided a digital magnetic recording/reproducing apparatus comprising an encoder for encoding video data to record it on a magnetic tape and a decoder for picking up and decoding such data recorded on the magnetic tape to restore the original video data:

wherein said encoder comprises a data compressive encoder for compressively encoding the video data, an ECC encoder for providing the compressively encoded data with an error-correcting code and ID code, forming the data into sync blocks as minimum units for error-correcting, and providing said sync blocks with a sync code, a re-arranger for re-arranging said sync blocks onto a plurality of tracks using a line-sequential method which traverses the tracks, and a channel coder for channel-coding said re-arranged data to transmit it to the magnetic tape; and

wherein said decoder comprises a channel decoder for channel-decoding data picked up from said magnetic tape, an inverse re-arranger for restoring the arrangement of the channel-decoded data to the original screen locations by sync blocks, an ECC decoder for error-correcting the restored predetermined number of the sync blocks, and a data decompressive decoder for decompression-decoding the error-corrected and compressively encoded data to restore the video data.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

Figure 1 illustrates a recording format for recording digital video data onto a magnetic tape, and head scanning tracks on the magnetic tape during a variable speed playback, in one example of the present invention ;

Figure 2 illustrates the formation of a sync block of Figure 1;

Figure 3 illustrates a re-arrangement recording format of a sync block in one example of the present invention;

Figure 4 illustrates reproducing regions during a quintuple-speed playback of the recording format of Figure 1; and

Figure 5 is a block diagram of one example of a digital magnetic recording/reproducing apparatus of the present invention.

Referring to Figure 1, reference numeral 100 represents a track (one-dot-and one-dash). Reference numeral 101 denotes a sync block (thick full line). Reference numeral 102 denotes a reproducible region (fine full line). Reference numeral 103 denotes a head scan track (two-dots-and-one-dash). A hatched region 104 denotes a reproducing region during a variable-speed playback.

Referring to Figure 2, a sync block 101 contains a sync code 105, an ID code 106, a first data code 107, a first error correcting code 108, a second data code 109, and a second error correcting code 110. ID code 106 has information about a field number, sector number, track number and sync number. First data code 107 can be independently decoded and has the minimum video information required to identify a picture during a variable-

speed playback. Second data code 109 can be decoded using first data code 107, and this is done during normal playback. For instance, first data code 107 includes the DC component and lower frequency component of a DCT transfer coefficient and second data code 109 includes the higher frequency component thereof. Therefore, during a high speed search, only the DC and lower frequency components are reproduced, excluding the higher frequency component, since human vision is not greatly sensitive to these frequencies. As parity codes, first and second error correcting codes 108 and 110 correct the errors of corresponding data codes during playback.

Referring to Figure 3, the format of data recorded on a magnetic tape is formed so that a screen of video data is disposed by sync blocks, line-sequentially scanning four tracks. Sync blocks which are an arithmetic progression whose initial value is 1 and whose equal difference is 4, are recorded on a first track T_1. Sync blocks which are an arithmetic progression whose initial value is 2 and whose equal difference is 4, are recorded on a second track T_2. Sync blocks which are an arithmetic progression whose initial value is 3 and whose equal difference is 4, are recorded on a third track T_3. Sync blocks which are an arithmetic progression whose initial value is 4 and whose equal difference is 4, are recorded on a fourth track T_4. Since, during a quintuple-speed playback operation, data on hatched regions are picked up along the head tracks, as shown in Figure 4, data by predetermined intervals is restored in screen segments S_1 to S_4. Therefore, even if the sync blocks are not mixed in a track, the overall information of pictures can be picked up during the high speed processing. Further, as described above, during the high speed search, only the first data code which is independently decodable in a sync block, is restored. Thus, the minimum size of information picked up via the head is not more than half the size of a sync

block, so that the increased amount of picked-up information improves picture quality during the high speed search. During normal playback, the sync blocks re-arranged during recording are restored to their original screen location and the second data code is restored as well as the independently decodable first data code.

Referring to Figure 5, an example of a digital magnetic recording/reproducing apparatus suitable for performing a detailed method of the present invention comprises an encoder and a decoder. The encoder comprises a data compressive encoder 111, an ECC encoder 112, a sync block re-arranger 113 and a channel encoder 114. The decoder comprises a channel decoder 115, an inverse re-arranger 116, an ECC decoder 117 and a data decompressive decoder 118.

Data compressive encoder 111 performs the block formation of luminance signal Y and color difference signals R-Y and B-Y. The block-formed data is transformed into DCT coefficients. DCT coefficients are vector-quantized roughly to generate first vector quantization data as the independently decodable first data code. Quantization errors during the first vector-quantization are multi-level dependently vector-quantized to generate second and third vector quantization data as the dependently decodable second data code.

ECC encoder 112 adds outer codes to the generated code rows, provides the first data code with a first ECC code, provides the second data code with a second ECC code, and provides the data code rows with an ID code and sync code to form a sync block. Here, the first and second ECC codes correspond to an inner code. Re-arranger 113 writes the data rows into

memory while incrementing the sync-block addresses, and reads out the written data according to a detailed recording format so as to re-arrange the sync blocks. The reading out is performed by getting access to the memory addresses read out from a ROM which maps and records memory addresses corresponding to the recording format. Channel coder 114 modulates the data to transmit it to a transmitting path. Channel decoder 115 restores a modulated signal picked up from the transmitting path. Inverse re-arranger 116 restores the restored data by sync blocks to re-arrange the data into its original sync-block locations. During a normal playback operation, ECC decoder 117 error-corrects the first and second data codes by predetermined units with the first and second ECC codes, i.e. inner and outer codes. Data decompression decoder 118 inverse-vector-quantizes and inverse-DCT-converts the error-corrected data so as to restore and output the luminance and color difference signals.

The above-described example of the present invention, during recording, records a screen of video data by sync blocks onto a plurality of tracks, using a line sequential scanning method which traverses the tracks of a magnetic tape, and, during playback, restores the data to its original location. Therefore, during a variable-playback operation such as a high speed search operation, a data recording format which improves picture quality, is readily implemented. Further, only the independently decodable first data code is restored, thereby reducing the minimum pickup to below sync-block size, so that more video data can be obtained with a better picture quality being provided during high speed search operations.

CLAIMS

1. A digital magnetic recording/reproducing method which compressively encodes video data to reduce a bit rate of the video data, forms the compressed data into sync-block units as minimum units for error-correcting, records the data on a plurality of tracks of a magnetic tape, and reproduces the recorded data, wherein said sync blocks of one picture are recorded such that they are arranged on said plurality of tracks using a line sequential method in the track traversing direction, and said arranged sync blocks are restored to their original locations.

2. A digital magnetic recording/reproducing method as claimed in claim 1, wherein each sync block contains a sync code, an ID code, an independently decodable first data code, a first error-correcting code for error correcting said first data code, a second data code decode-dependent on said first data code, and a second error-correcting code for error-correcting said second data code.

3. A digital magnetic recording/reproducing method as claimed in claim 2, wherein, during variable-speed playback, only said first data code is restored.

4. A digital magnetic recording/reproducing apparatus comprising an encoder for encoding video data to record it on a magnetic tape and a decoder for picking up and decoding such data recorded on the magnetic tape to restore the original video data:

wherein said encoder comprises a data compressive encoder for compressively encoding the video data, an ECC encoder for providing the compressively encoded data with an error-correcting code and ID code, forming the data into sync blocks as minimum units for error-correcting, and providing said sync blocks with a sync code, a re-arranger for re-arranging said sync blocks onto a plurality of tracks using a line-sequential method which traverses the tracks, and a channel coder for channel-coding said re-arranged data to transmit it to the magnetic tape; and

wherein said decoder comprises a channel decoder for channel-decoding data picked up from said magnetic tape, an inverse re-arranger for restoring the arrangement of the channel-decoded data to the original screen locations by sync blocks, an ECC decoder for error-correcting the restored predetermined number of the sync blocks, and a data decompressive decoder for decompression-decoding the error-corrected and compressively encoded data to restore the video data.

5. A digital magnetic recording/reproducing method substantially as hereinbefore described with reference to the accompanying drawings.

6. A digital magnetic recording/reproducing method and apparatus substantially as hereinbefore described with reference to the accompanying drawings.