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Narayan et al.

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[54] **SUB-FRAME DECODER WITH AREA DEPENDENT UPDATE RATE FOR DIGITAL CAMCORDER TRANSMISSION STANDARD**

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[73] Assignee: **Texas Instruments Incorporated**, Dallas, Tex.

[21] Appl. No.: **08/967,559**

[22] Filed: **Nov. 12, 1997**

Related U.S. Application Data

[60] Provisional application No. 60/030,995, Nov. 15, 1996.

[51] **Int. Cl.**[6] **H04N 7/26**

[52] **U.S. Cl.** **348/420**; 348/390; 348/845

[58] **Field of Search** 348/420, 421, 348/390, 384, 845; H04N 7/26

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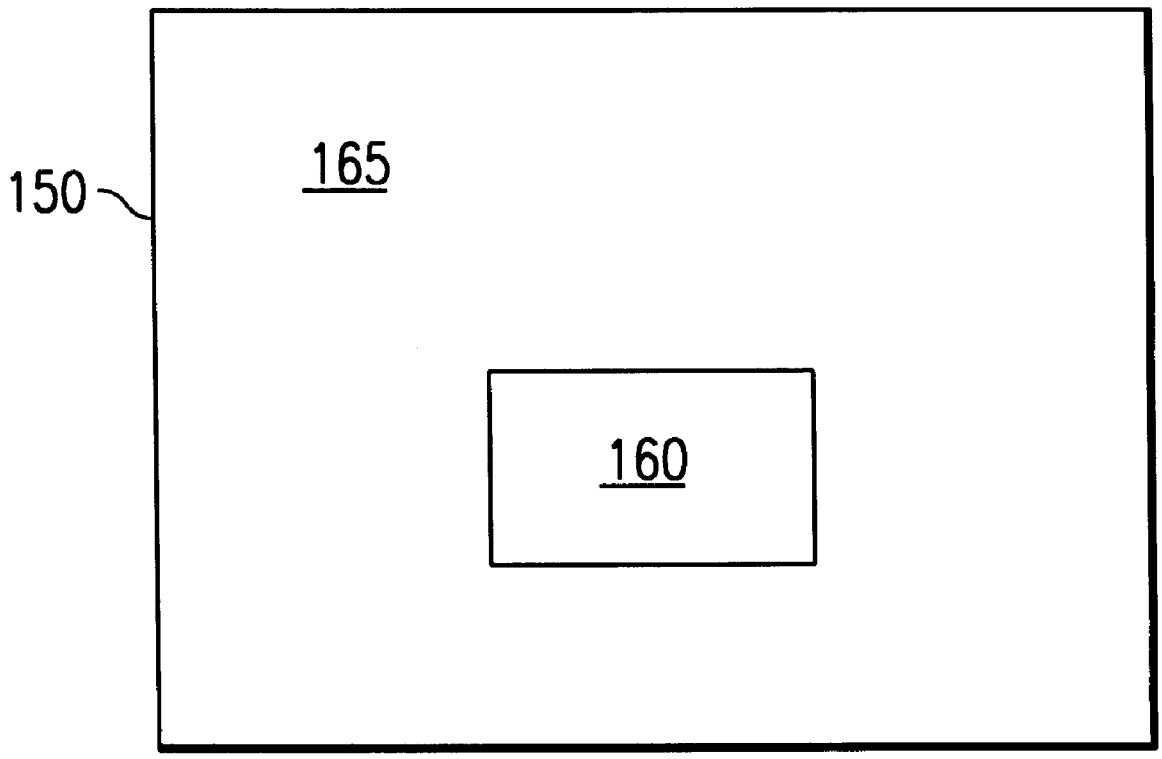
Primary Examiner—Howard Britton

Attorney, Agent, or Firm—Robert D. Marshall, Jr.; Gerald E. Laws; Richard L. Donaldson

[57] **ABSTRACT**

This invention is a method of decoding a stream of video image data transmitted as independent image frames consisting of plural marcoblocks transmitted in a nonsequential order. The method defines a sub-frame corresponding to a proper subset of the full frame. The method determines if a currently received macroblock is within the sub-frame. The method decodes the sub-frame. The sub-frame may be decoded at less than or equal to the frame rate of the video image data. A table has one entry for each macroblock that stores a transmission order within the video frame for the corresponding macroblock. The method determine if a current macroblock is within the sub-frame by reading the table. Each macroblock consists of a plurality of contiguous blocks and includes luminance data for any included blocks and chrominance data for the macroblock as a whole. The method optionally decodes the luminance data for each included block and ignores the chrominance data. The method decodes the sub-frame employing only data prior to an end of data marker or the end of a data group allocated to that block, and ignores data following an end of data marker. The method may also decode a full frame of video image data at a full frame decode rate less than the sub-frame decode rate. The method preferably employs a digital camcorder to generate the stream of video image data and a notebook computer for decoding and display.

30 Claims, 3 Drawing Sheets



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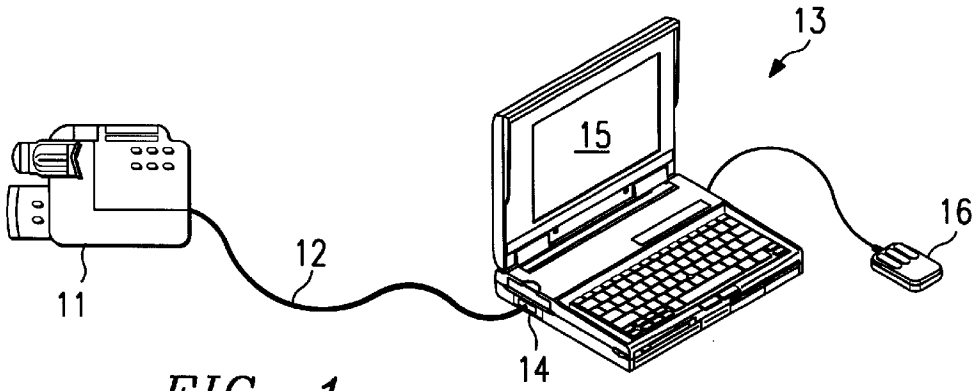

FIG. 1

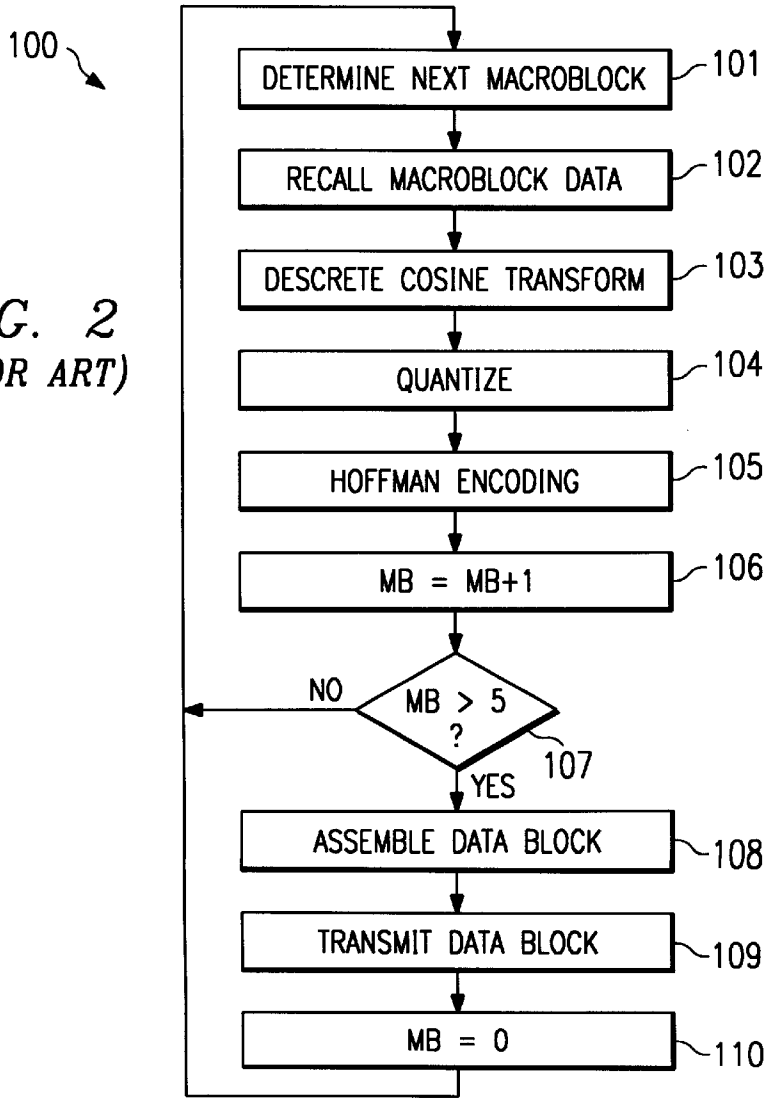

FIG. 2
(PRIOR ART)

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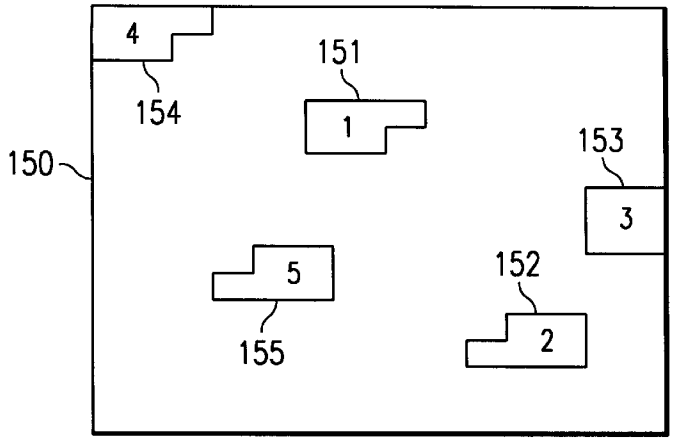
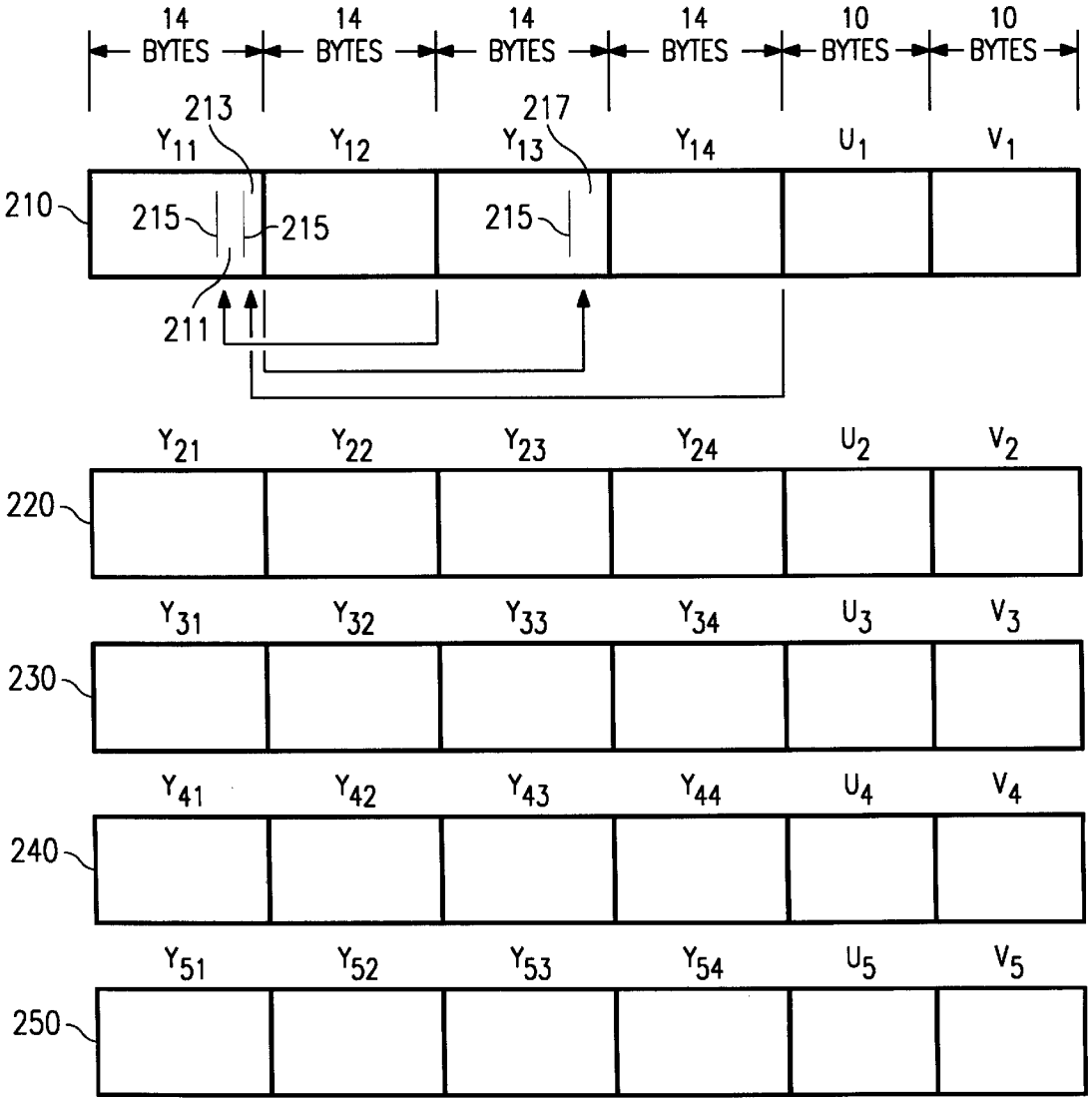


FIG. 3

FIG. 4
(PRIOR ART)



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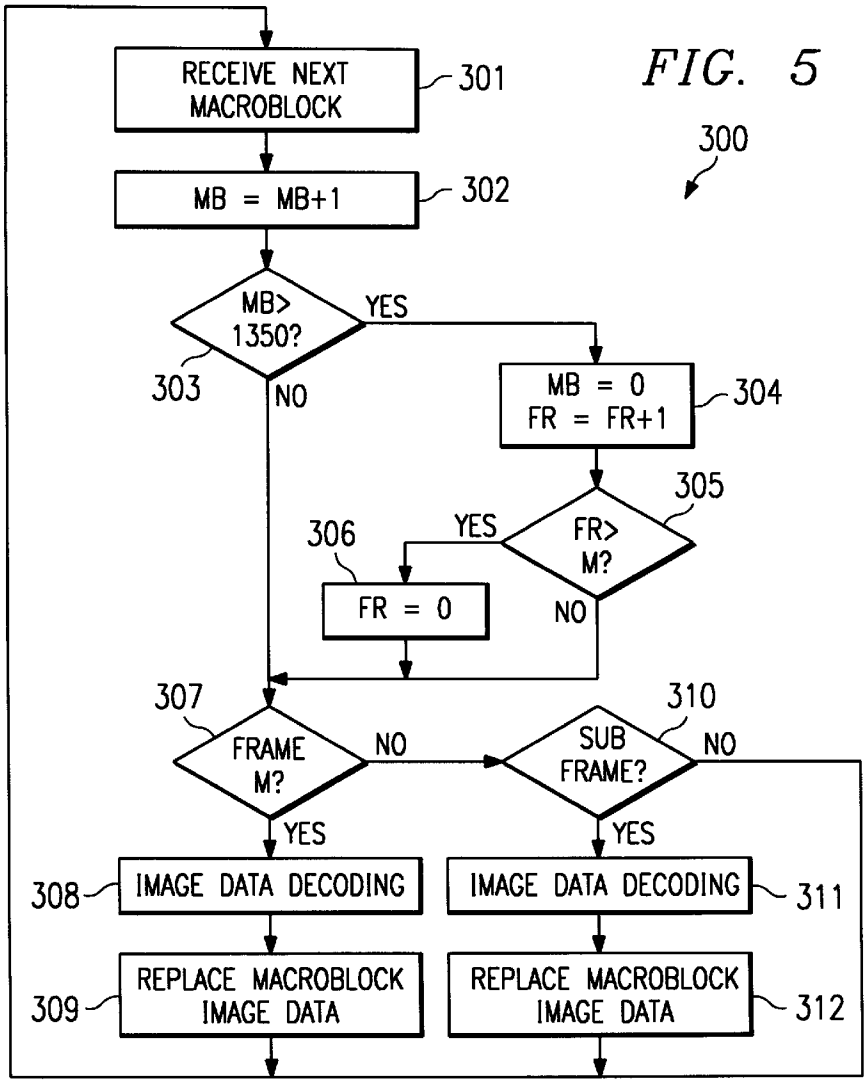

FIG. 5

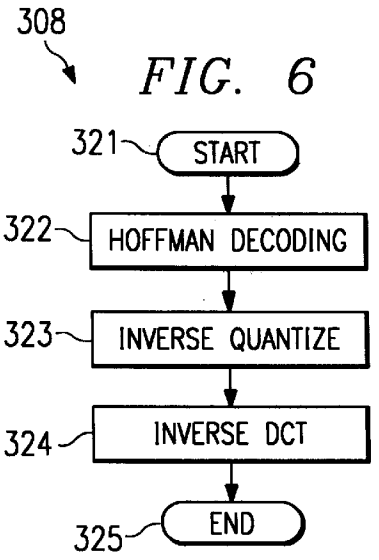

FIG. 6

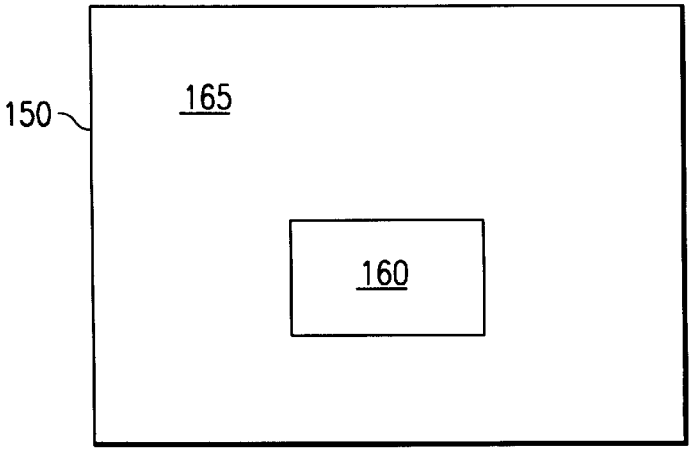

FIG. 7

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SUB-FRAME DECODER WITH AREA DEPENDENT UPDATE RATE FOR DIGITAL CAMCORDER TRANSMISSION STANDARD

This application claims priority under 35 USC 119(e) (1) of the provisional application No. 60/030,995, filed Nov. 15, 1996.

TECHNICAL FIELD OF THE INVENTION

The technical field of this invention is encoded video image decoding and especially software only decoding on a personal computer.

BACKGROUND OF THE INVENTION

Digital video camcorders are now available as commercial products. These digital camcorders produce digital video images which may be digitally manipulated and displayed. Personal computers are built for manipulating and storing digital data. Current standards for video camcorder data transmission require substantial amounts of hardware for image decompression when used in conjunction with a general purpose personal computer. The expense of this required hardware limits the number of applications where coupling a digital camcorder to a personal computer is economically feasible. Therefore there is a need in the art for a technique enabling software only decoding of encoded digital images is useful.

SUMMARY OF THE INVENTION

This invention is a method of decoding a stream of video image data transmitted as independent image frames consisting of plural marcoblocks transmitted in a nonsequential order. The method defines a sub-frame corresponding to a proper subset of the full frame. The method determines if a currently received macroblock is within the sub-frame. The method decodes the sub-frame. The sub-frame may be decoded at less than or equal to the frame rate of the video image data.

In the preferred embodiment the video image data is transmitted in plural macroblocks and the sub-frame consists of whole macroblocks. A table has one entry for each macroblock. The table stores a transmission order within the video frame for the corresponding macroblock. The sub-frame is defined by selecting a plurality of contiguous macroblocks. The method determine if a current macroblock is within the sub-frame by reading the table to see if the currently received macroblock has a transmission order entry corresponding to the sub-frame.

In the preferred embodiment each macroblock consists of a plurality of contiguous blocks. Each macroblock includes luminance data for any included blocks and chrominance data for the macroblock as a whole. The method optionally decodes the luminance data for each included block and ignores the chrominance data. Each macroblock includes plural data groups. The blocks are represented by data of differing lengths. If the data corresponding to a block does not fill a data group allocated to that block, the data is marked by an end of data marker. The method decodes the sub-frame employing only data prior to and end of data marker or an end of the data group, and ignores data following an end of data marker. The method may also decode a full frame of video image data at a full frame decode rate less than the sub-frame decode rate.

The method preferably employs a digital camcorder to generate the stream of video image data. This is transmitted to a personal computer, preferably a notebook computer, for decoding and display.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of this invention are illustrated in the drawings, in which:

FIG. **1** illustrates a camcorder and a notebook computer connected in the manner of this invention;

FIG. **2** illustrates in flow chart form the encoding of video data in the prior art SD format;

FIG. **3** illustrates an example of five superblocks of a single video frame from which five macroblocks are selected in the encoding sequence of the prior art SD format;

FIG. **4** illustrates the encoding of the five macroblocks selected from the five superblocks illustrated in FIG. **3**;

FIG. **5** illustrates in flow chart form the decoding of video data in accordance with this invention;

FIG. **6** illustrates in flow chart form the steps of the data decoding blocks of FIG. **5**; and

FIG. **7** illustrates a video frame showing the areas decoded at differing rates.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. **1** illustrates the system contemplated in a preferred embodiment of this invention. Note that FIG. **1** illustrates a notebook computer according to the preferred embodiment, but this invention may be practiced with any personal computer. A digital camcorder **11** forms a digital image. This digital image is compressed according to a digital compression standard known as SD format. This compressed digital image is recorded on a digital tape in a digital tape drive internal to digital camcorder **11**. The compressed digital image is also transmitted via cable **12** in an electrical interface known as IEEE 1394. Cable **12** connects to an IEEE 1394 interface card **14** preferably formed as a PCMCIA card in computer **13**. This IEEE 1394 serves as only a convenient electrical interface and other types of data links may be used. In accordance with the preferred embodiment, computer **13** employs software to decode the compressed digital image data transmitted via cable **12** from digital camcorder **11**. Computer **13** may display the decoded digital image data on viewing screen **15**. This image display may occupy the entire viewing screen **15** or may occupy only a window within viewing screen **15**.

The digital data transmitted by digital camcorder **11** is encoded in a format known as SD format. In the SD format each video frame is divided into an array of 720 horizontal pixels and 480 vertical pixels. This array of 720 by 480 pixels is grouped into blocks consisting of 8 by 8 arrays of pixels. The frame is thus 90 blocks wide in the horizontal and 60 blocks high in the vertical. These blocks are grouped into macroblocks. Each macroblock consists of four adjacent blocks. Most macroblocks consist of four horizontally adjacent blocks. Some of the macroblocks consist of four blocks disposed in a square. Each horizontal line of the frame encompasses **18** 4-by-1 macroblocks **9** 2-by-2 macroblocks. Most vertical stripes encompass **60** 4-by-1 macroblocks. Some vertical stripes encompass **20** 2-by-2 macroblocks. These macroblocks are in turn grouped into superblocks. Each superblock includes 27 macroblocks. The superblocks have three different shapes, which mesh to fill the frame. There are 50 superblocks in each frame.

FIG. **2** illustrates flow chart **100** of the encoding sequence according to the prior art SD format. This encoding serves

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