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(54) **SYSTEMS AND METHODS FOR GROUP OF PICTURES ENCODING**

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(52) **U.S. Cl.**

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(57)

**ABSTRACT**

**Related U.S. Application Data**

(63) Continuation of application No. 14/634,964, filed on Mar. 2, 2015, now abandoned.

(60) Provisional application No. 61/955,946, filed on Mar. 20, 2014.

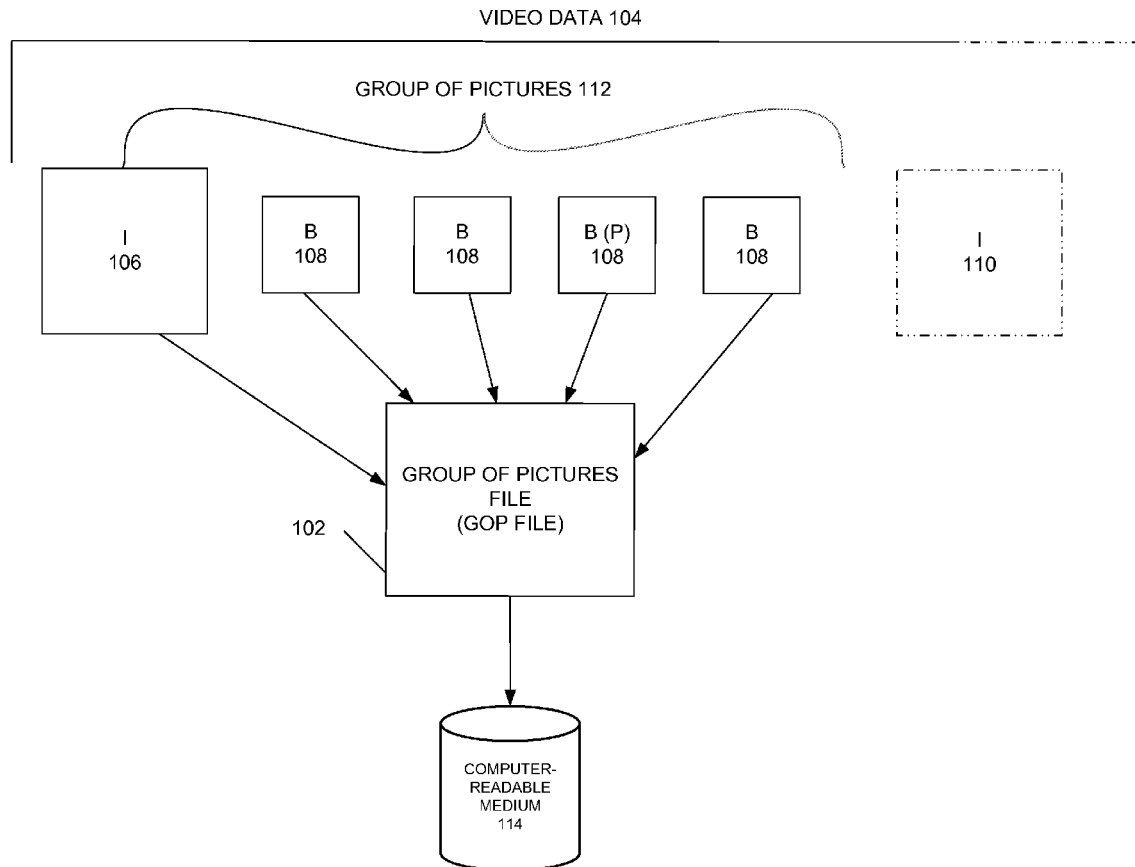
**Publication Classification**

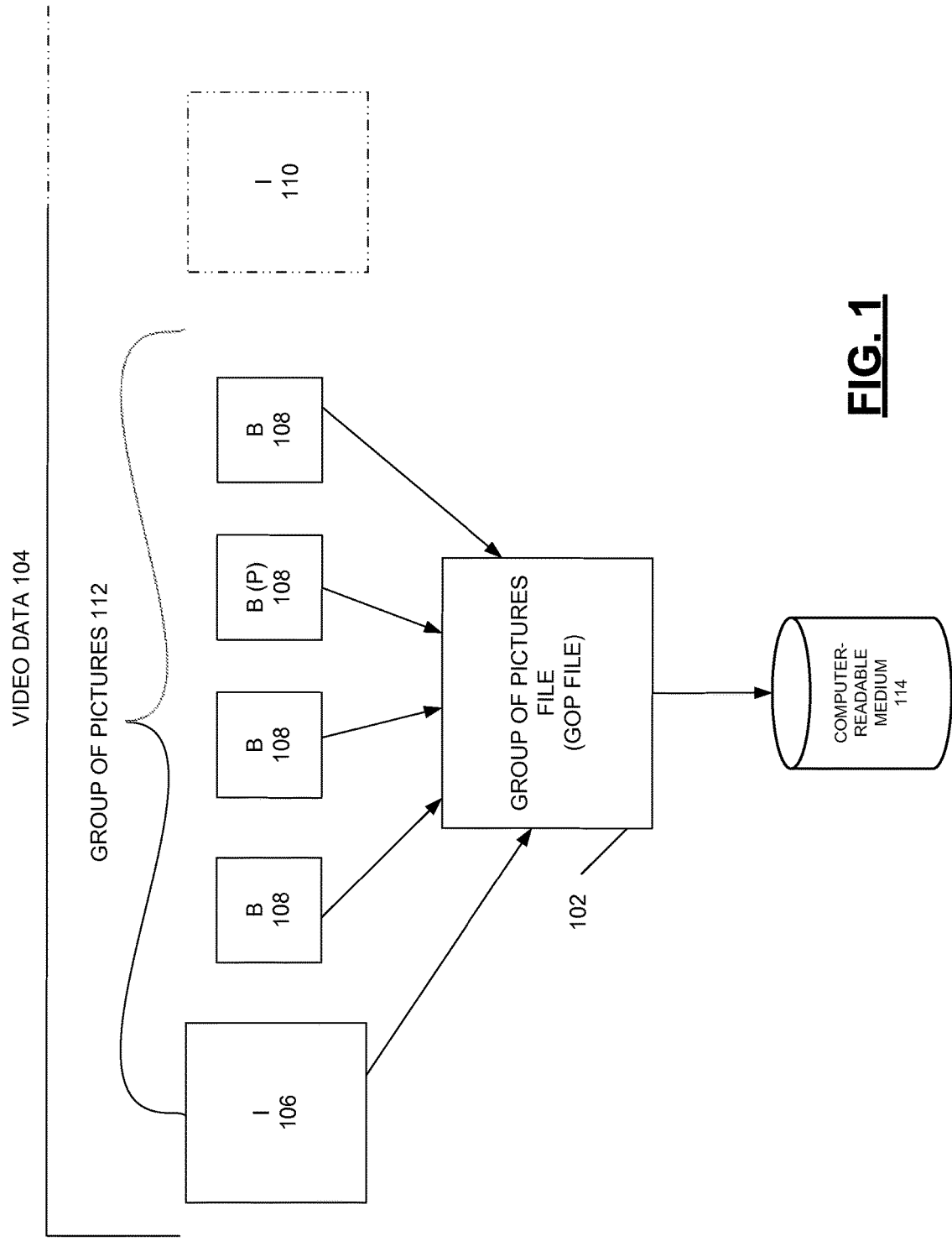
(51) **Int. Cl.**

*H04N 19/114* (2006.01)

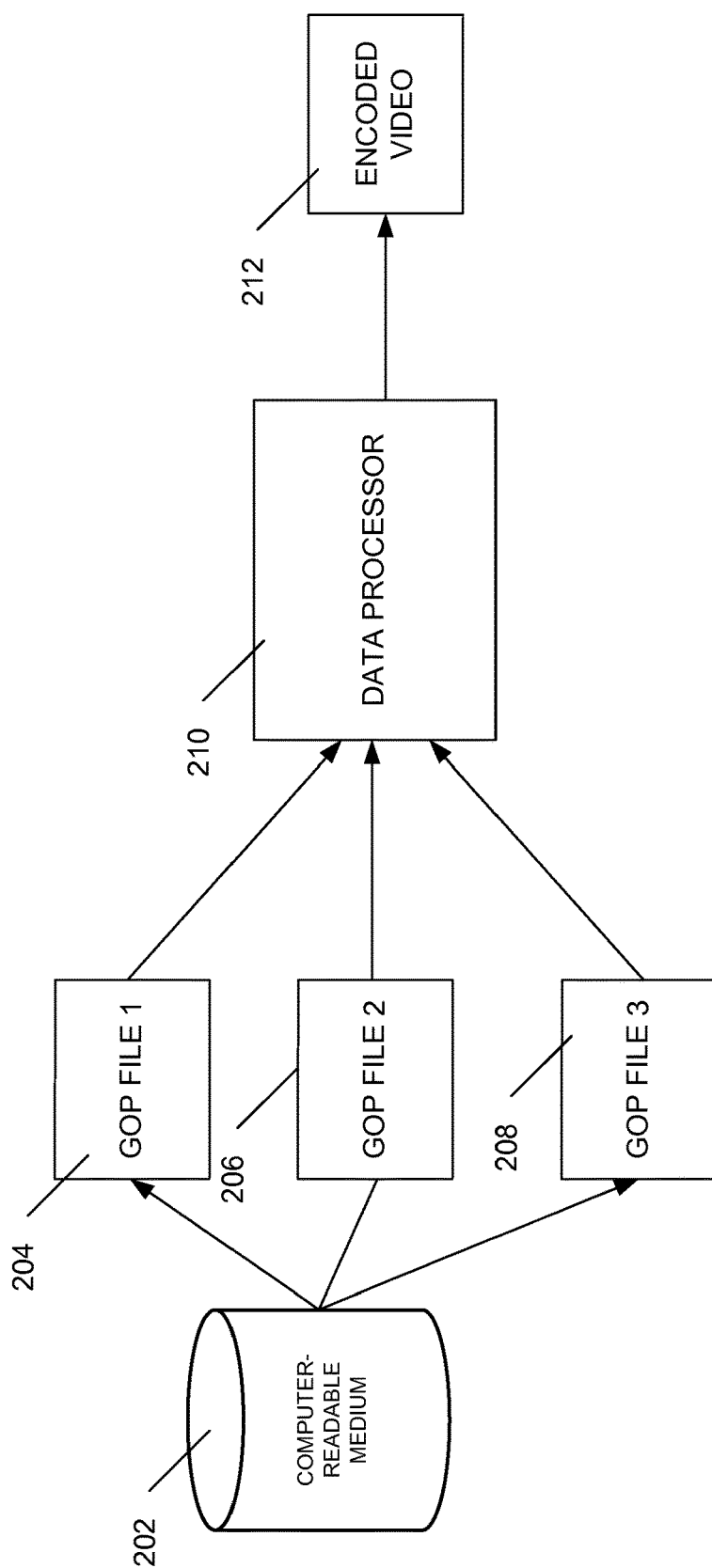
*H04N 19/40* (2006.01)

Systems and methods are provided encoding a video. Video data is captured. The video data is stored in a group of pictures format, where the group of pictures format comprises a plurality of GOP files, each GOP file including exactly one group of pictures unit. The video data is encoded into a prespecified format. Encoding includes accessing the GOP files containing the video data in the group of pictures format, and encoding the video data into the prespecified format using the GOP files to generate an encoded video.

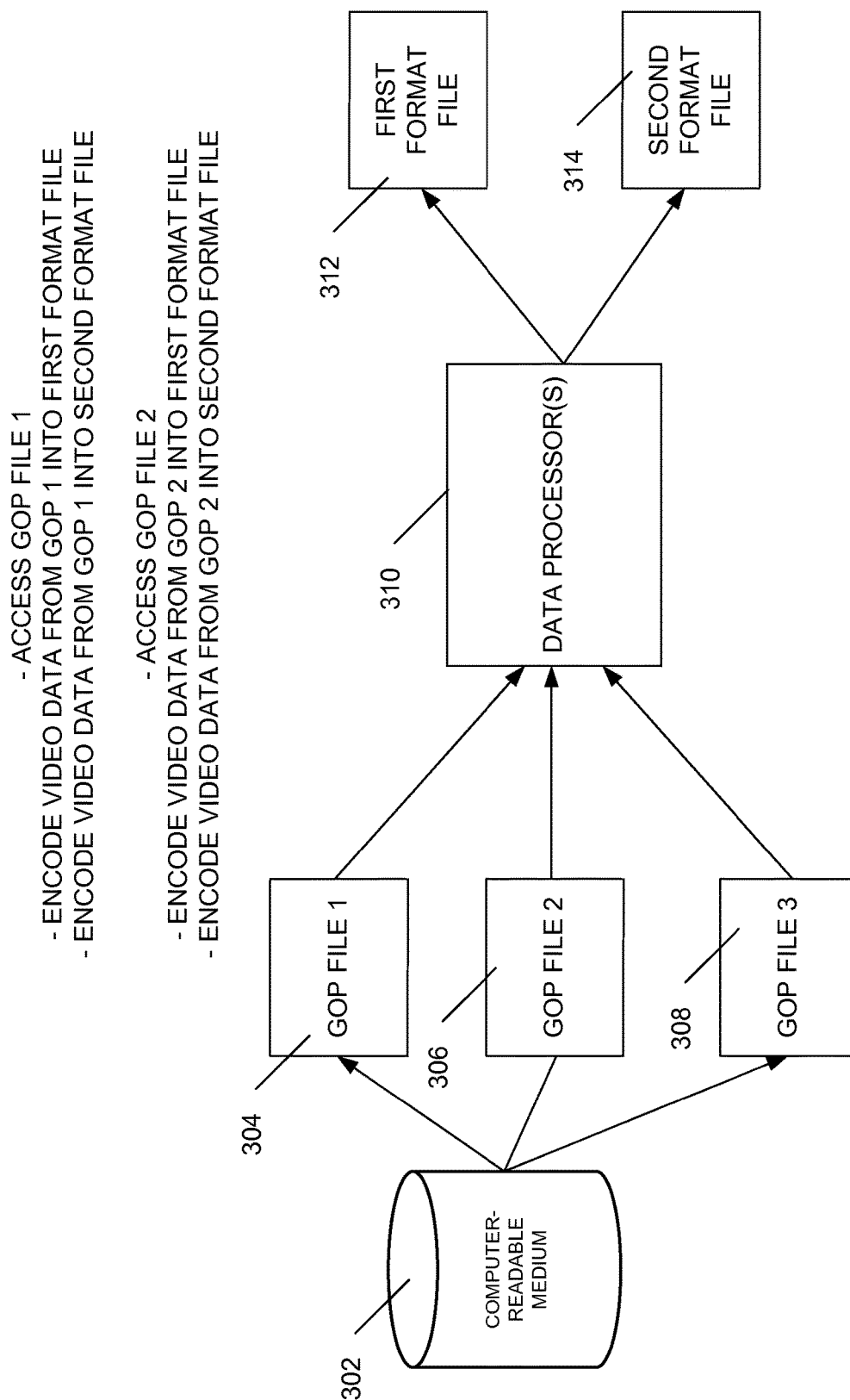




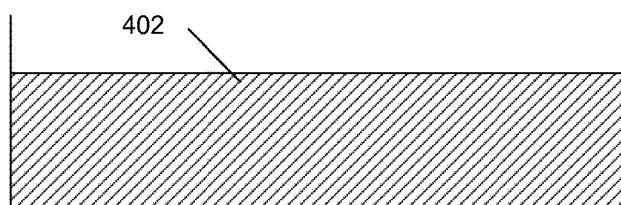
**FIG. 1**



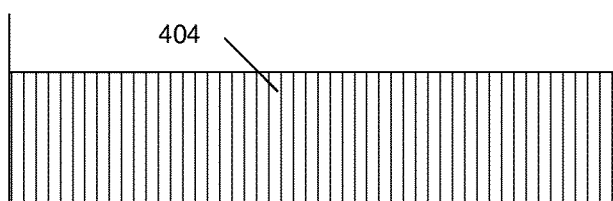
**FIG. 2**



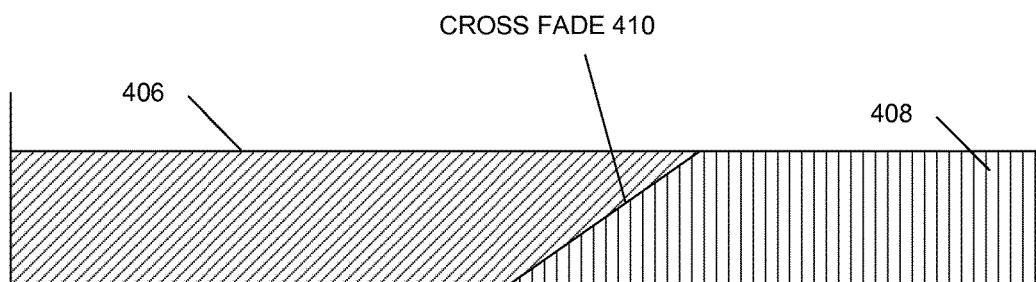
**FIG. 3**



FIRST VIDEO DATA

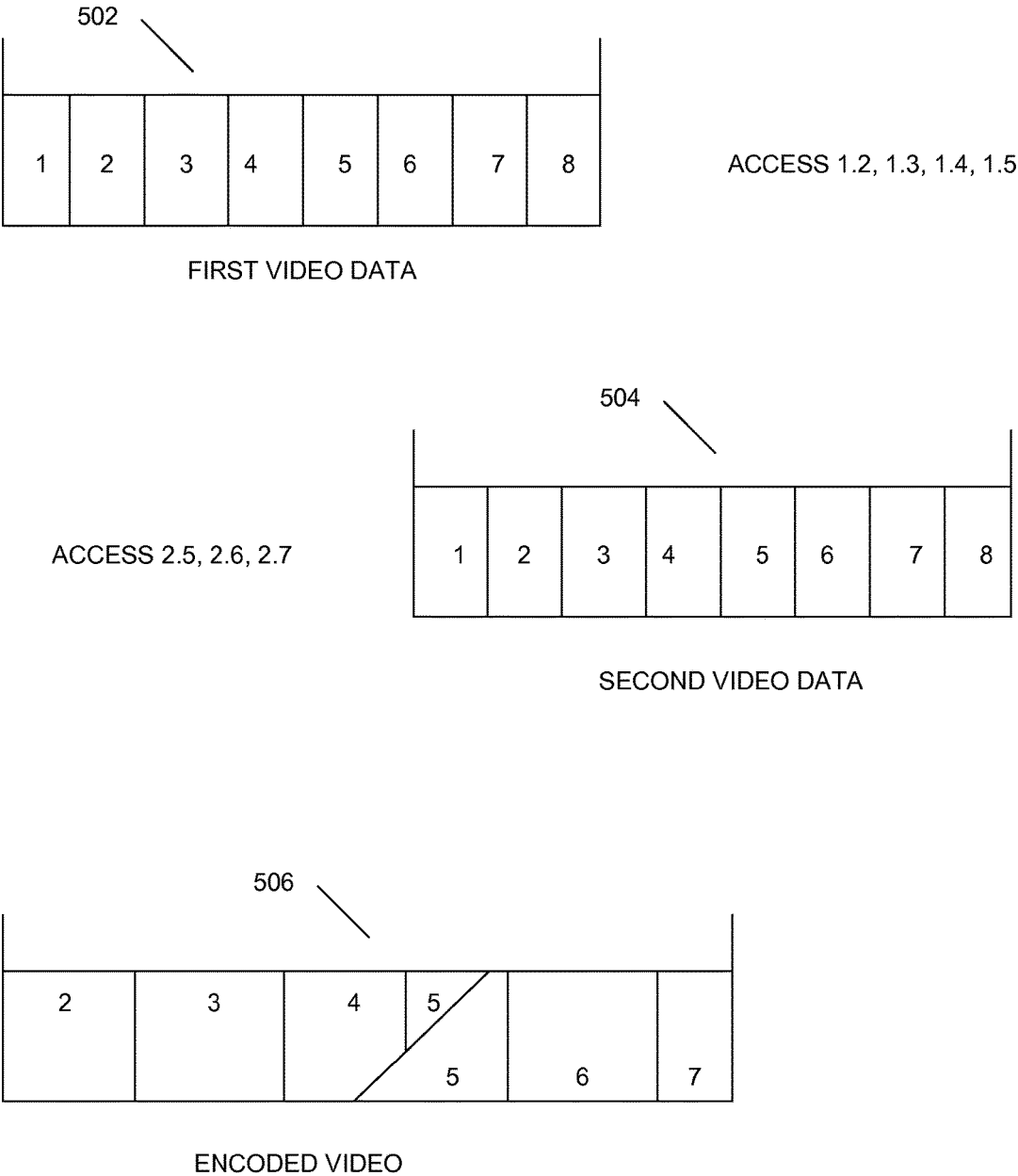


SECOND VIDEO DATA

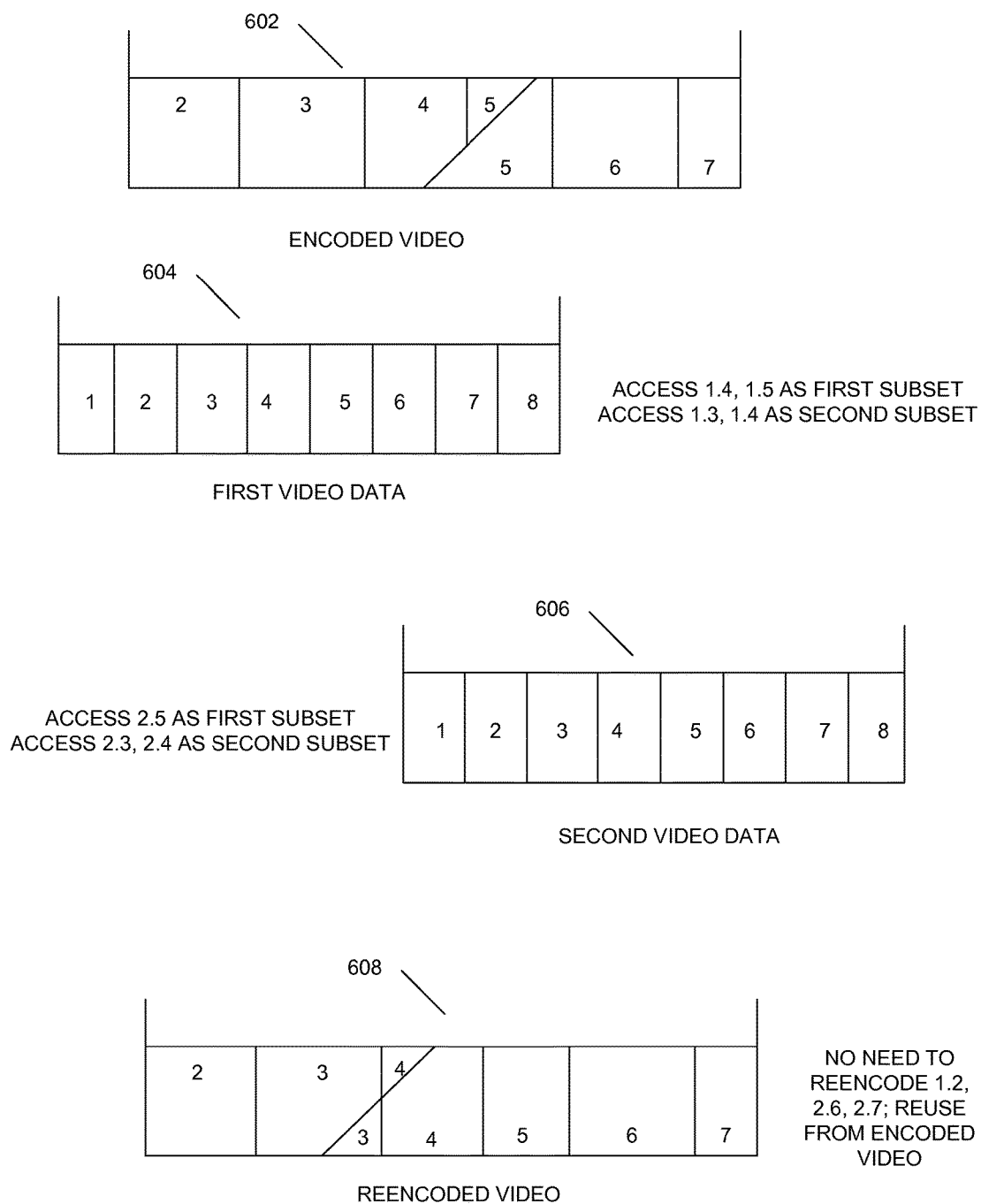


ENCODED VIDEO

**FIG. 4**



**FIG. 5**



**FIG. 6**

## SYSTEMS AND METHODS FOR GROUP OF PICTURES ENCODING

### CROSS REFERENCE TO RELATED APPLICATIONS

**[0001]** This application claims priority to U.S. Provisional Patent Application No. 61/955,946, filed Mar. 20, 2014, entitled "Systems and Methods for Group of Pictures Encoding," the entirety of which is herein incorporated by reference.

### FIELD

**[0002]** This disclosure is related generally to digital video and more particularly to digital video encoding.

### BACKGROUND

**[0003]** The demand for digital video continues to increase, especially in view of the continually falling costs of bandwidth for delivery of such video. While data processing speeds continue to increase, video encoding is still often a time consuming endeavor. Thus, there is a continuing need to streamline video encoding processes.

### SUMMARY

**[0004]** Systems and methods are provided encoding a video. Video data is captured. The video data is stored in a group of pictures format, where the group of pictures format comprises a plurality of GOP files, each GOP file including exactly one group of pictures unit. The video data is encoded into a prespecified format. Encoding includes accessing the GOP files containing the video data in the group of pictures format, and encoding the video data into the prespecified format using the GOP files to generate an encoded video.

**[0005]** As another example, a system for encoding a video includes a computer-readable medium encoded with video data stored in a group of pictures format, wherein the group of pictures format comprises a plurality of GOP files, each GOP file including exactly one group of pictures unit. A data processor is configured to encode the video data in the group of pictures format using the GOP files to generate an encoded video.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0006]** FIG. 1 is a block diagram depicting example contents of a group of pictures (GOP) file.

**[0007]** FIG. 2 is a block diagram depicting a system for encoding a stream of video.

**[0008]** FIG. 3 is a block diagram depicting a system encoding video data in multiple formats at the same time using GOP files.

**[0009]** FIG. 4 is a diagram depicting an example combination of two video data portions in an encoded video.

**[0010]** FIG. 5 is a diagram depicting example GOP files involved in generating the encoded video of FIG. 4.

**[0011]** FIG. 6 is a diagram depicting a process for reencoding a video based on a transition adjustment.

### DETAILED DESCRIPTION

**[0012]** FIG. 1 is a block diagram depicting example contents of a group of pictures (GOP) file. A GOP file 102 is a file containing data associated with a collection of video frames. A frame is one of many still pictures that when

displayed in fast sequence produces a video display. Digital video utilizes a variety of video frame types as a form of compression that can facilitate transmission of digital video utilizing reduced bandwidth. Video frames can include I frames (e.g., intra coded picture frames) that contain a picture that is coded independently of all other frames. Thus, an I frame can be rendered on its own, without referencing data from other frames. Other types of video frames require reference to data from other frames for picture rendering. For example, an intermediate video frame may identify only pixels of a picture that have changed since a previous frame or previous I frame. By not including data associated with unchanged pixels, such an intermediate video frame often requires less data than an I frame (especially in portions of video containing limited pixel changes where displayed objects exhibit little motion). Example intermediate frames include P frames (e.g., predictive coded picture frames) that contain motion compensated difference information relative to one previously decoded picture and B frames (e.g., bipredictive coded picture frames) that contain motion compensated difference information relative to one or more previously decoded pictures. In the example of FIG. 1, captured video data 104 includes a first independently coded I frame 106 followed by a plurality of intermediate frames 108 (e.g., P frames and B frames), further followed by a second independently coded I frame 110.

**[0013]** A group of pictures is an independent unit of video data that includes exactly one independently coded picture frame and one or more intermediate frames that directly or indirectly reference the independently coded picture frame. A GOP file 102 contains exactly one group of pictures unit 112. A group of pictures unit includes one independently coded picture frame (e.g., I frame 106) and one or more intermediate frames 108 that directly or indirectly reference the independently coded frame. The GOP file 102 does not include the second independently coded frame 110. Each group of pictures of the video data 104 is compiled into a GOP file 102, where each GOP file 102 is stored in a computer-readable medium 114.

**[0014]** A computer-readable medium containing a collection of GOP files (e.g., an unencoded collection of an I frame and referencing P and B frames) can be utilized to generate encoded video in a variety of contexts. FIG. 2 is a block diagram depicting a system for encoding a stream of video. A computer-readable medium 202 is encoded with video data stored in a group of pictures format, where the group of pictures format comprises a plurality of GOP files 204, 206, 208, each GOP file 204, 206, 208 including exactly one group of pictures unit. A data processor 210 is configured to encode the video data in the group of pictures format using the GOP files 204, 206, 208 to generate an encoded video 212. In one example, the data processor 210 is configured to sequentially access the GOP files 204, 206, 208, process each GOP file, and add data to the encoded video 212 based on that GOP file.

**[0015]** FIG. 3 is a block diagram depicting a system encoding video data in multiple formats at the same time using GOP files. A computer-readable medium 302 contains a plurality of GOP files 304, 306, 308. A data processor(s) 310 is configured to access a first GOP file 304. The data processor 310 then encodes video data from the first GOP file 304 into a first format as part of a first format file 312. Then, or at the same time, the data processor 310 encodes video data from the first GOP file 304 into a second format



as a part of a second format file **314**. The data processor then accesses a second GOP file **306**. The data processor **310** then encodes video data from the second GOP file **306** into the first format as part of the first format file **312**. Then, or at the same time, the data processor **310** encodes video data from the second GOP file **306** into the second format as a part of the second format file **314**. The system and process described in FIG. **3** can accelerate encoding of the two files **312**, **314** into different formats by limiting the memory accesses to each group of pictures to a single access. If the video files in different formats **312**, **314** were encoded wholly in serial, the data processor **310** would need to access each group of pictures from the computer-readable medium **302** twice.

**[0016]** FIG. **4** is a diagram depicting an example combination of two video data portions in an encoded video. First video data **402** and second video data **404** are captured and represented on respective timelines. A system receives instructions to generate an encoded video that includes a first portion **406** that includes the first video data **402** and a second portion **408** that includes the second video data. The instructions further command a transition portion. In the example of FIG. **4**, the transition between the first portion **406** and the second portion **408** is a cross fade, where during the transition more of the second video data **404** is displayed on the screen and less of the first video data is included as the transition progresses. Example transitions include cross fades, dissolves, peels, slides, hard transitions, and wipes.

**[0017]** FIG. **5** is a diagram depicting example GOP files involved in generating the encoded video of FIG. **4**. First video data **102** includes 8 GOP files, and second video data also includes 8 GOP files. In the commanded encoded video **106**, GOP files **1.2**, **1.3**, **1.4**, and **1.5** are present containing first video data, while GOP files **2.5**, **2.6**, and **2.7** are present containing second video data. In the commanded encoded video, GOP files **1.2**, **1.3**, **2.6**, and **2.7** are displayed in full, while GOP files **1.4**, **1.5**, and **2.5** are associated a subset of GOP files that are associated with the transition. A data processor is configured to receive the identification of the portion of the first video data (i.e., the portions associated with GOP files **1.2**, **1.3**, **1.4**, and **1.5**) and the portion of the second video data (i.e., the portions associated with GOP files **2.5**, **2.6**, and **2.7**) to be included in the encoded video **106** and accesses those GOP files. The processor is further configured to use the accessed GOP files to encode the video **506** in a prespecified format, including the transition, as commanded.

**[0018]** FIG. **6** is a diagram depicting a process for reencoding a video based on a transition adjustment. An encoded video **602** includes a portion associated with first video data **604** and a portion associated with second video data **606**, as generated in the example of FIG. **5**. In the encoded video, a first subset of GOP files (i.e., GOP files **1.4**, **1.5**, and **2.5**) are associated with the transition between the first video data **604** and the second video data **606**. A command is received to adjust the transition as shown at **608** to generate a reencoded video. Using traditional methods, the entirety of the first video data **604** and the second video data **606** would need to be accessed to generate the reencoded video **608**. In contrast, the use of GOP files in the depicted system eliminates the need for access and reencoding for several of the GOP files. A second subset of GOP files (i.e., GOP files **1.3**, **1.4**, **2.3**, and **2.4**) are associated with the transition of the reencoded video.

**[0019]** The system is configured to access GOP files associated with the first subset and the second subset (i.e., GOP files **1.3**, **1.4**, **1.5**, **2.3**, **2.4**, and **2.5**). The reencoded video **608** will change at the portions associated with these GOP files, but will not change at portions associated with GOP files outside of the first subset and the second subset (i.e., GOP files **1.2**, **2.6**, and **2.7**). The system reencodes the encoded video **602** based on the accessed first and second subset GOP files without reaccessing the GOP files outside of the first subset and the second subset. Instead, the system reutilizes the encoded portions of those unchanged periods in the encoded video. In the example of FIG. **6**, the system reuses portions of the encoded video associated with GOP files **1.2**, **2.6**, and **2.7** in the reencoded video without accessing the associated GOP files or reencoding video data associated with those portions. The system reencodes portions associated GOP files **1.3**, **1.4**, **2.3**, **2.4**, and **2.5** while removing portions associated with GOP file **1.5** (e.g., remove a portion of the encoded video **602** associated with the transition, remove a portion of the encoded video **602** associated with the changed transition, and using the encoded video, GOP files from the first subset, and GOP files from the second subset to reencode the encoded video).

**[0020]** This application uses examples to illustrate the invention. The patentable scope of the invention includes other examples.

**1-20.** (canceled)

**21.** A computer-implemented method for encoding a video, the method comprising:

receiving first encoded video data comprised of a first set of GOP units, wherein each GOP unit comprises exactly one independently coded frame and one or more dependently coded frame;

receiving second encoded video data comprised of a second set of GOP units;

receiving instructions for generating third encoded video data based on the first encoded video data and the second encoded video data, wherein the instructions identify a transition portion from the first encoded video data to the second encoded video data; and

generating the third encoded video data by—

determining a first subset of the first set of GOP units and a first subset of the second set of GOP units corresponding to the transition portion;

encoding a transition GOP unit from the first subset of the first set of GOP units and the first subset of the second set of GOP units; and

combining a second subset of the first set of GOP units, a second subset of the second set of GOP units, and the transition GOP unit to form the third encoded video data.

**22.** The method of claim **21** wherein the first subset of the first set of GOP units comprises one GOP unit.

**23.** The method of claim **21** wherein the first subset of the first set of GOP units comprises a plurality of GOP units.

**24.** The method of claim **21** wherein the encoded transition GOP unit includes at least one frame from the first set of GOP units and at least one frame from the second set of GOP units.

**25.** The method of claim **21** wherein the second subset of the first set of GOP units and the second subset of the second set of GOP units are combined in the generated third encoded video data without re-encoding the GOP units.

**26.** The method of claim **21** wherein the second subset of the first set of GOP units and the second subset of the second set of GOP units correspond to GOP units that do not fall within the transition portion.

**27.** The method of claim **21** wherein the transition portion corresponds to a cross fade, a dissolve, a peel, a hard transition, or a wipe.

**28.** A non-transitory computer-readable medium containing instructions configured to cause one or more processors to perform a method for encoding a video, the method comprising:

receiving first encoded video data comprised of a first set of GOP units, wherein each GOP unit comprises exactly one independently coded frame and one or more dependently coded frame;

receiving second encoded video data comprised of a second set of GOP units;

receiving instructions for generating third encoded video data based on the first encoded video data and the second encoded video data, wherein the instructions identify a transition portion from the first encoded video data to the second encoded video data; and

generating the third encoded video data by—

determining a first subset of the first set of GOP units and a first subset of the second set of GOP units corresponding to the transition portion;

encoding a transition GOP unit from the first subset of the first set of GOP units and the first subset of the second set of GOP units; and

combining a second subset of the first set of GOP units, a second subset of the second set of GOP units, and the transition GOP unit to form the third encoded video data.

**29.** The non-transitory computer-readable medium of claim **28** wherein the first subset of the first set of GOP units comprises one GOP unit.

**30.** The non-transitory computer-readable medium of claim **28** wherein the first subset of the first set of GOP units comprises a plurality of GOP units.

**31.** The non-transitory computer-readable medium of claim **28** wherein the encoded transition GOP unit includes at least one frame from the first set of GOP units and at least one frame from the second set of GOP units.

**32.** The non-transitory computer-readable medium of claim **28** wherein the second subset of the first set of GOP units and the second subset of the second set of GOP units are combined in the generated third encoded video data without re-encoding the GOP units.

**33.** The non-transitory computer-readable medium of claim **28** wherein the second subset of the first set of GOP

units and the second subset of the second set of GOP units correspond to GOP units that do not fall within the transition portion.

**34.** The non-transitory computer-readable medium of claim **28** wherein the transition portion corresponds to a cross fade, a dissolve, a peel, a hard transition, or a wipe.

**35.** A computer-implemented method for encoding a video, the method comprising:

receiving first encoded video data comprised of a set of GOP units, wherein each GOP unit comprises exactly one independently coded frame and one or more dependently coded frame;

receiving instructions for generating second encoded video data based on the first encoded video data, wherein the instructions identify a transition from a first time of the first encoded video data to a second time of the first encoded video data; and

generating the second encoded video data by—

determining a first subset of the set of GOP units and a second subset of the set of GOP units corresponding to the transition;

encoding a transition GOP unit from the first subset of the set of GOP units and the second subset of the set of GOP units; and

combining a third subset of the set of GOP units, a fourth subset of the set of GOP units, and the transition GOP unit to form the second encoded video data.

**36.** The method of claim **35** wherein the first subset of the set of GOP units corresponds to the first time of the first encoded video data and the second subset of the set of GOP units corresponds to the second time of the first encoded video data.

**37.** The method of claim **35** wherein the first subset of the set of GOP units comprises one GOP unit.

**38.** The method of claim **35** wherein the first subset of the set of GOP units comprises a plurality of GOP units.

**39.** The method of claim **35** wherein the encoded transition GOP unit includes at least one frame from the first subset of the set of GOP units and at least one frame from the second subset of the set of GOP units.

**40.** The method of claim **35** wherein the third subset of the set of GOP units and the fourth subset of the set of GOP units are combined in the generated second encoded video data without re-encoding the GOP units.

**41.** The method of claim **35** wherein the third subset of the set of GOP units and the fourth subset of the set of GOP units correspond to GOP units that do not fall within the transition.

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