

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
6 October 2005 (06.10.2005)

PCT

(10) International Publication Number  
**WO 2005/093751 A1**

(51) International Patent Classification<sup>7</sup>: **G11B 27/034**,  
27/32, 20/10, G06F 17/30, H04N 7/24

(21) International Application Number:  
PCT/US2004/005683

(22) International Filing Date: 26 February 2004 (26.02.2004)

(25) Filing Language: English

(26) Publication Language: English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

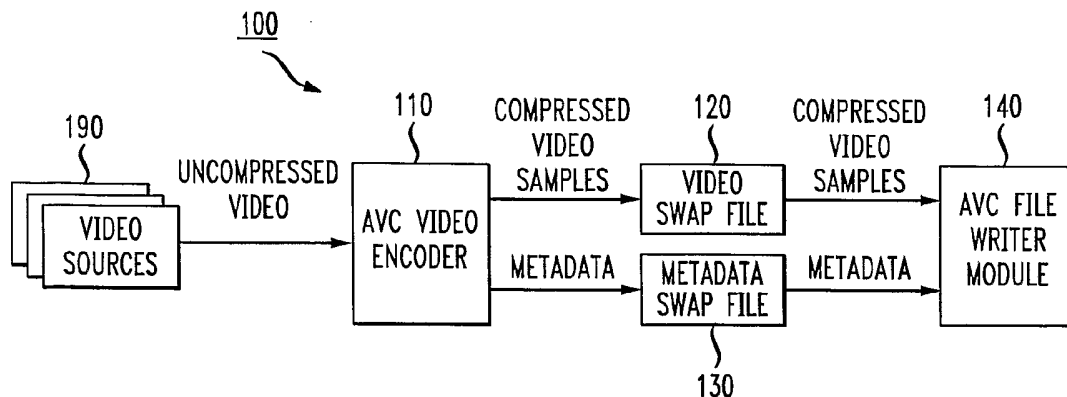
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ADVANCED VIDEO CODING (AVC) MULTIMEDIA FILE WRITING METHOD AND SYSTEM



(57) Abstract: There is provided an Advanced Video Coding (AVC) file creation system that includes intermediate swap files for reducing initial metadata to media data interdependence.

## ADVANCED VIDEO CODING (AVC) MULTIMEDIA FILE WRITING METHOD AND SYSTEM

### BACKGROUND OF THE INVENTION

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### FIELD OF THE INVENTION

The present invention generally relates to video coding and, more particularly, to an efficient file writing method and system for Advanced Video Coding (AVC) based video files.

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### BACKGROUND OF THE INVENTION

The standardized Advanced Video Coding (AVC) file is an awkward media storage format that is difficult to efficiently create. This is due to the amount of interdependency between the metadata and video data that is written to the file. The interdependencies make writing the file difficult because the application must know how much data it is going to write to disk prior to actually writing the data. This makes the file creation process difficult because video content may be created using a video encoder in a real-time or near real-time fashion. As a result, the AVC file writer does not know how much memory to allocate, nor does the AVC file writer know how many samples it must allocate memory for during the creation process. In particular, if there is such an enormous amount of content to be stored in the AVC file, then the AVC file writer may run out of memory when partially through the encoding and file creation process because of the unexpected amount of memory needed for storing the metadata table. Equally important, if the application is unsure

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of the amount of data that is to be written, it is unable to initially write the reference of how much data is contained within the file until after the file has been written. One solution to this problem is to fill in dummy spaces within the file, and then go back to place the correct values in those referenced locations requiring the data sizes.

5 However, this is still an undesirable solution because in this situation, the media samples must be written directly to the file as they are received from the encoder, while the metadata is buffered into available memory. Once all of the data is written to the file, the application can have a "scratchpad" of the metadata, and then write the metadata to the file. There are two problems with this method. First, the metadata is  
10 all stored in system memory. If a video sequence happens to be of a very long length, which is quite common, then all memory could become exhausted. Second, the metadata appears in the file after the media data and not before the media data. It is desirable to have the media data after the metadata in the file in order to quickly read the metadata from the file during an initial examination for determining what type  
15 of content is stored within the file. If the file happens to be several hundred megabytes or even a gigabyte, then this initial examination of the file could result in a severe delay, especially if the application is planning to examine more than one file.

Accordingly, it would be desirable and highly advantageous to have an efficient file writing method and system for Advanced Video Coding (AVC) based  
20 video files that overcomes the above described problems of the prior art.

### SUMMARY OF THE INVENTION

The problems stated above, as well as other related problems of the prior art, are solved by the present invention, an efficient file writing method and system for  
25 Advanced Video Coding (AVC) based video files.

According to an aspect of the present invention, there is provided an Advanced Video Coding (AVC) file creation system that includes intermediate swap files for reducing initial metadata to media data interdependence.

According to another aspect of the present invention, there is provided an  
5 Advanced Video Coding (AVC) file creation system that includes at least one intermediate swap file for temporarily storing metadata, and at least one other intermediate swap file for temporarily storing compressed media data. Moreover, the AVC file creation system further includes an AVC file writer module for reading the metadata and the compressed media data from the at least one intermediate swap  
10 file and the at least one other intermediate swap file, respectively, and for creating an AVC file such that the metadata corresponding to a given media stream is written to the AVC file before the compressed media data corresponding to the given media stream is written to the AVC file.

According to yet another aspect of the present invention, there is provided a  
15 method for creating an Advanced Video Coding (AVC) file that includes the steps of temporarily storing metadata in at least one intermediate swap file, and temporarily storing compressed media data in at least one other intermediate swap file. Moreover, the method further includes the step of creating an AVC file from the metadata and the compressed media data temporarily stored in the at least one  
20 intermediate swap file and the at least one other intermediate swap file, respectively, such that the metadata corresponding to a given media stream is written to the AVC file before the compressed media data corresponding to the given media stream is written to the AVC file.

These and other aspects, features and advantages of the present invention will become apparent from the following detailed description of preferred embodiments, which is to be read in connection with the accompanying drawings.

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## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating an Advanced Video Coding (AVC) filing writing system 100, according to an illustrative embodiment of the present invention;

FIG. 2 is a flow diagram illustrating the writing of an Advanced Video Coding (AVC) file using the AVC file writing system of FIG. 1, according to an illustrative  
10 embodiment of the present invention; and

FIG. 3 is a block diagram illustrating the AVC file writer module 140 of FIG. 1, according to an illustrative embodiment of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

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The present invention is directed to an efficient file writing method and system for Advanced Video Coding (AVC) based video files. Advantageously, the present invention allows for the creation of AVC files that have the metadata before the media data so that, for example, the metadata can be quickly read to ascertain the type of content stored in the file. Moreover, the present invention allows for a recovery of  
20 data in the event of a failure during the file creation process. These and other advantages of the present invention are further described below.

It is to be appreciated that the present invention generally relates to the Advanced Video Coding (AVC) file format (International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) 14496, Part  
25 15), jointly developed by the International Telecommunication Union (ITU) and the

Moving Pictures Experts Group (MPEG). However, given the teachings of the present invention provided herein, one of ordinary skill in the related art will contemplate this and various other file formats to which the present invention may be applied while maintaining the spirit and scope of the present invention.

5 It is to be understood that the present invention may be implemented in various forms of hardware, software, firmware, special purpose processors, or a combination thereof. Preferably, the present invention is implemented as a combination of hardware and software. Moreover, the software is preferably implemented as an application program tangibly embodied on a program storage  
10 device. The application program may be uploaded to, and executed by, a machine comprising any suitable architecture. Preferably, the machine is implemented on a computer platform having hardware such as one or more central processing units (CPU), a random access memory (RAM), and input/output (I/O) interface(s). The computer platform also includes an operating system and microinstruction code. The  
15 various processes and functions described herein may either be part of the microinstruction code or part of the application program (or a combination thereof) that is executed via the operating system. In addition, various other peripheral devices may be connected to the computer platform such as an additional data storage device, a modem and/or some other type of data transfer/communication  
20 device.

It is to be further understood that, because some of the constituent system components and method steps depicted in the accompanying Figures are preferably implemented in software, the actual connections between the system components (or the process steps) may differ depending upon the manner in which the present  
25 invention is programmed. Given the teachings herein, one of ordinary skill in the

related art will be able to contemplate these and similar implementations or configurations of the present invention.

The present invention provides a method and system for efficiently creating Advanced Video Coding (AVC) based files by generating multiple temporary swap files for the metadata and the multimedia content. As a result, the present invention will ensure that the metadata is written to the AVC file before the media data as well as providing a means for ensuring that system memory will not become exhausted during the process. Therefore, in this case, after the temporary swap files are written to disk, the files are then processed, whereby the metadata is converted into the correct syntax for the AVC file as well as for the multimedia data. The metadata is then initially written to the AVC file, and afterwards, the media data is written to the file. Overall, the present invention is more advantageous than the previously mentioned prior art because the present invention uses the disk drive storage space as a temporary storage media, while ensuring the proper ordering of the data within the file, and also limiting the risk of exhausting all available system memory.

To begin with, at least two temporary swap files shall be used during the creation process. The first file will be used to temporarily store the metadata, while the second file will be used to temporarily store the media data. In some situations, a third or even fourth file (and so forth) may exist because the possibility exists for more than one stream to be encoded and/or trans-coded for file based storage. For example, a multimedia presentation may contain both audio and video, and both streams may wish to be stored within the AVC file format.

FIG. 1 is a block diagram illustrating an Advanced Video Coding (AVC) filing writing system 100, according to an illustrative embodiment of the present invention. The AVC file writing system 100 includes an AVC video encoder 110, a video swap

file 120, a metadata swap file 130, and an AVC file writer module 140. One or more video sources 190 may provide uncompressed video to the AVC video encoder 110 as described below. As noted herein, more than one video swap file and/or metadata swap file may be employed in accordance with the present invention.

5        FIG. 2 is a flow diagram illustrating the writing of an Advanced Video Coding (AVC) file using the AVC file writing system of FIG. 1, according to an illustrative embodiment of the present invention. Uncompressed video is received from the one or more video sources 190 by the AVC video encoder 110 (step 210).

10        The AVC video encoder 110 encodes the uncompressed video into compressed video samples and metadata (step 220). The AVC video encoder 110 then writes the compressed video samples to the video swap file 120 (step 230) and writes the metadata to the metadata swap file 130 (step 240). Optionally, the video frames may be separated in the video swap file 120 by a unique start code that is used for video frame alignment during the AVC file creation process below. The  
15        unique start code may include a sample number that corresponds to the associated metadata. Once the swap files 120 and 130 are completely written and the AVC video encoder 110 is no longer providing any data, the metadata swap file 130 will be read.

20        The AVC file writer module 140 receives (reads) the compressed video samples and the metadata written to the video swap file 120 and metadata swap file, respectively, and writes an AVC file such that, for each video stream that is to be included in the AVC file, the metadata is first written to the AVC file and then the compressed video samples thereafter (step 250).

25        Possible metadata to be stored in the metadata swap file 130 shall include, but is not limited to, the following: sample number; decoding timestamp of sample;

presentation timestamp of sample; sample size; and synchronization sample (i.e., it is a key-frame such as an I-frame).

Thus, the media data will be stored in a compressed form (i.e., compressed video samples) within a temporary swap file (i.e., video swap file 110) where video frames are separated by a unique start code, possibly including a sample number that corresponds to the associated metadata. The unique start code shall not appear in the video data, and if it does, it shall be masked by an escape code in the sequence. The unique start code will ensure proper processing for video frame alignment when creating the final AVC multimedia file that is output from the AVC file writer module 140. This unique start code does not only apply to AVC based streams, but shall also apply to any other stream stored in a temporary swap file such as other video or audio compression standards.

FIG. 3 is a block diagram illustrating the AVC file writer module 140 of FIG. 1, according to an illustrative embodiment of the present invention. The AVC file writer module 140 includes a first metadata parser 310, a second metadata parser 320, a media writing module 330, a metadata writing module 340, and a generic file writing module 350.

As noted above, the inputs to the AVC file writer module 140 are video media data provided from video swap file 120 and metadata provided from the metadata swap file 130. The output from the AVC file writer module 140 is an AVC file 399.

The video media data and the metadata are parsed by metadata parser 310. Media data that is output from the metadata parser 310 is input to media writing module 330. Metadata that is output from metadata parser 310 is further parsed by metadata parser 320 to output total media size to the media writing module 330, and to output metadata and metadata size to metadata writing module 340. The

metadata writing module 340 uses the Application Programming Interface (API) of the generic file writing module 350 to write the metadata to the AVC file 599 prior to the writing of media data to the AVC file 599.

5 In addition to writing the AVC file such that it can be quickly read to determine content type, another advantage to writing the swap files to disk involves the recovery in the event of a failure. Because the swap files are written to disk, and limited amounts of data is stored in memory, the ability to easily recovery in the event of a failure during the creation process is realizable.

10 Although the illustrative embodiments have been described herein with reference to the accompanying drawings, it is to be understood that the present invention is not limited to those precise embodiments, and that various other changes and modifications may be affected therein by one of ordinary skill in the related art without departing from the scope or spirit of the invention. All such changes and modifications are intended to be included within the scope of the invention as defined  
15 by the appended claims.

**CLAIMS**

1. An Advanced Video Coding (AVC) file creation system, comprising:

intermediate swap files for reducing initial metadata to media data  
5 interdependence.

2. The AVC file creation system of claim 1, wherein at least one of the  
intermediate swap files is for writing compressed media data thereto and at least  
another one of the intermediate swap files is for writing metadata thereto, the  
10 compressed media data and the metadata both corresponding to a same  
uncompressed media data.

3. The AVC file creation system of claim 1, wherein the intermediate swap  
files collectively correspond to more than one media stream, and each of the  
15 intermediate swap files correspond to only one of the more than one media stream  
and to only one of media data and meta data.

4. The AVC file creation system of claim 1, further comprising an AVC file  
writer module for reading the intermediate swap files and creating an AVC file there  
20 from by first writing metadata for a given media stream to the AVC file and then by  
subsequently writing media data for the given media stream to the AVC file.

5. The AVC file creation system of claim 1, wherein said intermediate  
swap files comprises two intermediate swap files for each of the media streams to be  
25 represented in AVC format, wherein one of the two intermediate swap files is for

temporarily storing metadata corresponding to a given media stream and another one of the two intermediate swap files is for temporarily storing media data corresponding to the given media stream.

5           6.     The AVC file creation system of claim 5, further comprising an AVC file writer module for reading the intermediate swap files and creating an AVC file there from, such that the metadata for each of the media streams is written to a given AVC file prior to the media data respectively corresponding thereto.

10           7.     The AVC file creation system of claim 1, wherein video frames are separated in the intermediate swap files by a unique start code used for video frame alignment during an AVC file creation process.

            8.     The AVC file creation system of claim 7, wherein the unique start code  
15 includes a sample number that corresponds to associated metadata.

            9.     An Advanced Video Coding (AVC) file creation system, comprising:  
            at least one intermediate swap file for temporarily storing metadata;  
            at least one other intermediate swap file for temporarily storing compressed  
20 media data;

            an AVC file writer module for reading the metadata and the compressed media data from the at least one intermediate swap file and the at least one other intermediate swap file, respectively, and for creating an AVC file such that the metadata corresponding to a given media stream is written to the AVC file before the

compressed media data corresponding to the given media stream is written to the AVC file.

10. The AVC file creation system of claim 9, wherein the metadata and the  
5 compressed media data correspond to a single media stream.

11. The AVC file creation system of claim 9, wherein the metadata and the  
compressed media data correspond to a plurality of media streams, the at least one  
intermediate swap file for temporarily storing metadata respectively consists of a  
10 single intermediate swap file for each of the plurality of media streams, and the at  
least one other intermediate swap file for temporarily storing compressed media data  
respectively consists of a single other intermediate swap file for each of the plurality  
of media streams.

12. The AVC file creation system of claim 9, wherein video frames are  
15 separated in the at least one other intermediate swap file by a unique start code used  
for video frame alignment during an AVC file creation process.

13. The AVC file creation system of claim 12, wherein the unique start code  
20 includes a sample number that corresponds to associated metadata.

14. A method for creating an Advanced Video Coding (AVC) file,  
comprising the steps of:

temporarily storing metadata in at least one intermediate swap file;

temporarily storing compressed media data in at least one other intermediate swap file;

creating an AVC file from the metadata and the compressed media data temporarily stored in the at least one intermediate swap file and the at least one other intermediate swap file, respectively, such that the metadata corresponding to a given media stream is written to the AVC file before the compressed media data corresponding to the given media stream is written to the AVC file.

15. The method of claim 14, wherein the metadata and the compressed media data correspond to a single media stream.

16. The method of claim 14, wherein the metadata and the compressed media data correspond to a plurality of media streams, said step of temporarily storing the metadata in the at least one intermediate swap file comprises the step of temporarily and respectively storing the metadata for each of the plurality of media streams in a different one of the at least one intermediate swap file, and said step of temporarily storing the compressed media data in the at least one other intermediate swap file comprises the step of temporarily and respectively storing the compressed media data for each of the plurality of media streams in a different one of the at least one other intermediate swap file.

17. The method of claim 14, wherein video frames are separated in the at least one other intermediate swap file by a unique start code used for video frame alignment during an AVC file creation process.

18. The method of claim 17, wherein the unique start code includes a sample number that corresponds to associated metadata.

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FIG. 1

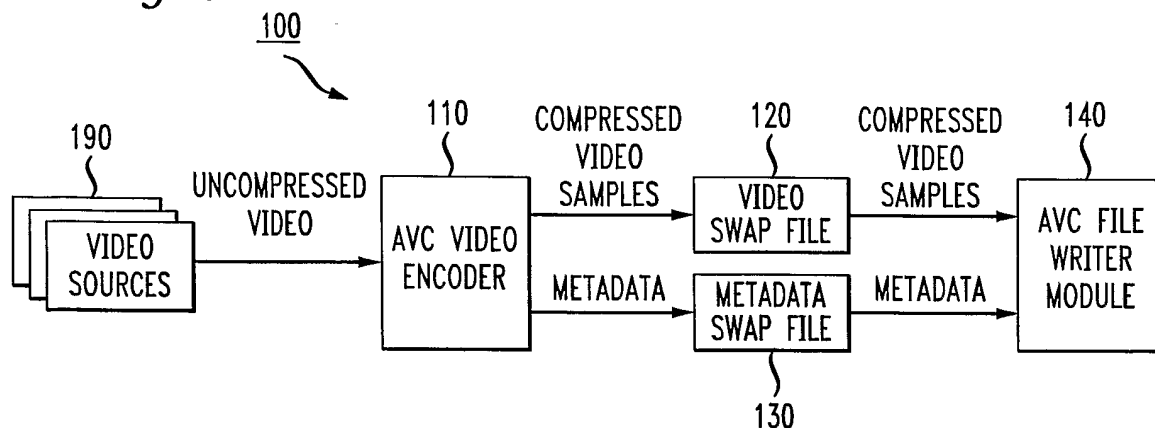


FIG. 2

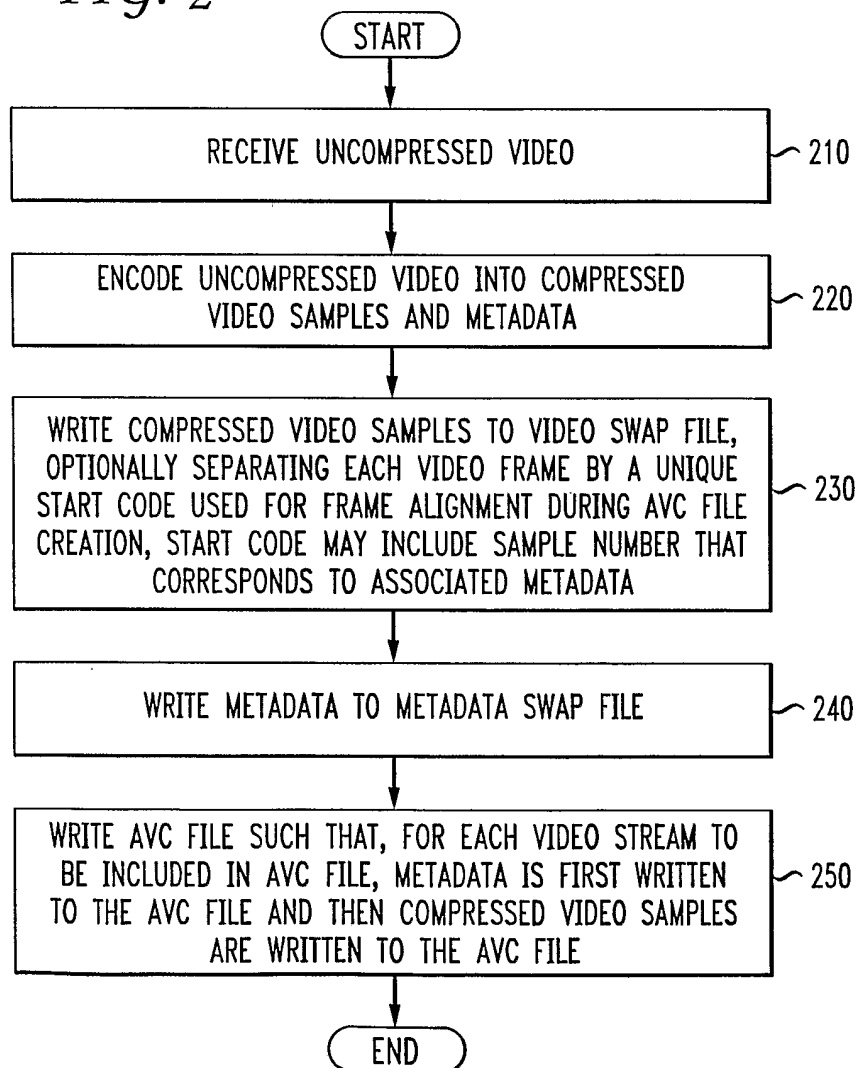
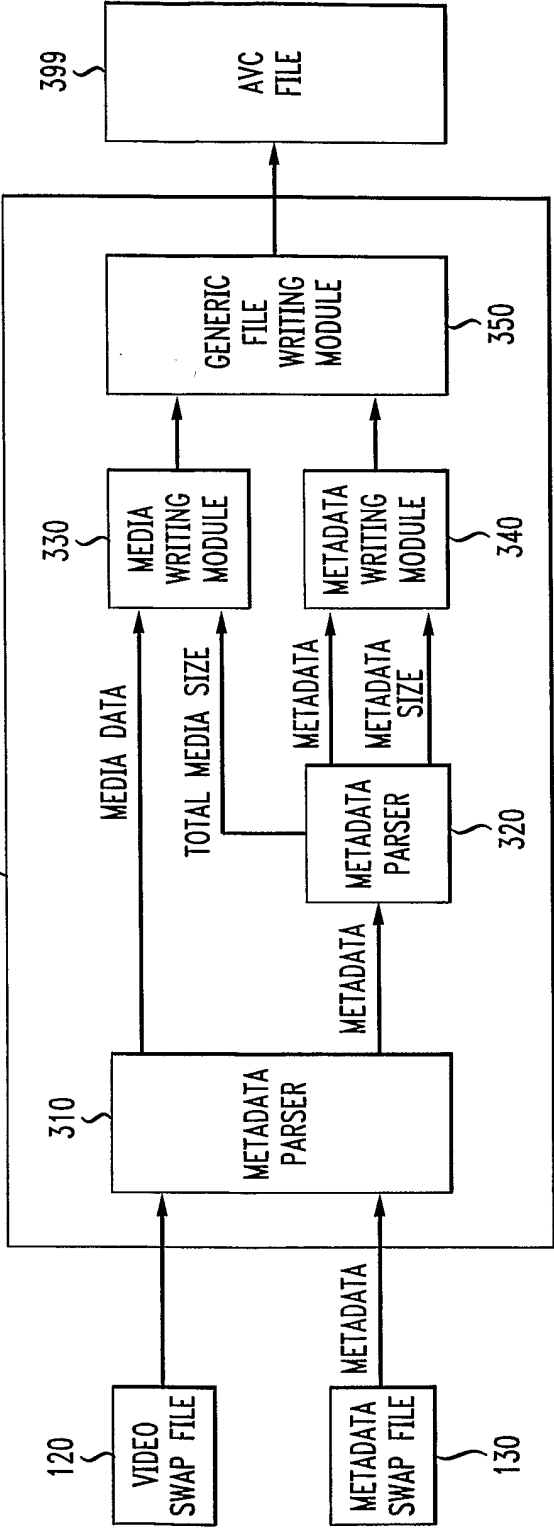


FIG. 3



# INTERNATIONAL SEARCH REPORT

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| <b>A. CLASSIFICATION OF SUBJECT MATTER</b><br>IPC 7 G11B27/034 G11B27/32 G11B20/10 G06F17/30 H04N7/24<br>H04N5/76                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                               |                                                                                                                            |
| According to International Patent Classification (IPC) or to both national classification and IPC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                               |                                                                                                                            |
| <b>B. FIELDS SEARCHED</b><br>Minimum documentation searched (classification system followed by classification symbols)<br>IPC 7 G11B G06F H04N                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                               |                                                                                                                            |
| Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                               |                                                                                                                            |
| Electronic data base consulted during the international search (name of data base and, where practical, search terms used)<br>EPO-Internal, WPI Data, PAJ                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                               |                                                                                                                            |
| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                               |                                                                                                                            |
| Category °                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                            | Relevant to claim No.                                                                                                      |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | WALKER T ET AL: "FIRST IDEAS ON THE STORAGE OF AVC CONTENT IN MP4"<br>INTERNATIONAL STANDARD ISO/IEC, XX, XX, May 2002 (2002-05), pages 1-39, XP001089885<br>Sec. 2: table; sec. 5.1: fig. 3(b); sec. 6, sec. 9, sec.14.1, sec. 14.2, fig. 25.<br>page 9, lines 15-19<br>page 11, lines 13-29 | 1-18                                                                                                                       |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | "TEXT OF ISO/IEC, 14496-15/FCD"<br>13 January 2003 (2003-01-13), ISO/IEC JTC1/SC29/WG11 MPEG02/N5483, XX, XX, PAGE(S) I-VII,1, XP001131064<br>sec. 4.1.1, fig. 1(b), sec. 5, table 4, sec. 5.4, sec. 5.6, sec. 5.9.1.2<br>page 7, lines 8-14<br>page 20, lines 1-30                           | 1-18                                                                                                                       |
| -----<br>-/-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                               |                                                                                                                            |
| <input checked="" type="checkbox"/> Further documents are listed in the continuation of box C. <input type="checkbox"/> Patent family members are listed in annex.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                               |                                                                                                                            |
| ° Special categories of cited documents :<br><div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div> |                                                                                                                                                                                                                                                                                               |                                                                                                                            |
| Date of the actual completion of the international search<br><div style="text-align: center; font-weight: bold;">3 November 2004</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                               | Date of mailing of the international search report<br><div style="text-align: center; font-weight: bold;">15/11/2004</div> |
| Name and mailing address of the ISA<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                               | Authorized officer<br><div style="text-align: center; font-weight: bold;">Bruma, C</div>                                   |

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US2004/005683

| C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                                                                                                                                                                                   |                       |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Category °                                           | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                | Relevant to claim No. |
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