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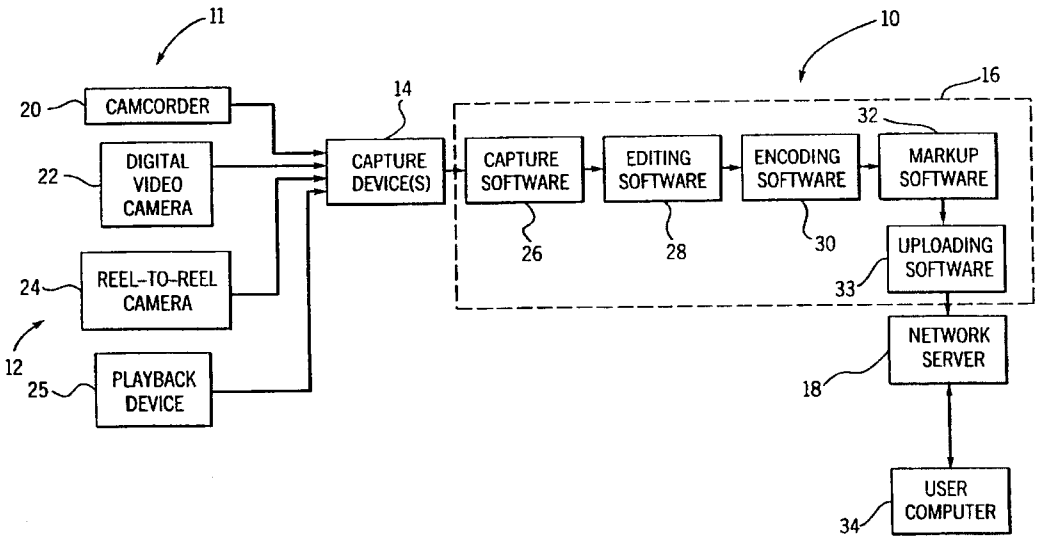
(54) Title: SYSTEM AND METHOD FOR STREAMING AN ENHANCED DIGITAL VIDEO FILE



(57) Abstract: A method of streaming video includes providing a source video signal having a predetermined source video parameter; converting the source video signal to a streaming digital video file while maintaining substantially the same source video parameter; uploading the streaming digital video file to a network server; expanding the viewing frame size of the display screen to a full screen display mode; and playing the streaming digital video file in the full screen display mode.

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TITLE OF THE INVENTION

SYSTEM AND METHOD FOR STREAMING AN ENHANCED DIGITAL VIDEO FILE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/137,297, filed June 3, 1999, U.S. Provisional Application No. 60/155,404, filed September 22, 1999, and U.S. Provisional Application No. 60/169,559, filed December 8, 1999.

FIELD OF THE INVENTION

The present invention relates generally to video imaging. More specifically, the present invention relates to a system and method for providing high quality digital video files for streaming across a network.

BACKGROUND OF THE INVENTION

Streaming video is a technique by which video is played in real time as it is downloaded over the Internet, as opposed to storing it in a local file first. A video player decompresses and plays the data as it is transferred to a user computer over the World-Wide Web. Streaming video avoids the delay entailed in downloading an entire file and then playing it with a plug-in application. Streaming video requires a communications connection (e.g., a network, Internet, etc.) and a computer powerful enough to execute the decompression algorithm in real time.

In the field of streaming video, the primary design challenge is that the viewer desires perfect video quality over a

limited-bandwidth network. Perfect video quality requires an enormous amount of digital data. Today's networks are not capable of providing life-like, full motion, full screen streaming video.

It is known to capture video using a capture device, compress the resulting captured video, store the compressed video, and send the compressed video across the Internet. However, prior attempts have failed to produce high quality streaming video that can be transmitted over the Internet. For example, prior attempts at streaming video have been unable to produce full-screen, real video frame rate video at any acceptable quality.

Several teachings have emerged that attempt to improve the quality and decrease the file size of streaming video. One teaching in the art is to reduce the number of frames per second that are being encoded, from the 25 to 30 fps of standard television to 6 or 7 fps or less for streaming video. While this reduces the amount of data that is being sent, the video appears jittery and corresponding voice appears asynchronous with the jittery video. Another teaching in the art is to capture the video at a small frame size of 160 x 120 or less. The small frame size of 160 x 120 is the widely used standard in Internet streaming video. Further teachings are directed to reducing the amount of data that is provided prior to compressing to reduce the file size resulting from compression. Other teachings in the art have pointed toward compressing a digital video file as much as possible prior to transmission. Full-screen, full-motion video has historically been viewed as requiring far too much data for transmission over a limited-bandwidth network.

Accordingly, there is a need for an improved system and method for providing an enhanced digital video file for streaming across a network. Further, there is a need for a digital video file having high quality at various screen sizes with minimal quality loss when the video is expanded to full screen size. Further still, there is a need for a digital video file having a real video frame rate that can be streamed across a limited bandwidth network, such as the Internet. Further yet, there is a need for a video transmission which, once commenced, need not be stopped.

BRIEF SUMMARY OF THE INVENTION

According to one exemplary embodiment, a method of streaming video includes providing a source video signal having a predetermined source video parameter; converting the source video signal to a streaming digital video file while maintaining substantially the same source video parameter; uploading the streaming digital video file to a network server; expanding the viewing frame size of the display screen to a full screen display mode; and playing the streaming digital video file in the full screen display mode.

According to another exemplary embodiment, a method of streaming an enhanced digital video file includes receiving a digital video file; encoding the received digital video file using a video encoder; associating a viewing frame size of at least 640 x 480 pixels with the encoded digital video file; uploading the encoded digital video file to a web page; and in response to a user request, streaming the uploaded digital video file over the Internet.

According to yet another exemplary embodiment, a system for streaming video includes means for providing a source video signal having a predetermined source video parameter; means

for converting the source video signal to a streaming digital video file while maintaining substantially the same source video parameter; means for uploading the streaming digital video file to a network server; and means for playing the streaming digital video file at a display mode of at least 640 x 480 pixels.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will become more fully understood from the following detailed description, taken in conjunction with the accompanying drawings, wherein like reference numerals refer to like parts, in which:

FIG. 1 is a block diagram of a system for generating an enhanced digital video file according to an exemplary embodiment;

FIG. 2 is a flowchart of a method for generating an enhanced digital video file according to the exemplary embodiment of FIG. 1; and

FIG. 3 is a block diagram of a system for playing a digital video file across a network.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, a system 10 for generating an enhanced digital video file is shown. System 10 may be used as shown, or portions of system 10 may be integrated with other video processing systems, such as medical imaging equipment, motion picture production equipment, etc. System 10 generates a digital video file expandable to a full screen size and having a real video frame rate (i.e., life-like, smooth, not jerky, comparable with recorded video formats, such as, NTSC (National Television Standards Committee) at 29.97 frames per second (fps), PAL (Phase

Alternative Line) at 25 fps, and SECAM (Séquentiel Couleur Avec Mémoire) at 25 fps)) with a file size that is suitable for streaming over the Internet, for such uses as high definition television, Web television, computers and servers utilized in wireless environments, etc.

As known in the art, video is recorded having certain standard recorded video parameters, such as, frame rate, and number of lines scanned. For example, it is will known that a source conforming to the NTSC (National Television Standards Committee) standard operates at 29.97 frames per second (fps), a source conforming to the PAL (Phase Alternative Line) standard operates at 25 fps, and a source conforming to the SECAM (Séquentiel Couleur Avec Mémoire) standard operates at 25 fps. It is will known in the art that the NTSC standard includes two interleaved frames at 240 lines scanned, while the PAL standard is 270 lines scanned. Note that the number of lines scanned corresponds to the number of vertical pixels in a standard 320 x 240 frame size compatible with standard capture cards, such as, a Dazzle LAV-1000S capture device manufactured by Dazzle, Inc. of Fremont, California.

System 10 includes one or more sources, including recording devices 12 or playback device 25, a capture device 14, a computer 16, and a network server 18. Recording devices 12 include a camcorder 20, a digital video camera 22, and a reel-to-reel camera 24, each of which may be hand-held or mounted on a tripod or stand. System 10 may include a playback device 25 (e.g., tape player, VHS (Vertical Helix Scan) player, Beta player, DVD (Digital Versatile Disk) player, etc.). Camcorder 20 may be a VHS recorder, Beta recorder, or other camcorder, and is configured to store video on magnetic tape. Digital video camera 22 may be any type of

digital video camera configured to generate video in a digital format. In this exemplary embodiment, digital video camera 22 stores the digital video data to a tape. Digital video camera 22 is configured to provide digital video data in real time or via the tape in a digital format, such as, Beta digital, AVI, MOV, MPEG (Motion Picture Experts Group), or other format compatible with the IEEE 1394 standard, etc., to capture device 14. AVI is an audio/video standard designed by Microsoft Corp., Redmond, Washington. According to one exemplary embodiment, a digital video camera including 3CCD technology is used to record the video. The 3CCD technology (3-chip charge-coupled device) includes a dichroic prism and three CCDs, each CCD being aligned to detect only the red, green, or blue color. A 3CCD camera will provide enhanced color resolution. Reel-to-reel camera 24 includes recording equipment that uses magnetic tape which must be threaded through the equipment and onto an empty reel. According to one alternative embodiment, a separate audio recording device, such as a microphone, may be utilized in conjunction with recording devices 12, in which embodiment recording devices 12 are used to record only video. Other recording devices may be used, such as, devices optimized for live video-conferencing.

Computer 16 includes a processor, memory, magnetic storage device, input/output devices and circuitry, etc. Computer 16 may include multiple computer at multiple sites, with different portions of the process described hereinafter operating on different computers.

Capture device 14 is coupled to one or more of sources 11. Capture device 14 is shown external to computer 16, but may alternatively be an internal capture device coupled within the housing

of computer 16 or an internal capture device within the housing of one of recording devices 12 or playback device 25. In this exemplary embodiment, a Dazzle LAV-1000S capture device is utilized, though other capture devices may be used, such as a Pinnacle DC10PLUS or Pinnacle DC30PRO device, both manufactured by Pinnacle Systems, Inc., Mountain View, California, or a MotoDV Mobile capture device, manufactured by Digital Origin, Inc., Mountain View, California. Capture software 26, such as Amigo 2.11, manufactured by Dazzle, Inc. or Adobe Premier 5.1, manufactured by Adobe Systems Inc., San Jose, California, is operable on computer 16 to interface capture device 14 with computer 16. Other capture software may be utilized, such as, RealProducer G2, manufactured by RealNetworks, Inc., Seattle, Washington.

In conjunction with capture software 26, capture device 14 is configured to receive a video signal from one of recording devices 12 or playback device 25, to digitize the video signal, and to store the video signal as a digital video file. The parameters of the video capture will be discussed below with reference to FIG. 2. The digital video file is an MPEG-1 file in this exemplary embodiment, but may alternatively be generated in other digital video formats, such as, MPEG-2, AVI, etc. Capture device 14 is a combined audio/video capture device, but may alternatively include discrete audio and video capture devices, the audio capture device configured to digitize any audio which corresponds to the video being captured by the video capture device. As a further alternative, audio captured device may be utilized alone without a video capture device. The audio capture device may be, for example, a Montego II device, manufactured by Voyetra Turtle Beach, Inc., Yonkers, New York,

and configured to generate a digital audio file in a digital audio format, such as, PCM (Pulse Code Modulation).

Editing software 28 is operable on computer 16. In this exemplary embodiment, Adobe Premier 5.1 is utilized, though other video editing software may be used. Editing software 28 receives the captured digital video file and enables an operator to edit the digital video file by adding or deleting frames, adjusting the color, contrast, and brightness of the frames, etc. The edits are then saved to the digital video file or can be exported to AVI or MOV file types.

Encoding software 30 is operable on computer 16. In this exemplary embodiment, RealProducer G2 is utilized, though other encoding software may be used. Encoding software 30 receives the edited digital video file and encodes the digital video file into an encoded format, such as, an RM format. Encoding software 30 may also compress the digital video file, if needed, to reduce the size of the digital video file, using a video compression algorithm, such as MPEG-1, MPEG-4, etc.

Markup software 32 is operable on computer 16. In this exemplary embodiment, a hypertext markup language (e.g., HTML, Dynamic HTML, Cold Fusion) is utilized. An operator marks up the encoded digital video file in HTML to prepare the digital video file for uploading to the network server 18. In this exemplary embodiment, a code segment representing a full screen frame size, such as 640 x 480 pixels, is associated with the digital video file in the HTML code. The full screen frame size code segment may alternatively include other screen sizes, such as 800 x 600 pixels, 1024 x 768 pixels, 1280 x 1024 pixels, and 1600 x 1200 pixels. During a subsequent video streaming step, the full screen frame size

code segment causes or enables a video player program, such as RealPlayer, manufactured by RealNetworks, Inc., to enlarge the streaming video to a full screen frame size, such as 640 x 480 pixels.

References herein to frame sizes in pixels, such as, 320 x 240 pixels, 640 x 480 pixels, are intended to include equivalent frames sizes thereto. For example, it is known that a frame size of 320 x 240 pixels may include an additional number of unneeded pixels (e.g., which can be as much as 10% of the total pixels) attributed to overscan. Thus, one equivalent to a 320 x 240 pixel frame size is 304 x 228 pixels. As a second example, when rectangular pixels are used, the exact pixel count differs from the stated frame size. Thus, one equivalent to a 320 x 240 pixel frame size is 352 x 240. Accordingly, references to frame sizes in pixels are intended to included these and other equivalent frame sizes, and the teachings herein include any and all such insubstantial variations.

The uploading process utilizes uploading software 33, such as, a Web FTP (file transfer protocol) software (e.g., WS FTP PRO, manufactured by Ipswitch, Inc., Lexington, Massachusetts.) The digital video file is uploaded to network server 18, which includes a computer configured to generate a web page on an internet-protocol network, such as the Internet or a company-wide intranet. A web page is a block of data written in a markup language, such as HTML, and any related files for scripts and graphics. Network server 18 may alternatively be coupled to a non-internet-protocol network, such as, an ethernet, a local area network, a wide area network, a wireless network, etc.

A user computer 34 may access the web page provided by network server 18 via a network, such as, the Internet. Upon

actuating a user input device (e.g., a web page button, hypertext link, etc.) associated with the uploaded digital video file, the HTML code launches a suitable video player program (e.g., RealPlayer) at user computer 34, activates the full screen frame size at user computer 34, and streams the video from the digital video file to user computer 34. Alternatively, the video player program may initially play the streaming video at a smaller frame size (e.g., 320 x 240), and the user may actuate a user input device on the video player to enlarge the streaming video to a full-screen size, such as 640 x 480. Notably, capture software 26, editing software 28, encoding software 30, markup software 32, and uploading software 33 may be operable on one computer or on different computers during different steps in the process.

According to one alternative embodiment, the encoded digital video file is stored directly to a storage device, such as, a compact disk, a digital video disk, a magnetic storage device, etc., for subsequent viewing on another computer, on a personal digital assistant (e.g., a Palm Pilot manufactured by Palm, Inc., Santa Clara, California), etc. According to another alternative embodiment, digital video data is provided on a storage device (e.g., a floppy disk, a hard disk storage, etc.) which has been pre-captured. The pre-captured digital video data is provided in a compressed or uncompressed digital video format to encoding software 30 for subsequent processing.

Referring now to FIG. 2, a method 50 for generating an enhanced digital video file according to the exemplary embodiment of FIG. 1 is shown. Method 50 is operable using one or more of the elements of system 10, as needed. While the steps of method 50 are explained with reference to captured video, it is understood that

captured audio may be processed along with the captured video, or perhaps processed independently in a similar manner. As will be seen, the recorded video will be captured and encoded at near-optimal levels, as determined by the selected parameters in these processes, thereby preserving the highest quality video content. While exemplary values are presented herein for such parameters, it is understood that one of ordinary skill in the art will recognize other combinations of parameters based on these teachings.

According to one exemplary embodiment, a customer provides pre-recorded video saved to a disk or other storage device. At step 52, if the video has been pre-recorded by the customer, the method proceeds to step 58. If the video has not yet been recorded, at step 54, video is recorded using one or more of recording devices 12 or playback device 25. The video is recorded into any suitable format, such as, VHS or Beta, and is played back using a television standard, such as, NTSC (National Television Standards Committee), PAL (Phase Alternative Line), SECAM (Séquentiel Couleur Avec Mémoire), a digital format, such as, AVI, MOV, MPEG, a digital format compatible with the IEEE 1394 standard, or another format, etc. At step 56, the video is captured by coupling one of recording devices 12 or playback device 25 to capture device 14, which is an external Dazzle LAV-1000 capture device in this exemplary embodiment, but may alternatively be an internal card or other capture devices, such as a Pinnacle DC10 device.

Capture software is also utilized, such as, Amigo 2.11, Adobe Premier 5.1 or Real Producer G2. Capture device 14 and capture software 26 generate a digital video file based on the recorded video. If the recorded video is in an analog format, capture device 14 digitizes the analog video to create digital video data. If

the recorded video is in a digital format, capture device 14 merely receives the digital video data and formats a file in the appropriate standard (e.g., AVI, MOV, MPEG1, etc.). According to one exemplary embodiment, capture software 26 is set for real video capture, i.e., having a frame rate of a television or movie standard, such as, 29.97 frames per second. Real video capture may further have a frame rate of between 24 and 30 frames per second, or at least substantially more than the 6 to 9 frames per second conventionally used in streaming video applications. Further, the video is captured with at least approximately 76,800 pixels per frame (at least approximately 69,000 pixels taking into consideration overscan). For a 4:3 aspect ratio, the frame size of the video capture is at least 320 x 240 in this exemplary embodiment (at least 304 x 228 taking into consideration overscan), or at least more than the 160 x 120 used in conventional streaming video applications. Frame sizes of 480 x 320 and 640 x 480 may also be utilized in the video capture. However, particularly advantageous results are associated with the 320 x 240 capture frame size.

In an alternative embodiment, a separate audio capture device is utilized in parallel with the video capture device. In the alternative embodiment, corresponding audio capture software is operable on computer 16 to digitize the audio into a digital audio format, such as PCM. The sampling rate is between 44 and 48 kiloHertz (kHz); the bus size is 16-bit, allowing an audio resolution of 16-bits; and the audio is sampled in stereo. These parameters may also be set using the video capture software in an embodiment wherein video and audio are captured using one capture device.

The captured video data may be stored as a data file in a storage device (e.g., a hard drive) or may be stored in memory and

fed directly to an encoder. The captured video data may further be compressed, for example, to an MPEG-1 file before being saved to the storage device.

At step 58, the digital video file is edited using a video editing software, such as, Adobe Premier 5.1. Adobe Premier 5.1 generates an output file in a MOV or AVI format, but may alternatively generate an output file in any digital video format. The edited digital video file may be stored in the storage device. Step 58 is optional but, if included, preferably Adobe Premier 5.1 maintains a frame size of at least 320 x 240 pixels and a real video frame rate.

At step 60, the edited digital video file is converted or encoded using a video encoding algorithm to create a streaming video file. The edited digital video file is first retrieved from the storage device (unless the digital video data is provided directly from capture device 14). In this exemplary embodiment, the digital video file is encoded to a RealMedia format (i.e., RM) using a RealNetworks encoding algorithm. RM is an audiovisual file format proprietary to RealNetworks, Inc. As a further alternative, Windows Media Encoder, manufactured by Microsoft Corp., may be utilized to encode the captured digital video file, for example, to an ASF format (Advanced Streaming Format) or ASX format. Further still, QuickTime, manufactured by Apple Computer, Inc., Cupertino, California, may be utilized to encode the captured digital video file, for example, to an MOV format.

Encoding may additionally include compression, if a smaller file size is desirable, as indicated by steps 62 and 64. The amount of compression may be selected by the operator using encoding software 30 or alternative compression software. During the encoding process, the digital video file is encoded to have a data

rate of between approximately 35 kbps (kilobits per second) to 750 kbps, and a frame rate of between approximately 24 fps (frames per second) and 30 fps (e.g. 29.97 fps.). The number of pixels per frame is set to at least approximately 76,800 (again, at least approximately 69,000 pixels taking into consideration overscan) which, for a 4:3 aspect ratio, is 320 x 240 pixels (again, at least 304 x 228 pixels taking into consideration overscan), or at least more than the 160 x 120 pixels of conventional usage. However, editing, encoding, and compression are optional steps.

At step 66, the digital video file is marked up with a markup language, such as, HTML. At step 68, a full screen frame size is associated with the digital video file. A full screen frame size is at least 640 x 480 pixels, and may also be 800 x 600 pixels, 1024 x 768 pixels, 1280 x 1024 pixels, 1600 x 1200 pixels, etc. In this exemplary embodiment, the markup language associated with the digital video file includes a code segment that causes the digital video file to stream at the desired full screen frame size. While the markup language is used to associate the full screen frame size code segment with the digital video file in this exemplary embodiment, the full screen frame size code segment may be associated with the digital video file in another step of the method, such as the encode step 60, compression step 62, or another step.

At step 70, the digital video file is uploaded to an Internet web page using uploading software, such as, WS FTP PRO. At step 72, a script (e.g., an ASCII file (American Standard Code for Information Interchange)) is associated with the marked-up digital video file. The script calls the video to stream in response to a user actuation from user computer 34. The script is written in a RAM format, such as from a Microsoft Notepad software program. The

script is included in the markup language associated with the digital video file. In this exemplary embodiment, an actuatable user input device (e.g., a hypertext link) is associated with the HTML code.

Thus, a user from anywhere in the world may access network server 18 via the Internet, actuate the user input device, and call the video to stream. Upon actuation, the HTML codes launch video playing software (e.g., RealPlayer) at the user computer, enlarge the viewing window of the software to full screen mode (i.e., at least 640 x 480), and begin streaming the video to the user computer. Alternatively, the user may expand the viewing screen to full screen mode by actuating an input device on the video player software. Other methods of expanding the viewing screen to a full screen are contemplated. The transmission speed of the digital video file is dependent upon the bandwidth of the user's network connection, but may range from approximately 35 kbps to 750 kbps, or as low as 28.8 kbps, with a frame rate of between approximately 24 fps to 29.97 or 30 fps.

According to one alternative embodiment, network server 18 is configured to query user computer 34 to ascertain the network connection used by computer 34 (e.g., 28.8 kbps modem, T1 line, ISDN, etc.). Thereafter, network server 18 determines the appropriate transmission rate based on the ascertained network connection.

EXAMPLE A

A Sony DCR VX-1000 digital video camera, having 3CCD technology, manufactured by Sony Electronics, Inc., Park

Ridge, N.J., was utilized to record a video signal. The video camera generated an output signal of 6MHz in NTSC format.

A Dazzle LAV-1000S external capture device was coupled to the video camera. Amigo 2.11, Dazzle's capture software was used. The Dazzle capture device and capture software were programmed with several parameters. The frame size was left at the default setting of 320 x 240 pixels. The frame speed was set to 29.97 frames per second. The bit rate was set to 3.0 Megabits (Mb) per second. The audio capture was set to 44 kHz, 16 bit sampling rate. An MPEG-1 file was generated based on the video signal using the capture device and software programmed with these parameters.

When the captured MPEG-1 file was provided to RealEncoder G2, the resulting encoded file failed to retain the real video frame rate. Therefore, Adobe Premier 5.1 was utilized to receive the MPEG-1 file and export it to a MOV or AVI or MPEG file., based on several parameters. The frame rate in Adobe Premier 5.1 was set to 29.97 fps. The frame size was set to 320 x 240. The "Quality" setting, representing the number of colors to appear in the edited file, was set to a high setting (e.g., 100%). Adobe Premier 5.1 generated an AVI file or an MOV file or a MPEG file, depending upon the operator selection.

RealEncoder G2 software was used to encode the AVI or MOV file into a streaming video file in RM format. The RealEncoder G2 software was programmed with several parameters. The bitrate was set to 220 kbps. The frame rate was set to 30 fps. The "Surestream" option was selected. "Surestream" technology adjusts the playing speed of the encoded digital video file to accommodate the network connection speed of the user. For sound

quality, "stereo/music", the highest quality, was selected. For image quality, "sharpest image", the highest quality, was selected. Regarding frame size, this version of RealEncoder generated an output signal having a frame size equal to that of the frame size of the MOV or AVI input file. RealEncoder compressed the MOV or AVI input file using the RealNetworks compression algorithm. An RM file was generated based on the these parameters.

The RM file was uploaded to an Internet server. Using Microsoft Notepad, a script was written in RAM format to 1) identify the location of the RM file, 2) launch RealPlayer on the user computer, 3) resize the viewing screen on the user computer to 640 x 480, and 4) begin the video stream. The result was unexpectedly high-quality, full-screen, real video frame rate, streaming video. The RM file was subsequently streamed to a client computer via a telephone modem and via other broadband connections. The same unexpectedly high-quality, full-screen, real video frame rate, streaming video was experienced. The streaming playback was intermittent due to the need to buffer to accommodate the lower bit-rate of transmission.

EXAMPLE B

According to another example, an NTSC analog signal is provided to a Pinnacle DC-10PLUS capture device. The Pinnacle capture device and associated software generate a digital video file in AVI format based on several parameters. The capture type is set to NTSC. The frame size is set to 320 x 240 pixels, or "1/4 full frame size". Brightness, sharpness, and color are adjusted, as desired. The compression rate is set to 2.5:1. The frame rate is set

to 29.97. Square pixel ratio is selected. Audio is set to stereo format, 44 kHz, 16 bit sampling. The data rate is set to 1739 kbps. The capture device utilizes a Miro codec to create a digital video file in AVI format.

Optionally, a header and footer is provided to the beginning and end of the digital video file. The header and footer include a trademark for the assignee of the present application. Adobe Premier is used to render the header, footer, and watermark to the digital video file. A parameter within Adobe Premier is set to a frame size of 320 x 240. Adobe Premier further utilizes a Miro codec to create a digital video file in AVI format.

The edited AVI file is encoded by RealProducer software. The following parameters are programmed in the RealProducer software. One set of parameters was used for a low-speed network connection at the user computer (hereinafter designated "LO"), and another set of parameters was used for a high-speed network connection at the user computer (hereinafter designated "HI"). RealNetworks "Surestream" technology is selected. Alternatively, "single-stream" can be selected, and an RAM file can be generated to query the connection speed of the user computer and stream the video at the proper connection speed. The encoding speed is set to, for LO, 28 kbps or 56 kbps, and for HI, LAN, DSL, Cable Modem, or T1. Sound quality is set to "voice only" or "stereo music" or "CD quality". Video quality is set to "sharper image". Frame rate is set to 29.97 fps. Target bit rate is set to 350 kbps. The target player is specified as RealPlayer G2. Frame size is set to 320 x 240. Based on these parameters, the RealEncoder software generates an RM file or other streaming video data file, which is subsequently uploaded to RealServer.

The exemplary embodiments disclosed herein provide greatly enhanced streaming video suitable for streaming over a limited-bandwidth network, such as the Internet. Several discoveries have enabled various aspects of this technology. The first discovery was that the efficiency of encoding from a captured digital video file to a streaming video file is increased with an increase in the frame size of the captured digital video file. Thus, while conventional teachings pointed toward minimizing the capturing and encoding frame sizes (typically to 160 x 120 pixels, which has widely become an Internet standard for streaming video) to reduce the size of the resulting file, the present inventors turned away from these teachings and increased the capturing and encoding frame sizes to 320 x 240 pixels. Second, one goal of the present inventors was to achieve full-screen, real video frame rate, streaming video. Conventional teachings would point toward encoding at a frame size of 640 x 480 pixels to achieve full-screen streaming video. However, with today's technology, enlarging the frame size of a captured digital video file during encoding to 640 x 480 (for example, from 160 x 120 pixels) pixels causes an enormous increase in the amount of data in the resulting encoded digital video file and requires enormous bandwidth to stream. Therefore, the present inventors discovered that encoding at 320 x 240 pixels (or its equivalent) provided greatly improved results when doubled to full-screen for viewing.

These conventional teachings were evidenced in the capabilities of the encoder used at the time of invention, namely, RealProducer G2. RealProducer G2 taught away from real video streaming since digital video files that were captured at a real video

frame rate (e.g., 30 fps) would be automatically reduced to a lower, non-real video frame rate (e.g., 15 fps) to reduce the size of the streaming video file. Furthermore, digital video files which were captured directly from a capture device using RealProducer G2 were encoded at a frame rate of only 6-7 fps and had no option to adjust frame size. Therefore, to obtain a real video frame rate, the inventors followed the steps in EXAMPLE A above to achieve the first high quality, full-screen, real frame rate streaming video file.

Referring now to FIG. 3, a system 80 for playing a digital video file across a network is shown, and a corresponding method is described. System 80 includes a network server 82 having a processor 84, a storage device 86, and a network interface 88. A capture device 90 is coupled to network server 82 and is configured to capture a video signal, as described hereinabove. Processor 84 controls capture device 90 and provides various parameters to capture device 90 regarding frame size, bit rate, etc. For example, one or more of the methods for capturing video and generating a digital video file described hereinabove may be implemented by processor 84, storage device 86, and capture device 90. Processor 84 and capture device 90 generate a digital video file in a digital video format (e.g., MPEG, AVI, etc.) and store it to storage device 86. As used in this description of FIG. 3, the term "storage device" includes such devices as magnetic tape, a hard drive, a floppy disk, magnetic disk, or other similar non-volatile storage media, but not including random access memory or other temporary memory. The capture process may alternatively be carried out on another computer, after which the resulting digital video file is stored in (e.g., uploaded to) storage device 86.

Network server 82 is coupled through network interface 88 to a network 92, such as the Internet, a LAN, etc. Processor 84 is configured to generate a web page having a hypertext link to the digital video file stored in storage device 86. A network client 94 includes a processor 96, a storage device 98, an input device 100, a display 102, and a network interface 104. Network client 94 is operable via a user to access the web page generated by network server 82 and to actuate the hypertext link to begin downloading the digital video file from storage device 86.

One drawback of downloading video files is that, for very large files, the delay before any portion of the digital video file can be viewed can be on the order of minutes, hours, or longer. Thus, according to one advantageous aspect of system 80, while the digital video file is being downloaded to network client 94 and stored in storage device 98, some of the digital video file which has already been downloaded and stored is being simultaneously played on display 102. A suitable player which supports AVI, MPEG, and other digital video formats is utilized for the video play. This procedure may be referred to as viewing/downloading. Stated another way, a first portion of the digital video file is played from storage device 98 while later portions of the digital video file are still downloading from storage device 86 via network 92 to storage device 98.

One method of launching the player and beginning the play of the first portion is for a user to simply select these steps via input device 100 (e.g., a mouse, a keyboard, etc.) a certain time after the downloading has begun. Alternatively, an algorithm may be provided, either attached to the digital video file (e.g., HTML, Java, a macro, etc.) or as part of the player (e.g., QuickTime, RealPlayer,

etc.) which begins playing the digital video file at a predetermined time after the download to storage device 98 has begun. This predetermined time may be pre-programmed or adjusted in real-time based on inputs from client server 94 or network server 82. According to one example, the algorithm calculates the predetermined time based on the download speed (e.g., including network connection speed of network interface 104, etc.), the viewing speed (e.g., frames per second, etc.), and the size of the digital video file. For example, if the viewing speed is four times the download speed, the algorithm monitors the amount of the file (e.g., in bytes) which is downloaded until 75% of the file is downloaded. When 75% of the file is downloaded, the algorithm begins playing the digital video file from storage device 98. By playing the file at this predetermined time, the digital video file will play substantially without delays for buffering. Of course, other predetermined times are contemplated, including those earlier and later than that set forth in this exemplary embodiment.

Thus, one can view a digital video file shortly after clicking on the hypertext link and before the entire digital video file has downloaded to storage device 98. Once the entire digital video file is finished playing, network client 94 retains a copy of the digital video file in storage device 98 for later playing.

According to one alternative, the digital video data is captured in real-time and streamed in real-time across network 92 (i.e., without first storing to storage device 86) to storage device 98.

While the embodiments and applications of the invention illustrated in the FIGS. and described above are presently preferred, it should be understood that these embodiments are offered by way of example only. For example, while the steps of the

exemplary embodiments contemplate recording audio and video at one time and streaming the audio and video at another time, the audio and video may alternatively be fed through system 10 in real-time, thereby facilitating real-time audio/video transmissions.

Furthermore, the exemplary software programs mentioned may be replaced by newly developed versions and/or programs in the future. Accordingly, the present invention is not limited to a particular embodiment, but extends to various modifications that nevertheless fall within the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A method of streaming video, comprising:

providing a source video signal having a predetermined source video parameter;

converting the source video signal to a streaming digital video file while maintaining substantially the same source video parameter;

uploading the streaming digital video file to a network server;

expanding the viewing frame size of the display screen to a full screen display mode; and

playing the streaming digital video file in the full screen display mode.

2. The method of claim 1, wherein the step of converting the source video signal includes associating a viewing frame size code segment with the streaming digital video file.

3. The method of claim 2, wherein the viewing frame size code segment is hypertext markup language.

4. The method of claim 2, wherein the viewing frame size code segment causes the video to stream upon actuation of a user input device.

5. The method of claim 4, wherein the user actuation includes selection of a hypertext link on a web page, wherein the hypertext link is associated with the streaming digital video file.

6. The method of claim 1, further comprising capturing and encoding the source video signal.

7. The method of claim 6, wherein the source video parameter includes the frame rate.

8. The method of claim 7, wherein the source video frame rate is at least 24 frames per second.

9. The method of claim 6, wherein the source video parameter includes the number of scanned lines of video per frame.

10. The method of claim 1, wherein the size of the full screen display mode is at least 640 x 480 pixels.

11. The method of claim 10, wherein the streaming digital video file has a capture frame size of at least 320 x 240 pixels.

12. The method of claim 6, further comprising editing the source video signal using video editing software.

13. A method of streaming an enhanced digital video file, comprising:

receiving a digital video file;

encoding the received digital video file using a video encoder;

associating a viewing frame size of at least 640 x 480 pixels with the encoded digital video file;

uploading the encoded digital video file to a web page; and

in response to a user request, streaming the uploaded digital video file over the Internet.

14. The method of claim 13, further comprising expanding the viewing frame size of a display screen to a full screen.

15. The method of claim 13, wherein the received digital video file is in the MPEG file format.

16. The method of claim 13, wherein the step of associating includes associating a viewing frame size of approximately 640 x 480 pixels with the encoded digital video file.

17. The method of claim 13, wherein the step of associating includes manually setting the viewing frame size to at least 640 x 480 pixels.

18. The method of claim 13, wherein the user request is received via an Internet web page.

19. The method of claim 13, further comprising, in response to the user request, automatically launching a video player at a user computer.

20. The method of claim 13, wherein the received digital video file has a frame rate of at least 24 frames per second and a frame size of at least 320 x 240 pixels.

21. A system for streaming video, comprising:

means for providing a source video signal having a predetermined source video parameter;

means for converting the source video signal to a streaming digital video file while maintaining substantially the same source video parameter;

means for uploading the streaming digital video file to a network server; and

means for playing the streaming digital video file at a display mode of at least 640 x 480 pixels.

22. The method of claim 21, further comprising means for expanding the viewing frame size of the display screen to a full screen display mode.

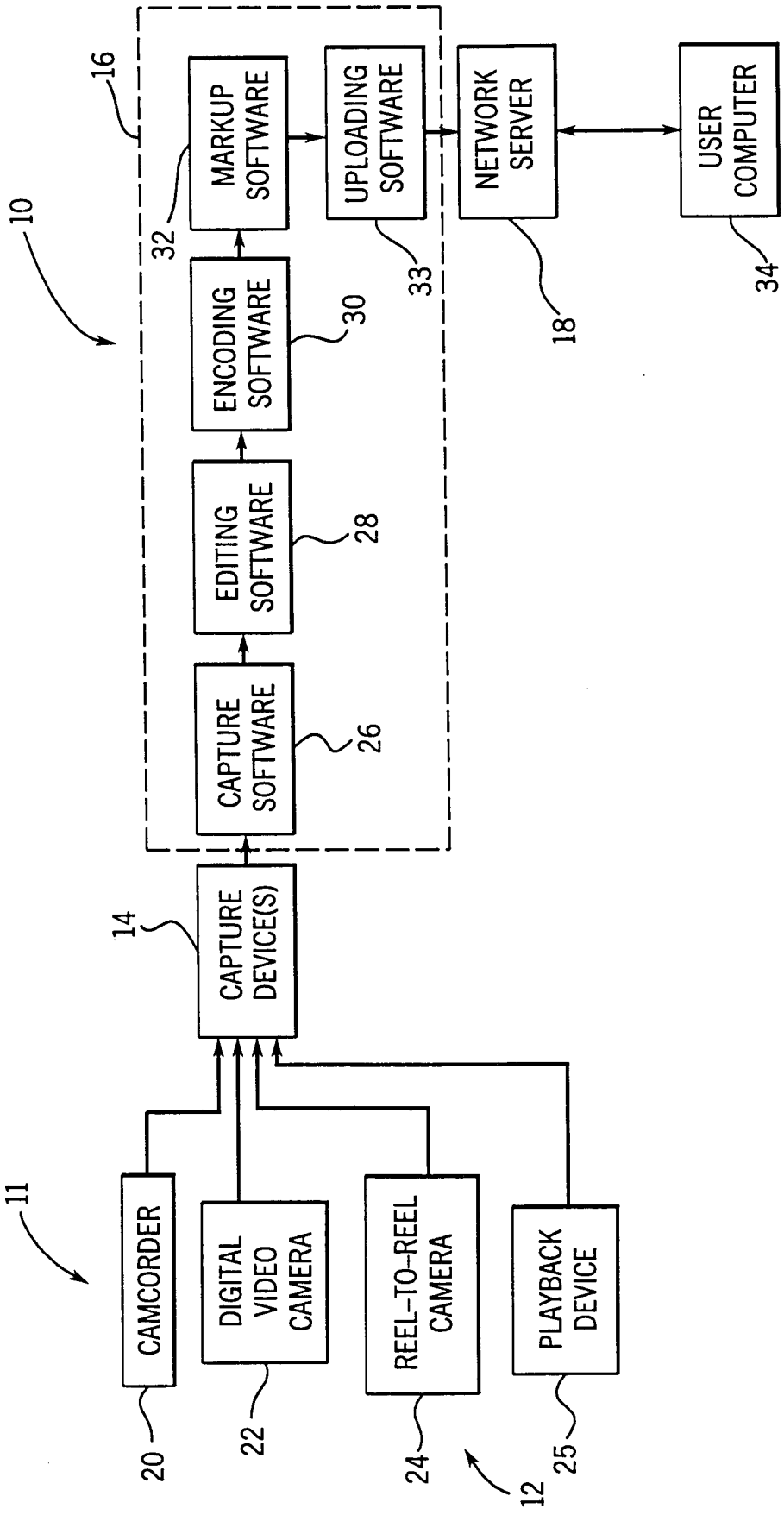
23. The system of claim 21, further comprising means for capturing the source video signal to generate the streaming digital video file.

24. The system of claim 23, wherein the means for capturing includes a Dazzle LAV-1000 device.

25. The system of claim 21, further comprising means for editing the streaming digital video file.

26. The system of claim 21, further comprising a means for encoding the digital video file into an RM file format.

27. The system of claim 21, further comprising means for linking the uploaded digital video file to an actuatable input device on a web page.


CAMCORDER
DIGITAL VIDEO CAMERA
REEL-TO-REEL CAMERA
PLAYBACK DEVICE
CAPTURE DEVICE(S)
CAPTURE SOFTWARE
EDITING SOFTWARE
ENCODING SOFTWARE
MARKUP SOFTWARE
UPLOADING SOFTWARE
NETWORK SERVER
USER COMPUTER
10
11
12
14
16
18
20
22
24
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32
33
34

FIG. 1

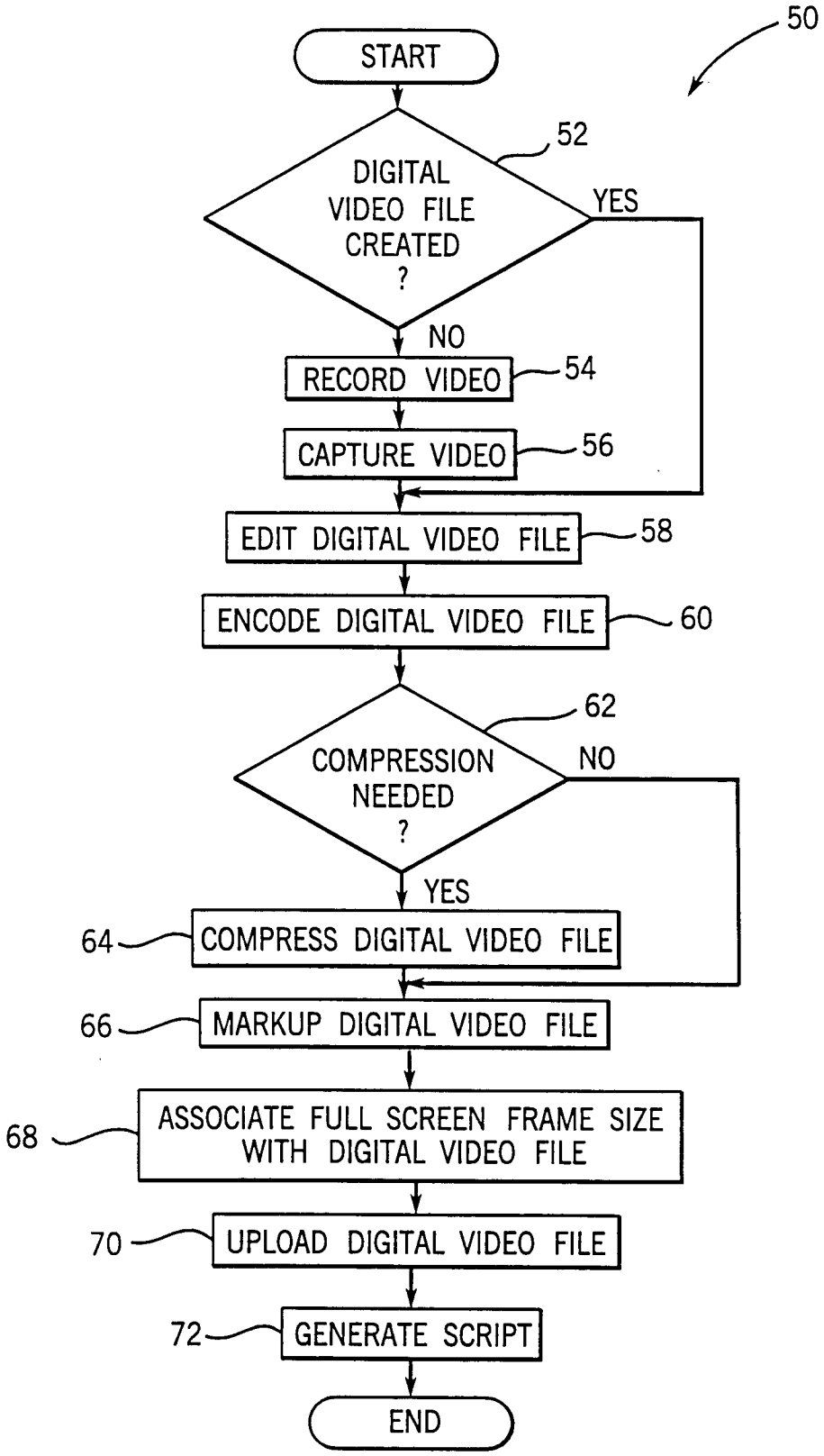
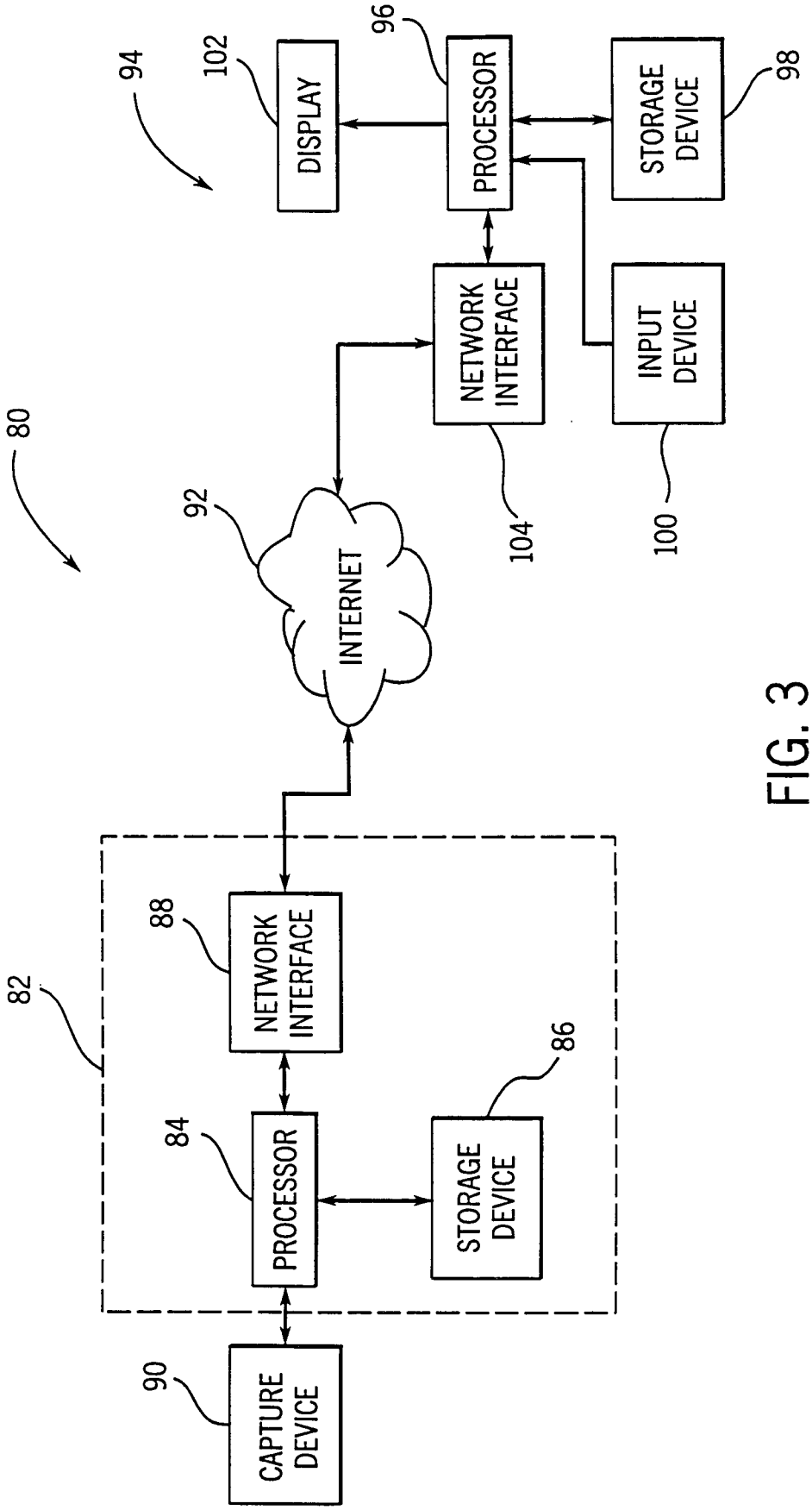

50
START
52
DIGITAL VIDEO FILE CREATED ?
YES
NO
RECORD VIDEO
54
CAPTURE VIDEO
56
EDIT DIGITAL VIDEO FILE
58
ENCODE DIGITAL VIDEO FILE
60
62
COMPRESSION NEEDED ?
NO
YES
64
COMPRESS DIGITAL VIDEO FILE
66
MARKUP DIGITAL VIDEO FILE
68
ASSOCIATE FULL SCREEN FRAME SIZE WITH DIGITAL VIDEO FILE
70
UPLOAD DIGITAL VIDEO FILE
72
GENERATE SCRIPT
END

FIG. 2


80
82
84
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94
96
98
100
102
104
DISPLAY
PROCESSOR
STORAGE DEVICE
NETWORK INTERFACE
INPUT DEVICE
INTERNET
NETWORK INTERFACE
PROCESSOR
STORAGE DEVICE
CAPTURE DEVICE

FIG. 3

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 00/15408

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N7/173 H04N7/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 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)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JOSÉ ALVEAR: "Web Developer.com Guide to Streaming Multimedia " 9 April 1998 (1998-04-09) , JOHN WILEY & SONS , NEW YORK XP002150042 page 65 -page 86 page 127 -page 139 page 183 -page 204 page 349 -page 370 ---	1-27
A	PROGRESSIVE NETWORKS INC.: "Real Video Content Creation Guide Version 1.0" 'Online! 12 June 1997 (1997-06-12) XP002149004 Retrieved from the Internet: <URL: http://docs.real.com/docs/ccguide_rv10.pdf > 'retrieved on 2000-10-13! page 99, line 7 -page 101, line 18 --- -/--	1-27

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"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.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 October 2000	02/11/2000

Name and mailing address of the ISA	Authorized officer
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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/US 00/15408

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	REALNETWORKS INC.: "Realproducer Pro User's Guide Version G2" 'Online! 2 February 1999 (1999-02-02) XP002150043 Retrieved from the Internet: <URL: http://docs.real.com/docs/prodprouserguide 2.pdf> 'retrieved on 2000-10-13! page 37, line 3 -page 40, line 11 ---	1-27
A	US 5 768 535 A (NORTHCUTT J DUANE ET AL) 16 June 1998 (1998-06-16) ---	
A	US 5 481 275 A (KHUBCHANDANI TEJU J ET AL) 2 January 1996 (1996-01-02) ---	
A	WO 98 35468 A (SLOTZNICK BENJAMIN) 13 August 1998 (1998-08-13) -----	

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information on patent family members

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PCT/US 00/15408

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		JP 9163362 A	20-06-1997
US 5481275 A	02-01-1996	NONE	
WO 9835468 A	13-08-1998	AU 6037198 A	26-08-1998
		EP 1016021 A	05-07-2000
		US 6011537 A	04-01-2000