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<p>(21) International Application Number: PCT/SE99/01581</p> <p>(22) International Filing Date: 10 September 1999 (10.09.99)</p> <p>(30) Priority Data:</p> <table border="0"> <tr> <td>60/099,951</td> <td>11 September 1998 (11.09.98)</td> <td>US</td> </tr> <tr> <td>09/326,410</td> <td>4 June 1999 (04.06.99)</td> <td>US</td> </tr> </table> <p>(71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE).</p> <p>(72) Inventors: GOMEZ, Peter; Kindstugatan 11 A, S-111 31 Stockholm (SE). LINDAHL, Göthe; Brunnsvägen 15, S-905 94 Umeå (SE).</p> <p>(74) Agent: ERICSSON RADIO SYSTEMS AB; Patent Support/Ericsson Research, S-164 80 Stockholm (SE).</p>		60/099,951	11 September 1998 (11.09.98)	US	09/326,410	4 June 1999 (04.06.99)	US	<p>(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, 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, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published</p> <p><i>Without international search report and to be republished upon receipt of that report.</i></p>	
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09/326,410	4 June 1999 (04.06.99)	US							
<p>(54) Title: AUTOMATED CONVERSION OF A VISUAL PRESENTATION INTO DIGITAL DATA FORMAT</p>									
<p>(57) Abstract</p>									
<p>A full multimedia production such as a seminar, conference, lecture, etc. can be captured in real time using multiple cameras (11, 13). A live movie of a speaker together with the speaker's flipping still images or slide show can be viewed interactively within the same video display screen (31-46). The complete production can be stored on a hard drive (17) for retrieval on demand, or sent live to a host server for live distribution throughout a data network. It is also possible to store the complete presentation on portable storage media, and/or to send it as an e-mail.</p>									

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AUTOMATED CONVERSION OF A VISUAL PRESENTATION INTO DIGITAL DATA FORMAT

5 This application claims the priority under 35 USC 119(e)(1) of copending U.S. Provisional Application No. 60/099,951, filed on September 11, 1998.

FIELD OF THE INVENTION

10 The invention relates generally to streaming video through a data network and, more particularly, to integrating still images into a stream of live, moving images.

BACKGROUND OF THE INVENTION

15 Many companies and education institutes have tried to use the Internet for distributing documentation of seminars, meetings, lectures, etc. including video. Those who have tried know that one problem is the cost for the video post-production, and that it is impossible to be able to send the material on the Internet when it is fresh and has high actuality. One day of normal video production of a seminar may cost \$25,000 - \$37,500. The production is typically accessible on the Internet from one week to fourteen days after the event. Experts are typically engaged that know about 20 filming, digitization and encoding. An expert in creating Web pages is also usually needed.

 A first problem in producing multimedia for the Internet is the large amount of tools a user has to manage. A second big issue is that it is time consuming. One hour of video takes about one hour to encode. A third problem is that if the user wants 25 to have synchronized flipping images (from e.g., an overhead-projector etc.) there is a lot of work finding the synchronization points and creating the control files. A fourth problem is that the use of several cameras requires several camera operators.

 Around the presentation or seminar there has to be at least one camera operator and often one person responsible for the sound and taking still pictures, with a digital 30 still picture camera, of drawings at, for example, a whiteboard, notepad or overhead. A stopwatch is used to keep records of all still pictures when they are presented,

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because it is not always possible to figure out, from after-the-fact viewing of the movie of the speaker, what pictures to show as JPEG. Powerpoint slideshows etc., and other computer-based presentations are often sent as e-mail the day after the presentation, for conversion to JPEG or other suitable format by the production staff. It is, of course, possible to take stills at the same time as the pictures are presented, which is done when external presenters hold presentations.

The Powerpoint slides, when they arrive by e-mail, are (as mentioned above) converted to JPEG by the streaming production staff. The slides are also resized to fit in an HTML page together with the video window.

The production of streaming videos for 28.8K, 56K and 100K bit rates needs an extra window for the real information shown on slides, etc., because the video window is very small and the information in it is unreadable.

The video film is often manually edited with software like Adobe Premier. After editing, if any, the encoder is used to compress the video and audio to the correct baud-rate and encode them to a streaming format like ASF (Active Streaming Format) or RMFF (Real Media File Format). The encoding takes the same amount of time as it takes to run through the movie. This is time consuming.

To be able to show the JPEG images (e.g. slide show) at the right time (compared to the movie events), synchronization points (time stamps) must be inserted in the stream file. In both Real Networks products and in Microsoft Netshow there are utilities available to do this. This typically requires an expert, even though the aforementioned tools have good user interfaces.

After all this has been accomplished, it is time to create HTML pages and frames. There has to be an HTML page for each picture.

It is therefore desirable in view of the foregoing to provide for distributing a visual presentation using Internet or another data network, without the aforementioned disadvantages of the prior art.

The present invention offers the ability to capture a full multimedia production such as a seminar, conference, lecture, etc. in real time using multiple cameras. A live movie of the speaker together with the speaker's flipping still images or slide show can be viewed interactively within the same video display screen. The complete

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production can be stored on a hard drive or sent live to a host server. The information can be retrieved on demand or distributed live throughout a data network such as the Internet or corporate Intranet. It is also possible to store the complete presentation on CD or other portable storage media, and/or to send it as an e-mail to a PC.

5 According to the invention, the tools are handled automatically in the background, shielded from the user, and the encoding is done in real-time. The synchronization points are set when the event is really happening. In one example, overhead-projector plastic slides, computer VGA-graphics, whiteboard drawings, etc. are captured and converted to JPEG, and the video encoding is done in MPEG and
10 stored together with the sound and synchronization points in an ASF file for RTSP (Real Time Streaming Protocol; see RFC 2326 published by IETF (www.IETF.org)) streaming.

BRIEF DESCRIPTION OF THE DRAWINGS

15 FIGURE 1 illustrates one example system according to the invention for automated conversion of a visual presentation into digital data format. FIGURE 2 diagrammatically illustrates an exemplary embodiment of the system of Figure 1.

 FIGURE 3 illustrates in flow diagram format exemplary operations of the synchronizing section of Figure 1.

20 FIGURE 4 illustrates in flow diagram format exemplary operations of the broadcast server of FIGURE 1 or the web server of FIGURE 2.

 FIGURE 5 illustrates pertinent portions of an exemplary embodiment of the still image controller of FIGURE 2.

25 FIGURE 6 illustrates pertinent portions of an exemplary embodiment of the still image grabber and converter of FIGURE 2.

 FIGURE 7 illustrates an exemplary embodiment of the difference determiner of FIGURE 6.

 FIGURE 8 illustrates exemplary operations which can be performed by the exemplary still image controller embodiment of FIGURE 5.

30 FIGURE 9 illustrates exemplary operations which can performed by the exemplary still image grabber and converter embodiment of FIGURE 6.

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FIGURE 10 illustrates an arrangement for implementing camera preset control techniques according to the present invention.

FIGURE 11 illustrates exemplary operations which can be performed by the arrangement of FIGURE 10.

5 FIGURE 12 illustrates one example of an interactive visual display provided by a graphical user interface according to the invention.

FIGURE 13 illustrates exemplary operations performed by the exemplary audio control for feeding the exemplary audio level graph display and handling of activation of input source.

10 FIGURES 14A-14C illustrate exemplary operations performed by the exemplary audio level graph display handling the GUI for audio level feedback and activation/launching of the standard mixer system installed in the operating system.

FIGURE 15 illustrates diagrammatically an exemplary modification of the system of FIGURE 2.

15 FIGURE 16 illustrates diagrammatically a further exemplary modification of the system of FIGURE 2.

FIGURE 17 illustrates diagrammatically a further exemplary modification of the system of FIGURE 2.

20 FIGURE 18 illustrates diagrammatically a further exemplary modification of the system of FIGURE 2.

DETAILED DESCRIPTION

As shown in FIGURE 1, an exemplary system according to the invention for automated conversion of a visual presentation into digital data format includes video
25 cameras 11 and 13, a microphone 12, an optional lap top computer 10, and a digital field producer unit 14, also referred to herein as DFP unit or DFP computer. One of the video cameras 13 covers the speaker and provides video information to the live video section, and the other video camera 11 covers the slide show, flip chart, white board, etc. and provides the corresponding video information to the still video section.
30 The microphone provides the audio to the sound section. In the example DFP unit of FIGURE 1, the live video is encoded (e.g., in MPEG) in real time during the speaker's

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visual presentation, and the still video of the slide show etc. is converted into JPEG files in real time during the presentation.

5 A synchronizing section 16 of FIGURE 1 operates automatically during the speaker's presentation to synchronize the still video information from the slide show, flip chart etc. with the live video information from the speaker. Both the live video and the still video can then be streamed live through a server to multiple individual users via a data network such as, for example, the Internet, a LAN, or a data network including a wireless link.

10 Alternatively, the live video and still video can be stored in storage unit 17 (e.g. hard disk), for a later replay broadcast via the server and data network. Also, the information in the storage unit 17 can be transferred to portable storage media such as floppy disks or CDS, for local replay by individual users later. The stored information can also be sent to a viewer as an e-mail.

15 A graphical user interface GUI permits a user to control operations of the FIGURE 1 system using a monitor and input apparatus (e.g., a keyboard, mouse, touch screen, etc.) suitably coupled to the GUI.

The encoding, converting and synchronizing portions of FIGURE 1, and the GUI, can be implemented using one (or more) suitably programmed data processor(s), as will be evident from the following description.

20 FIGURE 2 is a detailed block diagram of an exemplary embodiment of the system of FIGURE 1. A video grabber card 23 receives as an input a video signal from the still image camera 11, and converts this video signal into digital video data which is in turn output to the still image grabber and converter 21. Similarly, a video grabber card 20 receives as input a video signal from the live video camera 13, and produces therefrom corresponding digital video data which is in turn output to the encoder and streamer 27. The video grabber card 23 also includes a port for receiving VGA data output from the laptop computer 10. Video grabber cards such as 20 and 23 are well known in the art.

25 The audio input and audio output sections can be realized, for example, by a conventional audio card such as a SOUNDBLASTER PCI card. The audio input section receives as input an audio signal from the microphone 12, and outputs a

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corresponding audio signal to the encoder and streamer 27. The audio output section also receives the audio signal output from the audio input section, and provides this signal to speaker, for example, an audio headset, so an operator can monitor the recorded sound quality.

5 The graphical user interface GUI includes a camera control section 29 that permits a user to control the cameras 11 and 13 via a conventional serial card 31. The serial card 31 also couples a user command input device, for example a touch screen as shown in FIGURE 2, to the graphical user interface GUI.

10 The digital video data output from video grabber card 20 is also input to a live image display portion of the graphical interface GUI. The live image display portion of the GUI causes the direct digital video data obtained from the live image camera 13 to be displayed to a user on a monitor such as the flat XVGA monitor illustrated in FIGURE 2. A conventional video card 24 coupled between the GUI and the monitor can suitably interface the digital video data from the live image display section to the
15 monitor.

 The GUI also includes a still image display portion coupled to the output of video grabber card 23 in order to receive therefrom the digital video data associated with the still video camera 11. The still image display section of the GUI uses the video card 24 to cause the digital video data associated with still image camera 11 to
20 be displayed to the user via the monitor.

 A DFP application section 19 (e.g., a software application running on the DFP computer 14) includes a still image grabber and converter portion 21 which receives as input the digital still video data from video grabber card 23, and produces therefrom, as an output, image data files such as JPEG or GIF files. Taking JPEG files
25 as an example output, each JPEG file produced by the still image grabber and converter portion 21 represents a freezing of the digital video data received from video grabber card 23 in order to produce at a desired point in time a still image associated with the video being recorded by the still video camera 11. The GUI includes a still image control section 25 having an output coupled to the still image grabber and
30 converter 21. The still image control portion 25 applies an appropriate control signal to the still image grabber and converter 21 when the still image grabber and converter

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21 is to "grab" (capture) the next still image and create the corresponding JPEG file. The serial card 31 connecting the user command input (e.g., the touch screen) to the GUI permits a user to access the still image control section 25, and thereby control the still image "grabbing" operation of the still image grabber and converter 21.

5 The DFP application section further includes an encoder and streamer module 27 which receives the digital video output from video grabber card 20, and continuously encodes and compresses this data into a digitally transferrable stream with low bandwidth. The corresponding audio information from the audio input section is also encoded and compressed into the digitally transferrable stream. The
10 encoding process is also conventionally referred to as streaming or streaming video. Encoding modules such as shown at 27 are conventionally known in the art. One example is the NetShow encoder and streamer conventionally available from Microsoft. In one example, the video encoding can be done in MPEG. The encoder and streamer module 27 can assemble the encoded video data in a document file, for
15 example an ASF file.

 The ASF file can be output from the encoder and streamer module 27 for live streaming out of the DFP unit 14, and also for storage at 171 in the storage unit 17. The encoder and streamer module 27 also encodes the digitized audio signal received from the audio input section. The encoded video information is also output from the
20 encoder and streamer module 27 to a streamed image display portion of the GUI, whereby the streaming video can be displayed on the monitor via the video card 24. The encoder and streamer module 27 receives a control input from an encoder control portion of the GUI. The encoder control portion permits a user, via the user command input and serial card 31, to control starting and stopping of the encoding process. In
25 addition, the encoder control provides a recording counter which tracks the passage of time during the encoding of the video event.

 The still image control section 25 in the GUI of FIGURE 2 controls the still image grabber and converter 21, which receives an input from video grabber card 23. Video grabber card 23 interfaces with the still image camera 11 which is used to
30 record the slide show, flip chart etc. The still image grabber and converter 21 can create, for example, JPEG files as an output.

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The still image control 25 can be automated according to the invention to cause the still image grabber and converter 21 to periodically create a JPEG image of the still video source, give the JPEG image file a unique name based on the current system time, and store the file at 173. One example file name is hhhmmss.jpg where hh is the current hour, mm is the current minute and ss is the current second. Along with the creation of the JPEG file, a corresponding wrapping HTML (Hyper Text Markup Language) file is created by an HTML & URL generator 26 and stored at 172 in the data storage unit 17. In one example, the HTML file can be created by copying a template from a template directory, and inserting the aforementioned file name hhhmmss in a name field of the template.

The HTML file name, hhhmmss.htm, is then sent as a relative URL (Uniform Resource Locator) from generator 26 to the encoder and streamer 27 for inclusion, at time stamp hhhmmss, in the encoded streaming video data (e.g., in an ASF file) output by the encoder and streamer 27. This synchronizes the still video information from the slide show with the "live" video information from the speaker. In addition, other files can be synchronized to the "live" video, such as sound, VRML, JAVA script, text files, voice-to-text files and files containing translations of voice-to-text files into other languages.

Conventional encoder and streamer products, such as the aforementioned NetShow product, provide functionality for passing URLs to the encoder for inclusion in the encoded streaming video data output. For example, the "SendScript" function in NetShow provides this functionality. SendScript can insert the URL into the ASF file if the URL is provided in the form of a Script Command Object, which can be easily done by workers in this art. The NetShow encoder can then insert the Script Command Object (i.e., the URL) at the desired time stamp, hhhmmss.

FIGURE 3 illustrates the above-described exemplary operations which can be performed, for example, by the components 21, 26 and 27 of FIGURE 2 to implement the synchronizing function 16 illustrated diagrammatically in FIGURE 1. At 31, the still image grabber and converter 21 creates a JPEG image file from a still video picture that has been grabbed from the still image camera. At 32, the JPEG file is given a unique name (e.g., hhhmmss.jpg) based on the system time at which the picture

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was grabbed, (available, for example, from the recording counter in the encoder control portion of GUI), and the JPEG file is stored. At 33, the HTML & URL generator 26 uses the received JPEG file to create a corresponding wrapping HTML file. At 34, the generator 26 names the HTML file (e.g., hhhmss.htm) based on the
5 system time at which the picture was grabbed, which can be provided by grabber/converter 21 to generator 26 along with the JPEG file. At 35, the generator 26 sends the HTML file name to the encoder 27 as a relative URL. At 36, the encoder and streamer 27 receives the URL, and includes the URL in its output ASF file at the time stamp corresponding to the system time on which the HTML file name was
10 based.

In the example of FIGURE 2, the streaming video output (e.g., an ASF file) provided by the encoder and streamer 27 is input to a web server, which can forward the streaming video output to a desired destination (e.g., a viewer's web browser) via a suitable data network, thereby providing a live broadcast of the event. The web
15 server can also add the appropriate server name and directory name to the relative URL (which typically does not include such information). The web server also is coupled to the storage section 17 to receive the JPEG documents, HTML documents and ASF files stored therein.

The web server is coupled to a network card that gives the web server access
20 to a data network, for example a local area network (LAN) or the Internet. In one embodiment, the network card can be an Ethernet network (PCI) card, which can handle TCP/IP and UUCP traffic in conventional fashion.

In another embodiment, a modem can be utilized by the web server to access the data network.

25 FIGURE 2 illustrates a web browser coupled to the web server via the data network and the network card. Examples of suitable web browsers include conventional Netscape and Internet Explorer browsers. During a live video streaming broadcast, a viewer can connect to the web server via the world wide web by typing a URL into the viewer's web browser (note that the web browser could also be
30 provided as part of the DFP unit itself). The live video stream is distributed over the web, with the "live" video synchronized to the still images from the still image camera.

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Both the live video stream and the still video image can be shown on the same web page.

After an event (for example a seminar) has been recorded, a viewer can replay the video recording by performing a similar web connection as in the above-described live broadcast case. A URL is typed into the viewer's web browser, which connects the viewer to the web server in the DFP computer. The web server will then stream out the recorded video information the same as it would be streamed during the live streaming broadcast. The still video images are synchronized as in the live case, and they change in the output video stream at the same relative time as they did during the actual event. The viewer can decide when to start (or restart) the video stream in order to view the event as desired, and can navigate to a particular part of the recorded event, for example, by using a slider control provided by the web browser.

A viewer also has the option of viewing the event locally from a disk or CD-ROM. All that is needed to view an event recorded on disk or CD-ROM is a web browser with a conventional video streaming plug-in such as supported by Internet Explorer.

The web browser preferably includes an ASF player, executing as a plug-in or an ActiveX control, that processes the ASF file and presents the audio/video to the viewer. When the player, for example a conventional multimedia player such as Microsoft Windows Media Player, encounters a Script Command Object in the ASF file, it interprets and executes Script Command Object. When the player identifies the Script Command Object as a URL, it passes the URL to the browser. The browser executes the URL as if it had been embedded inside an HTML document. According to one embodiment, the URL points to HTML document hmmmss.htm, which in turn contains a pointer to the corresponding JPEG document hmmmss.jpg.

If the Windows Media Player control is embedded in an HTML file that uses frames, the URL can be launched in a frame that is also specified by the Script Command Object. This allows the Windows Media Player control to continue rendering the multimedia stream in one frame, while the browser renders still images or Web pages in another frame. If the Script Command Object does not specify a frame, then the URL can be launched in a default frame.

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FIGURE 4 illustrates exemplary operations of the web browser and web server of FIGURE 2. The operations of FIGURE 4 are advantageously executed during the web browser's processing of the ASF file. When a URL is detected (for example in the form of a Script Command Object) at 41 by the ASF player, the web browser at 5 43 interprets the URL for server destination and protocol to use (e.g., HTTP), connects to the web server and sends the web server a request for the HTML document. At 44, the web server accesses the HTML document from storage 172 and extracts therefrom the JPEG file name. At 45, the web server retrieves the JPEG file from storage 173 and sends it to the browser. At 46, the browser displays the JPEG image at the 10 appropriate time with respect to the video streaming presentation.

During replay broadcasts, the web server retrieves and forwards the stored ASF file (containing the encoded/compressed "live" video data) from storage at 171, and also accesses the stored HTML documents, and retrieves and forwards the stored JPEG documents, generally as described above with respect to live streaming operation. The 15 web browser receives the ASF file and JPEG documents, and synchronously integrates the "still" video images into the "live" video stream using generally the same procedure discussed above with respect to live streaming operation.

As mentioned above, still image control portion 25 of the GUI can, either in response to user input or automatically, direct the still image grabber and converter 20 portion 21 to grab a still image and convert it into JPEG format. FIGURE 5 illustrates pertinent portions of an exemplary embodiment of the still image controller 25. The exemplary arrangement of FIGURE 5 permits the still image grabber and converter 21 (see FIGURE 2) to be controlled either by user input (i.e., manually) or automatically. A selector 51 receives a user (manual) input from a grab still button which is provided 25 in the user command input portion (e.g., the touch screen) and can be actuated by a user whenever the user desires to grab a still picture from the still image camera. The selector 51 has another input connected to an output 57 of a delay timer 52. The selector 51 is controlled by a manual/automatic signal which can be preset from the user command input into the settings & wizards section 22 of the GUI. When the 30 manual/automatic signal indicates manual operation, the selector 51 connects the grab still button input to its output 55, and when the manual/automatic signal indicates

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automatic operation, the selector 51 connects the output 57 of timer 52 to selector output 55. The selector output 55 is coupled to the still image grabber and converter 21, and provides thereto a grab still signal. The manual/automatic signal is also coupled at 54 to the still image grabber and converter 21.

5 A delay calculator 53 calculates a delay value which is preloaded at 58 from the delay calculator 53 into the timer 52. The delay calculator 53 calculates the desired delay value as a function of the bit rate used in the live video streaming operation and the size of the JPEG file created by the still image grabber and converter 21 in response to the grab still signal at 55. The JPEG file size information from the still
10 image grabber and converter 21 is provided at 56 to the delay calculator 53.

FIGURE 6 illustrates pertinent portions of an exemplary embodiment of the still image grabber and converter 21 of FIGURE 2, particularly those portions which interface with the exemplary still image controller embodiment of FIGURE 5. A still image grab/convert portion 61 receives the output of video grabber card 23 and,
15 responsive to activation of the grab still signal from the still image controller, grabs a picture, converts it into JPEG format, and notes the current time (e.g., from the counter in the encoder control portion of GUI). A file creator portion 62 receives the JPEG data and current time information (indicative of the time that the picture was grabbed) from the still image grab/convert portion 61, and creates a JPEG file in
20 response to a create file input 68. When the file creator portion 62 creates a JPEG file, it outputs the file size information to the delay calculator 53 of FIGURE 5.

The still image grab/convert portion 61 provides the pixel data received from the video grabber card 23 to a data storage section at 65 and 66. Each time a still image is grabbed, the pixel data is provided to a current picture storage section 65
25 whose previous contents are then loaded into a last picture storage section 66. In this manner, the pixel data associated with the current still image and the most recently grabbed previous still image (i.e., the last still image) are respectively stored in the data storage sections 65 and 66. A difference determiner receives the current and last picture data from the storage sections 65 and 66, and determines a difference measure,
30 if any, between the current still image and the last still image. If the difference determiner determines that a difference exists between the two still images, then

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information indicative of this difference is provided to a threshold portion 64, which compares the difference to a threshold value to determine whether the images differ enough to warrant creation of a new JPEG file corresponding to the current image. If the difference information received from difference determiner 63 exceeds the threshold of threshold portion 64, then the output 69 of threshold portion 64 is activated, whereby the create file signal 68 is activated by operation of an OR gate 60 that receives the threshold output 69 as an input. The OR gate 60 also receives as an input the manual/automatic signal from FIGURE 5, whereby the file creator 62 can be directed to create a JPEG file either by activation of the threshold portion output 69 or by a "manual" indication from the manual/automatic signal.

FIGURE 7 illustrates one exemplary embodiment of the difference determiner 63 of FIGURE 6. In the example of FIGURE 7, the pixel data corresponding to the current image is applied to a first exclusive OR circuit 71 and the pixel data corresponding to the last image is applied to a second exclusive-OR circuit 72. Each exclusive-OR circuit exclusive-ORs all of the received pixels together. The outputs of the exclusive-OR circuits 71 and 72 are input to a compare circuit 73 which compares the two exclusive-OR outputs. The difference measure output from the compare circuit 73 can then be applied to the threshold portion 64 of FIGURE 6.

FIGURE 8 illustrates exemplary operations of the exemplary still image controller arrangement of FIGURE 5, and FIGURE 9 illustrates exemplary operations of the still image grabber and converter arrangement illustrated in FIGURES 6 and 7.

Referring first to FIGURE 8, the output of the delay timer 52 is activated at 86, and it is thereafter determined at 80 whether the manual/automatic signal indicates manual or automatic operation. If manual operation is indicated, then at 81 the selector 51 of FIGURE 5 couples the grab still button to the grab still input of the still image grabber and converter 21, thereby enabling manual control of the grab still function. If automatic operation is indicated at 80, then at 82 the selector 51 couples the output of delay timer 52 to the grab still input of the still image grabber and converter 21, thereby enabling automatic control of the grab still function. At 83, the delay calculator 53 awaits JPEG file size information from the still image grabber and converter. When the JPEG file size information has been received at 83, the delay

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calculator at 84 computes a delay value, for example, by dividing the JPEG file size by the streaming video bit rate, and loads the computed delay value into the timer.

In response to being loaded with the delay value, the timer de-activates its output at 85, and the timer output remains de-activated until the timer expires at 87, whereupon the timer activates its output again at 86. Thereafter, the above-described procedures can be repeated.

FIGURE 9 illustrates exemplary operations of the still image grabber and converter arrangement of FIGURE 6. It is first determined at 91 whether the grab still input of still image grab/convert portion 61 is activated. When the grab still signal is activated, a picture is grabbed and converted into JPEG format at 92. At 93, if the manual/automatic signal indicates "manual" operation, then the file creator portion 62 creates a JPEG file at 94. Thereafter the grab still signal is again monitored at 91.

If the manual/automatic signal indicates "automatic" operation at 93, then at 95 the difference determiner 63 compares the last image to the current image. If the last image does not differ from the current image at 96, then the grab still signal is monitored at 91. If the images differ at 96, then the difference measure is compared to a threshold value TH at 97. If the difference measure does not exceed the threshold value at 97, then the grab still signal is monitored at 91. If the difference measure exceeds the threshold at 97, then the file creator portion 62 creates a JPEG file at 98.

After the JPEG file has been created at 98, information indicative of the size of the JPEG file is provided at 99 to the delay calculator 53 of FIGURE 5. Thereafter, the grab still signal is monitored at 91.

Considering FIGURES 5, 6, 8 and 9 together, it can be seen that, whenever a new JPEG file is created (see 98 of FIGURE 9), the JPEG file size information is provided to the delay calculator 53 (see 99 of FIGURE 9 and 83 of FIGURE 8). The delay calculator computes the delay value and loads it into the delay timer 52 (see 84 of FIGURE 8), in response to which the delay timer 52 deactivates its output until the delay time has expired (see 85-87 of FIGURE 8). This ensures that automatic activation of the grab still signal 55 does not occur so often that the viewer's facilities are overloaded with JPEG pictures.

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It should be noted that the DFP computer of FIGURES 1 and 2 can be located remotely from the cameras/microphone and/or the touch screen monitor, and linked to the remote component(s) by a suitable conventional communication link which can include, for example, a wireless communication link.

5 Conventional compression algorithms (like MPEG) used in video streaming are typically based on the fact that not everything in a video picture has changed, and such algorithms therefore try to transmit only changes in the picture. This can be readily done if the camera position changes very little. However, in a live visual presentation, changes in camera position are typically quite desirable because, if the
10 camera position is not substantially changed during the entire visual presentation, it may not be possible to capture all visible events, and the production may look very dull afterwards. Accordingly, the present invention also utilizes camera presets to simplify the video encoding when changes in camera position occur.

 When the encoder 27 of FIGURE 2 is operating, the user can select a preset
15 camera position using the camera control section 29, and the serial card 31 (for example RS-232), which controls the camera to move toward the desired position. However, rather than processing all video information taken in by the camera during movement to the desired position, the system of FIGURE 2 accesses, from the settings and wizards block 22, predetermined video information which represents the visual
20 appearance expected to be presented to the video camera when the video camera reaches the preset position. Thus, the present invention eliminates the need for processing a large amount of video information while the camera is moving to the desired position. FIGURE 10 illustrates an exemplary implementation of the above-described use of predetermined video information corresponding to preset
25 camera positions. In FIGURE 10, the camera controller 29 (see FIGURE 2) receives from the user command input a preset selection command to move the live video camera to a preset position. At 106, the camera controller 29 applies preset information from the preset selection command to a data storage portion 105 in the settings and wizards section 22 of the GUI. In the data storage portion 105, the
30 various preset camera positions and corresponding video information are indexed against various preset indices, one of which is received from the user in each preset

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selection command. For example, the camera position information, position1, and the video information, video1, correspond to the preset index, preset1. The camera position information may also advantageously include other preset camera control information, for example, brightness, contrast, etc.

5 In response to the preset index received at 106 from camera controller 29, the data storage section 105 outputs (at 108) the corresponding camera position information to the camera controller 29, and also outputs (at 107) the corresponding video information to an input of a selector 101 whose other input is coupled (at 104) to receive video information from the video grabber card 20 (or 23).

10 In response to receiving the camera position information from the data storage section 105, the camera controller 29 can output a control signal at 102 to cause the selector 101 to couple the video information at 107 from data storage section 105 to an output 103 of selector 101, which output 103 is coupled to the encoder 27 (or still image grabber and converter 21). Also in response to receiving the camera position
15 information from data storage section 105, the camera controller 29 outputs suitable camera control signals to move the selected camera to the desired preset position. When the camera reaches the preset position, camera controller 29 can use control signal 102 to couple selector input 104 to selector output 103.

20 To account for multiple possible input video sources, such as camera 11 and computer 10 available via video grabber card 23, and camera 13 available via video grabber card 20, the preset selection command provided by the user can indicate a selected input video source. This selected input information can then be applied to the data storage portion 105 as part of the preset information, so that presets associated with the selected input source can be accessed.

25 FIGURE 11 illustrates exemplary operations of the arrangement of FIGURE 10. At 110, the user stores the desired camera preset information, including the preset indices (e.g., preset1, preset2, etc.) and the corresponding camera position and video information, using the user command input and the monitor. When the selected camera has been moved, via camera control 29, to the desired position (as interactively
30 visually monitored by the user), the preset index and corresponding camera position information (from camera control 29) and video information (from the video card 20)

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are stored in the data storage section 105. An example procedure for establishing and storing camera presets is described in more detail below relative to the graphical user interface GUI.

After the preset indices, camera position information and video information
5 have been stored at 110, the camera controller 29 awaits at 112 a preset selection command from the user. When a preset command is received at 112, the corresponding video information and camera position information is retrieved at 113. At 114, the video information is applied to the encoder, and the camera controller 29 outputs appropriate control signals to move the live camera to the desired preset
10 position. Thereafter, the next preset selection command is awaited at 112.

FIGURE 13 illustrates how the audio control 250 of FIGURE 2 monitors the audio VU level and triggers signals to the graphical display of a VU meter 251 shown in FIGURE 2. The audio level is compared against a range-parameter (252 and 254) and a signal is generated when a change is discovered (253). Referring also to
15 FIGURES 14A-14C, the graphical display computes the amount of blocks to display and changes the colors of the blocks that exceed a certain limit (see 270 and 271 in FIGURE 14A). This kind of display is quite common on audio devices like stereo players, etc. and should be well known and understood by any user. The user has the possibility to access a standard system mixer from the GUI (see 259 in FIGURE 14B)
20 in order to reduce or raise the volume, etc. FIGURE 14C shows at 255-258 how a user can select and change the input audio source via the GUI.

FIGURE 12 illustrates how the graphical user interface GUI can be used in combination with, for example, a touch screen (or a display/mouse combination) to control various aspects of the process of recording an event such as a seminar.
25 FIGURE 12 shows outlines of various images presented to the user via the touch screen or other display, which images correspond to various control functions provided by the GUI. Thus, the exemplary control operations described below can be performed by a user via the touch screen (or a display/mouse combination) and the GUI.

In the process of presetting the cameras, a camera control switch 10 is first
30 used to activate either the live video camera 13 or the still video camera 11. Camera translation control at 8 and camera zoom control at 9 can then be touched (or clicked)

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as desired to aim and zoom the activated camera. The view that results from the aiming and zooming of the activated camera can be observed at either the preview portion 3 (for the live camera) or the preview portion 5 (for the still camera). When the resulting view is satisfactory, the corresponding camera position can be chosen as a preset camera position, by pressing either button 11 (for the live camera) or button 12 (for the still camera).

The views corresponding to six different camera presets can be displayed at 1 (live camera presets), and 2 (still camera presets). Any of the presets can be selected for the corresponding camera by pressing the desired view at 1 or 2.

The desired audio level can be set using the sound control button 13.

The video streaming process can be started by pressing a start button provided in an encoder control portion 4. The streamed image can be displayed at 3. Encoder control portion 4 also provides a running counter/clock which indicates to the user the amount of time that has elapsed during the encoding session.

A picture from the still image camera can be grabbed by pressing the grab still button 6. The latest picture grabbed from the still image camera is displayed at 7.

Because the preview portion 3 associated with the live camera 13 is not capable of displaying both the actual live image from the camera and the streamed image output from the encoder 27 (the streamed image being delayed several seconds behind the actual live image), an external monitor 200 (see FIGURE 2) is provided so that a view of the actual live image from camera 13 is available at all times.

FIGURE 15 diagrammatically illustrates an exemplary modification of the system of FIGURE 2, wherein a wireless link couples the DFP computer 14 to the video cameras 11 and 13 and the audio source 12. In this example, the video cameras 11 and 13, and the audio source 12 are coupled at 151 to a radio transceiver 153 located remotely from the computer 14 of FIGURE 2. The radio transceiver 153 can use conventional techniques to transmit the received video and audio signals across a radio link 154 to a further radio transceiver 155. The radio transceiver 155 can use conventional techniques to output the video and audio signals, at 151A, to the video grabber cards 20 and 23 and the audio input of the computer 14. In this example, the computer 14 can otherwise operate generally in same manner as described above.

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The radio transceiver 155, which can be co-sited with the computer 14, receives camera control signals at 152. The camera control signals are provided by the camera control section 29 via the serial card of FIGURE 2, generally as described above. The radio transceiver 155 can use conventional techniques to transmit the camera control signals across the radio link 154 to the radio transceiver 153. At 152A, the radio transceiver 153 outputs the camera control signals to the cameras 11 and 13 for controlling the cameras in generally the same manner as described above with respect to FIGURE 2.

The radio transceivers 153 and 155, and the corresponding radio link 154 can be provided as an analog FM radio network (for example at around 2.500 MHz frequency) for radio transmissions of shorter distances, such as within a room or lecture hall. With the illustrated connection of the cameras and the audio source to the radio transceiver 153, the video (together with audio) can be transmitted to the computer 14 in full motion.

FIGURE 16 diagrammatically illustrates another exemplary modification of the system of FIGURE 2, wherein the video and audio signals are encoded remotely from the encoder and streamer 27 and the still image grabber and converter 21, and the encoded information is transmitted across a wireless communication link. Also in the example of FIGURE 16, the wireless communication link is used to provide user camera control inputs and preset selections to the arrangement of FIGURE 10. In FIGURE 16, video information from the video grabber cards 20 and 23 is encoded using respective MPEG encoders whose outputs 162 and 163 are coupled to a radio transceiver 165. Also in FIGURE 16, the audio input of FIGURE 2 is shown coupled to an audio encoder whose output 161 is coupled to the radio transceiver 165.

The radio transceiver 165 can use conventional techniques to transmit the encoded audio and video data across a radio link 167 to a further radio transceiver 166 which uses conventional techniques to output the encoded audio data, encoded live video data and encoded still video data respectively at outputs 161A, 162A and 163A. The encoded audio and live video data at 161A and 162A can be provided directly to the encoder and streamer 27 of FIGURE 2, to be assembled into an ASF file. The encoded still video information at 163A is applied to an I-frame extractor 168, which

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extracts the MPEG I-frames from the encoded still video information. The extracted I-frames are provided to the still image grabber and converter 21 of FIGURE 2. The still image grabber and converter 21 can operate generally in the same manner described above with respect to FIGURE 2, such that JPEG files are derived from the extracted I-frames.

Also in FIGURE 16, the camera control inputs and preset selections from the user (see FIGURE 10) are input to the radio transceiver 166, for transmission across the radio link 167 to the radio transceiver 165. At 164, the radio transceiver 165 provides the camera control inputs and preset selections to the camera control section 29 in the same general fashion as illustrated in FIGURE 10. In response to the inputs at 164, the camera control section 29 interfaces with the multiplexer 101 and data storage portion 105 of FIGURE 10 generally as described above, and also interfaces with the cameras 11 and 13 via the serial card, also generally as described above. As to the interfacing of the camera control section 29 with the multiplexer 101 and data storage portion 105 of FIGURE 10, this is further illustrated in FIGURE 16 at the inputs to the MPEG encoders, which inputs can be driven by either the associated video grabber card (20 or 23) or by the data storage portion 105, as shown parenthetically at the MPEG encoder inputs.

As seen from FIGURES 2 and 16, the wireless communication link at 165-167 couples the audio and live video encoding functionality of the encoder and streamer 27 to the ASF file assembly functionality of the encoder and streamer 27. Examples of the wireless communication link at 165-167 include a wireless LAN (for example, up to 10 megabits/second), or digital Bluetooth technology (for example up to 2 megabits/second) commercially available from Telefonaktiebolaget L/M Ericsson publ. Using the aforementioned technologies, the wireless link can cover up to a few kilometers. If the wireless communication link is provided according to third generation mobile telephone and communication systems within UMTS, having a speed of up to 2 megabits/second, then the range of the communication link 165-167 can be extended as far as desired.

FIGURE 17 diagrammatically illustrates another example modification of the system of FIGURE 2, wherein GSM (Global System for Mobile Communications)

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radio techniques are used to transmit still video and audio information, but live video is not transmitted. In this example, the audio input of FIGURE 2 is coupled to an audio encoder whose output 171 is coupled to a radio transceiver (for example a GSM radio transceiver) 174. The still image grabber and converter 21 of FIGURE 2 is also
5 coupled at 172 to the radio transceiver 174. The radio transceiver 174 uses conventional GSM techniques to transmit the encoded audio and the JPEG files (received at 172 from still image grabber and converter 21) across a GSM radio link 175 to a further GSM radio transceiver 176. The radio transceiver 176 uses conventional GSM techniques to provide the encoded audio to the encoder and
10 streamer 27 (to be assembled into an ASF file) at 171A, and to provide the JPEG files to the HTML and URL generator 26 at 172A. As seen from FIGURES 2 and 17, the audio encoding functionality and the ASF file assembly functionality of encoder and streamer 27 are coupled via the wireless link at 174-176.

The radio transceiver 176 receives at 173 camera control signals from the
15 camera control portion 29 of FIGURE 2 via the serial card of FIGURE 2, and transmits these camera control signals across the radio communication link 175 to the radio transceiver 174, which at 173A forwards the camera control signals to the still video camera 11.

FIGURE 18 diagrammatically illustrates another example modification of the
20 system of FIGURE 2 wherein the viewer's application (e.g., ASF player in the web browser of FIGURE 2) is coupled to the DFP computer 14 of FIGURE 2 via a wireless communication link. In the example of FIGURE 18, the web server of FIGURE 2 is coupled at 181 to a conventional radio interface 183, which uses conventional techniques to transmit the streaming video across a radio interface 185 to a radio
25 transceiver 184. At 181A, the radio transceiver 184 provides the streaming video (as received via radio link 185) to the viewer application. Thus, in FIGURE 18, the viewer application and the web server can communicate generally as described above, but via the conventional wireless communication link at 183-185.

At 182, the radio transceiver 184 can receive from the viewer application a
30 request to stream data without the live video, such that only the audio and the still video information is transmitted. The radio transceiver 184 uses conventional

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techniques to transmit this request via the radio link 185 to the radio interface 183, which in turn forwards this request at 182A to the web server. In response to such requests, the web server sends only the encoded audio and JPEG information. Such operation is especially desirable when the wireless communication link at 183-185 is a relatively low bandwidth link. On the other hand, if UMTS is used to implement the wireless link at 183-185, then the full output of encoder and streamer 27 (live video, still video and audio) can be transmitted across the wireless link in generally the same way as if a wireline link were used.

The radio interface 183 of FIGURE 18 can be a radio transceiver co-sited with the computer 14 of FIGURE 2. In another embodiment, the radio interface 183 represents a portion of a conventional wireless communication network coupled to the web server (at 181, 182A) via a suitable gateway.

It will be evident to workers in the art that the DFP computer embodiments described above can be implemented using one or more suitable PCs or other desktop computer workstations, for example, a Wintel-based 300 MHZ double processor PC.

It will be evident to workers in the art that the above-described features of the present invention greatly simplify the process of converting a visual presentation into digital format for transmission through a data network. Anyone, not just experts, can use a system according to the invention to create, for example, a low cost Internet multimedia production.

Although exemplary embodiments of the present invention are described above in detail, this does not limit the scope of the invention, which can be practiced in a variety of embodiments.

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IN THE CLAIMS:

1. A method of converting a visual presentation into a digital format, comprising:

monitoring a first sequence of first visible events in the visual presentation, and
5 also monitoring a second sequence of second visible events in the visual presentation, wherein timewise corresponding relationships exist between at least some of the first visible events and at least some of the second visible events;

while the first and second sequences are occurring, producing in response to the first and second sequences first and second digital signals that respectively
10 represent the first and second sequences but are not indicative of said timewise corresponding relationships; and

while the first and second sequences are occurring, processing current portions of the first and second digital signals while successive portions of the first and second digital signals are concurrently being produced in response to the first and second
15 sequences, said processing step including automatically producing digital data indicative of said timewise corresponding relationships.

2. The method of Claim 1, wherein said processing step includes capturing portions of the second digital signal and converting each of said captured
20 portions into a corresponding still image data format, said still image data-formatted portions representing respective parts of the second sequence, and wherein said automatically producing step includes assigning to each still image data-formatted portion a time reference indicative of a time at which the corresponding portion of the second digital signal was captured.

25 3. The method of Claim 2, wherein said step of converting into still image data-formatted portions includes creating JPEG files corresponding to said captured portions.

30 4. The method of Claim 3, wherein said automatically producing step includes creating HTML files respectively corresponding to the JPEG files.

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5. The method of Claim 2, wherein said processing step includes encoding the first digital signal to produce an encoded data stream, said assigning step including assigning said time references relative to elapsed time in said encoded data stream, and the method further including inserting into the encoded data stream, at respective points in time corresponding to the time references, information indicative of the respective still image data-formatted portions corresponding to the time references.

6. The method of Claim 5, wherein said step of inserting information includes inserting into the encoded data stream, at the respective points in time, Uniform Resource Locators (URLs) which respectively correspond to the still image data-formatted portions.

7. The method of Claim 6, wherein said encoding step includes producing from the first digital signal an Active Streaming Format (ASF) file, and wherein said step of inserting URLs includes inserting the URLs in the ASF file.

8. The method of Claim 2, wherein said processing step includes selecting respective points in time at which to capture said portions of the second digital signal, and permitting said selecting step to be performed either automatically or manually.

9. The method of Claim 8, wherein said step of converting into still image data-formatted portions includes creating digital data files corresponding to said captured portions.

10. The method of Claim 9, wherein said selecting step includes selecting one said point in time automatically based on a file size of a digital data file corresponding to a previously captured portion of the second digital signal.

11. The method of Claim 9, wherein said step of selecting points in time includes automatically separating, by a separation time, the points in time respectively associated with two consecutively captured portions of the second digital signal, said

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separating step including determining the separation time, said determining step including dividing a file size of a digital data file corresponding to an earlier captured one of the consecutively captured portions by a data rate used in said encoding step.

5 12. The method of Claim 2, wherein said processing step includes determining whether a currently captured portion of the second digital signal differs sufficiently from a previously captured portion of the second digital signal, and creating a digital data file corresponding to the currently captured portion only if a sufficient difference is determined.

10

 13. A method of converting a visual presentation into a digital format, comprising:

 producing a digital signal representing the visual presentation, including using a video camera to record the visual presentation;

15

 outputting the digital signal;

 moving the video camera from a current camera position to a predetermined camera position; and

20

 while moving the video camera to the predetermined camera position, outputting a predetermined digital signal representing a visual appearance that will be presented to the video camera when the video camera reaches the predetermined camera position.

 14. The method of Claim 13, including maintaining a corresponding relationship between position information corresponding to the predetermined camera position and video information corresponding to the visual appearance associated with the predetermined camera position.

25

 15. The method of Claim 14, including a user establishing the corresponding relationship, including moving the video camera to a first position and monitoring a visual presentation associated with the first position.

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16. The method of Claim 15, wherein said establishing step includes using a graphical user interface to move the video camera and monitor the visual presentation.

5 17. A system for converting a visual presentation into a digital format, comprising:

means for producing a digital signal representing the visual presentation, including a video camera to record the visual presentation;

means for outputting the digital signal;

10 means for moving the video camera from a current camera position to a predetermined camera position; and

means operable while moving said video camera to the predetermined camera position for outputting a predetermined digital signal representing a visual appearance that will be presented to the video camera when the video camera reaches the
15 predetermined camera position.

18. The system of Claim 17, including an information storage apparatus for maintaining therein a corresponding relationship between position information corresponding to the predetermined camera position and video information
20 corresponding to the visual appearance associated with the predetermined camera position.

19. The system of Claim 18, including a user interface apparatus coupled to the video camera for permitting a user to establish said corresponding relationship
25 by moving the video camera to a first position and monitoring a visual presentation associated with the first position.

20. The system of Claim 19, wherein said user interface apparatus includes a graphical user interface.

30

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21. An apparatus for synchronizing information that represents first and second synchronized sequences of visible events, comprising:

an input for receiving first and second digital signals which are produced in response to the first and second sequences and which respectively represent the first and second sequences but are not indicative of said synchronization of the first and second sequences;

a data processing unit coupled to said input for processing current portions of the first and second digital signals while successive portions of the first and second digital signals are concurrently being produced in response to the first and second sequences and received at said input, said data processing unit including a first data path for processing of said first digital signal and a second data path for processing of said second digital signal, and said data processing unit including a synchronizer coupled to one of said first and second data paths and operable concurrently with said processing of said current portions for automatically producing information indicative of said synchronization of the first and second sequences; and

an output coupled to said data processing unit for outputting information representing the first and second sequences and the synchronized relationship therebetween.

22. The apparatus of Claim 21, wherein said first data path includes an encoder for receiving said first digital signal and producing therefrom an encoded data stream, wherein said second data path includes a converter for receiving said second digital signal and capturing portions of said second digital signal and converting each of said captured portions into a corresponding still image data format, and wherein said synchronizer is coupled between said encoder and said converter for synchronizing the still image data-formatted portions with the encoded data stream.

23. The apparatus of Claim 22, wherein said still image data formatted portions include JPEG data files.

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24. The apparatus of Claim 22, wherein said synchronizer includes a timer that measures elapsed time during production of said encoded data stream by said encoder, said converter having an input coupled to said timer, said converter responsive to said timer for providing each of said still image data-formatted portions with a corresponding time reference relative to the encoded data stream produced by said encoder.

25. The apparatus of Claim 24, wherein said synchronizer includes an input coupled to said converter for receiving from said converter information indicative of said corresponding relationships between said still image data-formatted portions and the respective time references, said synchronizer further including an output coupled to said encoder for providing to said encoder indications of said corresponding relationships.

26. The apparatus of Claim 25, wherein said encoder is responsive to said indications from said synchronizer for inserting into said encoded data stream, at points in time corresponding to said time references, information indicative of the respective still image data-formatted portions corresponding to said time references.

27. The apparatus of Claim 21, wherein one of said first and second data paths includes a wireless communication link.

28. The apparatus of Claim 21, wherein said first data path includes a wireless communication link and said second data path includes a wireless communication link.

29. The apparatus of Claim 21, including a wireless communication link coupled to said output for transmitting said last-mentioned information to a user located remotely from said output.

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30. A system for converting a visual presentation into a digital format, comprising:

means for monitoring a first sequence of first visible events in the visual presentation, and also for monitoring a second sequence of second visible events in the visual presentation, wherein timewise corresponding relationships exist between at least some of the first visible events and at least some of the second visible events;

5 means operable while the first and second sequences are occurring for producing, in response to the first and second sequences, first and second digital signals that respectively represent the first and second sequences but are not indicative of said timewise corresponding relationships; and

10 means operable while the first and second sequences are occurring for processing current portions of the first and second digital signals while successive portions of the first and second digital signals are concurrently being produced in response to the first and second sequences, said means for processing including means

15 for automatically producing digital data indicative of said timewise corresponding relationships.

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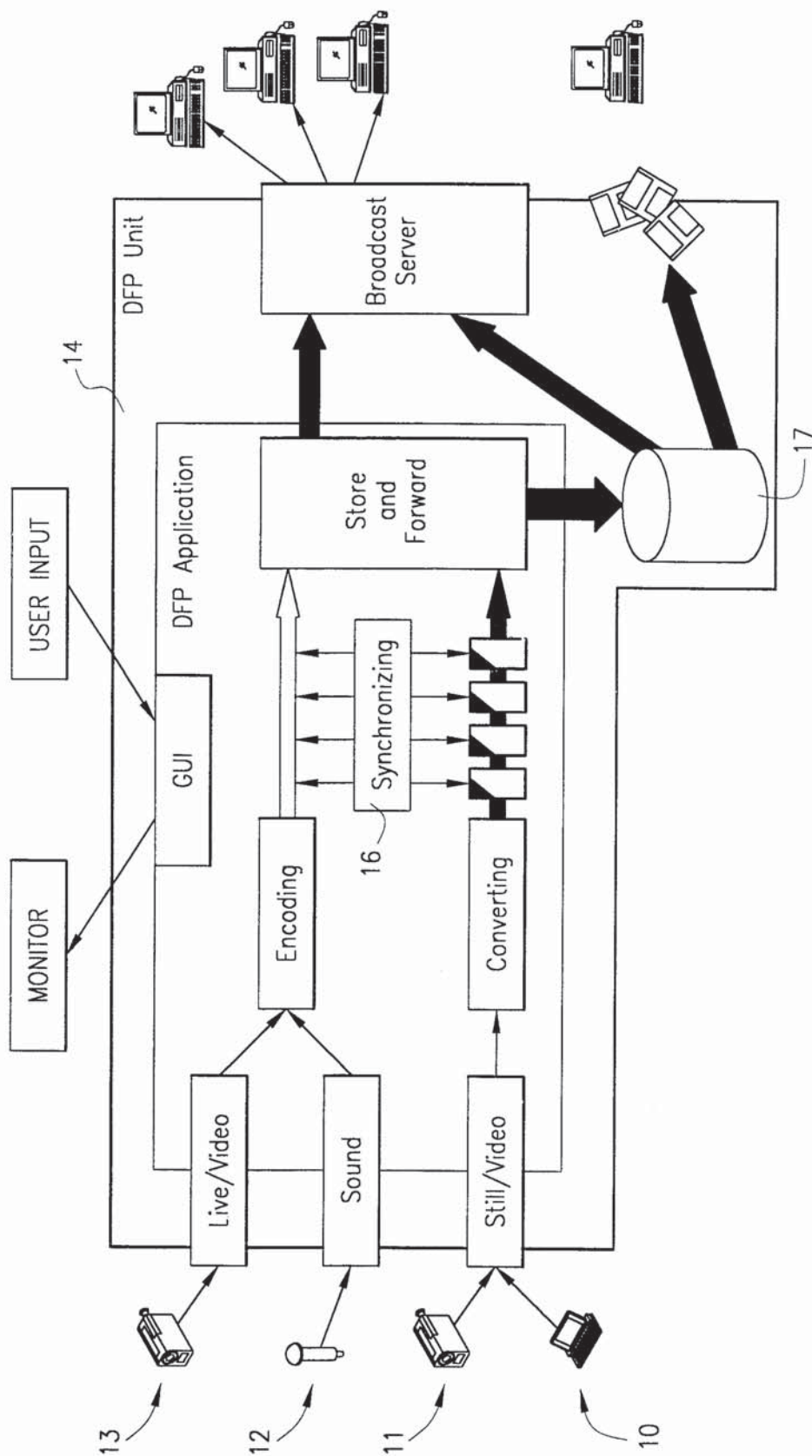


FIG. 1

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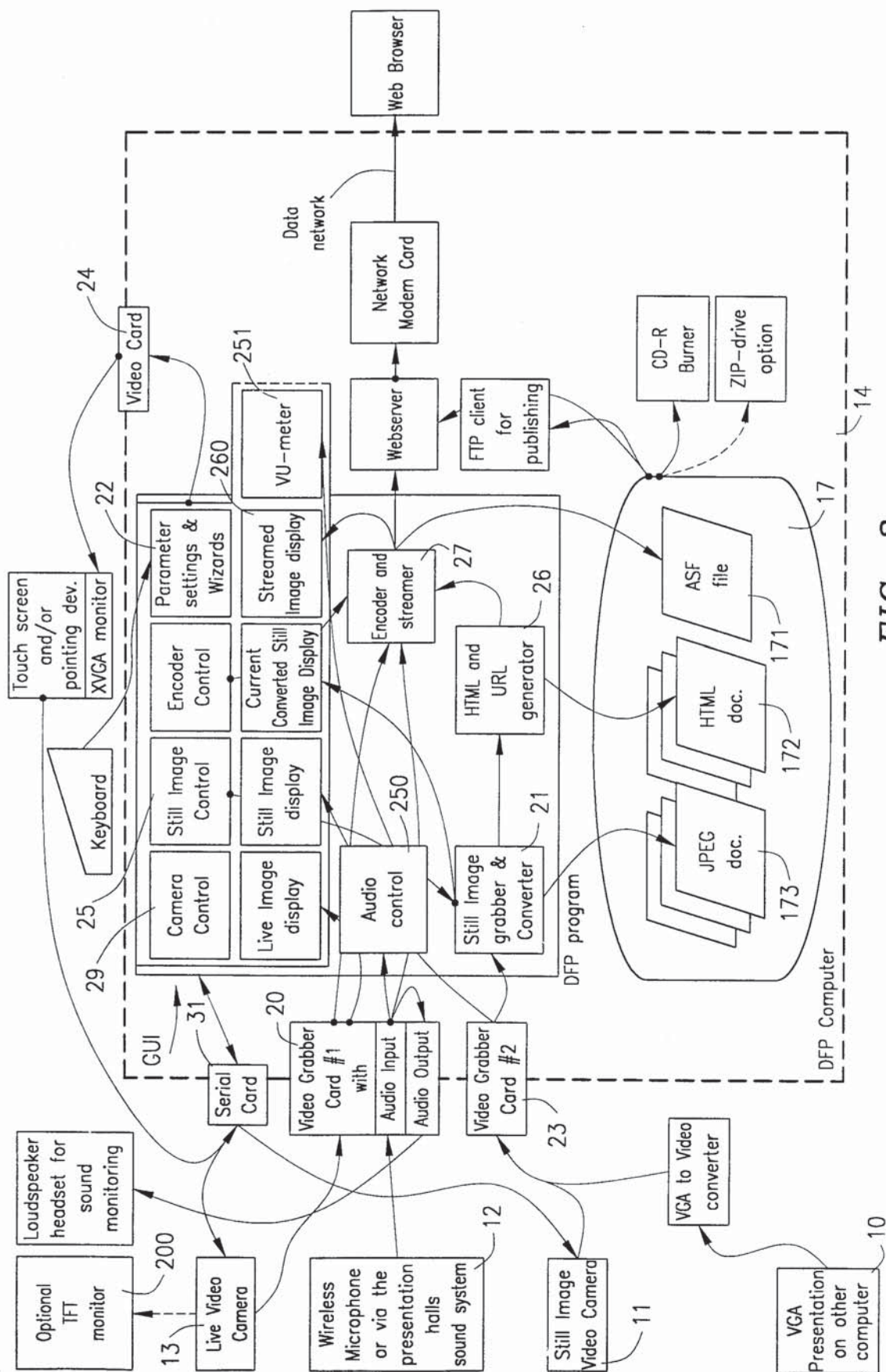
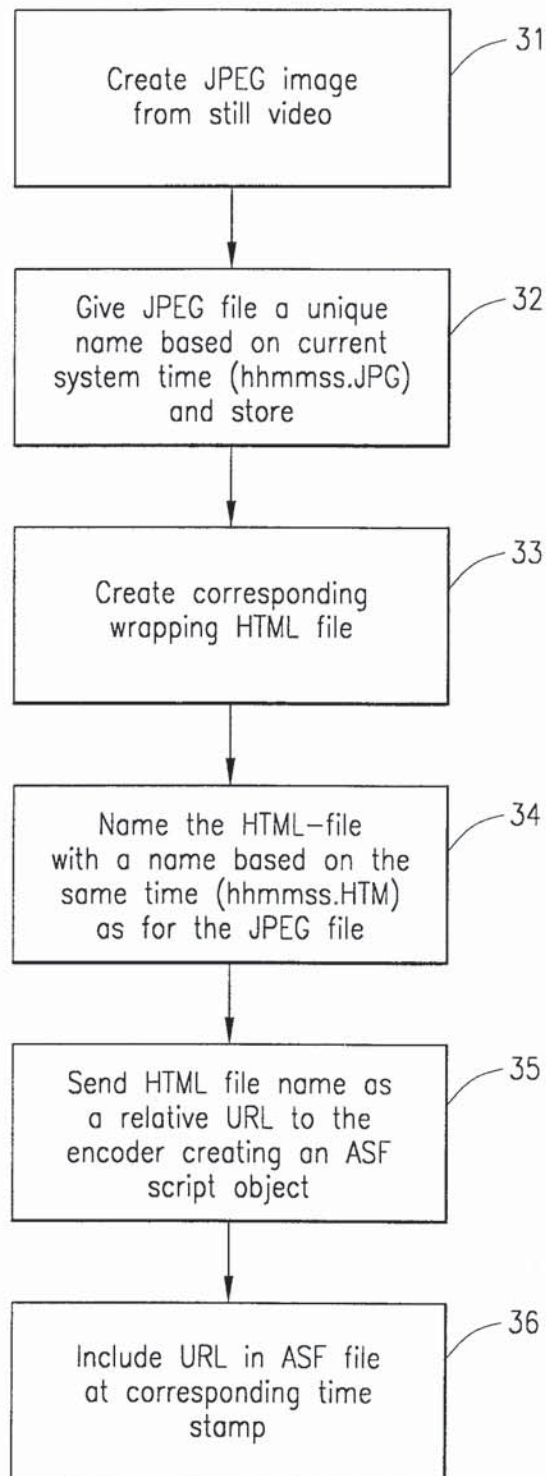
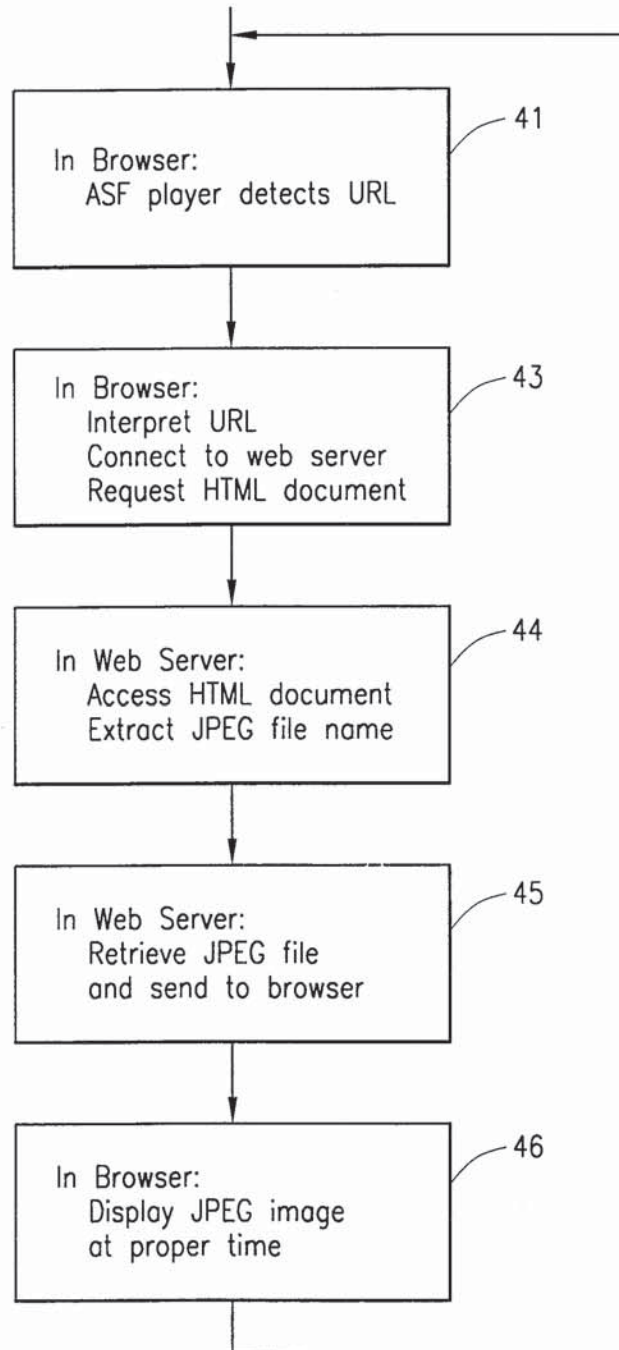


FIG. 2

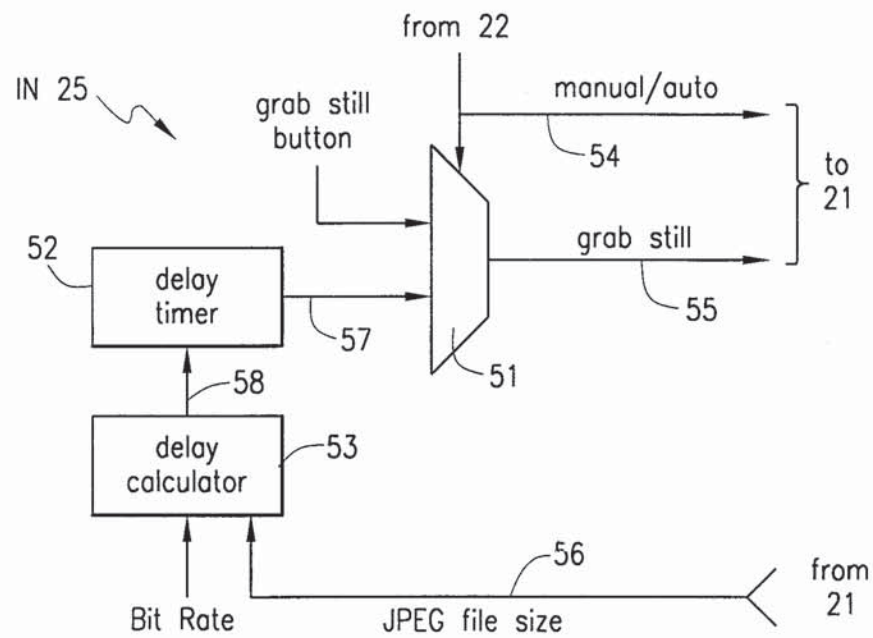
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**FIG. 3**

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**FIG. 4**

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**FIG. 5**

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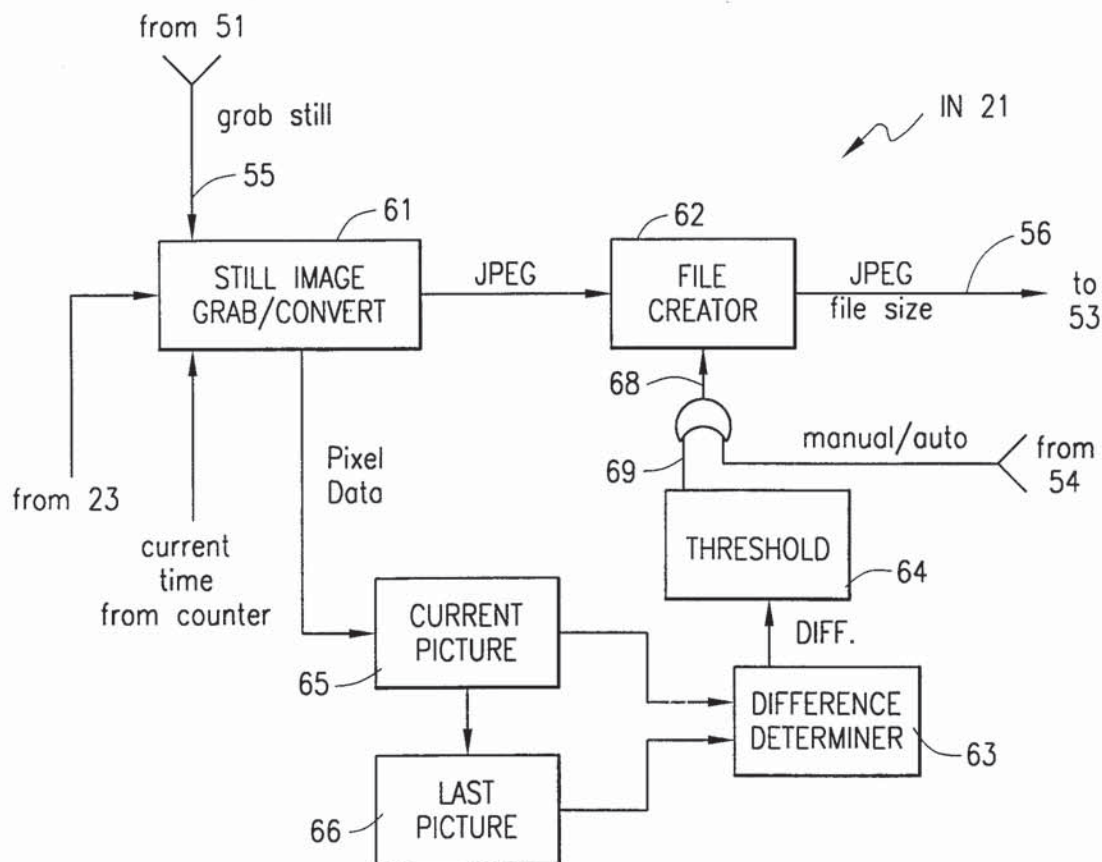


FIG. 6

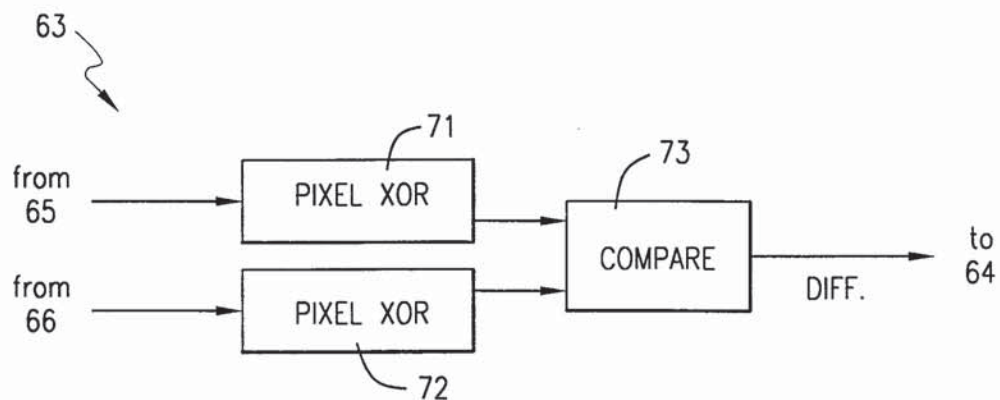


FIG. 7

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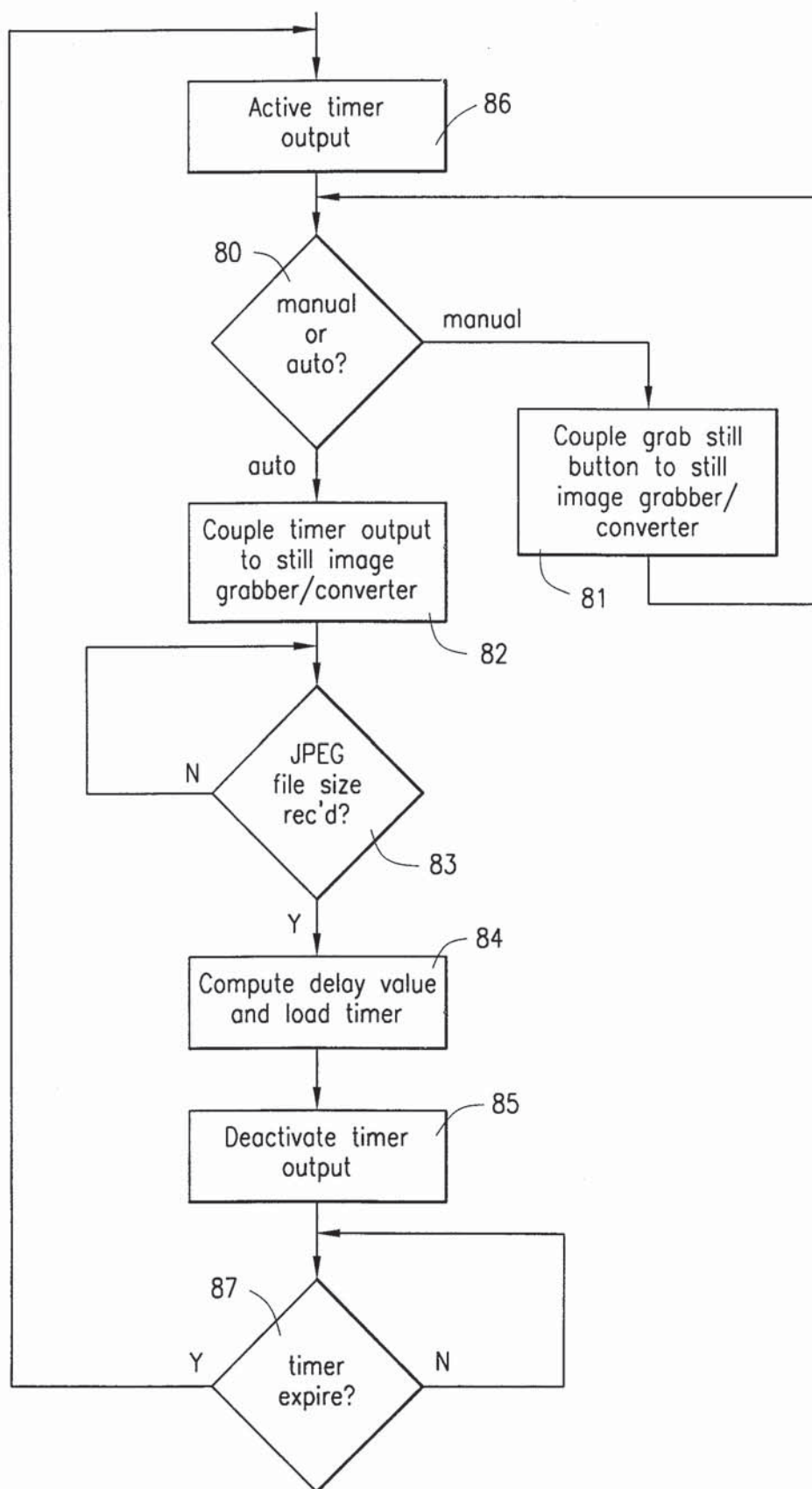
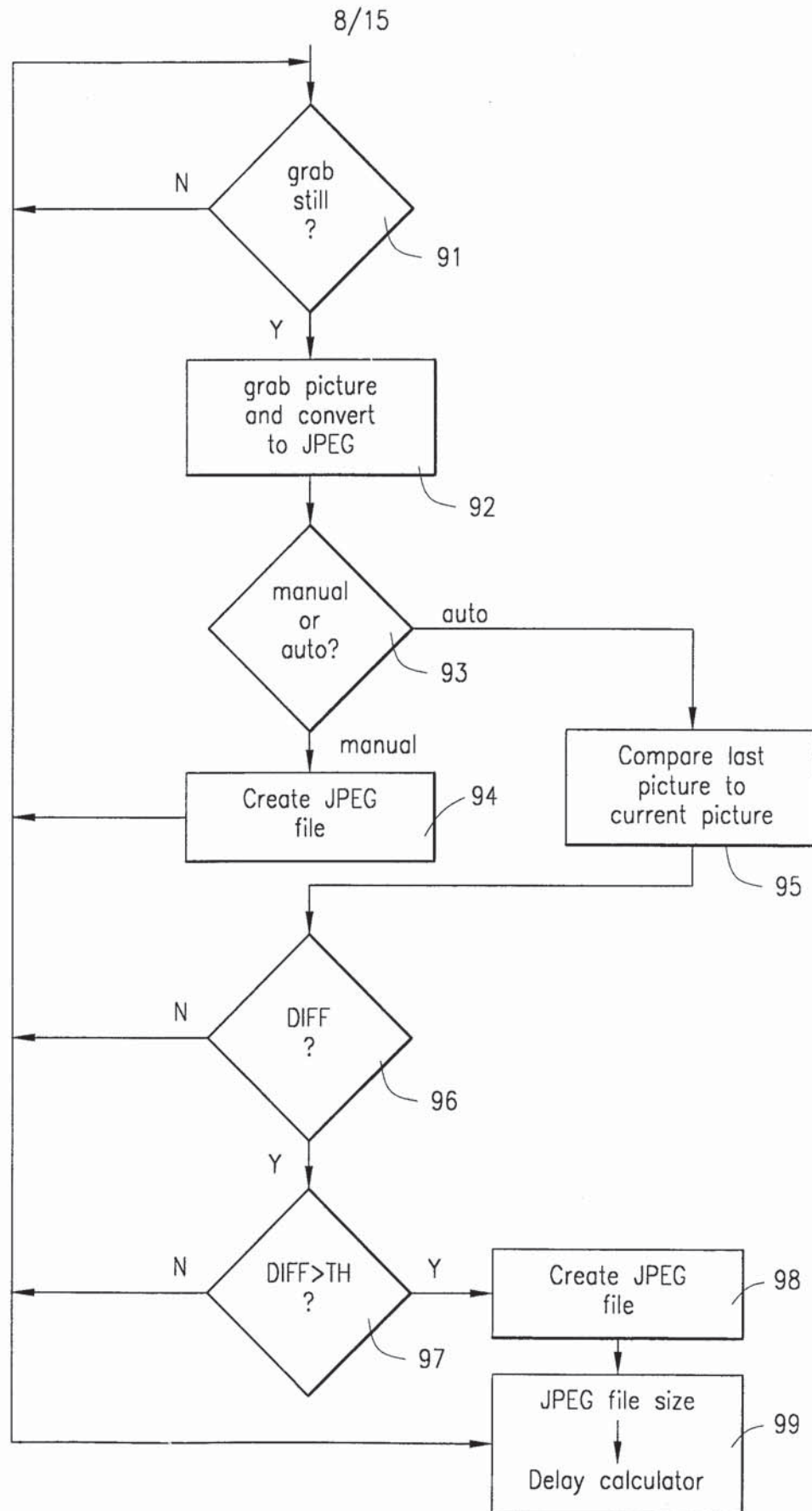


FIG. 8

**FIG. 9**

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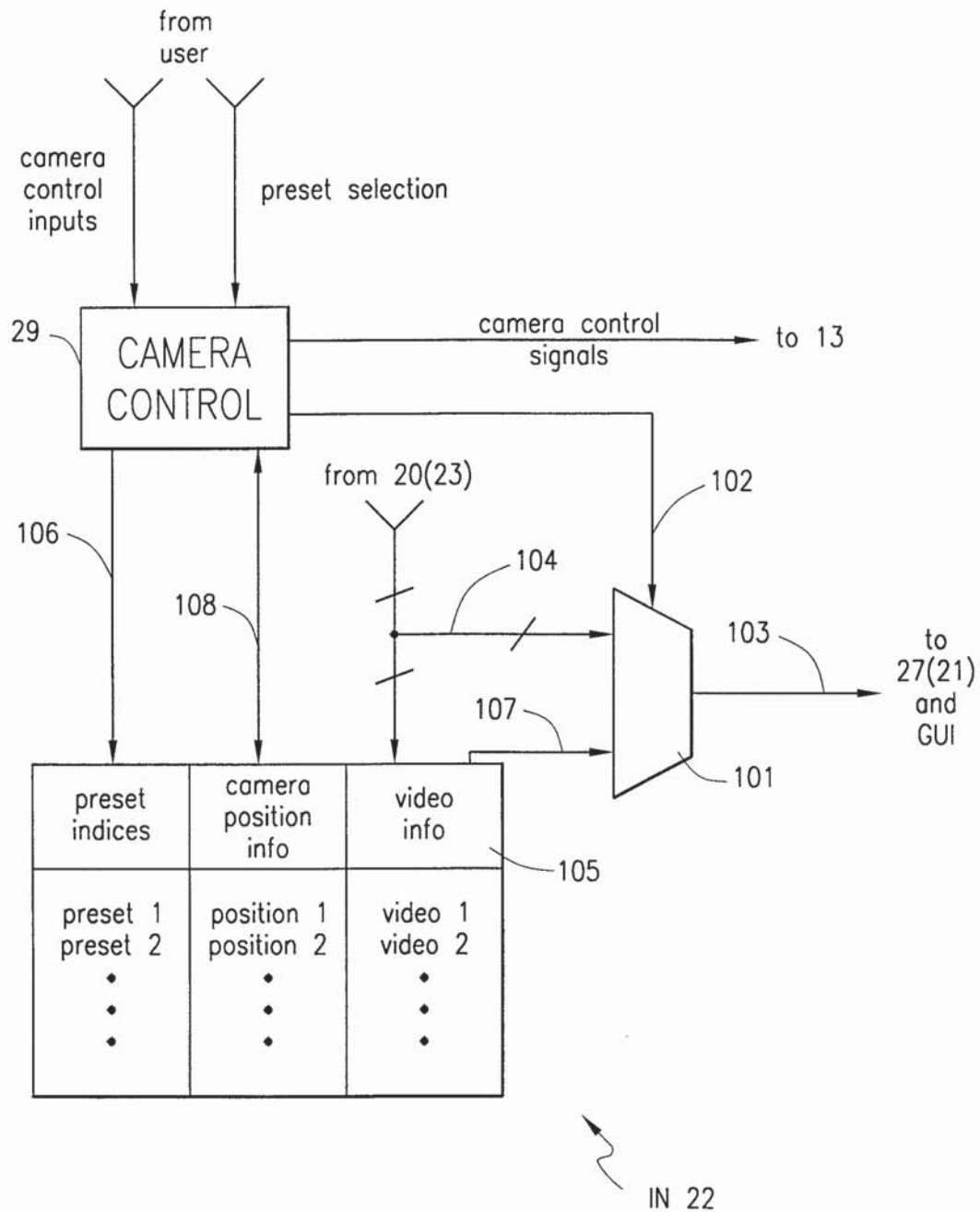
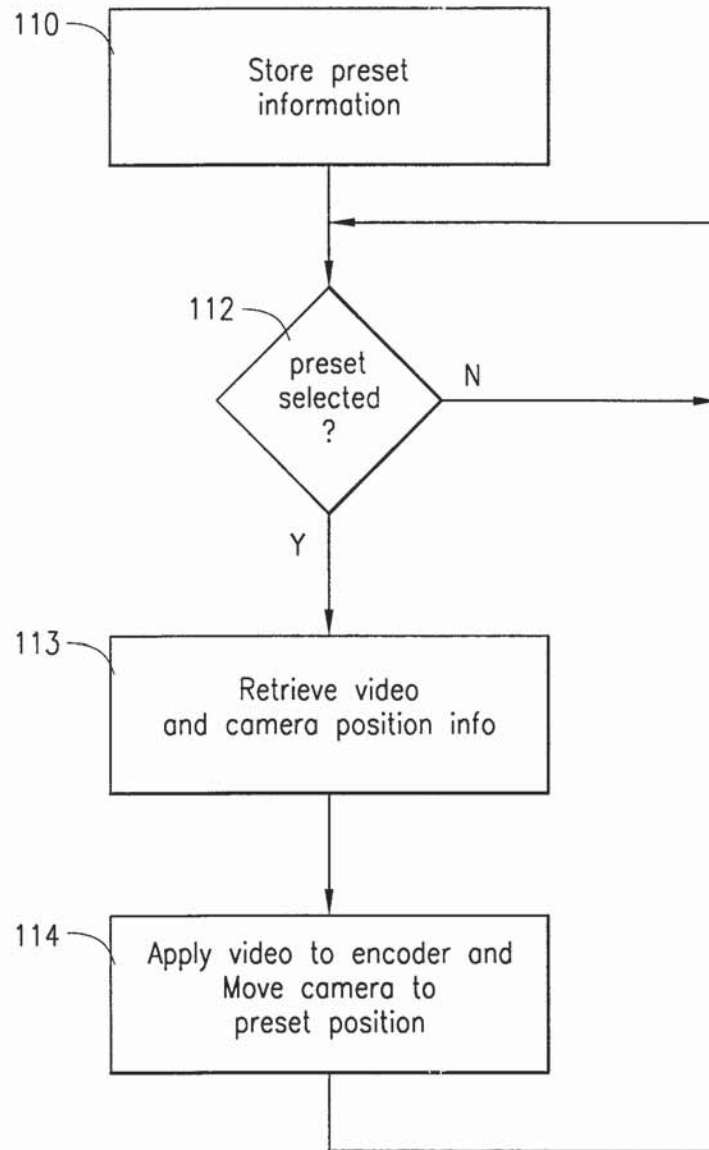


FIG. 10

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*FIG. 11*

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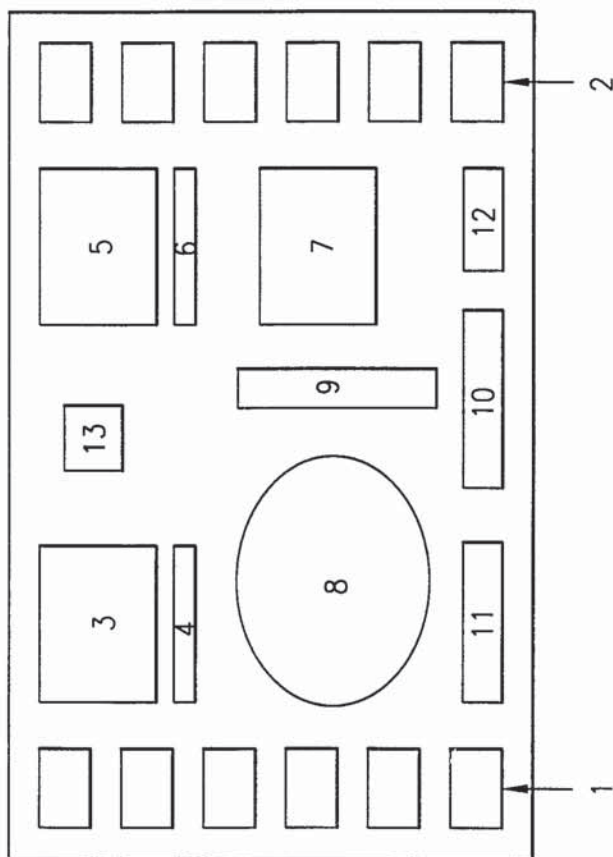


FIG. 12

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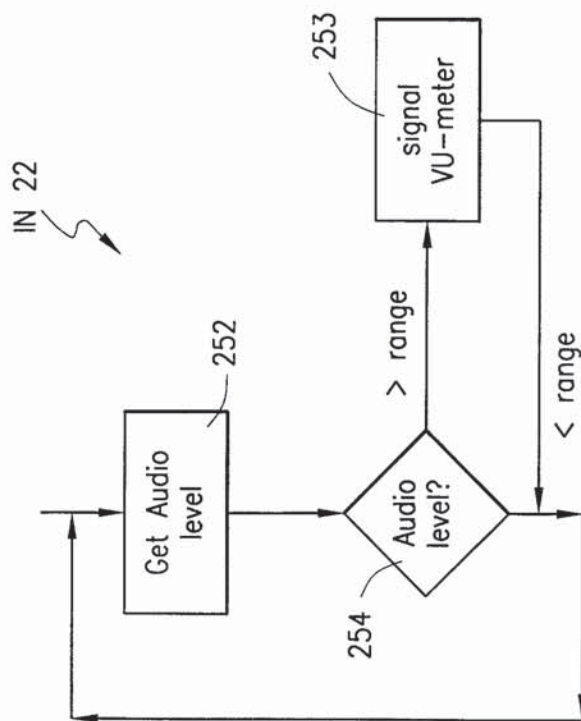


FIG. 13

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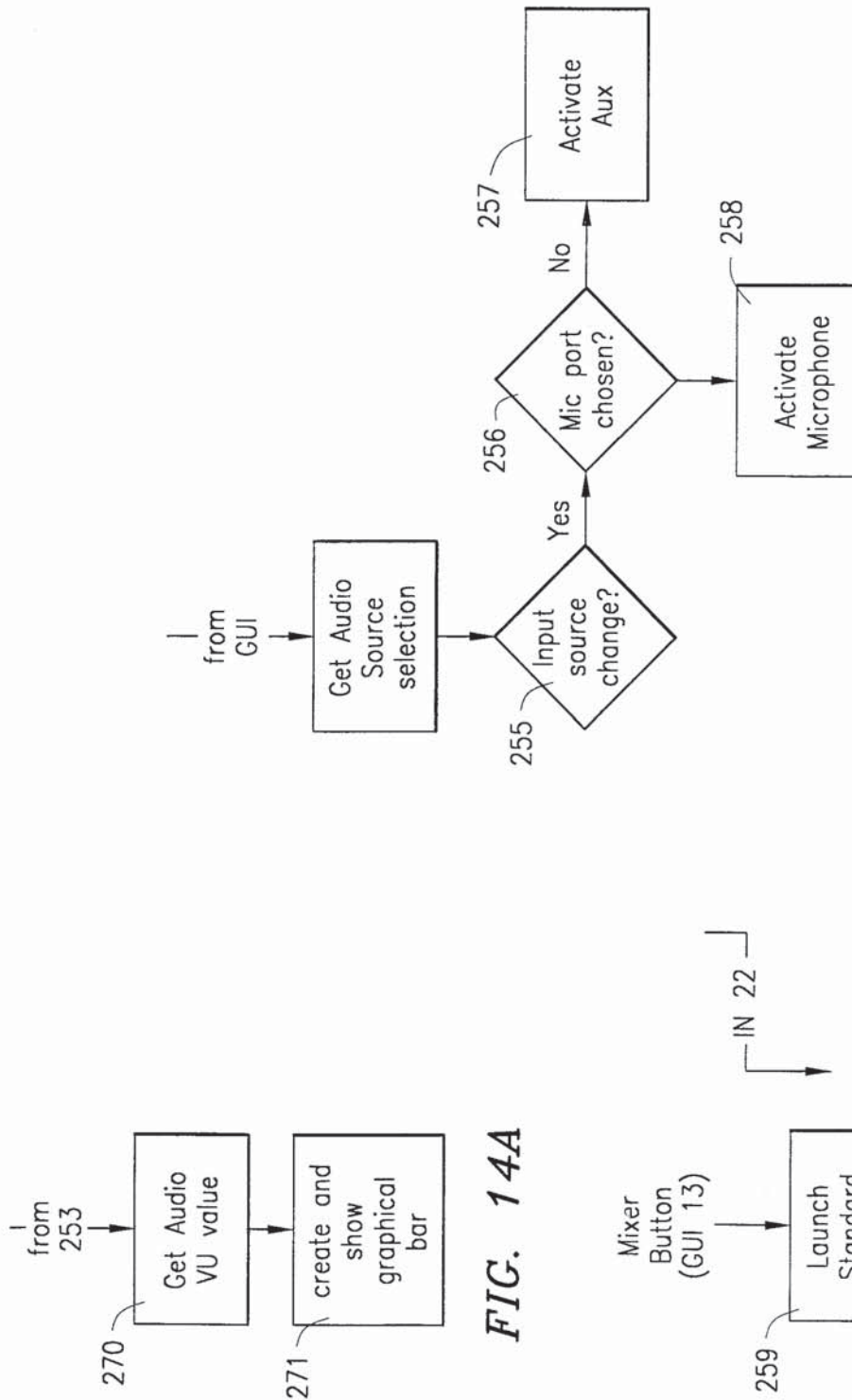


FIG. 14C

FIG. 14A

FIG. 14B

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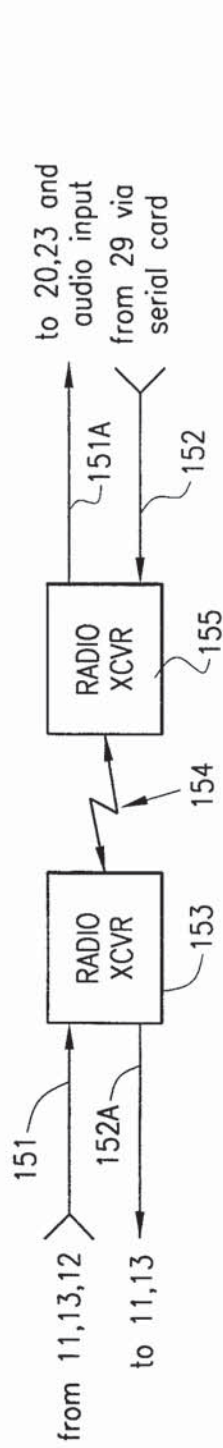


FIG. 15

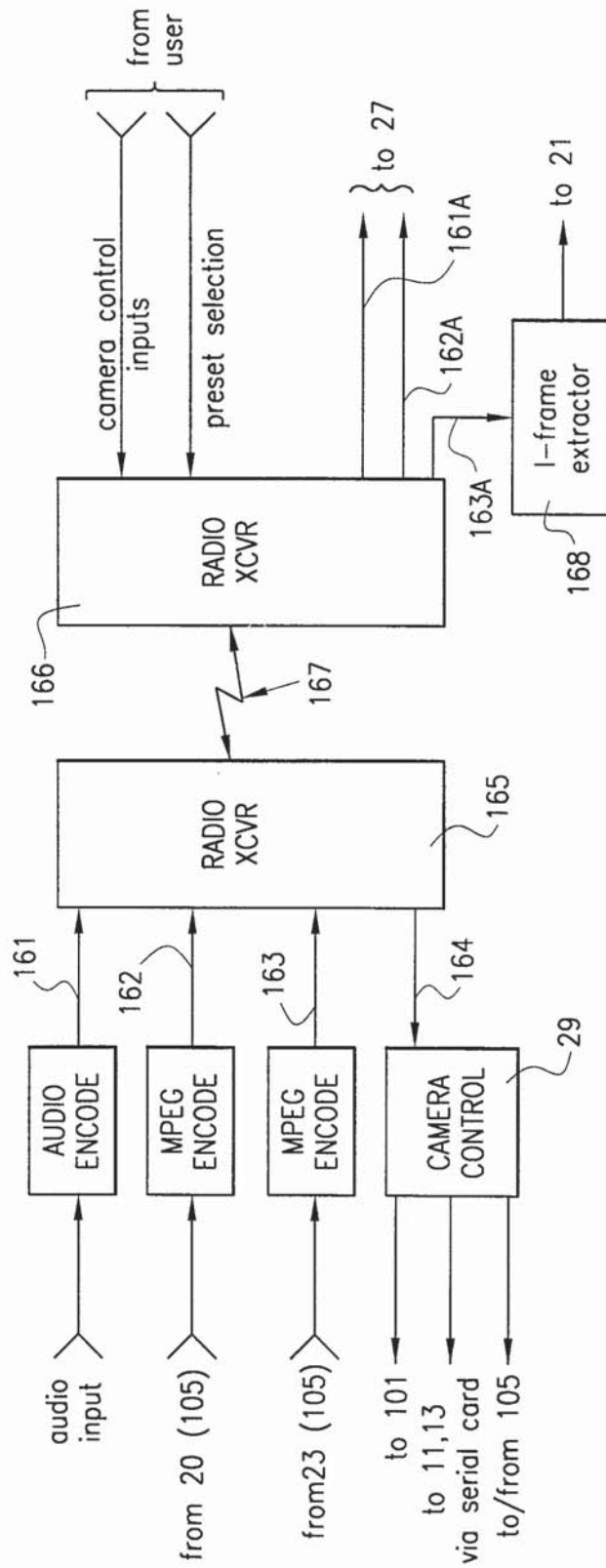


FIG. 16

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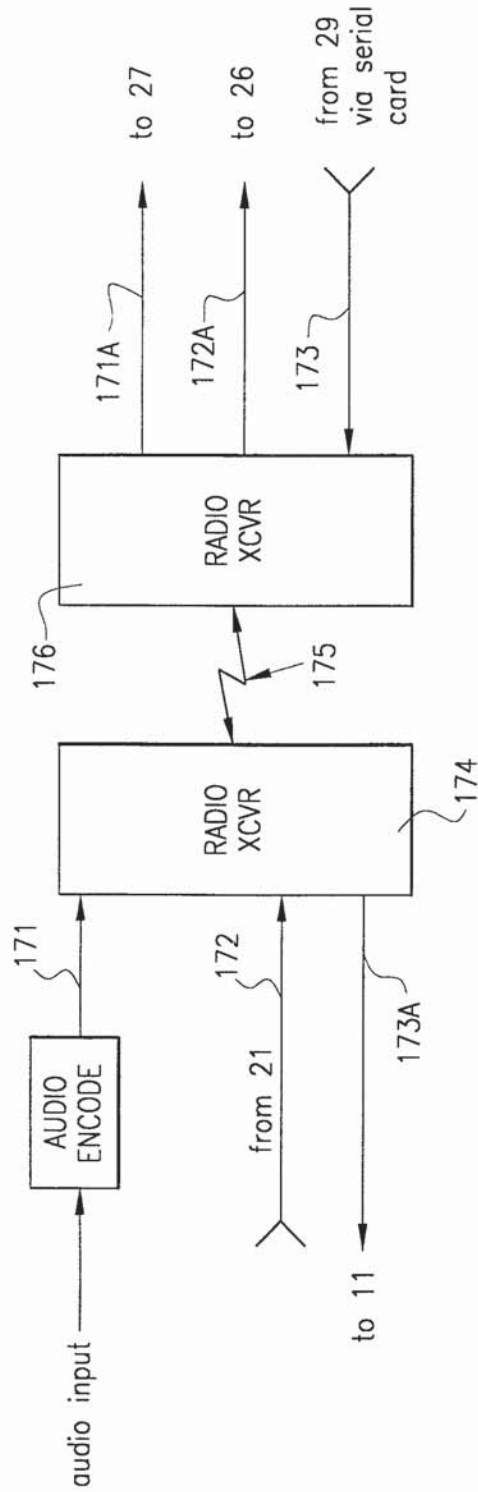


FIG. 17

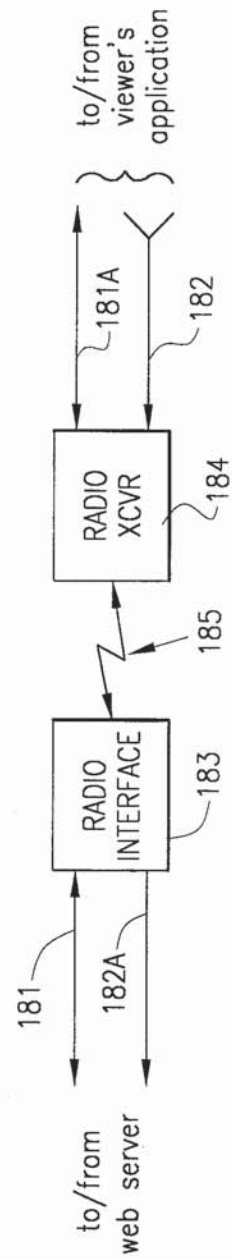


FIG. 18