UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF NEW MEXICO

HAWK TECHNOLOGY SYSTEMS, LLC, Plaintiff, v. LAGUNA DEVELOPMENT CORP., Defendant.	)	Case No. 1:14-CV-1076

COMPLAINT

Plaintiff, HAWK TECHNOLOGY SYSTEMS, LLC ("Hawk"), hereby sues Laguna Development Corp. ("LDC") and alleges:

NATURE OF THE ACTION

1. This is a civil action for patent infringement of United States Patent No. RE43,462 ('462 Patent) and United States Patent No. RE37,342 ('342 Patent). The '462 Patent is a reissue of United States Patent No. 5,265,410 (the '410 Patent).

PARTIES

2. Hawk is a limited liability company organized and existing under the laws of the State of Florida and maintains its principal place of business at 2 South Biscayne Blvd., Suite 3800, Miami, Florida 33131.

3. Laguna Development Corp. ("Defendant" or "LDC"), is a federally chartered tribal corporation organized and existing under 25 U.S.C. § 477, with its principal place of business located at 14500 Central Ave. SW, I-40, Albuquerque, New Mexico 87121.

JURISDICTION AND VENUE

4. Pursuant to 28 U.S.C. §§ 1331 and 1338(a), this Court has original jurisdiction over the subject matter of this action because this is an action arising under the Patent Laws of the United States, 35 U.S.C. § 1 *et. seq.*

5. This court has personal jurisdiction over Defendant because Defendant is (a) transacting business in the State of New Mexico; (b) committing tortious acts within the State of New Mexico; and (c) engaging in substantial and non-isolated activity within the State of New Mexico.

6. Pursuant to 28 U.S.C. §§ 1391 and 1400(b), venue is proper in this district.

GENERAL ALLEGATIONS

7. Hawk was formed in 2012 to commercialize the inventions of its founder, Barry Schwab.

8. Hawk is the owner by assignment of the '462 Patent and the '342 Patent.

COUNT I: DIRECT INFRINGEMENT OF THE '462 PATENT

9. The allegations contained in paragraphs 1-8 above are hereby re-alleged as if fully set forth herein.

10. This cause of action arises under the Patent Laws of the United States, 35 U.S.C. § 1 *et seq.*

11. Plaintiff is the owner by assignment of the '462 Patent, with sole rights to enforce it and to sue infringers.

12. A copy of the '462 Patent titled "Dual Format Digital Video Production System" is attached as **Exhibit A**.

Claim 1 Of The '462 Patent

13. Claim 1 of the '462 Patent states:

A video storage and display system, comprising:

one or more video cameras, each outputting a signal representative of a video image;

means to receive the signals from each camera and digitally compress the images;

two forms of high-capacity storage media, one being randomly searchable while the other continues to store the digitally compressed image; and

a computer configured to receive the digitally compressed images, the computer being interfaced to the following devices:

a display screen, means to receive externally derived operator commands, and

the high-capacity storage media, and wherein the computer is programmed to perform the following functions:

display the digitally compressed images from the cameras in different windows on the display screen, each window being associated with an update rate and dimensions in pixels,

vary the spatial parameters and temporal parameters at which a particular image is updated in its window in accordance with one of the externally derived commands,

store the digitally compressed images in the high-capacity storage media, and

vary the spatial parameters and temporal parameters at which a particular image is stored in accordance with one of the externally derived commands.

('462 Patent, Col. 10, line 57 – Col. 11, line 20).

Claim 12 Of The '462 Patent

14. Claim 12 of the '462 Patent states:

The method of simultaneously displaying and storing multiple video images, comprising the steps of:

receiving video images at a personal computer based system from one or more sources;

digitizing any of the images not already in digital form using an analog-to-digital converter;

displaying at least certain of the digitized images in separate windows on a personal computer based display device, using a first set of temporal and spatial parameters associated with each image in each window;

converting one or more of the video source images into a data storage format using a second set of temporal and spatial parameters associated with each image; and

simultaneously storing the converted images in a storage device.

('462 Patent, Col. 11, line 62 – Col. 12, line 10).

Claim 15 Of The '462 Patent

15. Claim 15 of the '462 Patent states:

A video storage and display system, comprising:

one or more video cameras, each outputting a signal representative of a video image;

means to receive the signals from each camera and digitally compress the images; and

a computer configured to receive the digitally compressed images, the computer being interfaced to the following devices:

a display screen,

means to receive externally derived operator commands including means for sensing a deviation from the normal-state image scene associated with at least one of the video cameras, the existence of the deviation being used as the basis for generating an externally derived command, and

a high-capacity storage medium, and programmed to perform the following functions:

display the digitally compressed images from the cameras in different windows on the display screen, each window being associated with an update rate and dimensions in pixels,

vary spatial parameters and temporal parameters at which a particular image is updated in its window in accordance with one of the externally derived commands,

> store the digitally compressed images in the high-capacity storage medium, and
>
> vary the spatial parameters and temporal parameters at which a particular image is stored in accordance with one of the externally derived commands.

('462 Patent, Col. 12, line 15 – 45).

16. Defendant uses Pelco Endura, a video storage and display system and methods that infringe the '462 Patent.

17. All conditions precedent to bringing this action have occurred or been waived.

18. Hawk has retained counsel to represent it in this matter and is obligated to pay its counsel a reasonable fee for its services.

19. Pursuant to 35 U.S.C. § 285, Hawk is entitled to recover its attorneys' fees.

20. Without Hawk's authorization, Defendant uses a video storage and display system and/or methods that infringe one or more of the claims in the '462 Patent.

21. Hawk has been damaged by Defendant's infringement.

WHEREFORE, Hawk respectfully requests the Court:

A. Enter a judgment finding that Defendant has directly infringed the '462 Patent;

B. Pursuant to 35 U.S.C. § 284, order Defendant to pay damages adequate to compensate for the infringement, but in no event less than a reasonable royalty for the use made of the invention, together with interest and costs;

C. Find this to be an exceptional case of patent infringement under 35 U.S.C. § 285 and award reasonable attorneys' fees, costs, and expenses incurred by Hawk in prosecuting this action; and

D. Award such other and further relief as the Court deems just and proper.

COUNT II: DIRECT INFRINGEMENT OF THE '342 PATENT

22. Plaintiff incorporates paragraphs 1-21 by reference.

23. The cause of action arises under the Patent Laws of the United States, 35 U.S.C. § 1 et seq.

24. Plaintiff is the owner by assignment of the '342 Patent, with sole rights to enforce the '342 Patent and to sue infringers.

25. A copy of the '342 Patent titled "Dual Format Digital Video Production System" is attached as Exhibit B.

26. The '342 Patent is valid, enforceable, and was duly issued in full compliance with Title 35 of the USC.

27. Upon information and belief, Defendant has infringed one or more claims of the '342 Patent, including at least Claim 40, by making, using and/or offering for sale a system that performs the dual recording of video signals for security, covered by one or more claims of the '342 Patent, including, without limitation, Claim 40.

28. Plaintiff has identified its patent in compliance with 35 U.S.C. § 287.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff respectfully requests the Court to:

A. Enter judgment for the Plaintiff on the Complaint on all causes of action asserted herein;

B. Award Plaintiff damages resulting from Defendant's infringement, in accordance with 35 U.S.C. § 284;

C. Award Plaintiff reasonable attorneys' fees, costs, and expenses incurred by Plaintiff in prosecuting this action; and

D. Award Plaintiff such further relief to which the Court finds Plaintiff entitled under the Law or equity.

DEMAND FOR JURY TRIAL

Plaintiff demands a trial by jury on all issues so triable.

Respectfully submitted,

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EXHIBIT A

US00RE43462E

(19) **United States**

(12) **Reissued Patent**
Washino et al.

(10) **Patent Number: US RE43,462 E**

(45) **Date of Reissued Patent: Jun. 12, 2012**

(54) **VIDEO MONITORING AND CONFERENCING SYSTEM**

(75) Inventors: **Kinya Washino**, Dumont, NJ (US); **Barry H. Schwab**, West Bloomfield, MI (US)

(73) Assignee: **Kinya (Ken) Washino**, Little Ferry, NJ (US)

(21) Appl. No.: **09/301,656**

(22) Filed: **Apr. 28, 1999**

Related U.S. Patent Documents

Reissue of:

(64) Patent No.: **5,625,410**
Issued: **Apr. 29, 1997**
Appl. No.: **08/418,823**
Filed: **Apr. 7, 1995**

U.S. Applications:

(63) Continuation-in-part of application No. 08/050,861, filed on Apr. 21, 1993, now Pat. No. 5,450,140, and a continuation-in-part of application No. 08/298,104, filed on Aug. 30, 1994, now Pat. No. 5,537,157.

(51) **Int. Cl.**
H04N 7/18 (2006.01)

(52) **U.S. Cl.** **348/154**; 348/552; 348/E5.022; 348/E5.042; 348/E5.043; 348/E5.108; 348/E5.111; 348/E7.016; 348/E7.049; 348/E7.079; 348/E7.081; 348/E7.083; 348/E7.086; 348/E9.038; 348/E9.039; 386/355; 386/E5.002; 386/E9.013; 375/240.11; G9B/27.01; G9B/27.051

(58) **Field of Classification Search** 348/154, 348/552, 398; 375/240.11; 386/112; 358/342; *H04N 7/18*
See application file for complete search history.

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Primary Examiner — Nhon Diep
(74) *Attorney, Agent, or Firm* — Gifford, Krass, Sprinkle, Anderson & Citkowski, P.C.

(57) **ABSTRACT**

A PC-based system for monitoring and storing representative images from video cameras may be utilized for security or other monitoring applications. Camera inputs from digital or analog sources are individually and independently digitized and displayed at a first set of image sizes, sampling rates, and frame rates, and may be stored in digital form on various recording media at a second set of image sizes, sampling rates, and frame rates, and these two sets of sizes and rates may or may not be identical. Provisions are included for adding detection or alarm systems which will automatically alter image size, sampling rate and/or frame rate of an individual input source, or activate other physical responses. In addition to security system monitoring, further applications of the invention are disclosed for process monitoring in manufacturing environments and also for applications in videoconferencing.

40 Claims, 8 Drawing Sheets

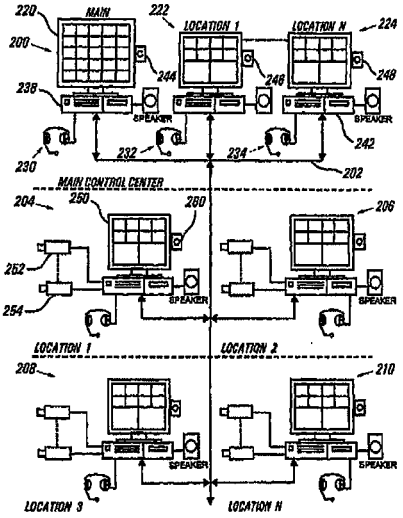

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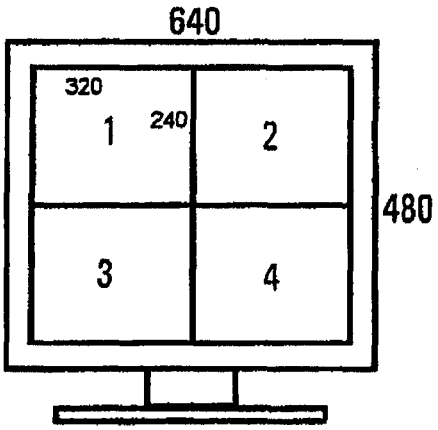
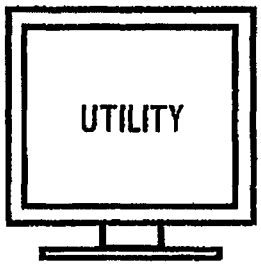
Figure 1

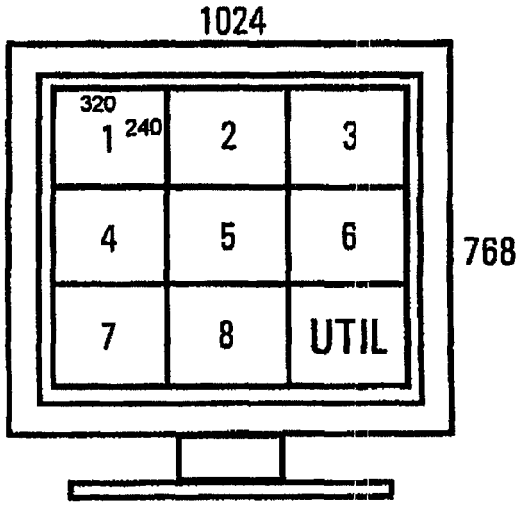


10" TO 14" VGA MONITOR



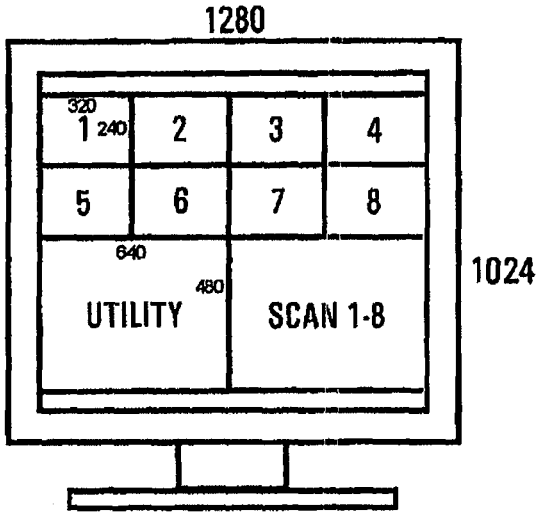
OPTIONAL MONITOR

Figure 2



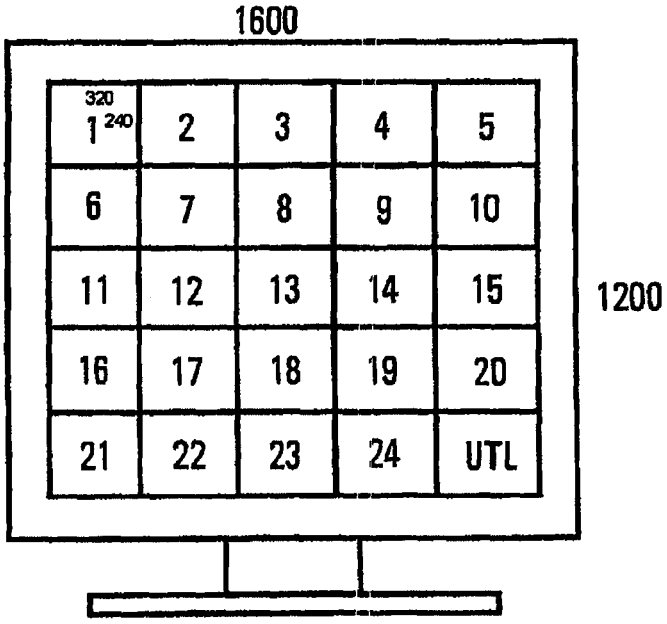
14" TO 17" SVGA MONITOR

Figure 3



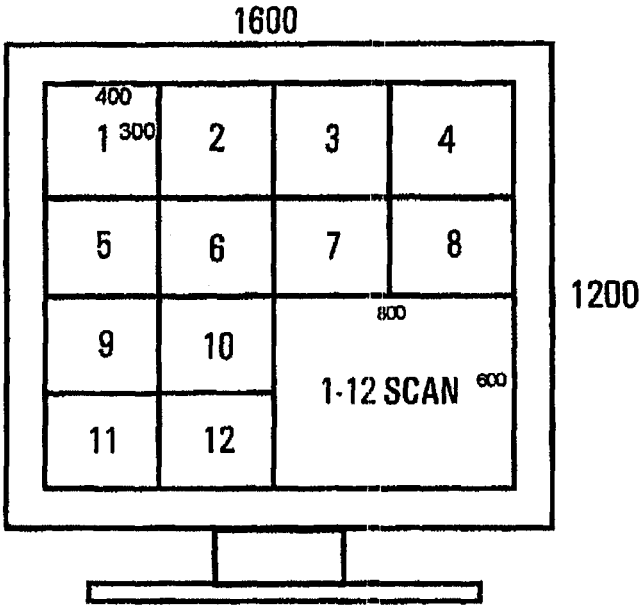
15" TO 20" HIGH RESOLUTION

Figure 4



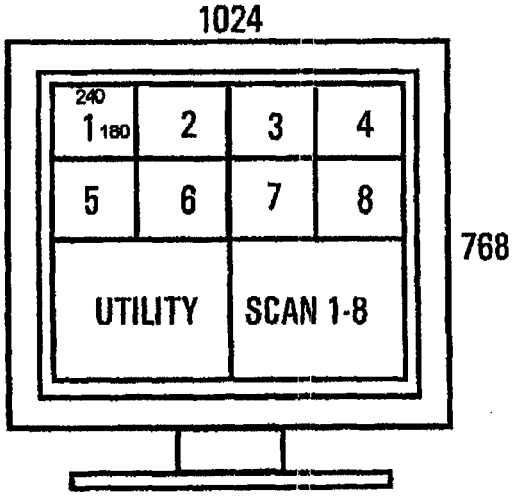
20" TO 21" SUPER HIGH RESOLUTION MONITOR

Figure 5



20" TO 21" SUPER HIGH RESOLUTION MONITOR

Figure 6



14" TO 17" SVGA MONITOR

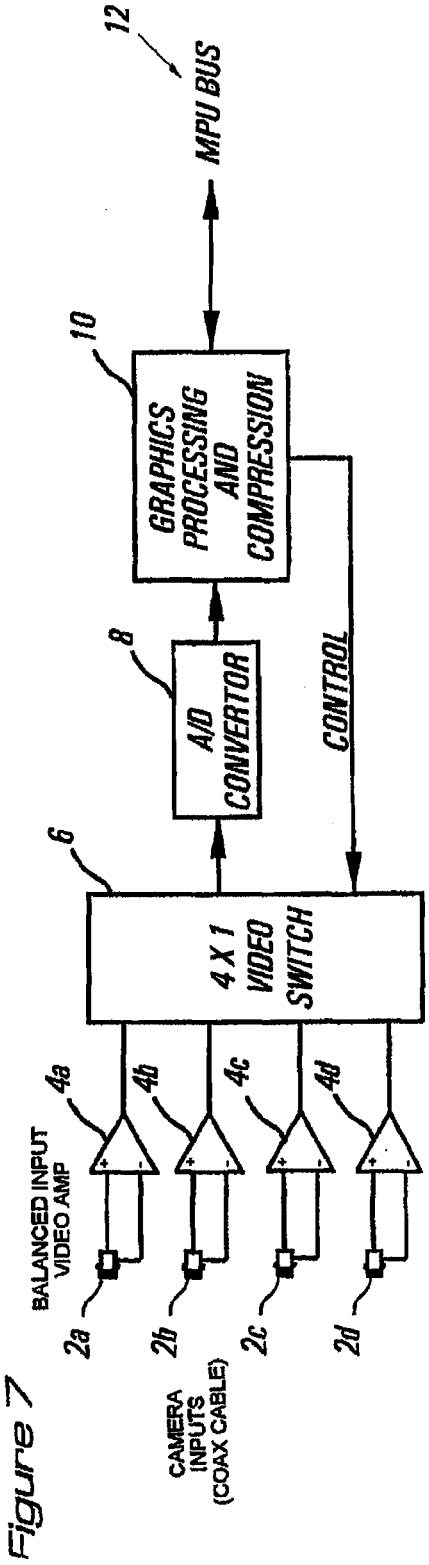


Figure 7

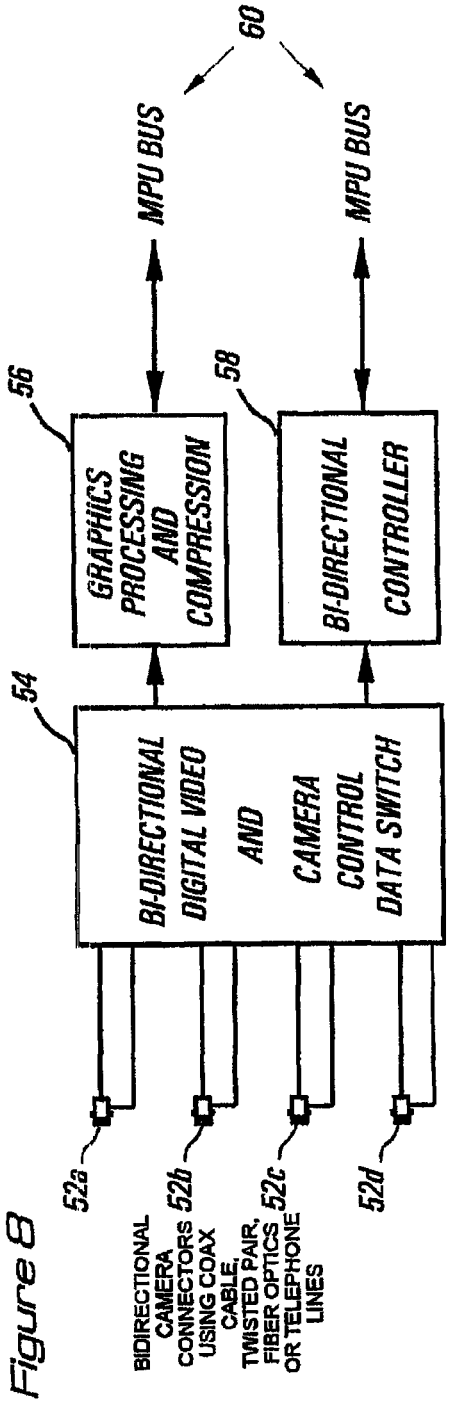


Figure 8

Figure 9

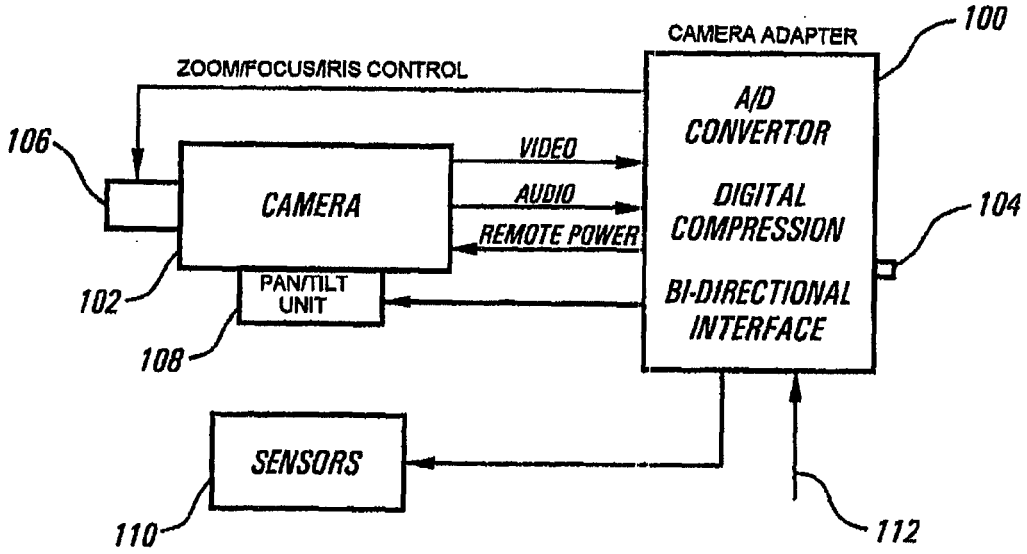


Figure 10

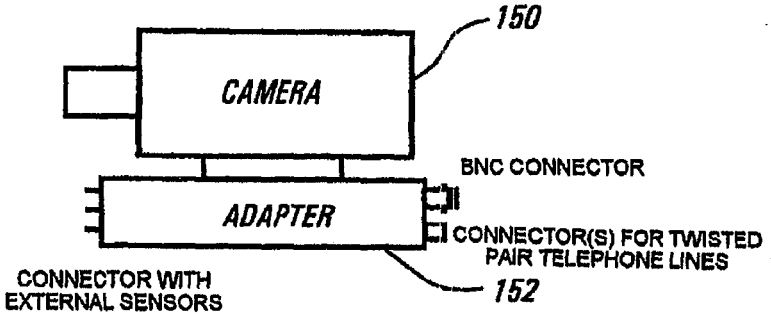


Figure 11

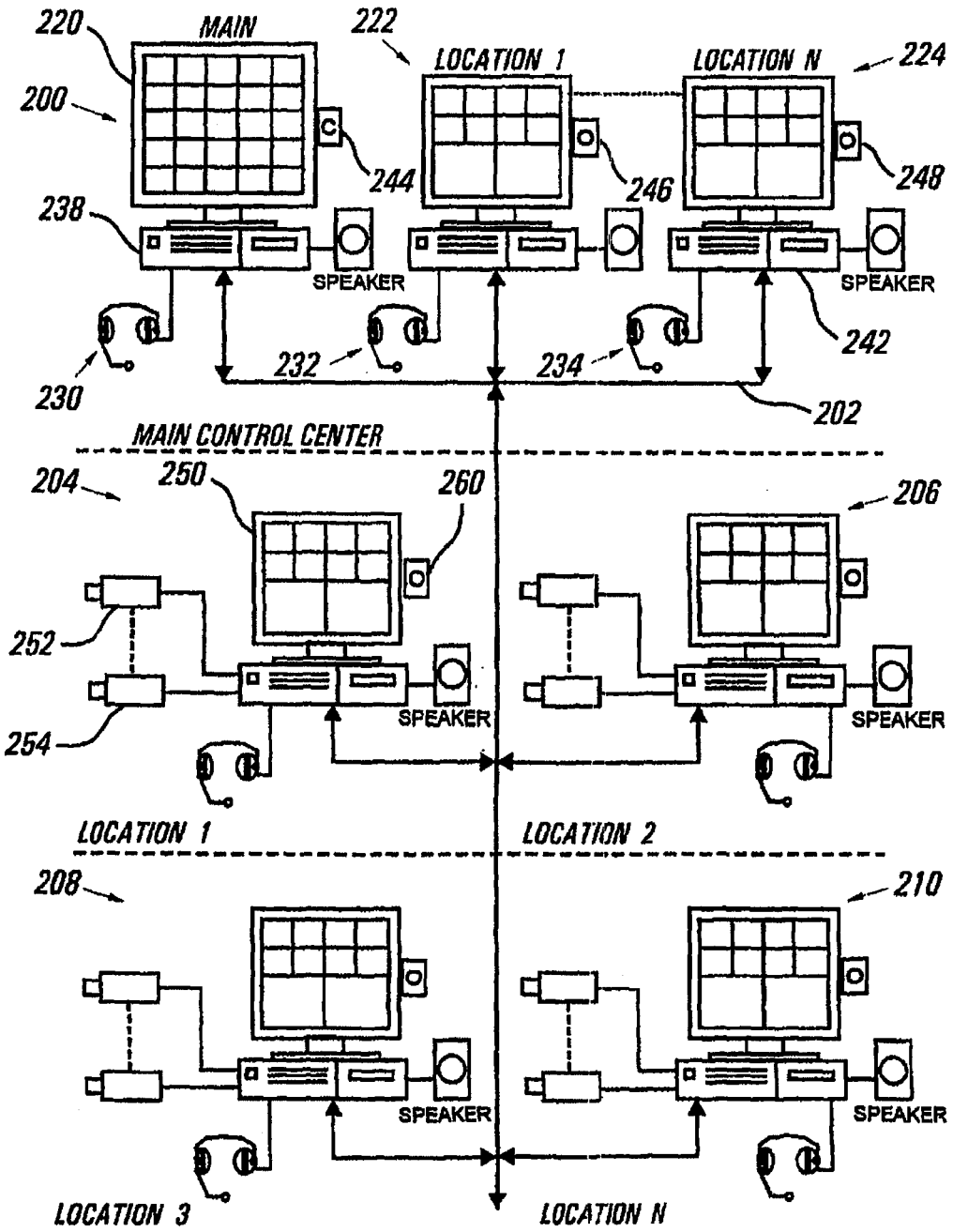
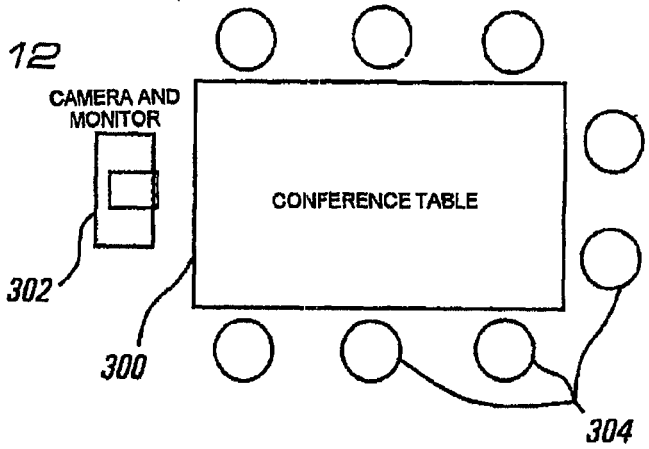

220
MAIN
222
LOCATION 1
LOCATION N
224
200
244
246
248
238
SPEAKER
SPEAKER
242
230
232
234
202
MAIN CONTROL CENTER
204
250
260
206
252
254
SPEAKER
SPEAKER
LOCATION 1
LOCATION 2
208
210
SPEAKER
SPEAKER
LOCATION 3
LOCATION N

Figure 12



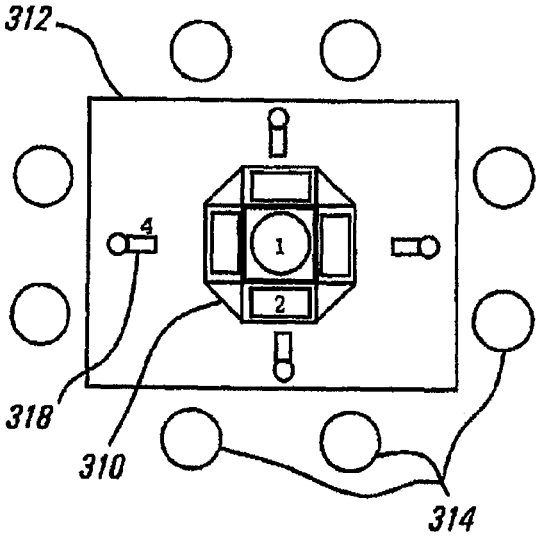
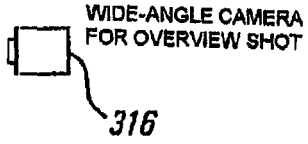


Figure 13a



1 = MULTI-CAMERA SECTION (2-8 CAMERAS)
2 = LCD DISPLAY SECTION (4+)
3 = SPEAKERS
4 = MICROPHONES

Figure 13b

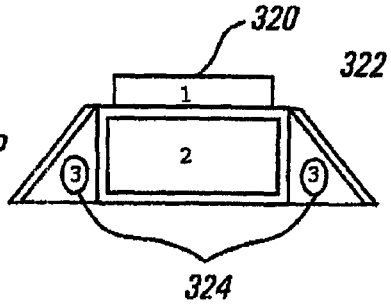


Figure 14

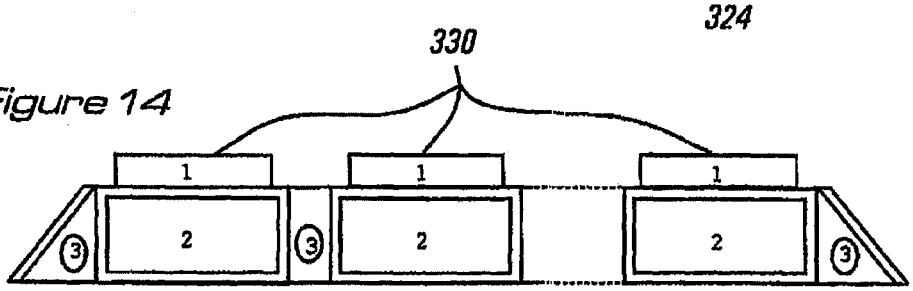


Figure 15

Mode	Ref. Fig.	Monitor Diag. Size	Monitor Pixel Dim.	Number of Windows by Size 240 x 180	320 x 240	400 x 300	480 x 360	640 x 480	800 x 600	Recording Time (Hrs.) @ 1 fps @ 100:1 DAT: B&W/Color	8-mm: B&W/Color
I	1	10" - 14"	640 x 480		4					960 / 480	1920 / 960
II	2	14" - 17"	1024 x 768		9					480 / 240	960 / 480
III	3	15" - 20"	1280 x 1024		8			2		360 / 180	720 / 360
IV	4	20" - 21"	1600 x 1200		25					180 / 90	360 / 180
V	5	20" - 21"	1600 x 1200			12			1	180 / 90	360 / 180
VI	6	14" - 17"	1024 x 768	8			2			240 / 120	480 / 240

VIDEO MONITORING AND CONFERENCING SYSTEM

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Ser. No. 08/050,861, filed Apr. 21, 1993 now U.S. Pat. No. 5,450,140 and Ser. No. 08/298,104, filed Aug. 30, 1994 now U.S. Pat. No. 5,537,157.

FIELD OF THE INVENTION

This invention relates generally to video monitoring, and, more particularly, to such systems employing means for digitizing camera images for display at a first image size, sampling rate, and frame rate, and for digital storage at a second image size, sampling rate, and frame rate.

BACKGROUND OF THE INVENTION

Existing systems for monitoring video signals from multiple sources either have relied upon switching means to sequence through each of the sources in a predetermined pattern, or else implement some form of "split screen" display, in which a conventional video monitor displays, for example, the output of four cameras, each occupying a portion of the display screen. Often, the video output is also supplied to signal storage means such as a VCR which is operated in a single-frame recording mode, providing a time-lapse record of the camera outputs. These types of systems are in common usage, and are well known in the art.

More recently, the availability of digital techniques for video signal processing and data compression has opened new video monitoring alternatives. Mathisen, for example, U.S. Pat. No. 4,198,656, describes a system employing a signal selector which is controlled by signal storage means, including a VCR functioning as a time-lapse frame recorder, and disc storage means functioning as a frame-store type device which provides continuity in the display while the selector is advancing through its sequence to the next signal source, or to the next recorded signal from one particular source. Each image is further provided with a digital code, which enables the image source to be identified upon playback.

Katz (U.S. Pat. No. 5,216,502) discloses a system for monitoring and recording transactions at multiple cashier lanes. According to the preferred embodiment, output signals from four cameras are fed to a four-quadrant multiplexer, which contains a frame store having provisions for reducing each camera image to one-quarter size and then displaying it in one of the four quadrants of the video monitor. The combined output signal is then recorded on a Video Cassette Recorder (VCR) to provide a more permanent record of the transaction. No description is given of the size-reduction method, but this kind of display may be implemented by employing a time-compression scheme for the horizontal lines, and eliminating alternate scan lines from the vertical dimension of the video frame. Data from the individual cash registers is encoded digitally, and then either recorded on lines of video in the vertical-interval or else recorded on the audio tracks of the VCR. The monitoring provisions include a video overlay generator, so that transaction information may be displayed concurrently with images of the event. Provisions are also included for selective recording of representative frames of video, as triggered by transaction events at individual cashier lanes. This further reduces the number of frames recorded, and extends the recording duration of the video cassette.

Neither of these two inventions disclose the use of image data compression schemes, nor of image resizing by digital means. Katz does disclose selective recording of frames of video, but only in analog form, and using conventional video recording means, such as a VCR.

Blum et al. (U.S. Pat. No. 5,237,408) disclose a system employing multiple interface circuit boards containing provisions for capturing and digitizing images from a plurality of cameras, further storing a slow-scan sequence of images for each camera in active buffer memory means as RAM on each of the interface boards. The display of these image sequences is preferably controlled by a PC with disk storage capabilities, and individual images selectively may be recorded on the hard disk, under operator control. Storage capacity is limited, however, because no image data compression is provided, and it is not practical to store large quantities or sequences of images. There are no provisions for automatic recording of images, nor any provision for storing these images in a data form differing from the display format image size.

Gormley (U.S. Pat. No. 5,258,837) discloses video compression means as a method for fitting multiple camera images within a single video display screen. However, Gormley clearly indicates that the system relies on fixed image-size compression of the digitized incoming video signal, and does not perform any kind of bandwidth compression. Provisions are included for storing images on a video recorder, but, as in other systems, these images are stored by taking the screen display as a whole, rather than storing independently constituted representations of the individual camera outputs.

In general, these conventional systems, regardless of the subsequent signal processing employed, accept analog video signals from the camera sources for input to the monitoring system. As such, these signals are susceptible to disturbances such as RF interference, ground-loop noise, and high-frequency signal loss due to long runs of coaxial cables. Automatic video switcher units sequence the source signals at a relatively slow rate, requiring as much as 16 seconds delay between successive viewings of a particular source when using a one source-per-second rate to sequence through 16 sources. When such a system is equipped with a time-lapse video recorder, the recording medium is expensive, has low resolution, and is limited in recording capacity.

Other systems, such as video conferencing arrangements, use multiple camera images and audio sources which are coordinated through electronic switching means and image display means, with interconnections between conferencing rooms locally or at remote sites via telephone lines or other communications links. Fabris et al. (U.S. Pat. No. 4,516,156) discloses a sophisticated implementation of such a system, employing satellite links for long-distance communications, a full range of camera remote controls (including lens controls and pan-tilt-head controls), and touch-screen monitor facilities for system controls of cameras and signal switching. This system, however, has no provisions for image storage, or any application of image data compression means coupled with display means or image storage means.

SUMMARY OF THE INVENTION

The present invention implements an automated video monitoring system by way of a PC-based platform employing

display windowing software, with camera sources being interfaced to an input circuit board which includes provisions for image data compression. Using a basic image size in pixels of 320×240, and optionally including color processing employing a Y-U-V 4:1:1 or 4:2:2 sampling technique, a range of performance standards are established. An economical simultaneous display of 4 sources in a 2×2 configuration on a conventional 10" VGA-format (640×480 pixels) monitor may be upgraded to a more elaborate 24-source (plus one utility window, which also may be used as a graphical-based input source device for transmitting control commands to the individual cameras) display in a 5×5 configuration on a high-resolution 20" (1600×1200 pixels) monitor. Other combinations are possible, including arrays of images of size 640×480 pixels or even 800×600 pixels, depending on the screen size of the display monitor and the capabilities of the video display adapter circuit card. In addition, not all image windows need to be of the same size, nor updated at the same rate, but rather they may be mixed and combined based on particular applications. Remote controls for the individual cameras may be implemented by way of windowing software and/or monitor touch-screen devices. Automatic sensing of particular events (representing security alarms, equipment or process disturbances, or a change in the person speaking in a videoconferencing environment) may be employed to cause reconfiguration by way of resizing the image or modifying the update rate of individual windows on the display screen, or by modifying the data format of recording images on a storage device.

Storage of images may be implemented by way of a tape back-up device, such as a DAT or 8-mm tape recorder, which are capable of storing as much as 960 hours of monitoring images, or by way of disk storage devices, preferably including removable disk drives such as magneto-optical disks or PCMCIA-compatible disk-drive modules. Images are preferably stored as a succession of data-compressed representations, corresponding to various window sizes sampled at diverse update rates; however, though the image representations need not be identical to the sizes and rates used for video monitors displaying the various images. In an alternative embodiment, cameras are provided with data compression means at the camera location, with a bi-directional data link providing control signals from the PC, and accepting data-compressed images from the cameras. Depending on the data rates selected, the transmission of these signals may be by means of coaxial cables, twisted-pair lines, or fiber-optic cables. These signals may alternatively be transmitted over internal PBX telephone lines, or over greater distances, including satellite links, as would be the case for remote monitoring of facilities or videoconferencing. The use of digital images allows the application of various useful techniques, such as digital noise reduction and motion-sensing, to trigger security alarms, for example.

It is an object of the invention to provide a more efficient method for monitoring camera outputs by means of a multiple-window display system implemented on a computer platform.

It is another object of the invention to provide an improved recording system for event-logging or security applications, by means of storing data-compressed digital images, including identifying information, which are more representative of events than typical analog time-lapse recordings, and further to implement this system on a computer platform.

It is a further object of the invention to provide extended recording time for event-logging or security applications by means of either tape-based, or disk-based, or both tape-based and disk-based data recording means.

It is yet another object of the invention to provide a system for remote monitoring of cameras by means of transmission of data-compressed digital images over communication links.

It is yet a further object of the invention to provide a convenient method of implementing videoconferencing facilities by means of a PC-based platform.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1-6** show various possible screen display configurations according to the invention;

FIG. **7** is a functional diagram of a PC-based system wherein plug-in printed-circuit boards implement digital processing for analog input signals;

FIG. **8** is a functional diagram of a plug-in printed-circuit board introduced with reference to FIG. **7**;

FIG. **9** is a functional diagram of a universal camera adapter having digital output signals;

FIG. **10** is a diagram of an integrated camera system;

FIG. **11** is a functional diagram of a PC-based monitoring system adapted for videoconferencing at multiple remote locations;

FIG. **12** is an overhead view of a physical layout of the system of FIG. **11**;

FIGS. **13**A and **13**B are drawings of a multiple-camera monitoring unit for table-top use in videoconferencing;

FIG. **14** is a side-view of an expanded multiple-camera monitoring unit implemented for videoconferencing;

FIG. **15** is a table listing a variety of possible operating modes, depending on computer monitor display facilities, in either a monitoring or a videoconferencing version of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention implements an automated video monitoring system by way of a PC-based platform employing display windowing software, with camera sources being interfaced to an input circuit board which includes provisions for image data compression. The basic video window size of 320×240 pixels from each camera source can be displayed on a variety of video monitors, in a number of formats, depending on system complexity. The preferred recording medium is a 4-mm helical-scan data cartridge, commonly referred to as a digital audio tape (DAT). Each tape cartridge is capable of storing 10 GB (gigabytes) of data. All recording times in the explanation below are based a data-compression ratio of 100:1, utilizing a 4:2:2 Y/U/V sampling method for color images. Other higher capacity media, such as 8-mm tapes capable of 20 GB of data storage, may be employed when longer times are desired.

FIG. **15** shows a variety of possible operating modes, depending on the particular implementation of the PC-based monitoring system. These six representative modes will be explained in detail with the understanding that the invention is by no means limited to the specific examples shown, and that many different alternatives are possible. It should be noted also that in certain of the implementations shown, the entire screen may not be occupied by the various windows, and any unused areas at the top, bottom, or sides may be utilized to display warning messages, control buttons, or other such facilities.

FIG. **1** shows a computer monitor display for a system configured in accordance with Mode I as listed in FIG. **15**. Using a commonly available 14" VGA-format computer monitor with a dimension in pixels of 640×480, four windows

having a dimension in pixels of 320×240 may be displayed simultaneously. Recording this data at the rate of one frame per second (1 fps) in black and white (B/W) and with 100:1 data-compression on a 10 GB DAT tape provides approximately 960 hours of images per tape, or alternatively more than 480 hours of color images. A second monitor optionally may be used to display utility windows including various system operating controls, as, for example, camera pan, tilt, zoom, focus, and so forth.

FIG. **2** shows a computer monitor display for a system configured in accordance with Mode II as listed in FIG. **15**. Using a 15" to 17" SVGA-format computer monitor with a dimension in pixels of 1024×768, nine windows, each having a dimension in pixels of 320×240, may be displayed simultaneously. Eight windows may be implemented as camera displays, and the ninth window may be used for the continuous display of the utility window, as described above. Recording of all eight windows at 1 fps will allow 480 hours of B/W images in this configuration per 10 GB DAT tape, or alternatively more than 240 hours of color images.

FIG. **3** shows a computer monitor display for a system configured in accordance with Mode III as listed in FIG. **15**. Using a 17" to 20" high-resolution computer monitor with a dimension in pixels of 1240×1024, eight windows having a dimension in pixels of 320×240 may be displayed, in addition to two windows having a dimension in pixels of 640×480. One of these larger windows may be implemented as a utility window, and the other larger window may be implemented for sequential display of the eight camera inputs at full camera resolution having a dimension in pixels of 640×480. Recording all eight camera image windows, and also the input-scan window, at 1 fps will allow 360 hours of B/W images in this configuration per 10 GB DAT tape, or alternatively more than 180 hours of images in color.

FIG. **4** shows a computer monitor display for a system configured in accordance with Mode IV as listed in FIG. **15**. Using a 20" high-resolution computer monitor with a dimension in pixels of 1600×1200, 25 windows with a dimension in pixels of 320×240 may be displayed simultaneously. Twenty-four windows may be implemented as camera displays, and one is implemented as a [the] utility window. Recording all twenty-four windows, and also the utility window, at 1 fps will allow 180 hours of B/W images in this configuration per 10 GB DAT tape. If color recording is desired, a 20 GB 8-mm data cartridge will allow 180 hours of color images.

FIG. **5** shows a computer monitor display for a system configured in accordance with Mode V as listed in FIG. **15**. Using a 20" high-resolution computer monitor with a dimension in pixels of 1600×1200, twelve larger windows having a dimension in pixels of 400×300 may be displayed, as well as one large high-resolution window, with a dimension in pixels of 800×600, to display the sequentially scanned output of the camera images. Recording in this format at 1 fps will provide 180 hours of B/W images in this configuration per 10 GB DAT tape. If color recording is desired, a 20 GB 8-mm data cartridge will allow 180 hours of color images.

FIG. **6** shows a computer monitor display for a system configured in accordance with Mode VI as listed in FIG. **15**. Using a 14" to 17" SVGA computer monitor with a dimension in pixels of 1240×1024, and implementing a smaller window size with a dimension in pixels of 240×180, eight windows are available for the camera image displays, and two large windows of 480×360 are available for sequentially-scanned camera images. Recording in this screen format at 1 fps allows 480 hours of B/W images in this configuration on a 20 GB 8-mm data cartridge, and allows 240 hours of images in color.

In any of the display configurations just described, it is also possible to use a video overlay technique to display the utility controls superimposed on the camera video. Regardless of which display or recording format is used, the PC based monitoring system includes various facilities and features, which will now be described in further detail.

In operation, the user need only observe the various display windows on the monitor screen, rather than concentrate on many monitors simultaneously, thereby reducing the risk of missing an important event. Since no video switcher is used in recording, and images from all sources are continuously recorded at the selected frame rate for each source, more information is recorded than in conventional analog systems, wherein events may be missed due to the sequential switching of input images. The digital format also improves the picture quality, as the signal-to-noise ratio will be higher than for analog systems. In addition, there is no loss of quality during recording or playback, and because the recording technique is digital, other types of information optionally may *be* recorded along with the camera data, such as audio, time, date, location, etc.

An additional feature is the capability to implement a dual-recording-media option. This facility provides the ability to record simultaneously both on a tape (for high capacity, long term storage) and also on a removable media, such as a removable hard disk (i.e. PCMCIA) or magneto-optical disk (for short-term storage of up to 24 hours of images). These disks facilitate high-speed searching of recorded information without interrupting the tape, as well as providing a back up for the recording on the tape. In addition, the system is capable of simultaneously searching the recorded images on the disk storage unit while continuing to store images on the tape storage unit.

It should be noted that there is no requirement that the image sizes or frame rates utilized for the video display match those utilized for the storage media. In practice, these two specifications may not agree, and will be determined by other factors, such as operator manipulation of the displayed image sizes or changes resulting from the detection of alarm conditions.

FIG. **7** shows a functional diagram of an analog input-digital processing card installed in the PC which allows the use of existing analog cameras and cables with the PC-based monitoring system. This card, which may be obtained from such manufacturers as Nova, Model No. V-SW, features four video inputs **2**a-**2**d having balanced or differential input circuitry for good noise immunity (or optically-coupled inputs for fiber-optic cabling), four video amplifiers **4**a-**4**d, a 4×1 video switcher **6** by which any one of the four video inputs may be selected as a signal source, and an analog-to-digital (A/D) converter **8**. The recording of camera inputs is digital, however, there is no provision for remote control of camera functions such as pan, tilt, zoom, and so forth. If additional inputs are desired, multiple cards may be installed in the PC. The output of the A/D converter **8** is supplied to the graphics processor and image data-compression engine **10**. This unit performs the various functions required to configure the image sizes and frame rates as specified by the equipment operator. Because the overall data recording bandwidth of the system is a factor in the selection of the individual picture data rates, computer software is provided to implement menu-driven management of the data bandwidth allocation to the various image sources. Based on this configuration, signals are provided to the video switcher **4** to facilitate the selection of the particular image sources as required. The data-compressed images are provided in digital form to the microprocessor data bus **12**. The microprocessor unit (not shown) in

turn provides control signals to the graphics processor **10** by way of this data bus, in accordance with the image data allocation configuration selected.

FIG. **8** is a functional diagram of a digital input/output-digital processing card which implements bi-directional digital communications to and from the camera/adapter unit over a single transmission line, thereby greatly reducing the cost of cable and installation, and allowing existing wiring to be used. Various implementations of this printed-circuit card are required, depending on the type of network interconnection media selected. In addition, system performance will depend on the type of network interconnection media. As an example, a fiber optic network will have a higher transmission rate and better signal quality than a telephone network. Interfacing technology for these communication methods are in common usage and well known in the art. This printed-circuit card also serves four cameras through inputs **52**a-**52**d, and additional cards can be implemented if required. The bi-directional digital video and camera control data switcher **54** serves to select the individual image sources as explained in reference to FIG. **7**. These source signals are then provided to the graphics processor and image data-compression engine **56**, which provides similar functions to those provided by the graphics processor **10**, discussed in reference to FIG. **7**. The processed data-compressed images are then provided to the microprocessor data bus **60**. However, in this implementation, the bi-directional nature of the data switcher **54** is exploited to provide full functional control of the camera facilities through the bi-directional controller **58**. These functional controls include the cameras themselves (lens and exposure control) and the camera's physical mounting provisions (pan and tilt). The various control signals for these functions are those traditionally provided to these kinds of equipment, and these concepts are well known in the art. In an alternative embodiment, the individual cameras are each equipped with separate image data-compression facilities, utilizing such techniques as motion-JPEG or MPEG compression. In this case, control signals for these additional functions are provided from the microprocessor bus **60** through the bi-directional controller **58** and the data switcher **54**.

FIG. **9** is a functional diagram of a digital output universal camera adapter. This is a fully digital version of the camera adapter as described in co-pending U.S. patent application Ser. No. 08/050,861, titled "PERSONAL-COMPUTER BASED VIDEO PRODUCTION SYSTEM" now U.S. Pat. No. 5,450,140. The A/D-converter, digital image data-compressor, and bi-directional interface camera adapter **100** accepts analog audio and video signals from the camera **102**, and converts them to digital signals in anticipation of the transmission of these signals over the interconnection network **104**. The camera adapter also receives camera control commands from the PC by means of the interconnection network, and translates them into the appropriate pan, tilt, zoom, focus and iris control signals for the particular camera equipment, including the camera lens **106** and the pan/tilt mounting facilities **108**. In addition, the camera adapter also has inputs for several "alarm system" type sensors **110**, as, for example, motion detectors, photocell detectors, or simple switches. These alarm signals are digitized, encoded, and then transmitted to the main PC by means of the [interconnection,network] *interconnection network*. Power is supplied for this equipment from a local source **112**. This camera adapter is implemented to provide a full-function system, adaptable to all existing types of cameras and control equipment. However, because of the large number of interconnections involved in the adapter, camera, pan/tilt unit, and sensors, the installation process may be somewhat complicated.

By equipping an individual camera input with digital frame store capabilities, it is possible to detect an alarm condition based on deviations from the normal-state image scene. For example, if a camera is monitoring a door exit or an area of a warehouse aisle that is not utilized during evening hours, any change in the image would represent an alarm condition. To allow camera movement, this sensing process would be disabled during pan, scan, tilt, zoom, and other camera positioning controls, and the sensing would be re-enabled after camera positioning ceased, or by manual operator control.

FIG. **10** is a functional diagram of an integrated camera system according to the invention including means to overcome problems associated with having a physically separate camera, pan/tilt unit, and adapter unit. The integrated system includes a camera **150** with pan/tilt control, A/D converter, digital data-compression circuitry, and requisite interfacing circuitry. Such provisions are preferably included in the camera base structure **152**, which simplifies installation, as no separate interconnecting cables are required. The integrated camera system optionally may include provisions for supplying electrical operating power from a network coaxial cable, and thereby may be implemented with only a single interconnecting cable. An integrated camera system of this type may be implemented in a physical package which is as small as the camera itself, since most of the electronics may be highly miniaturized by developing custom integrated circuits, including LSI, ASIC, DSP, and mixed-signal processing.

It will be appreciated that in any of these implementations, alarm or sensor signals may be utilized to automatically reconfigure the system operating mode, as, for example, increasing the frame rate or image size for an image source associated with the sensor which has initiated the alarm signal condition. As explained above, the displayed windows and image sizes may be reconfigured into an operating mode different from the reconfiguration of the digital storage mode. If desired, the operator may choose to allow the system to automatically adjust the compression ratio utilized for a particular window in response to alarm signal conditions. Alternatively, the compression ratio may be adjusted in response to the selection by the operator of a particular window for closer monitoring, by switching to an image window having larger dimensions in pixels. For some applications, the use of a resolution-independent data compression scheme, such as the "Fractal Compression" method of Iterated Systems, Inc., will be preferred, since images compressed by this method may be resized to fit larger or smaller windows as desired, without loss of apparent resolution. In addition, automatic switching of the audio signals associated with a particular window in response to alarm signal condition will enable the operator to fully investigate such events, and the audio signals may serve to attract the operate's attention to the event. Such switching optionally may be coupled with operator selections for monitoring purposes as well, and in both of these options may be integrated into the system previously described for recording the images, with or without any associated audio signals, onto the mass-storage media.

FIG. **11** illustrates a PC-based monitoring system implemented for videoconferencing at multiple remote locations. In this application of the invention, a main control center, shown generally as **200**, is interconnected, by way of a network, with remote locations, shown generally as **204** to **210**, designated as "1" through "N". The network **202** may be implemented by way of telephone lines (slow speed), ISDN Lines (medium speed), or alternatively coaxial cable or fiber optics cables (high speed). The higher speed implementations permit transmission at higher frame rates and higher image resolutions. As an alternative, wireless networks or micro-

wave links optionally may be used. Network communication between the main and remote locations is bi-directional; the main computer receives audio, video, and sensor data from each of the remote locations, and transmits controls for camera pan, tilt, focus, zoom, and so forth. Audio and video communications for the system operators also is provided, by means of an additional camera and headset at each location.

The application of these PC-based monitoring techniques also may [he] *be* implemented in cases in which the central monitoring area may be located at some distance from the remote site. In this case, the physical hardware and networking facilities will follow the example shown in FIG. **11**, with the understanding that "Location 1" through "Location IN" will now refer to separate monitoring for security applications or other monitoring purposes.

The purpose of the main control center is to manage multiple cameras at multiple locations. By monitoring and controlling the remote locations from a central location **220**, the system may function without an operator at each location. Optionally, additional computers shown, by way of example, as **222** and **224** at the main location may be implemented to simplify the monitoring and control of the remote locations. The main control center stores the data from remote locations in the main control storage facilities, shown, by way of example, as **238**, **240** and **242**, using digital tape and removable media, including, by way of example, PCMCIA-based removable media or magneto-optical (MO) media. The images may be stored at various frame rates and resolutions, depending on the requirements for the intended use of the stored images. Intercom provisions as shown as **230**, **232** and **234**, facilitate the coordination of activities between the main control center and the various remote locations, and video camera units are provided at each of the computers, shown, by way of example, as **244**, **246** and **248**.

Each remote location includes a PC/monitor **250**, with multiple video cameras, shown, by way of example, as **252** and **254**, including provisions **256** for image and data storage utilizing digital tape and other removable media. This remote location may be operated under control from either the main location (as described above), or a local operator, or by specific software designed for automatic control. In the case of software-controlled operations, provisions are included for control to be assumed by the main control center, if necessary. As in the case of the main control computers, each of the remote computers is equipped with intercom facilities as **258** and video cameras as **260**.

In the traditional videoconferencing situation, only one camera and monitor are used. Unfortunately, this results in an unnatural scene which provides the users with only a single viewing perspective. The use of a wide-angle camera lens which is needed to include many people seated around a table creates a distorted view, especially for those seated furthest from the camera. FIG. **12** shows an overhead view of the typical videoconferencing arrangement, including conference table **300**, camera and monitor **302**, and conference participants, shown as circles as **304**.

Using the PC-based monitoring system, it is possible to create a video conference that presents a much more natural viewing appearance. As shown in FIG. **13**A, a multiple-camera, multiple-display unit **310** [preferably] is preferably located directly on the conference table **312**. This reduces the camera-perspective-distorting effects just described, because conference members **314** may be seated in a more comfortable and convenient position. The resulting video image is also much more natural. Each controller remote site computer-display section **322** (as described herein below) simultaneously shows all of the members participating in the remote conference, with an individual video window allocated for each participant, under control from the PC-based monitoring system operator. In practice, the remote site equipment operator will select one of the display operating modes as described in FIG. **15**, depending on the number of subjects (camera views) and the capabilities of the remote site computer equipment. Optionally, an additional camera **316** fitted with a wide-angle lens will provide an overall view of the conference room, in accordance with more traditional systems.

To facilitate the aiming of the individual cameras for the participants, an arrangement such as that implemented at airport gates to assist the parking of airplanes (typically an "I" and an "O" formed of neon light tubes is utilized for airplane gate parking) optionally may be included. In this case, the two indicators are mounted so as to overlap only when viewed directly along the optical axis of the camera lens system. Thus, the camera position need only be adjusted so as to cause the indicators to overlap, thereby assuring that the camera correctly is aimed at the subject. A number of microphones **318** are situated around the conference table in locations suitable for proper audio coverage of the participants' speech.

FIG. **13**B shows a side-view depicting the physical layout of each of the four sides of the multiple-camera, multiple-display unit **310**. The top unit **320** houses the individual cameras (2 to 8 units) and associated electronics, optionally including aiming provisions as described herein above. An LCD display screen **322** shows the various camera images of the conference participants. Speakers located at positions **324** provide audio from the remote sites.

As shown in FIG. **14**, the multiple-camera/display unit shown in FIG. **13**B preferably is modular in construction including removable side panels, in order to facilitate expansion along either horizontal axis so as to accommodate any size or shape conference table, with each section of the unit serving up to four conference participants. In the preferred embodiment, the entire unit preferably is constructed so as to provide a low profile, by utilizing slanted LCD display panels **330** to create a minimum obstruction for the local conference participants. If a low profile design is not required, the display panels optionally could be larger, and mounted vertically. Until color LCD panels become more cost-effective, the display unit would be constructed with any of the currently available small LCD projector systems. Each conference location may include a designated PC operator, however, the implementation of the network connection facilitates control of the system from a remote location.

It should be noted that the implementation of the PC-based monitoring system is not limited to these examples of security systems or videoconferencing. Many alternative implementations, such as workplace, factory, production line, and process monitoring, would benefit from this system, and these alternative implementations should be considered to be within the scope of the invention.

We claim:

1. A video storage and display system, comprising:

[a plurality of] *one or more* video cameras, each outputting a signal representative of a video image;

means to receive the signals from each camera and digitally compress the images;

two forms of high-capacity storage media, one being randomly searchable while the other continues to store the digitally compressed image; and

a computer configured to receive the digitally compressed images, the computer being interfaced to the following devices:

a display screen,

means to receive externally derived operator commands, and

the high-capacity storage media, and wherein the computer is programmed to perform the following functions:

display the digitally compressed images from the cameras in different windows on the display screen, each window being associated with an update rate and dimensions in pixels,

vary [the dimensions and the rate] *spatial parameters and temporal parameters* at which a particular image is updated in its window in accordance with one of the externally derived commands,

store the digitally compressed images in the high-capacity storage [medium] *media*, and

vary the [dimensions and the rate] *spatial parameters and temporal parameters* at which a particular image is stored in accordance with one of the externally derived commands.

2. The video storage and display system of claim **1**, further including means associated with the computer for controlling the operation of one or more of the video cameras.

3. The video storage and display system of claim **1**, wherein the means to digitally compress the image from a particular camera is disposed at the location of the camera.

4. The video storage and display system of claim **1**, wherein the means to digitally compress the image from a particular camera is disposed at the location of the computer.

5. The video storage and display system of claim **1**, further including a separate computer associated with each camera, the computers being networked together over a common communication bus, enabling an operator situated at a particular computer to display the images gathered by other cameras in separate windows on that operator's display screen.

6. The video storage and display system of claim **1**, wherein *one or both of* the high-capacity storage [medium] *media* comprises a magnetic tape.

7. The video storage and display system of claim **1**, wherein *one or both of* the high-capacity storage [medium] *media* comprises a magnetic disk.

[**8**. The method of simultaneously displaying and storing multiple video images, comprising the steps of:

receiving video images from a plurality of sources;

digitizing one or more of the images if not already in digital form;

displaying at least certain of the digitized images in separate windows on a display device, using a first, predetermined frame rate and resolution associated with each window; and

simultaneously storing the displayed images using a second, predetermined frame rate and resolution associated with each image.]

9. The method of claim [**8**] *12*, further including the step of receiving a command to set the frame rate and resolution associated with the display and storage of a particular image.

10. The method of claim **9**, wherein the command is based upon an operator input.

11. The method of claim **9**, wherein the command is based upon an external stimulus.

12. The method of simultaneously displaying and storing multiple video images, comprising the steps of:

receiving video images *at a personal computer based system* from [a plurality of] *one or more* sources;

digitizing [one or more] *any* of the images [if] not already in digital form *using an analog-to-digital converter*;

displaying at least certain of the digitized images in separate windows on a *personal computer based* display device, using a first set of temporal and spatial parameters associated with each image in each window;

[simultaneously storing the displayed images] *converting one or more of the video source images into a data storage format* using a second set of temporal and spatial parameters associated with each image; *and*

simultaneously storing the converted images in a storage device.

13. The method of claim **12**, the temporal parameters including frame rate.

14. The method of claim **12**, the spatial parameters including image dimension in pixels.

15. A video storage and display system, comprising:

[a plurality of] *one or more* video cameras, each outputting a signal representative of a video image;

means to receive the signals from each camera and digitally compress the images; and

a computer configured to receive the digitally compressed images, the computer being interfaced to the following devices:

a display screen,

means to receive externally derived operator commands including means for sensing a deviation from the normal-state image scene associated with at least one of the video cameras, the existence of the deviation being used as the basis for generating an externally derived command, and

a high-capacity storage medium, and programmed to perform the following functions:

display the digitally compressed images from the cameras in different windows on the display screen, each window being associated with an update rate and dimensions in pixels,

vary [the dimensions and the rate] *spatial parameters and temporal parameters* at which a particular image is updated in its window in accordance with one of the externally derived commands,

store the digitally compressed images in the high-capacity storage medium, and

vary the [dimensions and the rate] *spatial parameters and temporal parameters* at which a particular image is stored in accordance with one of the externally derived commands.

16. The video storage and display system of claim 1, wherein one or more video images or camera control signals are received through a network connection.

17. The video storage and display system of claim 1, wherein one or more of the high-capacity storage media comprises a removable or permanent magnetic disk, a removable or permanent magneto-optical disc, a removable optical disc or a removable or permanent semiconductor-based device.

18. The video storage and display system of claim 1, wherein the temporal parameters include frame rate and the spatial parameters include image dimension in pixels.

19. The method of claim 12, wherein one or more video images or camera control signals are received through a network connection.

20. The method of claim 12, wherein the high-capacity storage medium comprises a removable or permanent magnetic disk, a removable or permanent magneto-optical disc, a removable optical disc or a removable or permanent semiconductor-based device.

21. The method of claim 12, including a display device associated with each source and a communication capability

enabling an operator situated at the display for one source to view images, in separate windows, gathered by one or more different source.

22. The video storage and display system of claim 15, further including a device for remotely controlling the operation of one or more of the video cameras.

23. The video storage and display system of claim 15, wherein one or more video images or camera control signals are received through a network connection.

24. The video storage and display system of claim 15, wherein the high-capacity storage medium comprises a removable or permanent magnetic disk, a removable or permanent magneto-optical disc, a removable optical disc or a removable or permanent semiconductor-based device.

25. The video storage and display system of claim 15, further including a memory for storing the sensed deviation information in conjunction with the image data.

26. The video storage and display system of claim 15, further including:

a computer and display device associated with each video camera; and

communication capability enabling an operator situated at the display device associated with one camera to view images, in separate windows, gathered by one or more different cameras.

27. The video storage and display system of claim 15, wherein the temporal parameters include frame rate and the spatial parameters include image dimension in pixels.

28. A video storage system, comprising:

one or more video sources, each outputting a signal representative of a video image;

means to receive the signals from each source and digitally compress the images;

two forms of a high-capacity video storage media; and

a computer interfaced to the following devices:

an input to receive externally derived operator commands, and

the high-capacity storage media, and

wherein the computer is programmed to perform the following functions:

store the digitally compressed images in the high-capacity storage media, and

vary the spatial parameters and temporal parameters at which a particular image is stored in accordance with one of the externally derived commands.

29. The video storage system of claim 28, wherein the high-capacity storage media include one medium being randomly searchable, and with the other being serially searchable.

30. The video storage system of claim 28, wherein one or more video images is received through a network connection.

31. The video storage system of claim 28, wherein the high-capacity storage media comprises a removable or permanent magnetic disk, a removable or permanent magneto-optical disc, a removable optical disc or a removable or permanent semiconductor-based device.

32. The video storage system of claim 28, wherein the temporal parameters include frame rate and the spatial parameters include image dimension in pixels.

33. A digital video recording and monitoring system configured for use with a display device, comprising:

one or more inputs for receiving video material characterized by having spatial parameters and temporal parameters;

circuitry for digitally compressing the video material;

a first video storage medium which is randomly addressable;

a second video storage medium which is serially addressable;

an output for delivering the video material to the display device;

a user control; and

processing hardware or software operative to perform the following functions under user control:

a) store the digitally compressed video material in one or both of the first and second video storage media, and

b) output the video material for monitoring to the display device.

34. The digital video recording and monitoring system of claim 33, wherein the processing circuitry is operative to simultaneously store the digitally compressed video material in the first and second video storage media.

35. The digital video recording and monitoring system of claim 33, wherein the first video storage medium is a magnetic disk.

36. The digital video recording and monitoring system of claim 33, wherein the second video storage medium is a magnetic tape.

37. The digital video recording and monitoring system of claim 33, wherein the processing circuitry further permits searching of the video material previously recorded on the first storage medium while continuing to store the material on the second storage medium.

38. The digital video recording and monitoring system of claim 33, wherein the spatial parameters and temporal parameters of the video material in the first or second storage medium are different from the spatial parameters and temporal parameters of the video material delivered to the display device.

39. The digital video recording and monitoring system of claim 33, further including one or more video cameras interfaced to the one or more inputs.

40. The digital video recording and monitoring system of claim 33, further including:

a plurality of video cameras interfaced to the one or more inputs; and

the video material from different cameras is visible in different windows on the display device.

41. The digital video recording and monitoring system of claim 33, wherein the temporal parameters include frame rate and the spatial parameters include image dimension in pixels.

* * * * *

EXHIBIT B

US00RE37342B1

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(12) **Reissued Patent**

Washino et al.

(10) **Patent Number: US RE37,342 E**

(45) **Date of Reissued Patent: Aug. 28, 2001**

(54) **DUAL FORMAT DIGITAL VIDEO PRODUCTION SYSTEM**

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(73) Assignee: **Multi-Format, Inc.**, Teterboro, NJ (US)

(21) Appl. No.: **09/016,777**

(22) Filed: **Jan. 30, 1998**

Related U.S. Patent Documents

Reissue of:

(64) Patent No.: **5,488,433**
Issued: **Jan. 30, 1996**
Appl. No.: **08/396,574**
Filed: **Mar. 1, 1995**

U.S. Applications:

(63) Continuation-in-part of application No. 08/298,104, filed on Aug. 30, 1994, now Pat. No. 5,537,157, and application No. 08/050,861, filed on Apr. 21, 1993, now Pat. No. 5,450,140.

(51) **Int. Cl.**[7] **H04N 5/76**

(52) **U.S. Cl.** **348/722**; 386/112; 386/117; 386/126; 386/54; 386/55

(58) **Field of Search** 348/231–233, 348/722; 360/14.1, 14.3; 386/117–120, 52–60; H04M 5/76

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Primary Examiner—Michael H. Lee

(74) *Attorney, Agent, or Firm*—Gifford, Krass, Groh, Sprinkle, Anderson & Citkowski, PC

(57) **ABSTRACT**

An audio/video production system is implemented on a PC-based platform, preferably utilizing various forms of removable magnetic, optical, or magneto-optical storage media. Specially modified cameras or other sources provide digitally data-compressed audio and video program materials in two formats, a first format having a higher data-compression ratio and intended for use in off-line systems to develop edit decision lists, and a second format having a lower data-compression ratio and intended for use in on-line editing and to produce the final representations of the programs. Off-line editing decisions may thus be developed on a PC using removable storage media, and final representations of the programs may be produced on-line in accordance with stationary-head or rotary-head digital-tape-based formats, such as DAT, 6-mm or 8-mm tapes. In an alternative embodiment, automatic and unattended editing, or extended program playback of more than 40 hours duration of digital video, is available.

50 Claims, 2 Drawing Sheets

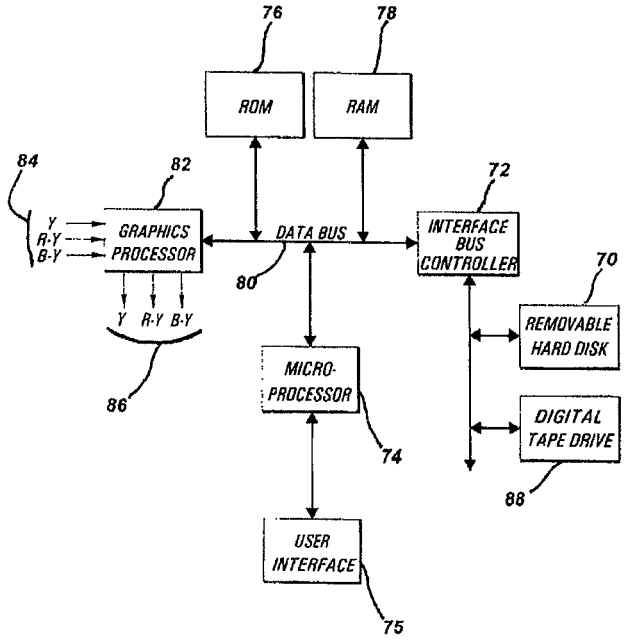


Figure 1

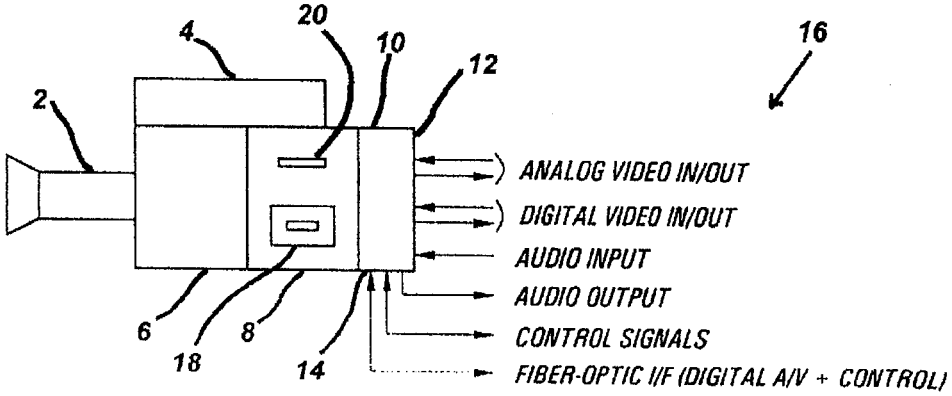


Figure 2

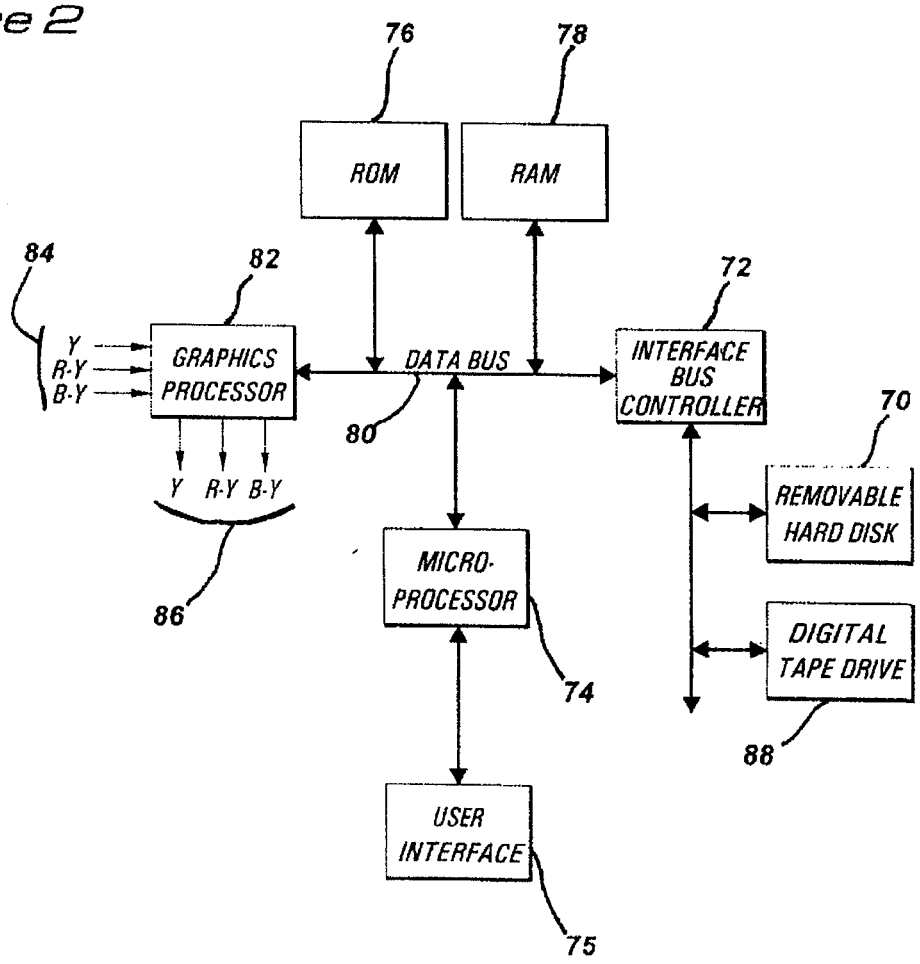


Figure 3

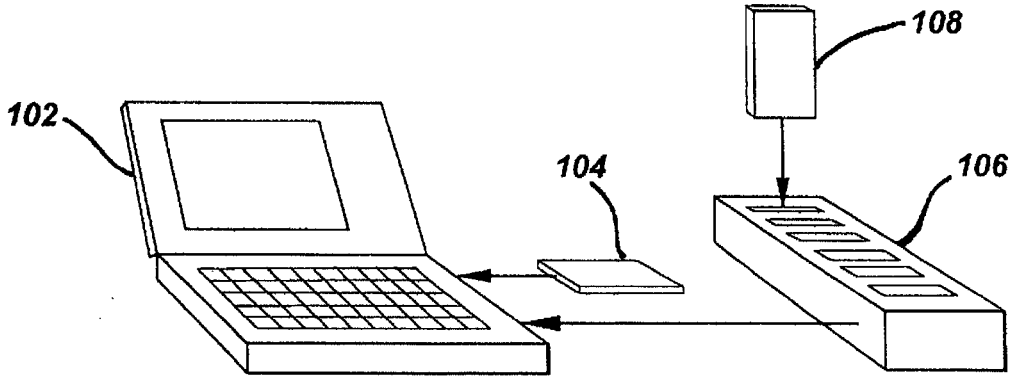
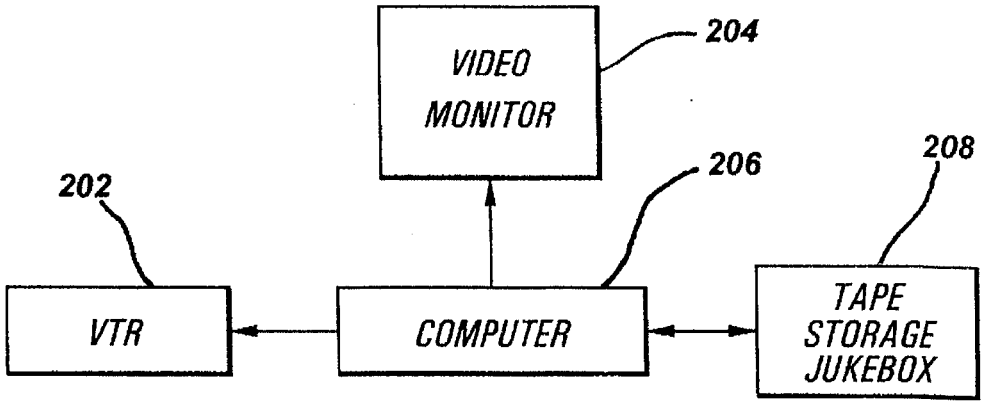


Figure 4



DUAL FORMAT DIGITAL VIDEO PRODUCTION SYSTEM

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of U.S. application Ser. No. 08/298,104, filed Aug. 30, 1994, *now U.S. Pat. No. 5,537, 157,* and U.S. application Ser. No. 08/050,861, filed Apr. 21, 1993, now patented, U.S. Pat. No. 5,450,140.

FIELD OF THE INVENTION

This invention relates generally to video recording systems associated with the editing of program materials, and, more particularly, to a system that takes advantage of a PC-based platform for performing non-linear editing functions.

BACKGROUND OF THE INVENTION

Traditional video editing systems are generally divided into two categories: linear and non-linear. Linear editing systems are generally integrated with tape-based program storage, while non-linear editing systems are associated more closely with disk-based storage media, wherein random-access storage more easily may be implemented. The typical linear editing system is implemented with one of the many "broadcast quality" videotape recording formats. The choices for analog recorders include, among others, 1" C-format, Betacam, Betacam-SP, ¾" U-matic, U-matic-SP, S-VHS, and Hi-8. The choices for digital recorders include, among others, D-1, D-2, D-3, D-5, DCT, and Digital Betacam. Each of these recording formats is incompatible with any other format, and all require sophisticated system facilities, including synchronization systems, edit controllers, audio and video switchers and processors, digital video effects [(DYE)] *(DVE)* systems, character generators, and other equipment. This, in turn, requires extensive physical plant facilities for electric power, air conditioning and air filtration, storage space, and maintenance equipment. Furthermore, large operational and maintenance staffs are required to keep the equipment in good working order. However, recording duration capacity for these types of videotape recorders ranges up to three hours or more, making them uniquely valuable for many applications, such as program distribution, archival storage, and as master program sources for mass duplication of videos for the home video market.

In contrast, non-linear systems are based on optical discs, or alternatively, on magnetic or magneto-optical disks. Because of the relatively high cost of these storage media when long-duration recording periods are required, such systems are relegated to use as off-line editing systems applied to the preparation of edit decision lists (EDLs) for use in edit suites incorporating linear editing systems. However, the rapid random-access features and editing ease are valuable for short programs.

As currently implemented by many manufacturers (such as AVID and videoCube), PC-based hard disk storage is very expensive. If equipped with 10 GB of storage capacity, the system, in practice, is utilized in a two-step process. First, the original unedited program material is digitized at a high data-compression ratio to provide representative pictures for use in an off-line editing environment, whereby the operator may develop an EDL. This EDL then is used to perform the required editing, using program materials that have been digitized and stored at much lower data-compression ratios. Because these two digitizing steps must be performed in real time, this is an expensive, time-consuming process which requires well-drained and expensive operational and engineering personnel.

SUMMARY OF THE INVENTION

It is an object of the invention to integrate the most valuable features of linear and non-linear editing system approaches.

It is another object of the invention to provide capabilities for automatic unattended editing from edit decision lists developed on an off-line editing system.

It is yet another object of the invention to provide a PC-based digital video recorder for applications such as broadcast television playback, video duplication source-master playback, or other related applications.

A further object of the invention is to provide extended playback of 40 hours or more of digital video programming, for cable television or other uses.

The present invention achieves these and other objectives by providing a PC-based audio/video production system which addresses the problem of providing inexpensive alternatives to the large, expensive edit suites currently in common use. Digital program source material, produced by specially modified cameras or other sources, provide data-compressed audio and video program materials in two formats having matched edit-time-code identification. A first format having a higher data-compression ratio and intended for use in an off-line editing system is used to develop an edit decision list, and a second format having a lower data-compression ratio is used in an on-line editing system for the production of a final representation of the program. As such, off-line editing decisions may be developed on a PC, including a portable PC, using removable storage media, and final representations of the programs may be implemented on a stationary-head or rotary-head digital-tape-based format, such as DAT, 6-mm or 8-mm.

By employing one of several new, small, inexpensive storage media such as PCMCIA-based disk drives, and by utilizing data-compression technology, the off-line editing capabilities are achieved in an economical system, with the digital-tape-based formats providing broadcast-quality required even for demanding applications. Recording duration capacity for these media is 60 to 120 minutes or longer for conventional NTSC or PAL video formats, and a natural extension to HDTV formats (with comparable program duration capacity) is achieved as commercial availability of storage media having higher recording densities becomes economically practical. Where compatibility to film materials is desirable, operation of the various system components at 24 frames-per-second is implemented.

A method of producing a final video program according to the invention therefore includes the steps of providing program source materials in the first and second digital formats, the first format being characterized in having a higher data compression ratio than the second; recording the materials in the first and second formats, respectively, onto first and second removable storage media along with correlated edit-time-code information in each case; interfacing the first storage medium to an off-line video editing system to develop an edit decision list: interfacing the second storage medium to an on-line video editing system; trans-

ferring the edit decision list developed in conjunction with the off-line video editing system to the on-line video editing system; and editing the materials in the second [formal] *format* on the second storage medium, in accordance with the edit decision list, to produce a final video program.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic drawing of a portable dual-format digital video recorder optionally implemented as part of a camcorder system;

FIG. **2** is a functional block diagram of a dual-format digital video recorder;

FIG. **3** is an oblique representation of an off-line digital video editing system implemented with a PC-based edit controller having provisions for accepting removable storage media; and

FIG. **4** is a block diagram of an on-line digital video editing system implemented with a PC-based edit controller having provisions for accepting removable storage media.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** shows a portable dual-format digital video recorder according to the invention, optionally implemented as part of a camcorder system. A lens **2** and viewfinder **4** are mounted on the body of a camera frame. The usual optical-splitter, CCD sensors and driver circuitry, and digital signal processing circuitry are located at **6**, with optional battery-pack capability being shown at **10**. The various analog and digital output signals and any input audio, video, or control signals, all shown generally at **16**, are interfaced through appropriate connectors disposed on the rear-panel **12** and sub-panel **14**. Provisions are included as shown for the input of analog audio signals, and for the output of both analog and digital audio signals. Preferably fiber-optic cabling is employed as a signal-carrying medium.

The internal video recording facilities are comprised of two parts. First, a lower data-compression-ratio digital audio/video signal is recorded on a stationary-head or rotary-head digital data tape recorder (such as quarter-inch cartridge, half-inch cartridge, DAT, 6-mm or 8-mm) in the removable-tape transport **18**, intended for utilization in an off-line video editing system, described herein below. Simultaneously, a second digital audio/video signal having a higher data-compression ratio is recorded on a removable storage media unit **20**. This removable storage medium is intended for utilization in an off-line video editing system, also described herein below. In practice, this removable storage medium may be implemented by any of several well known technologies, such as magnetic or magneto-optical disks, optical discs, or semiconductor memory modules. The two signal recording media implemented in the two parts of the internal video recording facilities may record the audio and video signals in separated form, or alternatively may be implemented by any of several well-known systems for interleaved audio/video data, such as the audio/video interleave ("AVI") system of Microsoft Corporation, the "M-Power" technique offered by Hewlett-Packard, or other systems.

Examples of removable storage media include PCMCIA-based removable disk drives (currently available with capacities of 420 MBytes, and soon to be available with capacities as high as 1 GByte) and 8-mm tape cassettes (currently available with capacity of 20 GB, and soon to be available with capacities as high as 80 GB). At a data-compression ratio of 50:1, 420 MBytes will store approximately 75 minutes of program material (in NTSC format using an image dimension in pixels of 320×240 for off-line editing), and at a data-compression ratio of 5:1, 20 GB also will store approximately 60 minutes of program material. When the newer 50 GB or 80 GB tapes become available, these tapes will be capable of storing either four hours of programming NTSC or PAL format, or two hours in an HDTV format, making them practical for use in those applications currently allocated to linear editing equipment, as described above. Alternatively, using the currently available MPEG-2 data compression with a ratio of 20:1, a 20 GB tape will accommodate four hours of NTSC or PAL recording (or one hour of HDTV); an 80 GB tape will accommodate 16 hours of NTSC or PAL recording (or four hours for HDTV). Where compatibility to film materials is desirable, operation of the various system components at 24 frames-per-second is implemented.

FIG. **2** is a functional diagram of a storage-device-based digital recorder according to the invention, either employed in a video camera, or implemented separately in editing and production facilities. As shown, a removable hard disk drive **70** and a digital tape drive **88** are interfaced through an interface bus controller **72**. Such a system achieves data transfer rates of 10 MB/sec, and higher rates on these or other data storage devices, such as high-capacity removable memory modules, is anticipated. In practice, alternative methods of storage such as optical or magneto-optical drives could be utilized, preferably based on various interface bus standards such as SCSI-2 or PCMCIA. In all cases, however, in order to ensure compatability with downstream editing facilities, both of the removable media for drives **70** and **88** should be recorded with identical or at least correlated edit-time-code information, so that edit lists developed from one storage medium will produce the same results when applied to the program material recorded simultaneously on the other storage medium.

Microprocessor **74**, through user interface provisions **75** (such as keyboards, touch-screens, etc.) controls the 64-bit or wider data bus **80**, which integrates the various components. Currently available microprocessors include the Alpha 21064 by Digital Equipment Corporation, and the MIPS R4400 by MIPS Technologies, Inc. Future implementations might rely on the already announced P6 by Intel Corp. or the PowerPC 620. An alternative architecture may be implemented using multiple processors working in parallel to increase the effective frame rate. The PCI data bus, for example, is capable of sustained data transfer rates of 100 MB/sec. A ROM **76** is used for fixed program storage. The RAM **78** preferably has the capacity to function as a buffer, representing 25 seconds or more of live NTSC video in 4:2:2 format, to enable "hot-swapping" of removable media without interruption of the input video signal during recording or alternatively the output video signal during playback. Graphics processor **82** represents dedicated hardware which performs the various manipulations required to process input video signals **84** and to output the video signals **86**. Although shown as Y/R-Y/B-Y format, either the inputs or outputs, or both, may be configured in alternative formats, such as RGB, YIQ, YUV or other commonly used alternatives.

While a software-based implementation of the data compression is possible, a hardware-based implementation is preferred, with the system employing, for the tape-based drives, a data-compression ratio of 5:1 for conventional signals (NTSC/PAL) and a 10:1 data-compression ratio for HDTV signals. For the hard-disk drive, a data-compression

ratio of 50:1 is preferably utilized. Examples of the many available options for this data compression function include the currently available Apple QuickTime system, fractal compression, MPEG-1 (for off-line applications) and Motion-JPEG (for on-line applications). In many applications, MPEG-2 data compression will be suitable for on-line editing. Audio signals may be included within the data stream, as proposed in the several systems for digital television transmission already under evaluation by the Federal Communications Commission, or by one of the methods available for integrating audio and video signals used in multi-media recording schemes, such as the Microsoft ".AVI" [Audio/Video Interleave] (*Audio/Video Interleave*) file format. As an alternative, an independent system for recording audio signals may be implemented either by employing separate digital recording provisions controlled by the same system and electronics, or by implementing completely separate equipment external to the camera system described above.

FIG. **3** shows an off-line digital video editing system, implemented with a PC-based edit controller having provisions for accepting materials in the form of removable storage media. The controller **102** is preferably of conventional design, but operates at least at the level of current Intel Pentium or high-level "486" processors. The unit is equipped with a color display, and preferably includes a PCI internal bus structure, and provisions for interfacing with a removable PCMCIA storage card **104**. In one embodiment this card **104** is implemented with magnetic or magneto-optical disks, or with an optical disc unit. Alternatively, a stand-alone external data storage unit (not shown) could be interfaced through the PCMCIA facilities, or by way of an SCSI-type interface.

As an optional feature, a PCMCIA expansion adapter **106** may be provided, so that a plurality of PCMCIA cards or PCMCIA devices **108** may be accessed conveniently through a single PCMCIA slot on the PC, as shown. This expansion adapter is provided with internal selection and multiplexing circuitry, so that each plug-in card or device may be accessed independently and without interference with any other card or device in [[he] *the* expansion adapter. The selection may be performed by employing techniques well-known in the art, such as the addressing schemes utilized for SCSI or GPIB data busses. Since a single 420 MByte PCMCIA card module is capable of holding 75 minutes of programming material with image dimensions in pixels of 320×240, 4:2:2 sampling and a 50:1 data compression ratio, an expansion adapter equipped with ten PCMCIA slots and plug-in cards is capable of providing ten hours of original program material, and this programming capacity is capable of being further expanded with other types of PCMCIA-compatible devices. As a further option, a custom-designed PC could be provided with multiple PCMCIA slots to accept a plurality of storage devices without the need for an external expansion adapter.

In operation, the off-line digital video editing system PC is used to edit and combine the materials stored on various data-storage devices, producing an edit decision list which then may be utilized by an on-line editing system. The availability of multiple storage devices enables the operator to rehearse and then confirm "A/B-roll" edits with only two storage devices, and "A/B/C-roll" edits with three storage devices. When equipped with expansion provisions or additional SCSI-bus devices, the system is capable of controlling the various storage devices so as to produce highly complicated sequences in a convenient and timely manner. While the lower-quality (higher data-compression ratio) program materials are utilized only for determining the edit points (edit decision list) for the program, the off-line editing system described herein below is capable of producing the final edited version of the program with high-quality results in accordance with the preferred embodiment.

The versatility of the system may be further enhanced if planning for the program is begun by providing script and staging information to the computer in advance of editing, or even in advance of filming or taping the original production. The script may be provided as a simple text file, or as a formatted word processor file, such as used in "WordPerfect" or "Word for Windows". As an alternative, the file may be of a custom format, as is commonly used by professional scriptwriters. This script and staging information is then reformatted to include specific commands, such as when to switch camera coverage to a particular actor, or the choice of a particular camera angle. Further details may now be included, such as the ability to identify close-up camera coverage, or points at which specific visual special effects (such as split-screen views or chroma-keyed backgrounds) or sound effects are to be incorporated. The modified script file is then used to guide the operator of the off-line editing system in making edit decisions to match the program materials to the script, to make any modifications to the script that are necessitated by the circumstances of the taping, or to take advantage of any unforeseen artistic opportunities presented by the actual taped materials.

In addition, it is common practice in broadcast-television news studios to use remotely-controlled cameras to telecast the live programs. These cameras are mounted on motorized bases which are capable of moving the cameras to any desired position on the stage, within the physical limits imposed by the stage itself (such as the length of the camera cables or the clearance available for cameras to move relative to each other on the stage). The zoom-lenses, pan-tilt mounts, and camera electronic control settings are manipulated through the camera remote-control facilities, which may include either separate electronic control panels or alternatively computer interfaces with appropriate control software, such as the unit described by [washino] *Washino*, U.S. Pat. No. 5,325,202. By coupling the software script materials to instructions for control of the camera movements, the capabilities of all of these systems may be optimized. The modified script file must be prepared before the actual taping occurs, however, and should include the physical layout of the sets and props for each scene.

The staging information described herein above, is identified by special camera-remote-control software, and the camera control operator is provided with a graphical interface which depicts the layout of the set and the "blocked" positions of the actors and props for a given scene. This system preferably also includes a user interface (such as a touch-screen or a mouse) to enable the camera control operator to program the cameras to be in the correct location, and to have the correct zoom-lens and pan-tilt positions, to capture the scene as desired, as described in co-pending application U.S. Ser. No. 08/050,861. At this time, the operator optionally may add information to control automated lighting systems, which are well-known in the [are] *art* of the film, video and stage production. This enhanced version of the modified script file is then used to direct camera actions during the actual taping of the scenes, and is further modified as part of the off-line editing process as the EDL is developed, as described above, in accordance with the invention.

An on-line digital video editing system is depicted in block-diagram form in FIG. **4**. The functional operation of

the editing system follows that of the digital video editing system disclosed in FIG. **2**, or in an alternative embodiment, may be implemented in a more sophisticated form, as described in our co-pending application "Multi-Format Audio/Video Production System," U.S. application Ser. No. 08/298,104 filed Aug. 30, 1994. This system is implemented with a PC-based edit controller **206** having separate provisions for accepting removable storage media. In the preferred embodiment, the digital video tapes recorded by the system of FIG. **2** are installed in a tape-storage "jukebox" **208** for easy access during editing. Such tape cassette handling devices are well-known in the art of computer data storage, and are generally utilized for data back-up applications or for archival storage.

The edits incorporated into the edit decision list are utilized to sequence the various digital tapes so as to assemble a recording of the desired program materials into a final finished product, which is then recorded on the videotape recorder **202**. This video recorder may be implemented as any of the commonly used choices for analog recorders, including, among others, 1" C-format, Betacam, Betacam-SP, U-matic-SP, and Hi-8. If implemented as a digital recorder, the available choices include, among others, D-1, D-2, D-3, D-5, DCT, and Digital Betacam. Furthermore, the final format could be another digital data tape such as the type used for program source material or any other removable storage media. Since the time-code identification numbers on the removable media of the off-line system correlate with those utilized in the on-line system, no conversion or adaptation of the edit decision list is needed. The video monitor **204** is used to manipulate the windows-based edit system control software, and to view the program materials as the edit process proceeds. This process will be essentially automatic, as all of the necessary decisions already have been made in the off-line editing process as described above. In addition, this is an appropriate time for adding digital video effects to the program or to implement any special effects included in the program script.

The invention may be used for other applications limited to record/playback, without implementing the full range of editing features. For example, in applications such as master playback for video duplication, the program master [nape] *tape* must be played, rewound to the beginning, and then restarted, on a repeating cycle. In facilities employing a conventional video tape recorder, this represents a great deal of physical stress on the program master tape, thereby requiring a large number of copies of this master tape when many production runs are required to complete an order. In addition, some production time is lost due to the rewinding process itself. In a disk-based application of the system disclosed herein, there is no significant deterioration of the master program even in repeated usage, and it is possible to begin playing a program at any point desired, with essentially no delay due to cueing the program media to the physical location containing that part of the recorded program. In order to provide the necessary recording time duration, additional hard-disk drives would be added to achieve the required playback duration. Based on an MPEG-2 data-compression ratio of 20:1 (with a 4:2:2 recording system for NTSC signals), two hours of digital video would require approximately 8 GB of disk storage capacity. Disk-drives offering capacity of 9 GB are currently available, and until removable media achieve comparable levels, a program would accordingly be loaded into internal or external disk-storage units from the required number of removable media units.

The invention may also be employed as a playback unit for cable television usage or other extended-playing time applications. By adding as many "juke-box" units as desired, it is a simple matter to extend the playback time capability of the system, with each "juke-box" providing approximately 40 hours of digital video playback. By fully utilizing the RAM-based audio/video buffering capabilities discussed with reference to FIG. **2**, it is possible to supply digital video playback on a continuous basis by changing the tape storage cassettes or cartridges "on-the-fly" while video playback proceeds. If provided with computer-readable identification codes on each cassette or cartridge, the computer is able to locate the "juke-box" and the particular physical storage slot containing program materials that previously have be scheduled for playback. Identification and library management systems of this type are well-known in the art, and are in common usage implemented as "cart-machines" employed for playback of commercial advertisements or other program materials at broadcast stations. In addition, playback at any frame rate or television system standard would be available, in accordance with our co-pending U.S. application Ser. No. 08/298,104 filed Aug. 30, 1994.

The versatility of the Digital Video Production System may be enhanced further, if planning for the program is begun by providing script and staging information to the computer in advance of editing, or even in advance of filming or taping the original production. Computer software having access to the script materials will enable the operator to match the scenes to the recorded video materials quickly, thereby speeding the editing process. In addition, it is common practice in broadcast-television news studios to use remotely-controlled cameras to telecast the live programs. By coupling the software script materials to instructions for control of the camera movements, the capabilities of all of these systems will be optimized.

Having thus described the system, we claim:

1. A digital audio/video production system adapted for use with an on-line video editing facility, the production system comprising:

a digital video recorder capable of simultaneously recording information representative of the same program source material, including correlated edit-time-code information, onto first and second removable storage media in first and second formats, respectively, the information in the first format being data-compressed relative to the information in the second format;

a programmed personal computer configured to receive the first removable storage medium, enabling an operator to edit the information representative of the program source material in the first format in off-line fashion so as to develop an edit decision list; and

means to transfer the edit decision list to an on-line video editing facility, the on-line editing facility being further configured to receive the second removable storage medium, whereby an operator of the on-line facility may edit the program source material in the second format using the edit decision list to create a final video production.

2. The digital video production system of claim **1**, wherein the information in the second format is non-compressed.

3. The digital video production system of claim **1**, wherein the digital video recorder forms part of a camcorder.

4. The digital video production system of claim **1**, wherein the first removable medium is a magnetic hard disk.

5. The digital video production system of claim **1**, wherein the first removable medium is an optical disk.

6. The digital video production system of claim **1**, wherein the first removable medium is a magneto-optical disk.

7. The digital video production system of claim **1**, wherein the second removable medium is a tape drive.

8. The digital video production system of claim 1, including digital audio and video program data which are interleaved.

9. The digital video production system of claim 1, the means to transfer the edit decision list to the on-line video editing facility including means to record the edit decision list onto a third removable storage medium.

10. The method of producing a final video program, comprising the steps of:

providing video program source material in first and second digital formats, the material in the first format being compressed relative to the material in the second format;

recording the material in the first and second formats, respectively, onto first and second removable storage media along with correlated edit-time-code information;

interfacing the first storage medium to an off-line video editing system to develop edit decision information;

transferring the edit decision list to an on-line video editing system;

accessing the program material in the second storage medium using the on-line video editing system; and

editing the material in the second format on the second storage medium in accordance with the edit decision list to produce a final video program.

11. The method of claim 10, the second format being a non-compressed format.

12. A digital video production system adapted to deliver program material and an accompanying edit decision list to an on-line video editing facility for the purpose of creating a final program, the system comprising:

digital video recording apparatus, including:

an input to receive a video program,

means to digitally compress the program in accordance with more than one compression ratio,

an interface to a first removable storage medium,

an interface to a second removable storage medium, and

means [no] *to* simultaneously record the video program onto the first removable storage medium at a first compression ratio and onto the second removable storage medium at a second compression ratio, the first compression ratio being greater than the second; and

an off-line digital video editing system, including:

an interface [co] *to* receive the first removable storage medium,

a display to review portions of the video program, enabling a user to make edit decisions concerning the program, and

an interface to third removable storage medium to store a list of the edit decision,

whereby an on-line video editing facility, upon receiving the second and third storage medium, may be used to produce a final, edited version of the program in accordance with the decision list.

13. The digital video production system of claim 12, wherein the second compression ratio is zero.

14. The digital video production system of claim 12, wherein the off-line digital video editing system forms part of a programmed personal computer.

15. The digital video production system of claim 12, wherein the digital video recorder forms part of a camcorder.

16. The digital video production system of claim 12, wherein the first removable medium is a magnetic disk drive.

17. The digital video production system of claim 12, wherein the first removable medium is an optical disk.

18. The digital video production system of claim 12, wherein the first removable medium is a magneto-optical disk.

19. The digital video production system of claim 12, wherein the second removable medium is a tape drive.

20. The digital video production system of claim 12, including interleaved digital audio and video program data are interleaved.

21. The digital video production system of claim 12, wherein the program includes separately recorded audio and video portions.

22. A digital video recording apparatus adapted [or] *for* use with an on-line video editing facility and a personal computer configured to perform off-line editing, including edit-list development, the apparatus comprising:

a camera outputting information representative of a video program;

means to digitally compress the program information [at a plurality of compression ratios];

a [removable] disk to store a [highly compressed] *randomly addressable* version of the program information suitable for off-line editing using the personal computer; and

a [removable] tape [drive] to store a [less compressed] *serially addressable* version of the program information suitable for on-line editing;

both versions of the program being stored with correlated edit-time-code information, thereby enabling the on-line editing to use the edit list developed during off-line editing.

23. The digital video recording apparatus of claim 22, wherein the camera, means to digitally compress the program[at a plurality of compression ratios, removable], disk drive, and [removable] tape drive are all integral to a camcorder.

24. A digital audio/video production system, comprising:

(a) digital video recording apparatus, including:

an input to receive a video program,

first and second removable digital storage media, and

means to simultaneously record the program, including correlated edit-time-code information, onto the first and second removable storage media in first and second formats, respectively, the first format being data-compressed relative to the information in the second format;

(b) a first video editing system, including:

means to receive the first removable storage medium; and

controls enabling an operator to edit the program in the first format and develop a set of edit decision directives; and

(c) a second video editing system, including:

means to receive the second removable storage medium,

means to receive the edit decision directives, and

means to edit the program information in the second format in accordance with the edit decision directives to create a final video production.

25. The digital audio/video production system of claim 24, wherein the digital video recording apparatus includes means to receive a plurality of the first removable storage media.

26. The digital audio/video production system of claim 24, wherein the second video editing system includes means

to receive a plurality of the second removable storage media, wherein the edit decision directive being applicable to all of the second removable storage media received.

27. The digital audio/video production system of claim **26**, wherein the digital video recording apparatus forms part of a camcorder.

28. The digital audio/video production system of claim **26**, wherein the first video editing system forms part of a programmed personal computer.

29. The digital audio/video production system of claim **26**, wherein the first removable digital storage medium is a magnetic disk.

30. The digital audio/video production system of claim **26**, wherein the first removable digital storage medium is an optical disk.

31. The digital audio/video production system of claim **26**, wherein the first removable digital storage medium is a magneto-optical disk.

32. The digital audio/video production system of claim **26**, wherein the first removable digital storage medium is a semiconductor memory.

33. The digital audio/video production system of claim **24**, wherein the second removable digital storage medium is a magnetic tape.

34. A video production method, comprising the steps of:

simultaneously recording information representative of a video program, *such material being characterized in having a multitude of sequential frames used to portray motion imagery* plus correlated edit-time-code information, onto first and second **[**removable **]** digital storage media in first and second formats, respectively, **[**the pro,ram information in the first format being data-compressed relative to the program information in the second format**]** *both formats including information representative of each frame characterizing the program*;

receiving the *program in the* first **[**removable storage medium**]** *format* at a first video editing facility and editing the program information at the first facility in the first format to develop a **[**see**]** *set* of edit decision directives based upon the edit-**[**mime**]***time*-code information; and

receiving the *program in the* second **[**removable storage medium and**]** *format with* edit decision directives at a second video editing facility and editing the program information at the second facility in the second format in accordance with the edit decision directives so as to create a final video production.

35. The video production method of claim **34**, further including the step of recording the final video production onto a third **[**removable**]** storage medium at the second video editing facility.

36. The video production method of claim **34**, further including the step of outputting the final video production as the program information is edited in the second format in accordance with the edit decision directives.

37. The video production method of claim **34**, wherein the step of editing the program information at the second facility further includes the step of adding audio special effects in the final video production.

38. The video production method of claim **34**, wherein the step of editing the program information at the second facility further includes the step of adding video special effects in the final video production.

39. The video production method of claim **38**, wherein the step of adding video special effects includes the step of adding titling.

40. Video recording apparatus, comprising:

an input for receiving video program source material, such material being characterized in having a plurality of sequential frames representative of motion imagery;

a video recorder in communication with the input for simultaneously recording information representative of the video program source material, including correlated edit-time-code information, onto first and second storage media, wherein the first storage medium is used to store the sequential frames in a randomly addressable manner, and the second storage medium is used to store the sequential frames in a serially addressable manner, such that each frame stored on one medium is associated with a time code correlated to a corresponding frame stored on the other medium.

41. The apparatus of claim 40, wherein the second storage medium is a video tape.

42. The apparatus of claim 40, wherein the video recorder forms part of a camcorder.

43. The apparatus of claim 40, further including means for receiving scripting information.

44. The apparatus of claim 43, wherein the means for receiving the scripting information forms part of the video recorder.

45. The apparatus of claim 43, further including an editing facility for receiving the recorded video program, and wherein the means for receiving the scripting information forms part of the editing facility.

46. The apparatus of claim 40, further including means for receiving camera-control information.

47. The apparatus of claim 46, wherein the means for receiving the camera-control information forms part of the video recorder.

48. The apparatus of claim 46, further including an editing facility for receiving the recorded video program, and wherein the means for receiving the camera-control information forms part of the editing facility.

49. The apparatus of claim 40, further including a first editing facility enabling an operator to edit the recorded video program and develop an edit decision list therefor.

50. The apparatus of claim 49, further including a second editing facility for editing the video program source material in accordance with the edit decision list.

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