A distributed patient monitoring system for visually monitoring patients and patient parameters using portable processing devices in different remote locations includes a monitoring processor. The monitoring processor is responsive to user initiated commands from multiple different portable processing devices in different remote locations and includes an input processor and a data processor. The input processor acquires vital sign parameters and associated video data representative of multiple sequences of video images of corresponding multiple different patients. The data processor processes the vital sign parameters and associated video data to provide processed first video data representing an image sequence including a composite image including a first area showing live video of a selected first patient and a second area presenting vital sign parameters of the selected first patient. The data processor also processes the vital sign parameters and associated video data to provide processed second video data representing an image sequence including a composite image including a first area showing live video of a selected second patient and a second area presenting vital sign parameters of the selected second patient. A communication network has bandwidth sufficient to communicate the processed first video data and second video data to first and second portable processing devices respectively of the multiple different portable processing devices in different remote locations in response to commands received from the first and second portable processing devices respectively.
FIG. 1
<table>
<thead>
<tr>
<th>ID</th>
<th>camera_id</th>
<th>input_channel</th>
<th>room_location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>cam1</td>
<td>1</td>
<td>050101</td>
</tr>
<tr>
<td>2</td>
<td>cam2</td>
<td>2</td>
<td>021502</td>
</tr>
<tr>
<td>3</td>
<td>cam3</td>
<td>3</td>
<td>031402</td>
</tr>
<tr>
<td>6</td>
<td>cam4</td>
<td>4</td>
<td>104401</td>
</tr>
</tbody>
</table>

*AutoNumber*
FIG. 8A

ROOM MAPPING TABLE (MAINTAINED BY RTLS)

<table>
<thead>
<tr>
<th>TAG ID</th>
<th>ROOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABCDEFG</td>
<td>BED1A</td>
</tr>
<tr>
<td></td>
<td>PEU-3</td>
</tr>
<tr>
<td></td>
<td>040502</td>
</tr>
</tbody>
</table>

FIG. 8B

TAG MAPPING TABLE (STATIC)

<table>
<thead>
<tr>
<th>TAG ID</th>
<th>CAM/IP</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABCDEFG</td>
<td>X.X.X.155</td>
</tr>
<tr>
<td></td>
<td>X.X.X.156</td>
</tr>
<tr>
<td></td>
<td>X.X.X.157</td>
</tr>
</tbody>
</table>
START

EMPLOY A MONITORING PROCESSOR RESPONSIVE TO USER INITIATED COMMANDS FROM MULTIPLE DIFFERENT PORTABLE PROCESSING DEVICES IN DIFFERENT REMOTE LOCATIONS

EMPLOY AN AUTHENTICATION PROCESSOR ENABLING A USER TO OBTAIN ACCESS AUTHORIZATION TO ACCESS PATIENT DATA IN RESPONSE TO ENTRY OF IDENTIFICATION DATA USING ANY PORTABLE PROCESSING DEVICE OF THE MULTIPLE PORTABLE PROCESSING DEVICES IN DIFFERENT REMOTE LOCATIONS

EMPLOY A USER INTERFACE, IN RESPONSE TO THE ACCESS AUTHORIZATION, ENABLING A USER TO, INITIATE EXECUTION OF A CLINICAL INFORMATION SYSTEM PROVIDING A USER WITH A CLINICAL APPLICATION DISPLAY IMAGE IDENTIFYING MULTIPLE DIFFERENT PATIENTS IN CORRESPONDING MULTIPLE DIFFERENT LOCATIONS AND SELECT A PARTICULAR PATIENT OF THE MULTIPLE DIFFERENT PATIENTS IN THE CLINICAL APPLICATION DISPLAY IMAGE

INITIATE GENERATION OF DATA REPRESENTING AN IMAGE SEQUENCE COMPRISING A COMPOSITE IMAGE INCLUDING A FIRST AREA SHOWING LIVE VIDEO OF A SELECTED PARTICULAR PATIENT AND A SECOND AREA PRESENTING VITAL SIGN PARAMETERS OF THE PARTICULAR PATIENT IN RESPONSE TO USER SELECTION OF AN IMAGE ELEMENT ASSOCIATED WITH THE PARTICULAR PATIENT OF THE MULTIPLE DIFFERENT PATIENTS IN THE CLINICAL APPLICATION DISPLAY IMAGE

APPLY RULES TO THE VITAL SIGN PARAMETERS TO IDENTIFY AN ALERT CONDITION INDICATING A SIGNIFICANT PATIENT CLINICAL CONDITION OR CHANGE OF CLINICAL CONDITION

END

FIG. 9
DISTRIBUTED PATIENT MONITORING SYSTEM

[0001] This is a non-provisional application of provisional application Ser. No. 60/910,674 filed Apr. 9, 2007 and of provisional application Ser. No. 60/911,302 filed Apr. 12, 2007, by J. R. Zaleski.

FIELD OF THE INVENTION

[0002] This invention concerns a distributed patient monitoring system for visually monitoring patients and patient parameters using a plurality of portable processing devices in different remote locations.

BACKGROUND OF THE INVENTION

[0003] Monitoring of patients, particularly patients in critical care is a burdensome and labor intensive task. This problem has been addressed by use of a centralized monitoring facility enabling a physician at the workstation of the centralized monitoring facility to monitor patient vital signs and video and audio. One known remote centralized patient monitoring system, described in U.S. Pat. No. 6,804,656, provides fixed location, static centralized monitoring of ICUs by a physician. The centralized monitoring employs a single command center and a workstation provides a single display area operated by clinical personnel. However it is fixed in location, inflexible in performance and architecture and fails to accommodate high bandwidth communication of patient related data. A system according to invention principles addresses these deficiencies and related problems.

SUMMARY OF THE INVENTION

[0004] A distributed patient monitoring system enables visual monitoring of patients and patient parameters using live motion video and audio data presented on multiple portable processing devices in different remote locations in response to user selection of a specific patient related item in an image showing specific patient electronic medical record data or a patient census list, for example. A distributed patient monitoring system for visually monitoring patients and patient parameters using portable processing devices in different remote locations includes a monitoring processor. The monitoring processor is responsive to user initiated commands from multiple different portable processing devices in different remote locations and includes an input processor and a data processor. The input processor acquires vital sign parameters and associated video data representative of multiple sequences of video images of corresponding multiple different patients. The data processor processes the vital sign parameters and associated video data to provide processed first video and audio data representing an image sequence and providing two-way audio communication including a composite image of a first area showing live video of a selected first patient and a second area presenting vital sign parameters of the selected first patient together with ancillary clinical data (e.g.: laboratory, physician notes, etc.). The data processor also processes the vital sign parameters and associated video data to provide processed second video data representing an image sequence including a composite image including a first area showing live video of a selected second patient and a second area presenting vital sign parameters of the selected second patient. A communication network has bandwidth sufficient to communicate the processed first video data and second video data to first and second portable processing devices respectively of the multiple different portable processing devices in different remote locations in response to commands received from the first and second portable processing devices respectively.

BRIEF DESCRIPTION OF THE DRAWING

[0005] FIG. 1 shows a distributed patient monitoring system for visually monitoring patients and patient parameters using a plurality of portable processing devices in different remote locations, according to invention principles.

[0006] FIG. 2 shows an architecture of a distributed patient monitoring system, according to invention principles.

[0007] FIG. 3 shows a Web-browser compatible user interface display image window enabling a user to initiate visual and audio monitoring of one or more patients and associated sets of patient parameters, according to invention principles.

[0008] FIG. 4 shows a networked linkage of components of the distributed patient monitoring system present in patient rooms including a mobile unit which can be wheeled into patient rooms as needed to support remote viewing of a patient anywhere within a healthcare enterprise, according to invention principles.

[0009] FIG. 5 illustrates a pan-tilt-zoom camera control system used for controlling a camera in a patient room, according to invention principles.

[0010] FIG. 6 shows a Web-browser based user interface display image window enabling a user to initiate remote visual and audio monitoring of a particular patient, according to invention principles.

[0011] FIG. 7 illustrates structured association of camera, room and channel identifier data, for example, for use in mapping a selected patient to a corresponding camera, according to invention principles.

[0012] FIGS. 8A and 8B illustrate data flow in a distributed patient monitoring system, according to invention principles.

[0013] FIG. 9 shows a flowchart of a process performed by a distributed patient monitoring system, according to invention principles.

DETAILED DESCRIPTION OF THE INVENTION

[0014] A distributed patient monitoring system enables a user to visually monitor patients and patient parameters using live motion video and audio data presented on multiple portable processing devices in different remote locations comprising distributed personal command centers. A mobile or stationary clinician in a healthcare enterprise monitors live motion video and audio data of a patient within a hospital room presented using a Web browser on a wireless tablet personal computer, palm pilot or other portable device. Execution of an individual command center application is initiated from within a patient specific display image view presenting specific patient electronic medical record data, in response to user selection of a specific patient related item or an item in a patient census list, for example. Patient identifier information is employed in acquiring video and audio data of a particular patient using association of the patient identifier with patient medical information and specific room and bed identifiers. The system in one embodiment advantageously employs a mobile hardware unit that enables viewing of any patient in the healthcare enterprise. Mobile units are located within an enterprise and use radio frequency identification.
The radio frequency identification tags placed on a mobile unit transmit location representative data to a centralized processor which associates the particular enterprise location with a patient location determined from the health information system. This enables a mapping of a location of the mobile unit of the viewing hardware to a particular patient clinical record, thereby enabling a user to view video and hear audio directly from a patient bedside when selected via the health information system.

Multiple clinicians at multiple locations are able to concurrently view patient information as well as communicate verbally via audio linkage with occupants of the patient room. Similarly, multiple viewing clinicians can, in turn and based on an on-line collaborative mechanism, alternately perform remote pan-tilt-zoom operation of the camera in the patient room. Patient parameters including vital sign data (heart rate, blood pressure, blood oxygen saturation etc. including data normally taken and displayed from within patient flow sheets) is also visible in an electronic medical record display image view. A health information system application analyzes individual patient vital sign data by comparing discrete values (values that are validated by a nurse for inclusion in a patient record) with predetermined thresholds.

The system enables one or more clinicians to view live motion video and to transmit and receive audio via a Web-enabled plug-in software component that allows the user to view a specific patient as part of the normal patient care management process. Video and audio data are acquired from cameras located within patient rooms and is associated with specific patients via virtual electronic linkages that permit associating patient demographic information (including standard patient identifiers) with a patient location. This information is used to launch a patient specific data image display view via a Web-based electronic health record as a child process that acquires patient specific information and searches for this information to display within a Web-browser on either a wired or wirelessly communicating computing device. Video and audio representative data derived at the point of care is also captured using a wireless mobile embodiment, thereby enabling viewing of any patient at any location within a healthcare enterprise. The patient information is viewed using a Web-based computer application that allows one or more distributed users to view a patient at any time from substantially any location within a healthcare organization. Multiple clinicians can view multiple patients concurrently or individually. In addition, patient parameter information is displayed and is visible to multiple clinicians concurrently. Discrete patient parameters (e.g., vital sign) information (validated by a nurse for inclusion within a patient health record) is processed using a rule information engine to assess whether the parameter values fall within normal ranges or meet certain thresholds.

The system provides a visual and audio link with patients through a Web-enabled browser and displays this information through a context-based link that enables clinicians to view specific patients without requiring them to select the patients from a census list, thereby facilitating the rapid review of patients and their parameters within their care. Web-based accessibility from within the patient record allows for remote viewing and collaboration among healthcare professionals virtually anywhere within a healthcare enterprise, advantageously obviating the need for a clinician to return to, or contact, a centrally located command center.

A processor, as used herein, operates under the control of an executable application to (a) receive information from an input information device, (b) process the information by manipulating, analyzing, modifying, converting and/or transmitting the information, and/or (c) route the information to an output information device. In specific embodiments a processor determines location of a mobile video and audio unit at a patient bedside and provides the capability for multiple viewing healthcare professionals to concurrently view and communicate verbally with a patient or healthcare providers present at the patient bedside. A processor may use, or comprise the capabilities of, a controller or microprocessor, for example. The processor may operate with a display processor or generator. A display processor or generator is a known element for generating signals representing display images or portions thereof. A processor and a display processor may comprise a combination of hardware, firmware, and/or software.

An executable application, as used herein, comprises code or machine readable instructions for conditioning the processor to implement predetermined functions, such as those of an operating system, a context data acquisition system or other information processing system, for example, in response to user command or input. An executable procedure is a segment of code or machine readable instruction, subroutine, or other distinct section of code or portion of an executable application for performing one or more particular processes. These processes may include receiving input data and/or parameters, performing operations on received input data and/or performing functions in response to received input parameters, and providing resulting output data and/or parameters. A user interface (UI), as used herein, comprises one or more display images, generated by a display processor and enabling user interaction with a processor or other device and associated data acquisition and processing functions.

The UI also includes an executable procedure or executable application. The executable procedure or executable application conditions the display processor to generate signals representing the UI display images. These signals are supplied to a display device which displays the image for viewing by the user. The executable procedure or executable application further receives signals from user input devices, such as a keyboard, mouse, light pen, touch screen or any other means allowing a user to provide data to a processor. The processor, under control of an executable procedure or executable application, manipulates the UI display images in response to signals received from the input devices. In this way, the user interacts with the display image using the input devices, enabling user interaction with the processor or other device. The functions and process steps (e.g., of FIG. 9) herein may be performed automatically or wholly or partially in response to user command. An activity (including at a step) performed automatically is performed in response to executable instruction or device operation without user direct initiation of the activity. Workflow comprises a sequence of tasks performed by a device or worker or both. An object or data object comprises a grouping of data, executable instructions or a combination of both or an executable procedure.

A workflow processor, as used herein, processes data to determine tasks to add to a task list, remove from a task list or modifies tasks incorporated on, or for incorporation on, a task list. A task list is a list of tasks for performance by a worker or device or a combination of both. A workflow processor may or may not employ a workflow engine. A work-
flow engine, as used herein, is a processor executing in response to predetermined process definitions that implement processes responsive to events and event associated data. The workflow engine implements processes in sequence and/or concurrently, responsive to event associated data to determine tasks for performance by a device and or worker and for updating task lists of a device and a worker to include determined tasks. A process definition is definable by a user and comprises a sequence of process steps including one or more, of start, wait, decision and task allocation steps for performance by a device and or worker, for example. An event is an occurrence affecting operation of a process implemented using a process definition. The workflow engine includes a process definition function that allows users to define a process that is to be followed and includes an Event Monitor, which captures events occurring in a Healthcare Information System. A processor in the workflow engine tracks which processes are running, for which patients, and what step needs to be executed next, according to a process definition and includes a procedure for notifying clinicians of a task to be performed, through their worklists (task lists) and a procedure for allocating and assigning tasks to specific users or specific teams.

[0022] FIG. 1 shows distributed patient monitoring system 10 for visually monitoring patients and patient parameters in patient rooms 41 using multiple portable processing devices 12 and 14 in different remote locations. System 10 includes portable devices (e.g., notebooks, Personal Digital Assistants, cell phones) 12 and 14, at least one repository 17, Clinical Information System Application (CIS) 51 and server 20 as well as patient rooms 41 (including cameras and patient monitoring devices) inter-communicating via network 21. Portable devices 12 and 14 individually include memory 28 and user interface 26. User interface 26 provides data representing display images for presentation on portable device 12 and 14.

[0023] Server 20 includes monitoring processor 15, data processor 29, input processor 27, authentication processor 39, workflow processor 34 and rules processor 19. Monitoring processor 15 is responsive to user initiated commands from multiple different portable processing devices 12 and 14 in different remote locations and includes input processor 27 and data processor 29. Workflow processor 34 initiates tracks and monitors task sequences performed by personnel and systems in response to events. Input processor 27 acquires vital sign parameters and associated video data representative of multiple sequences of video images of corresponding multiple different patients. Data processor 29 processes vital sign parameters and associated video data to provide processed first video data representing an image sequence including a composite image including a first area showing live video of a selected first patient and a second area presenting vital sign parameters of the selected first patient. Data processor 29 similarly provides processed second video data representing an image sequence including a composite image including a first area showing live video of a selected second patient and a second area presenting vital sign parameters of the selected second patient. Data processor 29 processes the vital sign parameters and associated video data to provide processed first and second video data by encoding the video data with a compression function compatible with, MPEG-4, MPEG-2 or DIVX, for example.

[0024] Input processor 27 acquires audio data of multiple different patients, data processor 29 processes the audio data to provide processed audio data by encoding the audio data with a compression function and communication network 21 is of bandwidth sufficient to communicate the processed first video data and second video data and audio data to first and second portable processing devices 12 and 14 respectively. Network 21 has sufficient bandwidth to convey video and audio data between rooms and other devices of the network. Input processor 27 acquires the audio data from multiple different microphones in patient rooms associated with multiple different patients and similarly acquires the associated video data from multiple different cameras in patient rooms associated with the multiple different patients. Further, input processor 27 acquires the vital sign parameters from patient monitoring devices attached to the multiple different patients.

[0025] Communication network 21 has sufficient bandwidth to communicate the processed first video data and second video data to first and second portable processing devices 12 and 14 respectively of the multiple different portable processing devices in different remote locations in response to commands received from the first and second portable processing devices 12 and 14 respectively. Rules processor 19 applies rules to the vital sign parameters to identify an alert condition indicating a significant patient clinical condition or change of clinical condition. Data processor 29 processes data representing the alert condition for inclusion in the processed first video data and the composite image includes an image element indicating the alert condition. Further, authentication processor 39 enables a user to obtain access authorization to access patient data in response to entry of identification data using any portable processing device of the multiple portable processing devices in different remote locations.

[0026] System 10 supports distributed patient monitoring, without centralization, so a clinician may view the patients themselves via video and their vital signs and listen to an individual or multiple selected patients from anywhere within an enterprise. Multiple clinicians may view multiple patients or single patients concurrently through a wireless or handheld portable device 12 and 14. Rules processor 19 analyzes validated discrete patient parameters by comparing patient vital sign parameters with predetermined thresholds. User interface processor 26 employs a Web browser application supporting viewing video transmitted through existing hospital network 21 as MPEG-4 (for example) compatible compressed images. Patient rooms 41 incorporate equipment including cameras connected via network 21 to portable devices 12 and 14 and one or more servers (e.g., server 20). Portable devices 12 and 14 incorporate a virtual camera controller Web compatible application allowing a clinician to control pointing, zoom, focus, and an iris of patient room cameras in pan, tilt and zoom operations via a Web browser in wireless portable devices 12 and 14.

[0027] FIG. 2 shows one embodiment of an architecture of a distributed patient monitoring system. A monitoring application within application server 76 enables the live viewing of patient data using video and audio hardware incorporated in portable device 12. Application server 76 links to Web-server 80 comprising an enterprise health information system managing access to electronic medical records. Web server 80 provides patient-specific information to the monitoring application once launched, enabling the viewing of specific patients from within a browser-based video viewer. Cameras and microphones are located within each patient room via a mobile or fixed embodiment and these rooms 41 are associ-
ated with specific patients via mapping information in a database. This association is made at the time of in-patient registration. Rules information engine server 82 enables analyzing validated discrete patient vital sign parameters (including monitored patient parameters) from each patient and displaying this information as notifications (subject to thresholds) to a clinician through the browser-based health information system located on the health information server 80. Portable device 12 communicates with servers 76, 80 and 82 via wireless access point 73 and network 21 and incorporates Web browser compatible user interface 26 for reproducing acquired video and audio data and patient parameters. In other embodiments servers 76, 80 and 82 may comprise a single server (e.g., server 20), or alternatively may be located in portable device 12 or in servers (or other processing devices) in patient rooms.

FIG. 3 shows Web-browser compatible user interface display image 303 presented by user interface 26 on portable device 12 and enabling a user to initiate visual monitoring of one or more patients and associated sets of patient parameters. Web-based image 303 is initiated from a patient health record related image provided by a Web compatible electronic medical record application as a child application. Patient specific registration and demographic information is passed from the parent medical record application to the child application enabling the child application to determine the location of the patient and acquire patient specific information and video and audio data for reproduction via a Web browser application to a clinician. Display image 303 displays patient identification and room location information. Compressed (e.g., MPEG-4 compatible) image sequence data is transmitted via Ethernet, for example, to a Web compatible application employed by user interface 26 of portable 12 where the data is decoded and displayed within image 303.

A virtual camera controller 314 enables real-time control of the viewed image by pan, tilt, zoom, focus, iris control of a camera in a patient room using a thin client (e.g. Active X compatible) application. Image control may also be initiated by dragging a cursor across the live image screen in pan and tilt directions. Image 303 presents an iris open and close feature, providing the capability to lighten or darken the image especially when in-room lighting is on or off (especially useful at night). A user is also able to perform live image zooming in and out using zoom feature 305. A user information panel 306 provides the user with icons indicating (a) whether patient privacy is selected, whereby in-room video and audio are disabled per clinician or patient request and (b) enabling patient video activation so a patient may be remotely viewed. Panel 306 also includes a patient audio icon enabling a user to select particular audio devices on a portable device 12 (FIG. 1) (i.e., internal or external microphone and speakers) and a pan-tilt control icon indicating whether a user currently controls camera movement. Multiple viewing clinicians may alternately control pan, tilt and zoom functionality by requesting control of the camera using a move camera icon button. Talk button 309 provides the capability by which a viewing clinician can communicate with in-room clinical personal or with a patient. Patient room, name, and medical record identifiers 311 are provided within the Web-based image 303. User list 315 provides the local user with the identity of other users viewing the patient simultaneously as well as their current functionality (e.g.: audio, PTZ control).

FIG. 4 shows a networked linkage of components of distributed patient monitoring system 10 of FIG. 1 that are present in patient rooms 41. The embodiment of FIG. 4 includes video and audio components (comprising camera and microphone) contained within specific rooms 403, 405 and 407. The cameras (and microphones) have individual camera identifiers that are associated in a database with corresponding patient room and bed identifiers and with specific patients. Camera and microphone data is processed by codecs (coders and decoders) in units 420, 422 and 424 which also include pan, tilt, zoom camera controllers. MPEG-4 encoder units 430, 432 and 434 encode camera video for transmission via a relatively high bandwidth (such as, optical fiber, wireless or other) network capable of at least 100 Mbits per second per patient in one embodiment, for example. Other embodiments may employ networks of lower bandwidth. MPEG-4 encoder units 430, 432 and 434 translate video data into compressed image representative data that is able to be transmitted over existing Ethernet (via TCP/IP) 1 Mbit per second per patient networks, for example. Mobile units 42, 444 and 446 comprise mobile video and audio units housing the camera and audio components in a self-contained housing portable (e.g., wheeled or carried) between patient rooms within a healthcare enterprise.

Data is transmitted via network switch 436 from encoder units 430, 432 and 434 to an application server (e.g., application server 76 FIG. 2, server 20 FIG. 1) where it is captured and processed by a monitoring application. Data is downloaded into a Web browser within user interface 26 of clinician portable device 12 from a monitoring application in application server 76, in response to data in repository 17 associating a camera and microphone identifier with a room and with a particular patient. System 10 advantageously provides distributed processing over the Web (e.g., port of network 21 FIG. 1) as well as processing of discrete patient parameters using a Rules engine (rules processor 19), direct notification of patient events managed by workflow processor 34 and data compression using an MPEG-4 encoder and decoder. A user authenticates into a portable device on network 21 and initiates execution of a clinical application provided by CIS 51. In response to a patient being selected in a display image associated with the clinical application, a video image of the patient (including patient vital sign parameters) is presented via a web browser in a composite image as a pop-up window.

FIG. 5 illustrates a camera control system used for controlling a camera in a patient room. A user is able to control a camera in a patient room using a virtual pan-tilt controller in Web page display image 503 provided by a viewer executable procedure of a monitoring application. The controller enables a clinician to move the camera in pan and tilt using either user interface control icons 504 or on-image control 505 using a mouse. An x-y coordinate grid 507 presented in image 503 enables a clinician to adjust camera viewing in pan and tilt. A user moves a cursor across the grid and the cursor snaps back to central (neutral) position when a user releases the mouse, for example.

System 10 displays live motion video and audio information of patients within a health care enterprise in a web-browser based window such that viewing of patient information may occur concurrently on multiple (distributed) wirelessly communicating computers, computing tablets or other stationary or mobile processing devices. The system enables a user to virtually control the viewing field of cameras located within patient rooms via a Web-browser based application that is downloaded from a remote application server
and to adjust video views of multiple patients using the Web-browser based application. The system decodes and displays compressed video information of patients acquired from raw camera video feeds via a mobile computing platform. Rules processor 19 processes and analyzes patient parameters and laboratory test results and compares parameters with predetermined thresholds and notifies users as to whether values collected and validated by clinical staff (e.g., nursing) fall within or outside of acceptable ranges.

**[0033]** FIG. 6 shows Web-browser based user interface display image 603 enabling a user to initiate remote visual and audio monitoring of a particular patient. Specifically, a user selects item 607 in a menu accessed within clinical application related image 603 specific to patient 605 (Blair Stuart). In response to this selection, execution of a remote visual and audio monitoring application is initiated for monitoring patient 605.

**[0034]** FIG. 7 illustrates structured association of camera, room and channel identifier data in a data table, for example, for use in mapping a selected patient to a corresponding camera. Specifically, row 705 illustrates association of a camera (camera identifier) with a video channel identifier (via which video data is conveyed) and with a patient room and location identifier. Monitoring processor 15 (FIG. 1) retrieves a camera identifier from the data table associated the camera and room using an active server page, for example. The camera identifier (e.g., cam1) is associated with a video matrix switch input channel (e.g., channel 1) and processor 15 provides input channel identifier data to the matrix switch (switch 436 FIG. 4). In response to the input channel data, matrix switch 436 directs the associated camera video from the corresponding camera in corresponding room location (location 050101) received on input channel 1 to portable device 12 for display.

**[0035]** FIG. 8A illustrates data flow associated with locating a mobile audio and video hardware unit (e.g., units 42, 4 and 446 FIG. 4). Data table 803 in repository 17 (FIG. 1) associates a patient with a medical record number, room identifier and bed identifier. In response to a user selecting a patient for viewing, a camera record selection in monitoring processor 15 uses data table 803 to determine a room identifier based on a received patient identifier and uses data table 805 associating room identifier, with bed and camera identifier to determine an associated camera identifier. Processor 15 uses data table 807 associating camera identifier, input channel and output channel identifier to determine input and output channel identifier (in switch 436 FIG. 4) associated with the determined camera identifier. Processor 15 further uses display communication manager 811 to select switch 436 input and output channels and display type 813 and uses associated Ethernet and serial communication protocols for transmitting patient video data on a device display type 816. FIG. 8B illustrates mapping of a mobile unit (e.g., 442 FIG. 4) tag to a room id. The tag is attached to the mobile unit and a tag to room mapping table is updated based on updated RFID position of a mobile unit and network connection under direction of a healthcare information (and workflow) system. As the mobile embodiment is located in the proximity of a patient, radio frequency transmission to a central processor via a network associates that location with a patient within the same location. This linkage enables display of video data within the Web-based interface.

**[0036]** FIG. 9 shows a flowchart of a process performed by a distributed patient monitoring system 10 (FIG. 1). In step 912 following the start at step 911, monitoring processor 15 (FIG. 1) responds to user initiated commands from multiple different portable processing devices in different remote locations. Input processor 27 in monitoring processor 15, acquires vital sign parameters and associated video data representative of multiple sequences of video images of corresponding different patients. Data processor 29 in monitoring processor 15, processes the vital sign parameters and associated video data to provide processed video data representing an image sequence. In one embodiment the processed video data comprises processed first video data representing an image sequence including a first image including an area displaying user selectable image elements individually associated with corresponding individual patients of the multiple different patients and processed second video data representing an image sequence including a composite image including a first area showing live video of a selected first patient and a second area presenting vital sign parameters of the selected first patient in response to user selection of an image element associated with the first patient in the first image. Communication network 21 linking portable devices 12 and 14, server 20, CIS 51 and patient rooms 41, has sufficient bandwidth to communicate the processed video data to the first and second portable processing devices respectively of the multiple different portable processing devices in different remote locations in response to commands received from the first and second portable processing devices respectively.

**[0037]** In step 917, authentication processor 39 enables a user to obtain access authorization to access patient data in response to selection of an image element data using any portable processing device of the multiple portable processing devices in different remote locations. In step 919, user interface 26, in response to access authorization, enables a user, to initiate execution of a clinical information application with a personal computing application display image identifying multiple different patients in corresponding different locations and select a particular patient of the multiple different patients in the clinical application display image. A display processor in user interface 26 in step 923 initiates generation of data representing an image sequence (processed video) for presentation in a composite image including a first area showing live video of a selected particular patient and a second area presenting vital sign parameters of the particular patient in response to user selection of an image element associated with the particular patient of the multiple different patients in the clinical application display image. The image element associated with the selected patient comprises a hyperlink presented in a list of different patients in the display image provided by the clinical information application.

**[0038]** A first portable processing device 12 of multiple portable processing devices, has a user interface 26 that enables a user, in response to access authorization, to initiate execution of a clinical information application providing a user with a clinical application display image identifying multiple different patients in corresponding different locations. Device 12 user interface 26 also enables a user to select a first patient of the multiple different patients in a clinical display image and display an image sequence including a composite image comprising a first area showing live video of the first patient and a second area presenting vital sign parameters of the first patient. Similarly, second portable processing device 14 of the multiple portable processing devices, has a user interface 26 that enables a user, concur-
rently with operation of the first portable processing device and in response to access authorization, to, initiate execution of a clinical information application providing a user with a clinical application display image identifying multiple different patients in corresponding multiple different locations. Device 14 user interface 26 also enables a user to select a second patient of the multiple different patients in the clinical application display image and display an image sequence including a composite image comprising a first area showing live video of the second patient and a second area presenting vital sign parameters of the second patient.

In step 926, rules processor 19, applies rules to the vital sign parameters to identify an alert condition indicating a significant patient clinical condition or change of clinical condition and the composite image includes an image element indicating the alert condition. The process of FIG. 9 terminates at step 929.

The systems and processes of FIGS. 1-9 are not exclusive. Other systems, processes and menus may be derived in accordance with the principles of the invention to accomplish the same objectives. Although this invention has been described with reference to particular embodiments, it is to be understood that the embodiments and variations shown and described herein are for illustration purposes only. Modifications to the current design may be implemented by those skilled in the art, without departing from the scope of the invention. The system has application to surgical theaters (operating rooms), emergency departments, first responders via ambulance, home-health care, patient-family viewing, mobile units, casinos, schools (classrooms), or applications within the aerospace industry, for example. The system is readily used in conjunction with existing critical care systems, medical/surgical ward systems, emergency department or operating room systems. The processes and applications may in alternative embodiments, be located on one or more (e.g., distributed) processing devices accessing a network linking the elements of FIG. 1. Further, any of the functions and steps provided in FIGS. 1-9 may be implemented in hardware, software, or a combination of both and may reside on one or more processing devices located at any location of a network linking the elements of FIG. 1 or another linked network including the Internet.

What is claimed is:

1. A distributed patient monitoring system for visually monitoring patients and patient parameters using a plurality of portable processing devices in different remote locations, comprising:
   - a monitoring processor responsive to user initiated commands from a plurality of different portable processing devices in different remote locations and including, an input processor for acquiring vital sign parameters and associated video and audio data and for controlling the selected viewing of said data representative of plurality of sequences of video images of a corresponding plurality of different patients; and
   - a data processor for processing said vital sign parameters and associated video data to provide, processed first video data representing an image sequence including a composite image including a first area showing live video of a selected first patient and a second area presenting vital sign parameters of said selected first patient and processed second video data representing an image sequence including a composite image including a first area showing live video of a selected second patient and a second area presenting vital sign parameters of said selected second patient; and
   - a communication network of bandwidth sufficient to communicate said processed first video data and second video data to first and second portable processing devices respectively of said plurality of different portable processing devices in different remote locations in response to commands received from said first and second portable processing devices respectively.

2. A system according to claim 1, wherein said data processor processes said vital sign parameters and associated video data to provide processed first and second video data by encoding said video data with a compression function.

3. A system according to claim 2, wherein said compression function is compatible with at least one of, (a) MPEG-4, (b) MPEG-2 and (c) DIVX.

4. A system according to claim 1, wherein said input processor acquires audio data of said plurality of different patients, said data processor processes said audio data to provide processed audio data and said communication network is of bandwidth sufficient to communicate said processed first video data and second video data and audio data to said first and second portable processing devices respectively.

5. A system according to claim 4, wherein said input processor acquires said audio data from a plurality of different microphones in patient rooms associated with said plurality of different patients.

6. A system according to claim 4, wherein said data processor processes said audio data to provide processed audio data by encoding said audio data with a compression function.

7. A system according to claim 1, wherein said input processor acquires said vital sign parameters from patient monitoring devices attached to said plurality of different patients.

8. A system according to claim 1, wherein said input processor acquires said associated video data from a plurality of different cameras in patient rooms associated with said plurality of different patients.

9. A system according to claim 1 including a rules processor for applying rules to said vital sign parameters to identify an alert condition indicating a significant patient clinical condition or change of clinical condition and wherein said data processor processes data representing said alert condition for inclusion in said processed first video data and said composite image includes an image element indicating said alert condition.

10. A system according to claim 1, wherein said data processor provides said processed first video data and second video data for concurrent viewing by users of said first and second portable processing devices respectively.

11. A system according to claim 1, wherein said data processor provides said processed first video data and second video data for concurrent viewing of the same patient by users of said first and second portable processing devices respectively.
12. A system according to claim 1, wherein said data processor enables a user to select and manipulate video image capture and display.

13. A distributed patient monitoring system for monitoring patients via visual and audio means and for viewing and monitoring patient parameters using a plurality of portable processing devices concurrently in different remote locations over distributed wired or wireless networks, comprising:

a monitoring processor responsive to user initiated commands from a plurality of different portable processing devices in different remote locations and including,

an input processor for acquiring vital sign parameters and associated video data representative of plurality of sequences of video images of a corresponding plurality of different patients; and

a data processor for processing said vital sign parameters and associated video data to process video data representing an image sequence including a composite image including a first area showing live video of a selected patient and a second area presenting vital sign parameters of said selected patient in response to user selection of an image element associated with said selected patient in a display image provided by a clinical information application; and

a communication network of bandwidth sufficient to communicate said processed video data to first and second portable processing devices respectively of said plurality of different portable processing devices in different remote locations in response to commands received from said first and second portable processing devices respectively.

14. A system according to claim 13, wherein said image element associated with said selected patient comprises a hyperlink.

15. A system according to claim 13, wherein said image element associated with said selected patient is presented in a list of different patients in said display image provided by said clinical information application.

16. A system for use by a portable processing device operating in a distributed patient monitoring system for visually monitoring patients and patient parameters using a plurality of portable processing devices in different remote locations, comprising:

an authentication processor enabling a user to obtain access authorization to access patient data in response to entry of identification data using any portable processing device of said plurality of portable processing devices in different remote locations;

a user interface, in response to said access authorization, enabling a user to:

initiate execution of a clinical information application providing a user with a clinical application display image identifying a plurality of different patients in a corresponding plurality of different locations, and select a particular patient of said plurality of different patients in said clinical application display image; and

a display processor for initiating generation of data representing an image sequence for presentation in a composite image including a first area showing live video of a selected particular patient and a second area presenting vital sign parameters of said particular patient in response to user selection of an image element associated with said particular patient of said plurality of different patients in said clinical application display image.

17. A system according to claim 16, including a rules processor for applying rules to said vital sign parameters to identify an alert condition indicating a significant patient clinical condition or change of clinical condition; and wherein said composite image includes an image element indicating said alert condition.

18. A system for use by a plurality of portable processing devices in different remote locations operating in a distributed patient monitoring system for visually monitoring patients and patient parameters, comprising:

an authentication processor enabling a user to obtain access authorization to access patient data in response to entry of identification data using any portable processing device of said plurality of portable processing devices in different remote locations;

a first portable processing device of said plurality of portable processing devices, having a user interface enabling a user, in response to said access authorization, to:

initiate execution of a clinical information application providing a user with a clinical application display image identifying a plurality of different patients in a corresponding plurality of different locations, and select a first patient of said plurality of different patients in said clinical application display image and display an image sequence including a composite image comprising a first area showing live video of said first patient and a second area presenting vital sign parameters of said first patient; and

a second portable processing device of said plurality of portable processing devices, having a user interface enabling a user, concurrently with operation of said first portable processing device and in response to said access authorization, to:

initiate execution of a clinical information application providing a user with a clinical application display image identifying a plurality of different patients in a corresponding plurality of different locations, and select a second patient of said plurality of different patients in said clinical application display image and display an image sequence including a composite image comprising a first area showing live video of said second patient and a second area presenting vital sign parameters of said second patient.

19. A distributed patient monitoring system for visually monitoring patients and patient parameters using a plurality of portable processing devices in different remote locations, comprising:

a monitoring processor responsive to user initiated commands from a plurality of different portable processing devices in different remote locations and including,

an input processor for acquiring vital sign parameters and associated video data representative of plurality of sequences of video images of a corresponding plurality of different patients; and

a data processor for processing said vital sign parameters and associated video data to provide, processed first video data representing an image sequence including a first image including an area
displaying user selectable image elements individually associated with corresponding individual patients of said plurality of different patients; and processed second video data representing an image sequence including a composite image including a first area showing live video of a selected first patient and a second area presenting vital sign parameters of said selected first patient in response to user selection of an image element associated with said first patient in said first image; and a communication network of bandwidth sufficient to communicate said processed first video data and second video data to first and second portable processing devices respectively of said plurality of different portable processing devices in different remote locations in response to commands received from said first and second portable processing devices respectively.

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