



- (51) **International Patent Classification:**
A61B 8/12 (2006.01) *A61B 6/00* (2006.01)
- (21) **International Application Number:**
PCT/US2014/064769
- (22) **International Filing Date:**
10 November 2014 (10.11.2014)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
61/903,764 13 November 2013 (13.11.2013) US
- (71) **Applicant:** **VOLCANO CORPORATION** [US/US];
3721 Valley Centre Drive, Suite 500, San Diego, California 92130 (US).
- (72) **Inventor:** **HOFFMAN, Joseph**; 632 Santa Ynez Way,
Sacramento, California 95816 (US).
- (74) **Agents:** **WEBB, Greg** et al.; Haynes and Boone, LLP, IP
Section, 2323 Victory Avenue, Suite 700, Dallas, Texas
75219 (US).

(81) **Designated States** (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) **Title:** VISUALLY OPTIMIZED INTRAVASCULAR IMAGING AND ASSOCIATED DEVICES, SYSTEMS, AND METHODS

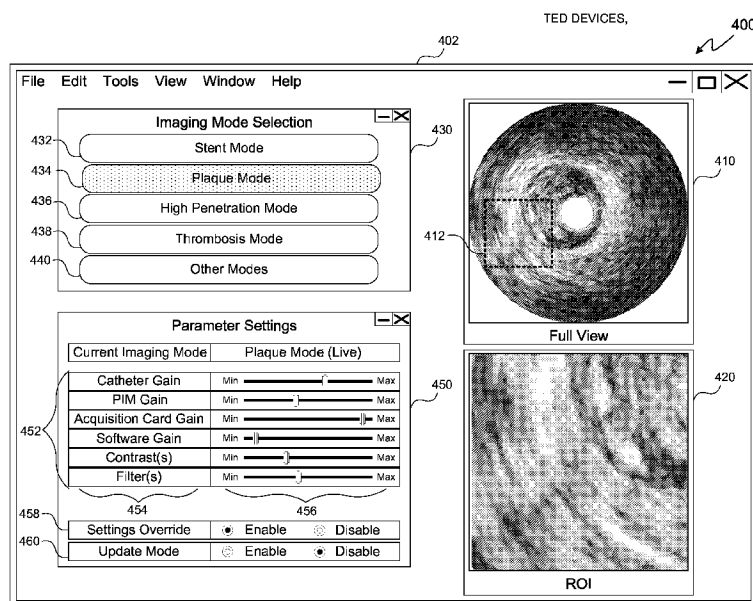


FIG. 4

(57) **Abstract:** Intravascular devices, systems, and methods are disclosed. In some embodiments, a medical imaging system for imaging vasculature of a patient is provided. The imaging system includes a console that has one or more processors with a medical imaging system interface running thereon, an acquisition card in communication with the one or more processors and in communication with a patient interface module (PIM), and an intravascular imaging component in communication with the PIM and disposed on a distal end of a flexible elongate member. The medical imaging system interface provides a plurality of settings groups for selection by a user, each of the settings groups having pre-acquisition parameters and post-acquisition parameters that are optimal for imaging a desired viewing target within the vasculature. Associated methods and computer-readable media are provided.

**VISUALLY OPTIMIZED INTRAVASCULAR IMAGING AND ASSOCIATED
DEVICES, SYSTEMS, AND METHODS**

TECHNICAL FIELD

The present disclosure is related to medical imaging systems as used in the treatment of various maladies. In particular, embodiments disclosed herein are particularly suited for use in intravascular and intracardiac imaging and treatment systems.

BACKGROUND

Heart disease is one of many serious conditions that can require emergency operations to save lives. A main cause of heart disease is the accumulation of plaque inside the blood vessels, which eventually occludes the blood vessels. Common treatment options available to open up the occluded vessel include balloon angioplasty, rotational atherectomy, and intravascular stents. Clinicians may rely on intravascular imaging systems to observe and characterize conditions in order to determine the best course of treatment. Other conditions also necessitate investigations within a patient's body.

Some of these techniques, like intravascular ultrasound (IVUS) and optical coherence tomography (OCT), may utilize intravascular devices like catheters and guidewires. Often intravascular catheters and guidewires are utilized to visualize the inner lumen of the blood vessel. Such catheters and guidewires contain imaging elements and may also contain other electronic, optical, or electro-optical components. Obtaining useful images from within the vasculature of a patient by imaging sensing devices has a number of difficulties. The structures and features to be visualized in a target area can have significantly different

properties which may respond very differently to a visualization mechanism such as ultrasound. For example, the ultrasonic backscatter from a stent is very different that from soft tissue or plaque. The different reactions complicate visualization of either type of feature in a target area.

Accordingly, there remains a need for improved intravascular devices, systems, and methods that can provide useful imaging data from the varied features to be observed within a target area.

SUMMARY

Embodiments of the present disclosure are directed to intravascular devices, systems, and methods.

In one embodiment, a method for optimally viewing medical images is provided. The method includes steps of positioning a medical imaging device into vasculature of a patient at an area of interest and selecting a desired settings group from a plurality of settings groups in a medical imaging system interface that provides control over the medical imaging device. The medical imaging device is communication with a medical imaging system, and the desired settings group includes parameters affecting acquisition over an acquisition pipeline of the medical imaging system. The method further includes a step of collecting imaging data at the area of interest using the medical imaging device.

In another embodiment, a medical imaging system for imaging vasculature of a patient is provided. The imaging system includes a console that has one or more processors with a medical imaging system interface running thereon, an acquisition card in communication with the one or more processors and in communication with a patient interface module (PIM), and an intravascular imaging component in communication with the PIM and disposed on a distal end of a flexible elongate member. The medical imaging system interface provides a plurality of settings groups for selection by a user, each of the settings groups having pre-acquisition parameters and post-acquisition parameters that are optimal for imaging a desired viewing target within the vasculature.

In yet another embodiment, a computer-readable medium including instructions is provided. The instructions when executed by one or more processors of an medical imaging system, causes the medical imaging system to perform a method for optimally viewing medical images. The method includes steps of selecting a desired settings group from a plurality of settings groups in a medical imaging system interface that provides control over

the medical imaging device, propagating the parameters of the desired settings group to components of the acquisition pipeline, collecting imaging data at the area of interest using the medical imaging device. The desired settings group includes parameters affecting acquisition over an acquisition pipeline of the medical imaging system.

Additional aspects, features, and advantages of the present disclosure will become apparent from the following detailed description.

These and other embodiments will be described in further detail below with respect to the following figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is diagram of a medical imaging system according to some embodiments of the present disclosure.

Fig. 2 is a diagram of another medical imaging system according to some embodiments of the present disclosure.

Fig. 3 is a diagram of an imaging pipeline such is present in the medical imaging systems of Figs. 1 and 2 according to some embodiments of the present disclosure.

Fig. 4 is a diagram of a medical imaging interface for live image viewing according to some embodiments of the present disclosure.

Fig. 5 is a diagram of a medical imaging interface for recorded image viewing according to some embodiments of the present disclosure.

Fig. 6 is a method for optimally viewing medical images according to some embodiments of the present disclosure.

For clarity of discussion, elements having the same designation in the drawings may have the same or similar functions. The drawings may be better understood by referring to the following Detailed Description.

DETAILED DESCRIPTION

For the purposes of promoting an understanding of the principles of the present disclosure, reference will now be made to the embodiments illustrated in the drawings, and specific language will be used to describe the same. It is nevertheless understood that no limitation to the scope of the disclosure is intended. Any alterations and further modifications to the described devices, systems, and methods, and any further application of the principles of the present disclosure are fully contemplated and included within the present disclosure as would normally occur to one skilled in the art to which the disclosure relates. In particular, it is fully contemplated that the features, components, and/or steps described with respect to one embodiment may be combined with the features, components, and/or steps described with respect to other embodiments of the present disclosure. For the sake of brevity, however, the numerous iterations of these combinations will not be described separately.

Fig. 1 is a schematic diagram depicting a medical imaging system 100. In general, the medical imaging system 100 provides for coherent acquisition, integration, and consolidation of multiple forms of acquisition and processing elements designed to be sensitive to a variety of methods used to acquire and interpret human biological physiology and morphological information and to coordinate treatment of various conditions. In one embodiment, the medical system 100 includes a processing system 101 that is a computer system with the hardware and software to acquire, process, and display medical data, but, in other embodiments, the processing system 101 may be any other type of computing system operable to process medical data. In the embodiments in which processing system 101 is a computer workstation, the system includes at least one processor such as a microcontroller or a dedicated central processing unit (CPU), a non-transitory computer-readable storage medium such as a hard drive, random access memory (RAM), and/or compact disk read only memory (CD-ROM), a video controller such as a graphics processing unit (GPU), and a

network communication device such as an Ethernet controller or wireless communication controller.

In some embodiments, the processing system 101 is programmed to execute steps associated with the medical image acquisition, analysis, and control described herein. Accordingly, it is understood that any steps related to data acquisition, data processing, instrument control, and/or other processing or control aspects of the present disclosure may be implemented by the processing system 101 using corresponding instructions stored on or in a non-transitory, computer-readable medium accessible by the processing system. In some instances, the processing system 101 is portable (*e.g.*, handheld, on a rolling cart, etc.). Further, it is understood that in some instances processing system 101 comprises a plurality of computing devices. In that regard, it is particularly understood that the different processing and/or control aspects of the present disclosure may be implemented separately or within predefined groupings using a plurality of computing devices. Any divisions and/or combinations of the processing and/or control aspects described below across multiple computing devices are within the scope of the present disclosure.

In the depicted embodiment, the medical imaging system 100 is deployed in a catheter lab 102 having a control room 104, with the processing system 101 being located in the control room. In other embodiments, the processing system 101 may be located elsewhere, such as inside the catheter lab 102, in a centralized area in a medical facility, or at an off-site location accessible by an extended network. The catheter lab and control room may be used to perform on a patient any number of medical sensing procedures known in the art. A patient 106, depicted in catheter lab 102, may be undergoing a single modality or multi-modality procedure either as a single procedure or in combination with one or more sensing procedures. For example, an angioplasty procedure may be performed to position a stent in a target location in a target region of the vasculature of the patient 106.

In the illustrated embodiment of Fig. 1, intravascular device 108 is a medical imaging device that may be utilized by a clinician to acquire medical imaging data about the patient 106 and/or to provide a treatment to the patient 106. For instance, the intravascular device 108 may images by using ultrasound (*e.g.*, IVUS), OCT, thermal, and/or other imaging techniques. The intravascular device 108 may be any form of device, instrument, catheter, or probe that is sized and shaped to be positioned within a vessel. In some embodiments, intravascular device 108 may be combined with a non-imaging component into a single package that is sized and shaped to be positioned within a vessel. As illustrated, the IVUS intravascular device 108 is an IVUS catheter that includes one or more sensors such as a phased-array transducer to collect IVUS sensing data. In some embodiments, the intravascular device 108 may be capable of multi-modality sensing such as both IVUS and intravascular photoacoustic (IVPA) sensing, or OCT and IVUS sensing, etc.

In the depicted embodiment, a patient interface module (PIM) 112 couples the intravascular device 108 to the medical imaging system 100. The PIM 112 facilitates the exchange of information between the intravascular device 108 and the processing system 101, serving as a medical device interface therebetween. This information includes imaging data transmitted from the intravascular device 108 to the processing system 101 and commands and settings, which may include individual parameter specifications, communicated from the processing system 101 to the PIM 112 and to the intravascular device 108 itself. Thus, the PIM 112 is operable to receive medical imaging and/or sensing data collected from the patient 106 using the intravascular device 108 and to transmit the received data to a processing system such as the processing system 101.

In the depicted embodiment, the PIM 112 includes analog-to-digital (A/D) and/or digital-to-analog (D/A) converters and transmits digital data to the processing system 101 and analog signals to the imaging device 108. However, in other embodiments, the PIM 112 may

transmit and receive analog and/or digital data to and from the processing system 101 and/or the imaging device 108. In one embodiment, the imaging PIM 112 transmits medical imaging data and/or receives commands over a high-speed data bus connection or a high-speed wireless networking standard. In embodiments where PIM 112 incorporates a user interface, commands may be received through the user interface rather than from a networked source.

A bedside controller 118 is also communicatively coupled to the processing system 101 and provides user control of the particular medical modality (or modalities) being used to diagnose the patient 106. In the current embodiment, the bedside controller 118 is a touch screen controller that provides user controls and diagnostic images on a single surface within the field of operation. In alternative embodiments, however, the bedside controller 118 may include both a non-interactive display and separate controls such as physical buttons and/or a joystick, and/or a keyboard and mouse. In the integrated medical imaging system 100, the bedside controller 118 is operable to present control options for the intravascular device 108 and patient imaging data collected therefrom in graphical user interfaces (GUIs). Additionally, the controller 118 may be coupled to the PIM 112 to communicate with it over a high-speed wired or wireless connection or link.

The medical imaging system 100 provides a medical imaging system interface by which a variety of settings groups may be selected from by a user. The settings groups include a plurality of parameters that are pre-set in order to optimize the viewing of specific features at a target area. More detail regarding the settings groups and the selection thereof is provided later in this disclosure.

A main controller 120 in the control room 104 adjacent to the catheter lab 102 is also communicatively coupled to the processing system 101 and/or the PIM 112. In the current embodiment, the main controller 120 is similar to the bedside controller 118 in that it includes a touch screen and is operable to display a multitude of GUI-based controls

corresponding to different medical sensing modes via a UI framework service executing thereon. In alternative embodiments, the main controller 120 may include a non-interactive display and standalone controls such as a mouse and keyboard. In some embodiments, the processing system 101 may be absent, such that the intravascular device 108 is controlled only through the bedside controller 118 and/or the main controller 120. In such an embodiment, the imaging data collected is at least temporarily stored in the controller 118 and/or 120.

Thus, while in the depicted embodiment PIM 112 is in communication with the processing system 101 as described above, in some embodiments, the bedside controller 118 receives data from and communicates commands to PIM 112 instead. And in some embodiments, the main controller 120 additionally or alternatively receives data from and communicates commands to PIM 112.

Referring to Fig. 2, shown therein is an alternative medical imaging system 200 that shares a number of features with the medical imaging system 100 described above in connection with Fig. 1. The medical imaging system 200 may be understood as a subset of the medical imaging system 100, while generally having the same capabilities when collecting, processing, and viewing imaging data from a patient. The medical imaging system 200 includes a controller 202, which may be a workstation-type controller or may be a hand-held computing device such as a tablet computing device. The controller 202 includes one or more processors, illustrated as central processing unit (CPU) 204, in communication with a memory 206 and an acquisition card 208, which may include a plurality of analog components and field-programmable gate arrays.

The memory 206 may include multiple types of memory and/or multiple levels of memory. Thus, memory 206 may include random access memory (RAM), read only memory (ROM), a hard disk drive, a solid-state drive, etc. The memory 206 stores data 210, which

may include imaging data collected using an intravascular device and parameter settings therefor, and programs 212, which may provide for imaging data collection, for the manipulation of collected data, and for the selection and implementation of settings and parameters associated with the imaging collection process and devices.

The acquisition card 208 provides an interface between the controller 202 and a PIM 220, being coupled thereto by a high-speed link 222. In some embodiments, more than one acquisition card may be present in the medical imaging system 200. For example, acquisition card 208 may be present on the controller 202, while another is present in the PIM 220 or in a bedside box, such as the beside controller 118 of Fig. 1. The PIM 220 includes a processor or microcontroller (MC) 224 that facilitates communication with and control of an imaging device 230, such as an IVUS catheter or intravascular device. The PIM 220 includes a sled 226 that can be used to move the PIM 220 and thereby the imaging device 230 during controlled translational movements, such as a “pullback” movement. The PIM 220 includes a device socket 228 that is used to couple the imaging device 230 to the PIM 220. The imaging device 230 includes a coupler 232 at its proximal end, which is inserted into the socket 228 to communicatively and physically secure the imaging device 230 to the PIM 220. In some embodiments, the imaging device 230 may be a rotational IVUS catheter. In such embodiments, the socket 228 is configured to rotate to provide for the rotation of the coupled imaging device 230.

The imaging device 230 further includes a chip 234. In some embodiments, the chip includes a ROM, such as an erasable programmable ROM (EPROM), that includes information regarding the imaging device 230, such as an identifier of the type of device it is. The chip 234 may further include parameters for settings, like gain, that may be implemented on the imaging device 230. The parameters may be changed by communication through the PIM 220. In some embodiments, the chip 234 is a microcontroller that can communicate with

the PIM 220 in the control of an imaging component 236 disposed at a distal end of the imaging device 230 and in receiving data therefrom. The chip 234 is illustrated as being included in the coupler 234, but in other embodiments may be located elsewhere within the imaging device 230 and/or the PIM 220.

Referring now to Fig. 3, the collection of imaging data from the imaging component 236 may include the application of many different settings parameters and processing along the imaging pipeline 300. The pipeline 300 extends from the imaging component 236 where data is collected all the way to a display 240 (coupled to the controller 202). The pipeline thus includes the imaging component 236, the chip 234, the PIM 220, the acquisition card 208, and the CPU 205, which may apply additional settings-associated processing by the programs 212 running thereon. In some embodiments, a many different settings may be controlled by various parameters. The settings may include several different gain settings, time gain compensation (TGC) settings, contrast settings, and various filter settings.

Beginning at the imaging component side and working through the pipeline 300, some of the controllable settings include transmit pulse frequency and shape, transmit pulse amplitude, coded transmit sequence, coded transmit frequency, coded transmit amplitude, transmit sequencing for arrays, pulse repetition frequency. The controllable settings also may include PIM rotational speed, PIM pullback speed, array beam forming and focusing, array apodization, digitization rate, frame rate, field-of-view, coherent data averaging (whether a-line based or frame-based), and bandpass filtering (analog or digital) to remove high-frequency noise and low-frequency drift, ringdown removal ON/OFF, ringdown removal settings, non-linear rank filter settings, envelope detection settings, dynamic range, saturation, blood flow detection settings (sensitivity, thresholds, and Doppler settings), compression settings, persistence, and other recursive filter settings, color mapping settings.

This large number of settings that may be controlled by varying parameters through the pipeline 300 can complicate the selection of appropriate parameters for a clinician during a given surgical procedure. The pipeline 300 may be understood as having two main stages: a pre-acquisition stage 302 and a post-acquisition stage 304 as illustrated in Fig. 3. The pre-acquisition stage 302 and the post-acquisition stage both include many settings and may include sequential settings of a single type. For example, the pipeline 300 may include a gain setting at the chip 234, another gain setting at the PIM 220, and yet another gain setting implemented by the acquisition card 208. While the gain settings at each of the pipeline-components may serve similar functions, they are not necessarily fungible. Thus, the application of a certain level of gain at the PIM 220 may have some differences if a similar level of gain were to be applied at the acquisition card 208. In some embodiments, the post-acquisition stage 304 may include some of the features provided by the acquisition card 208, while the pre-acquisition stage 302 includes some other features provided thereby.

Allowing a user access to individually adjust each parameter in pipeline components of the pre-acquisition stage 302 and the post-acquisition stage 304 could complicate the operation enough to make an imaging system like the system 200 too difficult to use in an effective manner for different types of evaluations. However, if control of the settings is not presented to the user, the full capabilities of the imaging system are not realized. Further, when imaging data is collected from imaging component 236, the imaging data passes through the pipeline 300. After the processed data leaves the acquisition card 208, it may be processed further by programs 212 running on the CPU 204 and/or it may be stored for later viewing and analysis. In general, after imaging data is stored in memory 206 or in networked storage, only some of the processing may be “undone”. The software processing performed by the programs 212 may be performed using different settings, but the settings applied during the pre-acquisition stage will limit the available adjustments.

Certain features at a target area within a patient may be better viewed by having certain settings applied. For instance at a particular target area within a patient, it may be useful to view both a stent and atherosclerotic plaque. Given the different properties of these two imaging subjects, different settings may be needed to image both in detail. For example, because the stent may reflect ultrasound energy much more readily than plaque does, a relatively lower gain setting may improve the useful detail in obtained images.

Also, certain filter stages may be better for one imaging subject than another. For example, aggressive filtering of the signal may lower the noise level and permit the visualization of plaque, plaque borders, or thrombus. However, the corresponding decrease in bandwidth may compromise the axial resolution and degrade the ability to visualize stents. Filters are used throughout the pipeline to achieve various goals. The analog and digital filters near the front of the pipeline 300 may limit the signal bandwidth in order to reduce noise. In some situations, a user may be willing to accept more noise, to get more bandwidth as it may provide improved image resolution. Or, the user might want to reduce noise at the expense of bandwidth. Filters later in the pipeline may serve other purposes such as envelope detection of the signal and “persistence”. Persistence may smooth moving images by performing a frame-to-frame weighted average. Thus, providing appropriate control to a user of a medical imaging system, like medical imaging systems 100 and 200, may facilitate the collection of more detailed, accurate imaging data.

One of the programs 212 running on the CPU 204 of the controller 202 of Fig. 2 or the bedside controller 118 or the main controller 120 of Fig. 1 provides a medical imaging system interface to facilitate the appropriate control of settings that may be applied in the imaging pipeline 300. Embodiments of such a medical imaging system interface are illustrated in Figs. 4 and 5 and described below.

Referring now to Fig. 4, an illustration of a medical imaging system interface 400 is shown. The system interface 400 is a graphical user interface that may be provided by medical imaging system 100 or 200 to a user during an imaging procedure. For example, the system interface 400 may be provided to a user through a display coupled to a controller running a program to enable the collection and processing of imaging data. The display may be a touch-screen display, allowing a user to make selections through the display itself. In embodiments of medical imaging systems in which the display is not a touch-screen display, inputs may be received by the use of a keyboard, mouse, or other input device, such as voice-control.

The system interface 400 includes a main window 402 that includes a number of controls and also presents several sub-windows, which may be adjusted in size so that a given sub-window occupies an entire display or so that it is essentially hidden from a user's view. The main window 402 includes a full view window 410, a region of interest (ROI) window 420, an imaging mode selection window 430, and an individual parameter settings window 450.

The full view window 410 provides the user with a scaled view of imaging data being collected from a target area at a moment. As illustrated, the full view window 410 shows a longitudinal view along a portion of vasculature within a patient. This window 410 may be increased or decreased in size. The full view window 410 also provides a user with the ability to select a region of interest, such as the ROI 412, for display in the ROI window 420. The ROI window 420 may allow for a full resolution view of the ROI 412 selection in the full view window 410 or simply a higher resolution view than in the full view window 410.

The system interface 400 further includes the imaging mode selection window 430. The selection window 430 includes a plurality of groups of settings, or settings groups, that are optimized for viewing a specific feature at the target area. For example, the selection

window 430 provides a button to select a stent mode 432 that includes a plurality of settings with parameters set so as to improve the visual depiction of a stent at the target area. This may be used to ensure proper positioning of the stent within the patient. For example, the stent mode 432 may lower gain settings applied by software in programs 212, the acquisition card 208, the PIM 220, and/or the imaging device 230. The contrast may be set higher. In contrast, by selection of a plaque mode 434, or soft tissue mode, a group of parameters may be implemented in various settings so that the gain is increased throughout the imaging pipeline, and the contrast may be set lower. In general, low contrast settings are better for looking at plaque subtleties and blood flow, while high contrast settings are used more for getting clear borders and gross morphology. High contrast is also typically preferred when the physician is sitting far from the display.

Furthermore, because certain elements within the image tend to have similar gray scale levels, boosting the intensity of these levels can emphasize these elements. For example, by boosting the lower intensity signals, it is possible that the appearance of blood could be enhanced. Inversely, by turning down these gray levels, the blood appearance might be de-emphasized.

The settings groups may be optimized such that an overall effect of a setting may be achieved non-uniformly across the pipeline. For example, in lowering the gain when switching from plaque mode 434 to the stent mode 432, more of the decrease may be obtained by a decrease of PIM-related gain than from acquisition card gain in some embodiments. The thrombosis mode 328 may include high gain and time gain compression. These settings are pre-programmed and then accessed by selection of a mode through the selection window 430.

As illustrated, the selection window 430 presents a stent mode 432, a plaque mode 434 (which appears selected in Fig. 4), a high penetration mode 436, a thrombosis mode 438,

and may include other modes 440. By selecting any mode on the selection window 430, a user of the medical imaging system may set parameters in a plurality of both pre-acquisition stage settings and post-acquisition stage settings. The implementation of the settings of a particular settings group may be propagated through the imaging pipeline in a number of ways. In some embodiments, parameters are directly communicated from the system interface 400 to the acquisition card 208, the microcontroller 224 of PIM 220, and/or the chip 234 of the imaging device 230. Alternatively, the desired setting may be requested and interpreted by each processor or microcontroller in the pipeline, and then implemented by that processor or microcontroller at its level. For example, a specific gain parameter may be transmitted to the chip 234 or a desired gain setting may be communicated to the chip 234, which then implements a corresponding parameter to achieve that desired gain setting.

In some embodiments, the ability of a user to adjust the parameters of the pipeline may be limited to a selection from the modes presented in the selection window 430. However, in other embodiments, when a mode is selected through the selection window 430, additional information may be presented to the user in a parameter settings window 450. The parameter settings window 450 indicates the current imaging mode, as selected from the selection window 430, and provides further detail. Exemplary settings 452 are displayed in the settings window 450 with a name or identifier 454 of the setting and an indication of the parameter 456 of the setting. In some embodiments, the settings window 450 includes an override selector 458. As illustrated, the override selector 458 is a “radio button” type of interface element, presenting the option to disable or to enable a settings override mode in which a user, having previously selected an imaging mode through the selection window 430, may then modify the pre-programmed settings. The parameter settings window 450 may present all available individual settings with their associated potential parameter values or may only present a subset. By enabling the settings override mode, a user may be able to

further tailor the pre-programmed settings associated with the selected imaging mode without having to set each parameter of each setting individually.

In some instances, a user may want to save the fine-tailoring so that the selection of an imaging mode in the selection window 430 includes the tailored setting or settings. The update mode selector 460 is an interface element that allows a user to do this. By enabling the update mode the individually adjusted parameters of the individual settings may be automatically stored for future access by selecting the associated settings mode in the selection window 430. When the update mode is disabled by the update mode selector 460, the tailoring of parameters is not saved and may be undone by selecting a different settings mode from the selection window 430.

Other embodiments of the medical imaging system interface 400 may include different types of interface elements. For example, rather than having slider-type selection elements, which may be continuously adjusted or have discrete positions along the length thereof, to adjust the parameters 456 of the settings 452, other types of user interface elements may be used, such as a dialog box, where a numerical parameter may be entered expressly, or radio buttons, or other elements. Thus, the selections presented to a user by the system interface 400 may provide the functions described above in many different ways. The windows 410, 420, 430, and 450 may be resized relative to each other or hidden. For example, once a user has selected a desired mode, such as high penetration mode 436, the user may collapse or hide the selection window 430 and the parameter settings window 450 and increase the size of the full view window 410 and/or the ROI window 420. The medical imaging system interface 400 may provide a manageable system to a user, allowing that user to make optimized adjustments throughout the imaging pipeline as seen in Fig. 3, including pre-acquisition and post-acquisition stage settings and associated parameters. These optimized adjustments may be excessively complicated and require more familiarity and

knowledge of the medical imaging system than a clinician has, but the medical imaging system interface 400 provides a streamlined system for accessing the appropriate settings.

Referring now to Fig. 5, a medical imaging system interface 500 is illustrated. The medical imaging system interface 500 shares many of the features described above in connection with the system interface 400. However, the system interface 500 further includes a recorded image library 502. The recorded image library 502 provides an interface to access a library of saved imaging data, whether “still” images or video, that were recorded earlier. The library 502 may include imaging data obtained months or days before, and may also include imaging data obtained just seconds before. Thus, for example, when a pullback movement is performed to gather imaging data along a length of an artery, the data is stored for subsequent viewing in memory (such as memory 206 of Fig. 2 or remote networked storage) and made accessible through the library 502.

The library 502 includes exemplary files 504A, 504B, and 504C. The library includes a filename, a file type, and a duration for each file. Additionally, the library 502 includes an indication of the acquisition mode that was used in the collection of the associated imaging data. Thus, the filename of the exemplary file 504A is File_1, it is a still image, thus the duration field is not applicable, and the data was acquired using the stent mode as selected in the imaging mode selection window 430. The library 502 permits selection of a file of imaging data and further presents buttons to view, archive, or delete the selected file. The view button 506A may cause the file to be displayed in both the full view window 410 and the ROI window 420 if a ROI 412 is selected. Selection of the archive button 506B may remove the file from the library 502 to an archive from which it may be retrieved later. By selecting the delete button 506C, the selected file is deleted or removed from the library 502 and marked for deletion.

While the imaging mode selection window 430 in the system interface 500 may present the same selections of settings groups or modes to a user as in the system interface 400, the settings window 450 contains some differences. The exemplary settings 452 are illustrated, with a subset 552 of the exemplary settings 452 being indicated as not applicable. As discussed above, after imaging data is collected using an intravascular imaging device, some of the acquisition settings may be altered while others cannot be altered. Post-acquisition stage settings may be altered even after imaging data is stored in a file, while pre-acquisition stage settings may not be altered at all or without computationally intensive reconstruction. Thus, the subset 552 of the exemplary settings 452 includes those settings that are not changeable when viewing recorded images from the library 502. Thus, when selecting from the selection window 430 to apply the associated settings group of the selected mode to the file selected from the library 502, only some of the settings from the selected mode, the post-acquisition settings, may be applied. Like the medical imaging system interface 400, the system interface 500 may facilitate the control of a medical imaging system to allow a user to better view imaging data with a specific type of target subject in mind.

Fig. 6 is a flowchart of a method 600 for optimally viewing intravascularly obtained medical images. The method 600 includes several enumerated steps as illustrated. However, embodiments of the method 600 may include additional steps before, after, and/or in between the enumerated steps. Thus, method 600 may begin in step 602 when a medical imaging device is positioned into vasculature of a patient at an area of interest. The medical imaging device is in communication with a medical imaging system. In step 604, a desired settings group is selected from a plurality of settings groups in a medical imaging system interface that provides control over the medical imaging device. The desired settings group includes parameters affecting acquisition throughout an acquisition pipeline of the medical imaging system. And in step 606, imaging data is collected at the area of interest using the medical imaging device.

To better describe an embodiment of the method 600 reference is made to the medical imaging system 200 of Fig. 2 and to the medical imaging system interface 400 of Fig. 4. Thus, the method 600 may begin when a clinician positions an imaging device 230 into the vasculature of a patient at a target area (step 602). The imaging device 230 may be an IVUS imaging device or an intravascular OCT imaging device. The target area may be a treatment site having a stent inserted and positioned therein.

The user/clinician selects a desired settings group, stent mode 432, using a mouse or other input device, from a plurality of settings groups presented in the selection window 430 (step 604). The stent mode 432 includes a plurality of settings each having a pre-programmed parameter as seen in the parameter settings window 450 of Fig. 4. By selecting the stent mode 432, the user selects the pre-programmed parameters for each of the various settings. These settings are optimized so that the stent may be clearly viewed. Then, after the stent has been adequately observed with the optimized settings, in order to more clearly depict the soft tissue near the stent, the plaque mode 434 may be selected. The selected settings group includes parameters for settings throughout the imaging acquisition pipeline, and thus includes pre-acquisition settings and post-acquisition settings. To implement the settings group, the parameters may be propagated throughout the imaging acquisition pipeline.

When the selected settings group, or mode, is chosen from the selection window 430, the imaging device 230 may be used to collect imaging data at the target area (step 606). This imaging data may be processed and recorded in memory 206 and/or viewed immediately, i.e. viewed live. If processed and recorded, it may be available through the library 502 of the system interface 500 of Fig. 5 as part of the method 600. In general, any of the features described above in connection with the system interfaces 400 and 500 may be employed in various embodiments of the method 600.

Additionally, some embodiments of the system interfaces 400 and 500, which may be part of the imaging systems 100 and 200, include tangible, non-transient, computer-readable media that include executable code that when run by a processor, such one or more processors of the controllers 118 and 120 or the processing system 101 of Fig. 1 or the CPU 204 of Fig. 2, may cause the processor(s) to perform the steps of method 600 as described above. Some common forms of computer-readable media that may include the steps of methods 600 are, for example, floppy disk, flexible disk, hard disk, magnetic tape, any other magnetic medium, CD-ROM, any other optical medium, RAM, ROM, any other memory chip or cartridge, and/or any other medium from which a processor or computer is adapted to read. The computer-readable media may be memory 206 of FIG. 2, which may include instructions that provide the system interfaces 400 and/or 500 when executed by a processor.

The systems 100 and 200, incorporating the system interfaces 400 and/or 500, performing the method 600 may provide a beneficial degree of optimization to a user, permitting the user to easily select the optimal settings for a desired target. The settings require many parameters to be set throughout the imaging pipeline, including some that may otherwise not be presented to the user. Observation of a target area using such systems and methods may be simpler, quicker, and provide more detail of the desired aspects of the area.

The examples provided above are exemplary only and are not intended to be limiting. One skilled in the art may readily devise other systems consistent with the disclosed embodiments which are intended to be within the scope of this disclosure. As such, the application is limited only by the following claims.

CLAIMS

What is claimed is:

1. A method for optimally viewing medical images, the method comprising:
positioning a medical imaging device into vasculature of a patient at an area of
interest, the medical imaging device in communication with a medical
imaging system;
selecting a desired settings group from a plurality of settings groups in a medical
imaging system interface that provides control over the medical imaging
device, the desired settings group including parameters affecting acquisition
over an acquisition pipeline of the medical imaging system; and
collecting imaging data at the area of interest using the medical imaging device.
2. The method of claim 1, further comprising displaying the imaging data on a display of
the medical imaging system.
3. The method of claim 1, wherein the acquisition pipeline of the medical imaging
system comprises:
an imaging device interface coupled to an imaging component;
an acquisition card coupled to receive information from the imaging device interface;
and
a medical imaging system interface running on a console of the medical imaging
system.
4. The method of claim 3, wherein the acquisition pipeline further comprises the
imaging component.

5. The method of claim 1, wherein each setting group includes parameters affecting acquisition over the acquisition pipeline, the parameters including at least one gain parameter, at least one time gain compensation (TGC) parameter, at least one contrast parameter, and at least one filter parameter.
6. The method of claim 5, wherein the parameters include an imaging component gain parameter, an imaging device interface gain parameter, an acquisition card gain parameter, and a system interface gain parameter.
7. The method of claim 1, wherein the parameters of each settings group include pre-acquisition parameters and post-acquisition parameters.
8. The method of claim 1, further comprising:
 - recording the collected imaging data into at least one recorded image file stored in a memory;
 - selecting an alternative desired settings group from the plurality of settings groups;
 - applying post-acquisition settings of the alternative desired settings group to the recorded image file; and
 - displaying the recorded image file in a medical imaging system interface based on the applied post-acquisition settings.
9. The method of claim 1, further comprising overriding at least one of the parameters of the desired settings group.
10. The method of claim 1, wherein the plurality of settings groups includes at least a stent settings group, wherein the parameters of the stent settings group are optimized

for viewing stents, and a plaque settings group, wherein the parameters of the plaque settings group are optimized for viewing intravascular plaque.

11. The method of claim 1, wherein the medical imaging system is an intravascular ultrasound imaging system.
12. A medical imaging system for imaging vasculature of a patient, the system comprising:
 - a console, the console having one or more processors with a medical imaging system interface running thereon;
 - an acquisition card in communication with the one or more processors and in communication with a patient interface module (PIM); and
 - an intravascular imaging component in communication with the PIM and disposed on a distal end of a flexible elongate member;wherein the medical imaging system interface provides a plurality of settings groups for selection by a user, each of the settings groups having pre-acquisition parameters and post-acquisition parameters that are optimal for imaging a desired viewing target within the vasculature.
13. The medical imaging system of claim 12, wherein the medical imaging system interface receives input through a bedside controller, a touch screen, and/or a keyboard and a mouse.
14. The medical imaging system of claim 13, wherein one of the plurality of settings groups is selected by a user through the medical imaging system interface.

15. The medical imaging system of claim 12, wherein the intravascular imaging component is an intravascular ultrasound IVUS component.
16. The medical imaging system of claim 12, wherein the intravascular imaging component is an optical coherence tomography (OCT) component.
17. The medical imaging system of claim 12, wherein the pre-acquisition parameters comprise at least a PIM gain and an acquisition card gain and the post-acquisition comprise include a software gain.
18. The medical imaging system claim of 12, wherein the settings groups comprise at least a stent settings group for viewing a stent and a soft tissue settings group for viewing soft tissue.
19. The medical imaging system of claim 12, wherein the pre-acquisition and the post-acquisition parameters comprise gain parameters, time gain compensation parameters, contrast parameters, and filters.
20. The medical imaging system of claim 12, further comprising a database for storing imaging data collected from the intravascular imaging component, and wherein the medical imaging system interface provide.
21. The medical imaging system of claim 20, wherein application of one of the settings groups to recorded imaging data comprises applying the post-acquisition parameters of the selectable settings group.

22. The medical imaging system of claim 12, wherein the pre-acquisition parameters and/or the post-acquisition parameters of a selected selectable settings group are modified by input received from a user through the medical imaging system interface.
23. The medical imaging system of claim 12, wherein application of a selected settings group comprises communicating at least one parameter to the acquisition card and at least one parameter to the PIM.
24. The medical imaging system of claim 23, wherein application of the selected settings group further comprises communicating at least one parameter to the intravascular imaging component.
25. The medical imaging system of claim 12, wherein the settings groups in the plurality of settings groups provided by the medical imaging system interface to the user depend on a type of the medical imaging component.
26. A computer-readable medium including instructions that when executed by one or more processors of an medical imaging system, causes the medical imaging system to perform a method for optimally viewing medical images, the method comprising:
 - selecting a desired settings group from a plurality of settings groups in a medical imaging system interface that provides control over the medical imaging device, the desired settings group including parameters affecting acquisition over an acquisition pipeline of the medical imaging system;
 - propagating the parameters of the desired settings group to components of the acquisition pipeline; and
 - collecting imaging data at the area of interest using the medical imaging device.

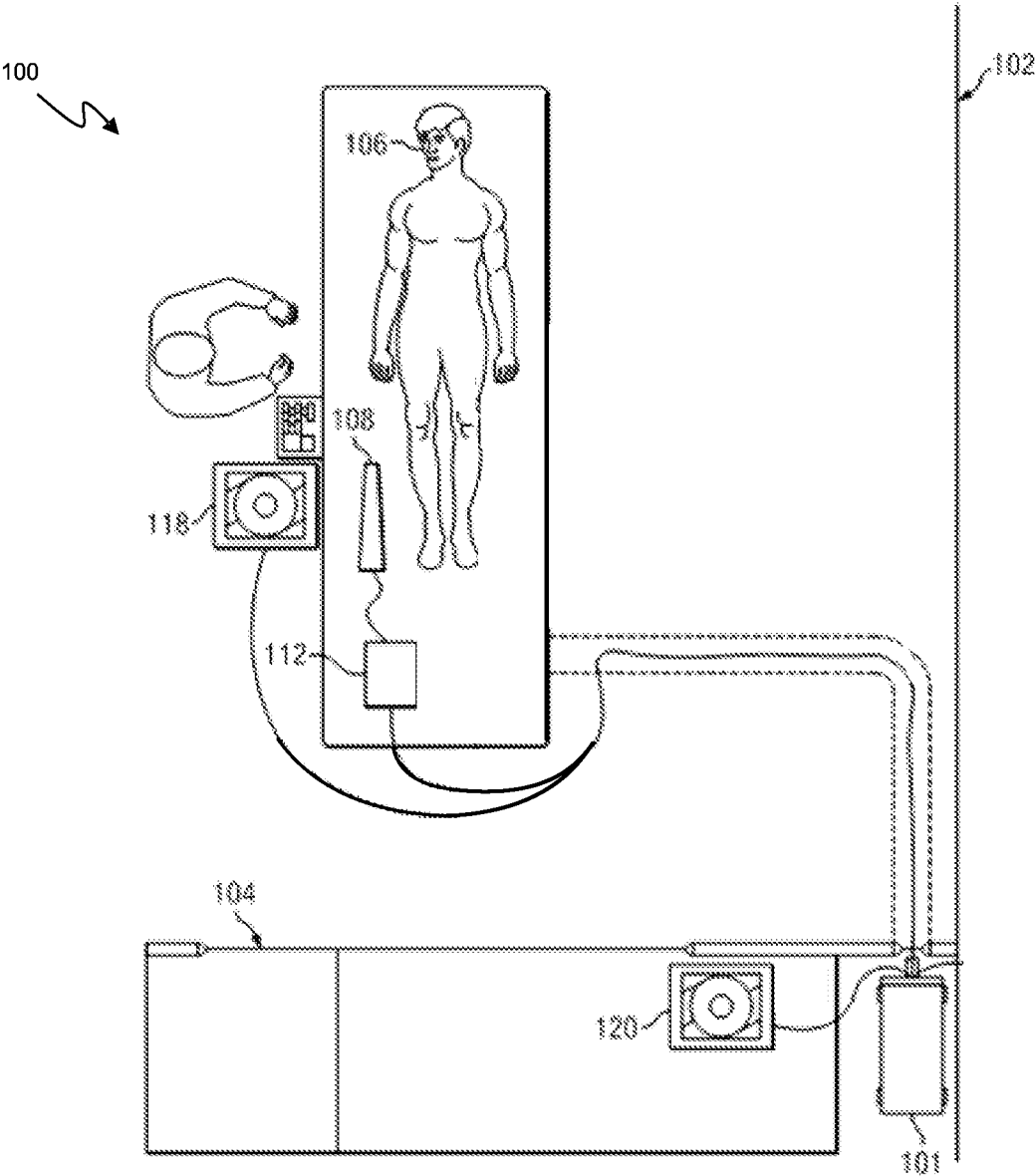


FIG. 1

TED DEVICES,

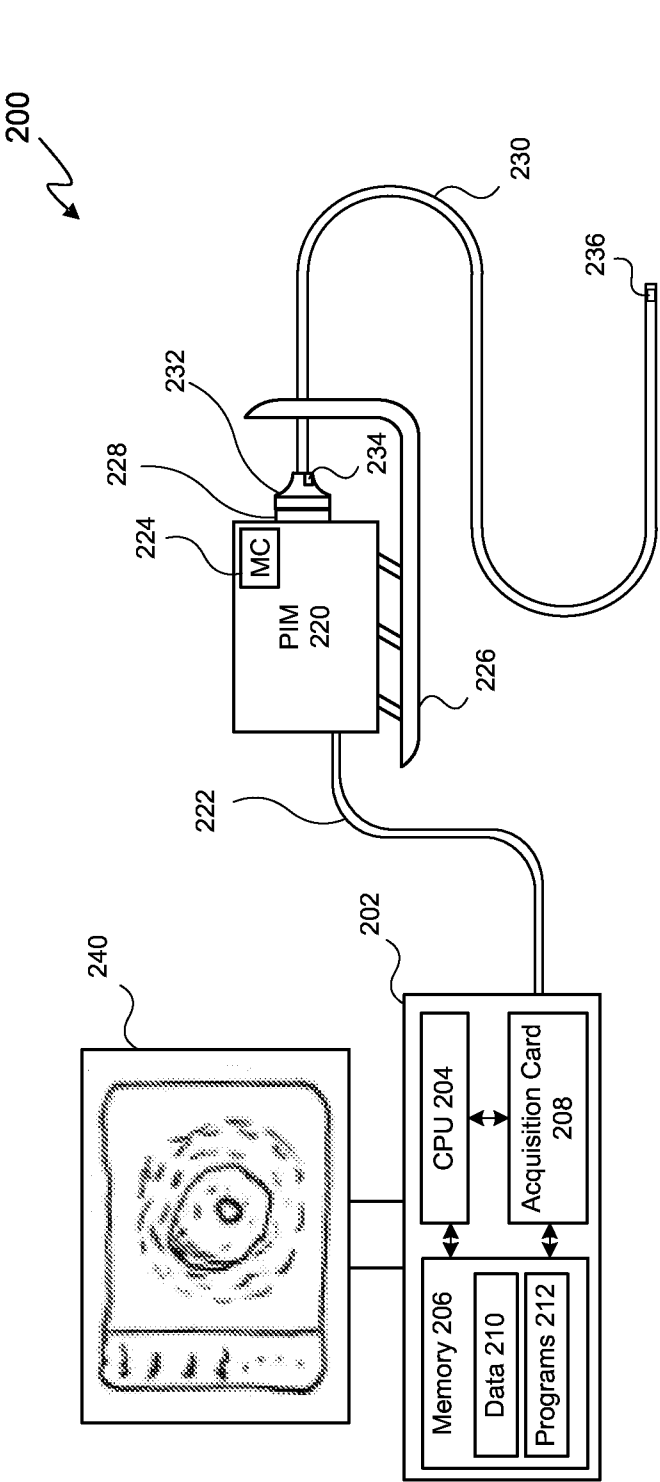


FIG. 2

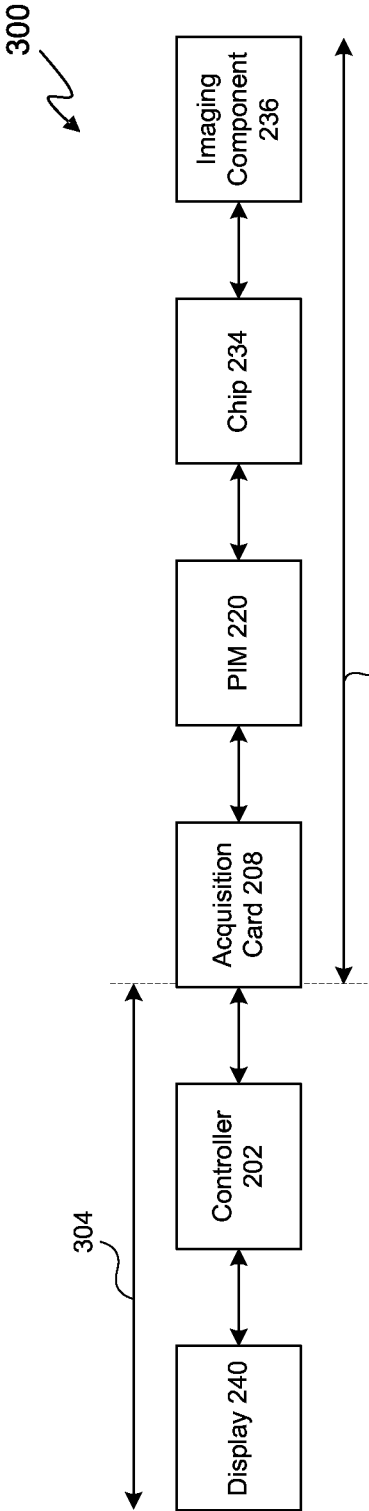


FIG. 3

TED DEVICES,

400

402

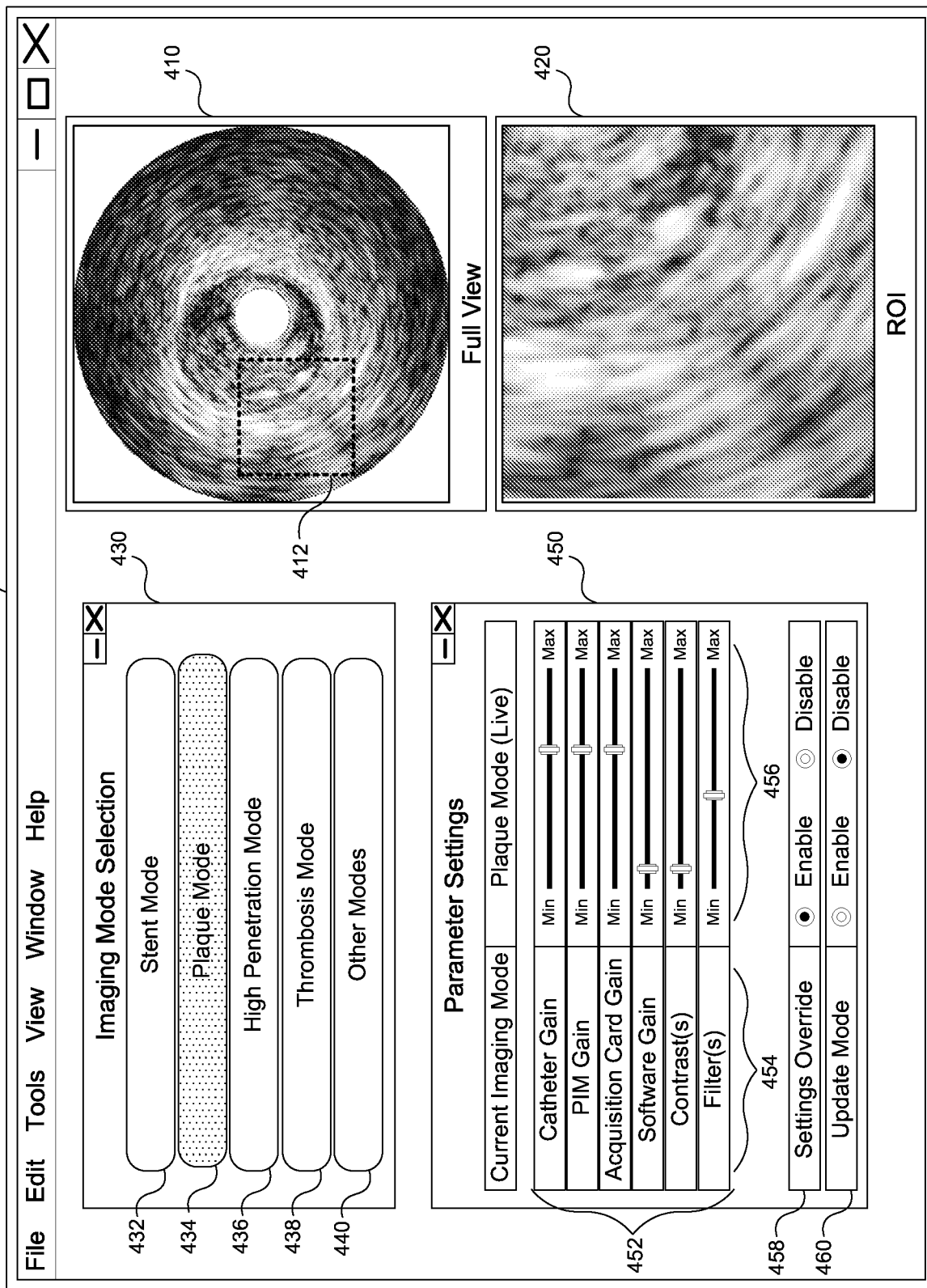


FIG. 4

TED DEVICES,

500

402

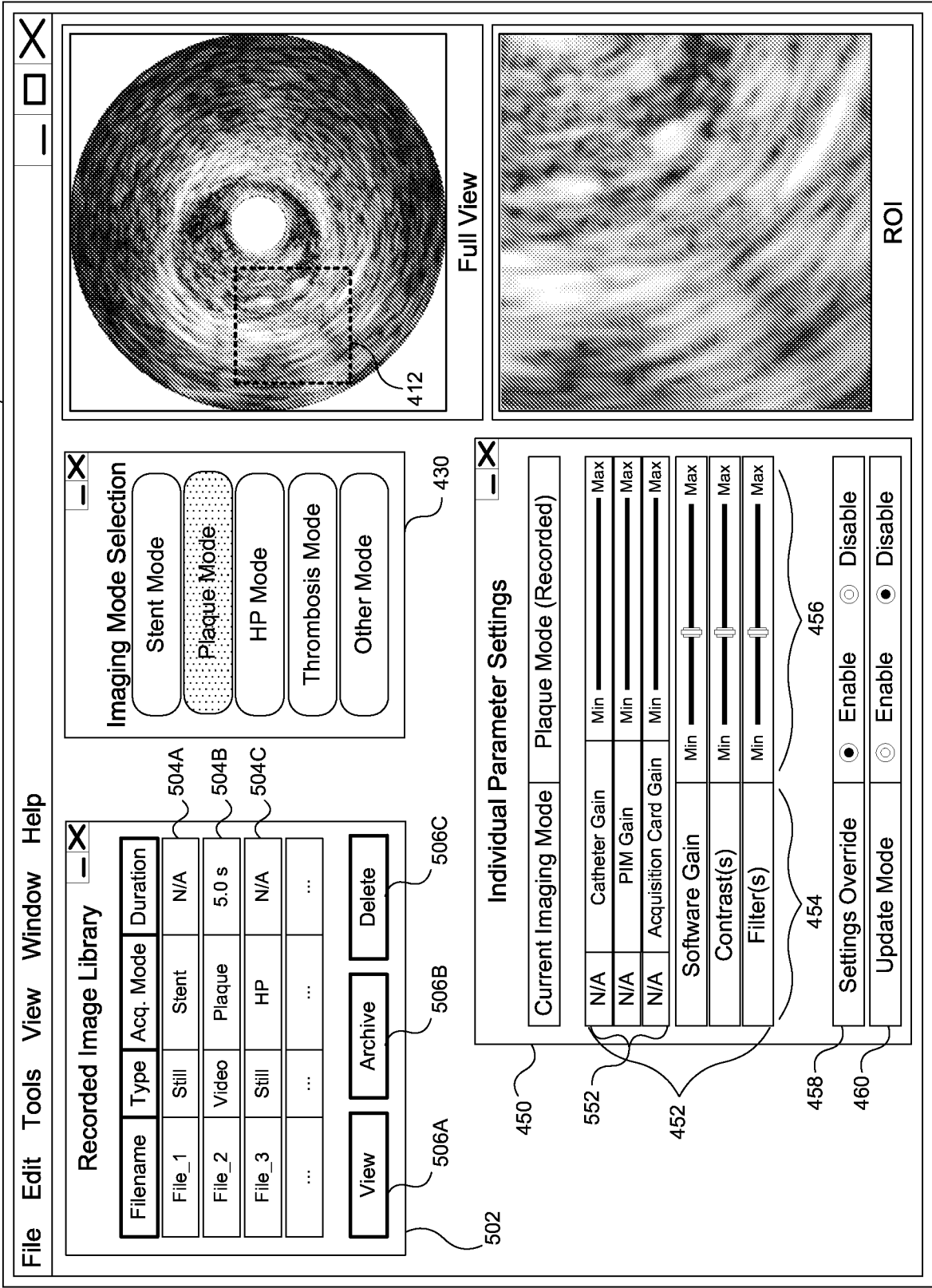
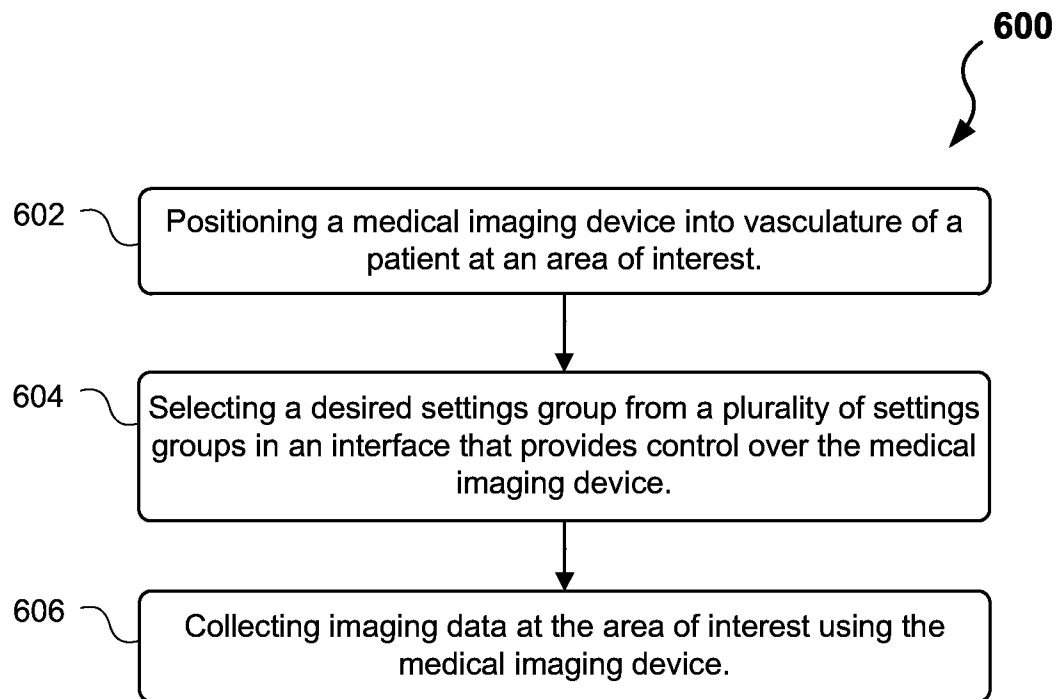


FIG. 5

**FIG. 6**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/064769**A. CLASSIFICATION OF SUBJECT MATTER****A61B 8/12(2006.01)i, A61B 6/00(2006.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61B 8/12; G09B 23/28; G06K 9/00; A61B 8/00; G06F 3/01; G01N 29/24; A61B 6/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: vasculature, acquisition, console, patient interface module, parameters

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2012-0065511 A1 (JOSEPH A. JAMELLO, III) 15 March 2012 See abstract, paragraphs [0014]-[0024] and figures 1-7.	12-16, 18-22, 25, 26
A		17, 23, 24
Y	US 2002-0168618 A1 (JAMES H. ANDERSON et al.) 14 November 2002 See abstract, paragraphs [0101]-[0104] and figures 1-12.	12-16, 18-22, 25, 26
A	US 2013-0011034 A1 (TIMOTHY GLYNN et al.) 10 January 2013 See abstract, paragraphs [0023]-[0049] and figures 1-6.	12-26
A	WO 2010-104775 A2 (VOLCANO CORPORATION et al.) 16 September 2010 See abstract, pages 7-13 and figures 1,2.	12-26
A	US 6142940 A (GEORGI LATHBURY et al.) 07 November 2000 See abstract, column 2, line 45-column 5, line 46 and figures 1,2.	12-26



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 February 2015 (13.02.2015)

Date of mailing of the international search report

13 February 2015 (13.02.2015)

Name and mailing address of the ISA/KR

International Application Division
Korean Intellectual Property Office
189 Cheongsu-ro, Seo-gu, Daejeon Metropolitan City, 302-701,
Republic of Korea

Facsimile No. ++82 42 472 3473

Authorized officer

KIM, Tae Hoon

Telephone No. +82-42-481-8407



Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 1-11
because they relate to subject matter not required to be searched by this Authority, namely:
Claims 1-11 pertain to a method of treatment of a human body by surgery or by therapeutic/diagnostic methods and, thus relate to a subject matter which is not required to search by the International Searching Authority under PCT Article 17(2)(a)(i) and PCT Rule 39.1(iv).
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/064769

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012-0065511 A1	15/03/2012	CN 103237503 A EP 2613706 A2 JP 2013-537067 A KR 10-2014-0018182 A WO 2012-034098 A2 WO 2012-034098 A3	07/08/2013 17/07/2013 30/09/2013 12/02/2014 15/03/2012 14/06/2012
US 2002-0168618 A1	14/11/2002	SG 142164 A1 US 2002-0123089 A1 US 2002-137014 A1 US 2003-0027242 A1 US 2004-0106167 A1 US 2006-0183183 A1 US 6942989 B2 US 7326562 B2 US 7371067 B2 WO 02-070980 A1 WO 02-086797 A1	28/05/2008 05/09/2002 26/09/2002 06/02/2003 03/06/2004 17/08/2006 13/09/2005 05/02/2008 13/05/2008 12/09/2002 31/10/2002
US 2013-0011034 A1	10/01/2013	US 2009-195514 A1 US 2014-009426 A1 US 2014-347277 A1 US 8289284 B2 US 8531428 B2 US 8803837 B2 WO 2009-021179 A1	06/08/2009 09/01/2014 27/11/2014 16/10/2012 10/09/2013 12/08/2014 12/02/2009
WO 2010-104775 A2	16/09/2010	EP 2405819 A2 EP 2405819 A4 JP 2012-520127 A US 2010-0234736 A1 US 2013-218020 A1 US 8403856 B2 WO 2010-104775 A3	18/01/2012 20/03/2013 06/09/2012 16/09/2010 22/08/2013 26/03/2013 13/01/2011
US 06142940 A	07/11/2000	CA 2344229 A1 EP 1119294 A1 JP 2002-526144 A JP 4602551 B2 US 6358207 B1 US 6361497 B1 WO 00-19907 A1	13/04/2000 01/08/2001 20/08/2002 22/12/2010 19/03/2002 26/03/2002 13/04/2000

专利名称(译)	视觉优化的血管内成像和相关的装置，系统和方法		
公开(公告)号	EP3068308A1	公开(公告)日	2016-09-21
申请号	EP2014861299	申请日	2014-11-10
[标]申请(专利权)人(译)	火山公司		
申请(专利权)人(译)	火山CORPORATION		
当前申请(专利权)人(译)	火山CORPORATION		
[标]发明人	HOFFMAN JOSEPH		
发明人	HOFFMAN, JOSEPH		
IPC分类号	A61B8/12 A61B6/00 A61B5/00 A61B5/0215 A61B5/1459		
优先权	61/903764 2013-11-13 US		
其他公开文献	EP3068308A4		
外部链接	Espacenet		

摘要(译)

公开了血管内装置，系统和方法。在一些实施例中，提供了一种用于对患者的脉管系统进行成像的医学成像系统。该成像系统包括控制台，其具有一个或多个处理器，其上运行医学成像系统接口，与一个或多个处理器通信并与患者接口模块（PIM）通信的采集卡，以及血管内成像组件。与PIM连通并设置在柔性细长构件的远端上。医学成像系统界面提供多个设置组以供用户选择，每个设置组具有预采集参数和采集后参数，其对于在脉管系统内成像期望的观察目标是最佳的。提供了相关方法和计算机可读介质。