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[Continued on next page]

(54) Title: PORTABLE ULTRASOUND INTERFACE FOR ULTRASOUND WORKSTATIONS

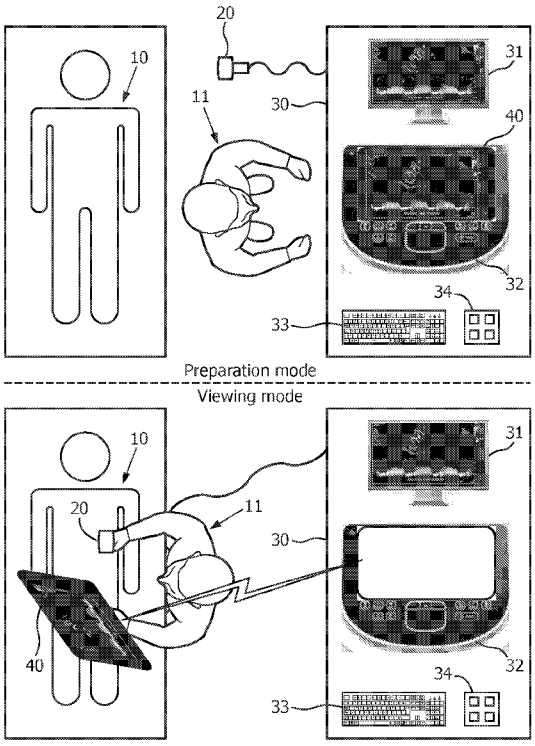

FIG. 1

(57) Abstract: An ultrasound system employing an ultrasound transducer (20), an ultrasound workstation (30) and an ultrasound tablet (40). In operation, the ultrasound transducer (20) generates ultrasound signals representative of an ultrasound imaging of an anatomical region, the ultrasound workstation (30) generates an ultrasound image of the anatomical region in accordance with a user interface with the ultrasound workstation (30) and/or the ultrasound tablet (40), and the ultrasound tablet (40) displays a portion or an entirety of the ultrasound image of the anatomical region in accordance with a user interface with the ultrasound workstation (30) and/or the ultrasound tablet (40). The ultrasound tablet (40) is attachable to and detachable from the ultrasound workstation (30).

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PORTABLE ULTRASOUND INTERFACE FOR ULTRASOUND WORKSTATIONS

The present invention generally relates to an ultrasound workstation serving as a primary source for generating and/or displaying ultrasound images via an ultrasound transducer. The present invention specifically relates to an ultrasound tablet interfacing with the ultrasound workstation to serve as an alternative primary source or a secondary source for generating and/or displaying the ultrasound images.

In a typical sonography session, a patient is lying or sitting on a bed, and an ultrasound workstation is set besides the patient. The sonographer holds an ultrasound transducer next to the patient's body while setting a number of imaging parameters as desired to generate and display ultrasound images of a particular anatomical region of the patient. More particularly, the sonographer will have one hand holding the ultrasound transducer on the patient's body and the other hand adjusting imaging parameters on the ultrasound workstation. However, while the eye-hand coordination of the sonographer in generating optimal ultrasound images of the anatomical region of interest is inconveniently limited by a degree of which a field of view of the sonographer is exclusive of either the ultrasound transducer or a display of the ultrasound workstation.

The present invention provides an ultrasound tablet interfacing with an ultrasound workstation to facilitate a field of view of the sonographer being inclusive of both the ultrasound transducer and a display of the ultrasound tablet. For purposes of the present invention, (1) the term "ultrasound transducer" is broadly defined herein as any device structurally configured for transmitting and receiving ultrasound waves to and from an anatomical region of a patient, (2) the term "ultrasound workstation" is broadly defined herein as any computer structurally configured to interface with an ultrasound transducer for purposes of generating and/or displaying ultrasound images of the anatomical region, and (3) the term "ultrasound tablet" is broadly defined herein as any portable computer structurally configured in a single panel with a touchscreen as an input device to interface with an ultrasound workstation for purposes of generating and/or displaying ultrasound images of the anatomical region.

One form of the present invention is an ultrasound system employing an ultrasound transducer, an ultrasound workstation and an ultrasound tablet. In operation, the ultrasound transducer generates ultrasound signals representative of an ultrasound imaging of an anatomical region, the ultrasound workstation generates an ultrasound image of the anatomical region in accordance with a user interface with the ultrasound workstation and/or the ultrasound tablet, and the ultrasound tablet displays a portion or an entirety of the ultrasound image of the anatomical region in accordance with a user interface with the ultrasound workstation and/or the ultrasound tablet. The ultrasound tablet is attachable to and detachable from the ultrasound workstation.

The foregoing form and other forms of the present invention as well as various features and advantages of the present invention will become further apparent from the following detailed description of various embodiments of the present invention read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the present invention rather than limiting, the scope of the present invention being defined by the appended claims and equivalents thereof.

FIG. 1 illustrates an exemplary embodiment of an ultrasound system in accordance with the present invention.

FIG. 2 illustrates exemplary embodiments of an ultrasound workstation and an ultrasound tablet in accordance with the present invention.

Referring to FIG. 1, a sonography session of a patient 10 executed by a sonographer 11 utilizes an ultrasound system of the present invention employing an ultrasound transducer 20, an ultrasound workstation 30 and an ultrasound tablet 40. In practice, ultrasound transducer 20 may be operated by sonographer 11 to generate a planar image or a volumetric image of an anatomical region of patient 10, ultrasound workstation 30 may be mobile or stationary relative to patient 10, and ultrasound tablet 40 is selectively attachable and detachable from a hard key platform 32 of ultrasound workstation 30.

As shown, the sonography session has a preparation mode and a viewing mode. For purposes of generally describing the preparation mode and the viewing mode, only user interface components of ultrasound workstation 30 including hard key platform 32, a keyboard 33 and a soft key touchscreen panel 34 are shown. Please note components

31-34 and ultrasound tablet 40 are not drawn to scale, but sized to emphasize hard key platform 32 and ultrasound tablet 40.

The preparation mode of the sonography session is based on ultrasound tablet 40 being attached to hard key platform 32 whereby ultrasound workstation 30 executes a wired communication of ultrasound data/images to ultrasound tablet 40 for the alternative primary or secondary display of ultrasound images by ultrasound tablet 40. The preparation mode generally involves sonographer 11 interfacing with components 32-34 to simultaneously or individually adjust imaging parameters of display 31 and the display of ultrasound tablet 40 as attached to hard key platform 32. Further alternatively or optionally, sonographer 11 may interface with a control touchscreen (not shown) (e.g., keyboard and/or key pad) of ultrasound tablet 40 to simultaneously or individually adjust imaging parameters of display 31 and the display of ultrasound tablet 40 as will be further described herein in connection with FIG. 2.

The viewing mode of the sonography session is based on ultrasound tablet 40 being detached from hard key platform 32 whereby ultrasound workstation 30 executes a wireless communication of ultrasound data/images to ultrasound tablet 40 for the alternative primary or secondary display of ultrasound images by ultrasound tablet 40. The viewing mode of the sonography session generally involves sonographer 11 using one hand to hold ultrasound transducer 20 on the body of patient 10, and the other hand to hold ultrasound tablet 40 to view a display of ultrasound images within and/or adjacent to a field of view of ultrasound transducer 20. Additionally, sonographer 11 may adjust imaging parameters on ultrasound tablet 40 as further described herein in connection with FIG. 2. Furthermore, sonographer 11 may utilize known features of a tablet including, but not limited to, a capability of zooming-in and/or zooming-out the ultrasound image via finger pointing on the control touchscreen of ultrasound tablet 40.

In practice, the preparation mode and the viewing mode of the sonography session as generally described herein may be specifically executed in numerous variations as would be appreciated by those having ordinary skill in the art. To facilitate further understanding of an interfacing ultrasound workstation 30 and ultrasound tablet 40 during a sonography session, FIG. 2 illustrates operation of controllers 35-37 of ultrasound workstation 30 (FIG. 1) and controllers 41 and 42 of

ultrasound tablet 40 with ultrasound tablet 40 (FIG. 2) being attached and detached from ultrasound workstation 30.

Referring to FIG. 2, a workstation central controller 36 of ultrasound workstation 30 is structurally configured to control all operations of ultrasound workstation 30 including, but not limited to, a processing of input commands IC from a user interface of hard keys and/or soft keys of workstation input devices 32-34 (FIG. 1) to adjust image parameters IP as known in the art. Examples of image parameters IP include, but are not limited to, a depth, a resolution, a focus, a gain, a greyscale mode, a flow mode and a color power angio.

An ultrasound image acquisition controller 35 of ultrasound workstation 30 is structurally configured to generate ultrasound data US_D from a processing of ultrasound signals received from ultrasound transducer 20 (FIG. 1) including, but not limited to, beamforming, filtering, information detection and scan conversion of the ultrasound signals in accordance with image parameters IP received from workstation central controller 35.

A workstation display controller 37 of ultrasound workstation 30 is structurally configured to generate an ultrasound image US_W for ultrasound display 31 from a processing of ultrasound data US_D including, but not limited to, a storage of ultrasound data US_D, a generation of necessary drive signals for ultrasound display 31 and an overlay of graphical information on ultrasound image US_W (e.g., system configuration/operating information, a patient identification, a time/date stamp, etc.)

A tablet central controller 41 of ultrasound tablet 40 is structurally configured to control all operations of ultrasound tablet 40 including, but not limited to, a processing of soft key commands SC from a user interface of soft keys of touchscreen display 43 to adjust image parameters IP as known in the art.

A tablet display controller 42 of ultrasound tablet 40 is structurally configured to generate an ultrasound image US_T for ultrasound display 43 from a processing of ultrasound data US_D and/or ultrasound image US_W including, but not limited to, a storage of ultrasound data US_D and/or ultrasound image US_W, a generation of necessary drive signals for ultrasound display 43, an overlay of graphical information on the ultrasound image US_T, and a generation of a control panel screen CP of soft keys for user interface.

Central controllers 35 and 41 are further structurally configured to establish a wired communication responsive to ultrasound tablet 40 being attached to ultrasound workstation 30, and to establish a wireless communication responsive to ultrasound tablet 40 being detached from ultrasound workstation 30. These communications facilitate a transfer/exchange of data and signals as needed between ultrasound workstation 30 and ultrasound tablet 40.

Of particular importance to the present invention is (1) a transfer of ultrasound data US_D and/or ultrasound image US_W from respective controllers 36 and/or 37 to controller 42 as controlled by central controllers 35 and 41, and (2) an exchange of input commands IC/soft key commands SC/input parameters IP between central controllers 35 and 41. More particularly as to the command/parameter exchange, central controller 35 and/or central controller 41 contain a mapping of input commands IC and soft key commands SC as known in the art to facilitate a command interpretation by the central controller(s).

In practice, controllers 35-37 may be implemented by hardware, software, firmware and/or circuitry of ultrasound workstation 30 as will be appreciated by those having ordinary skill in the art, and controllers 41 and 42 may be implemented by hardware, software, firmware and/or circuitry of ultrasound tablet 40 as will be appreciated by those having ordinary skill in the art.

Still referring to FIG. 2, an attachment of ultrasound tablet 40 to ultrasound workstation 30 generally involves:

(1) Ultrasound acquisition controller 36 providing ultrasound data US_D to workstation display controller 37 in accordance with image parameters IP from workstation central controller 35 as directed by input commands IC from workstation input devices 32-34 to facilitate a desired display 31 of ultrasound image US_W;

(2) A wired (or wireless) communication of input commands IC/image parameters IP from workstation central controller 35 to tablet central controller 41 and a wired (or wireless) communication of ultrasound data US_D/ultrasound image US_W from US image acquisition controller 36 and/or workstation display controller 37 to tablet display controller 42 to facilitate a desired display 43 of ultrasound image US_T in

accordance with image parameters IP as directed by input commands IC from workstation input devices 32-34 (ultrasound image US_T being a highlighted portion or an entirety of ultrasound image US_W);

(3) Alternatively or optionally, a desired display 43 of control touchscreen CT providing a user interface of soft keys to generate soft key commands SC to adjust image parameters IP for tablet display controller 42; and

(4) Alternatively or optionally, a wired (or wireless) communication of generated soft key commands SC/image parameters IP from tablet central controller 41 to workstation central controller 35 to adjust image parameters IP for US image acquisition controller 36 and/or workstation display controller 37.

A subsequent detachment of ultrasound tablet 40 from ultrasound workstation 30 generally involves:

(1) A wireless communication of ultrasound data US_D /ultrasound image US_W from US image acquisition controller 36 and/or workstation display controller 37 to tablet display controller 42 to facilitate a desired display 43 of ultrasound image US_T in accordance with image parameters IP as directed by soft key commands SC (ultrasound image US_T being a highlighted portion or an entirety of ultrasound image US_W);

(2) A wireless communication of soft key commands SC/image parameters IP from tablet central controller 41 to workstation central workstation 35 to facilitate a desired display 31 of ultrasound image US_W in accordance with image parameters IP as directed by soft key commands SC; and

(3) Alternatively or optionally, a wireless communication of soft key commands SC/image parameters IP from workstation central controller 35 to tablet central controller 41 to facilitate a desired display 43 of ultrasound image US_T in

accordance with image parameters IP as directed by input commands IC (ultrasound image US_T being a highlighted portion or an entirety of ultrasound image $US_{W)}$.

In practice, the operation of ultrasound workstation 30 and ultrasound tablet 40 as generally described in connection with FIG. 2 may be specifically executed in numerous variations as would be appreciated by those having ordinary skill in the art. For example, workstation input devices 32-34 may be exclusively operated to control image parameters IP for US image acquisition controller 36 while control touchscreen CT may be exclusively utilized to control image parameters IP for display controllers 37 and 42.

Referring to FIGS. 1 and 2, those having ordinary skill in the art will appreciate numerous benefits of an ultrasound tablet of the present invention including, but not limited to, (1) remote access to functional buttons of an ultrasound workstation; (2) remote visualization of a display of an ultrasound workstation to thereby facilitate a closer look for both a sonographer and a patient; (3) a capability to change image parameters via a touch-screen while directly looking at the image and the outcome; (4) a capability to perform direct measurements on the ultrasound image (e.g., size of tumor, circumference of anatomy) rather than by conventional approach which is by mouse clicks with a good hand-eye coordination; (5) a touch-screen-based volume rendering of ultrasound data with a capability to zoom-in/zoom-out with finger pointing; (6) a quick share of ultrasound image data with another clinician in the same or another room for a second opinion, and (7) the display of an ultrasound tablet having extra screens for additional features.

While various embodiments of the present invention have been illustrated and described, it will be understood by those skilled in the art that the embodiments of the present invention as described herein are illustrative, and various changes and modifications may be made and equivalents may be substituted for elements thereof without departing from the true scope of the present invention. In addition, many modifications may be made to adapt the teachings of the present invention without departing from its central scope. Therefore, it is intended that the present invention not be limited to the particular embodiments disclosed as the best mode contemplated for carrying

out the present invention, but that the present invention includes all embodiments falling within the scope of the appended claims.

1. An ultrasound system, comprising:

an ultrasound transducer (20) operable to generate ultrasound signals representative of an ultrasound imaging of an anatomical region;

an ultrasound workstation (30) operable in communication with the ultrasound transducer (20) to generate an ultrasound image of the anatomical region in accordance with a user interface with the ultrasound workstation (30); and

an ultrasound tablet (40) operable in communication with the ultrasound workstation (30) to display at least a portion of the ultrasound image of the anatomical region as generated by the ultrasound workstation (30) in accordance with a user interface with the ultrasound tablet (40),

wherein the ultrasound tablet (40) is attachable to and detachable from the ultrasound workstation (30).

2. The ultrasound system of claim 1, wherein the ultrasound tablet (40) is in wireless communication with the ultrasound workstation (30) responsive to being detached from the ultrasound workstation (40).

3. The ultrasound system of claim 1, wherein the ultrasound tablet (40) is in wired communication with the ultrasound workstation (30) responsive to being attached to the ultrasound workstation (40).

4. The ultrasound system of claim 1, wherein the ultrasound tablet (40) is in wired communication with the ultrasound workstation (30) responsive to being attached to the ultrasound workstation (40).

5. The ultrasound system of claim 1, wherein the ultrasound workstation (30) is further operable in communication with the ultrasound tablet (40) to display the ultrasound image of the anatomical region in accordance with the user interface with the ultrasound tablet (40).

6. The ultrasound system of claim 1, wherein the ultrasound tablet (30) is further operable in communication with the ultrasound workstation (30) to display the at least a

portion of the ultrasound image of the anatomical region in accordance with the user interface with the ultrasound workstation (30).

7. An ultrasound system, comprising:

an ultrasound transducer (20) operable to generate ultrasound signals representative of an ultrasound imaging of an anatomical region;

an ultrasound workstation (30) operable in communication with the ultrasound transducer (20) to generate an ultrasound image of the anatomical region in accordance with a user interface with the ultrasound workstation (30); and

an ultrasound tablet (40) operable in communication with the ultrasound workstation (30) to display at least a portion of the ultrasound image of the anatomical region as generated by the ultrasound workstation (30) in accordance with the user interface with the ultrasound workstation (30),

wherein the ultrasound tablet (40) is attachable to and detachable from the ultrasound workstation (30).

8. The ultrasound system of claim 7, wherein the ultrasound tablet (40) is in wireless communication with the ultrasound workstation (30) responsive to being detached from the ultrasound workstation (40).

9. The ultrasound system of claim 7, wherein the ultrasound tablet (40) is in wired communication with the ultrasound workstation (30) responsive to being attached to the ultrasound workstation (40).

10. The ultrasound system of claim 7, wherein the ultrasound tablet (40) is in wired communication with the ultrasound workstation (30) responsive to being attached to the ultrasound workstation (40).

11. The ultrasound system of claim 7, wherein the ultrasound workstation (30) is further operable to display the ultrasound image of the anatomical region in accordance with the user interface with the ultrasound workstation (30).

12. An ultrasound system, comprising:

an ultrasound transducer (20) operable to generate ultrasound signals representative of an ultrasound imaging of an anatomical region;

an ultrasound workstation (30); and

an ultrasound tablet (40),

wherein the ultrasound workstation (30) is operable in communication with the ultrasound transducer (20) and the ultrasound tablet (40) to generate an ultrasound image of the anatomical region in accordance with a user interface with the ultrasound tablet (40),

wherein the ultrasound tablet (40) is operable in communication with the ultrasound workstation (30) to display at least a portion of the ultrasound image of the anatomical region as generated by the ultrasound workstation (30) in accordance with the user interface with at least one of the ultrasound workstation and the ultrasound tablet (40), and

wherein the ultrasound tablet (40) is attachable to and detachable from the ultrasound workstation (30).

13. The ultrasound system of claim 12, wherein the ultrasound tablet (40) is in wireless communication with the ultrasound workstation (30) responsive to being detached from the ultrasound workstation (40).

14. The ultrasound system of claim 12, wherein the ultrasound tablet (40) is in wired communication with the ultrasound workstation (30) responsive to being attached to the ultrasound workstation (40).

15. The ultrasound system of claim 12, wherein the ultrasound tablet (40) is in wired communication with the ultrasound workstation (30) responsive to being attached to the ultrasound workstation (40).

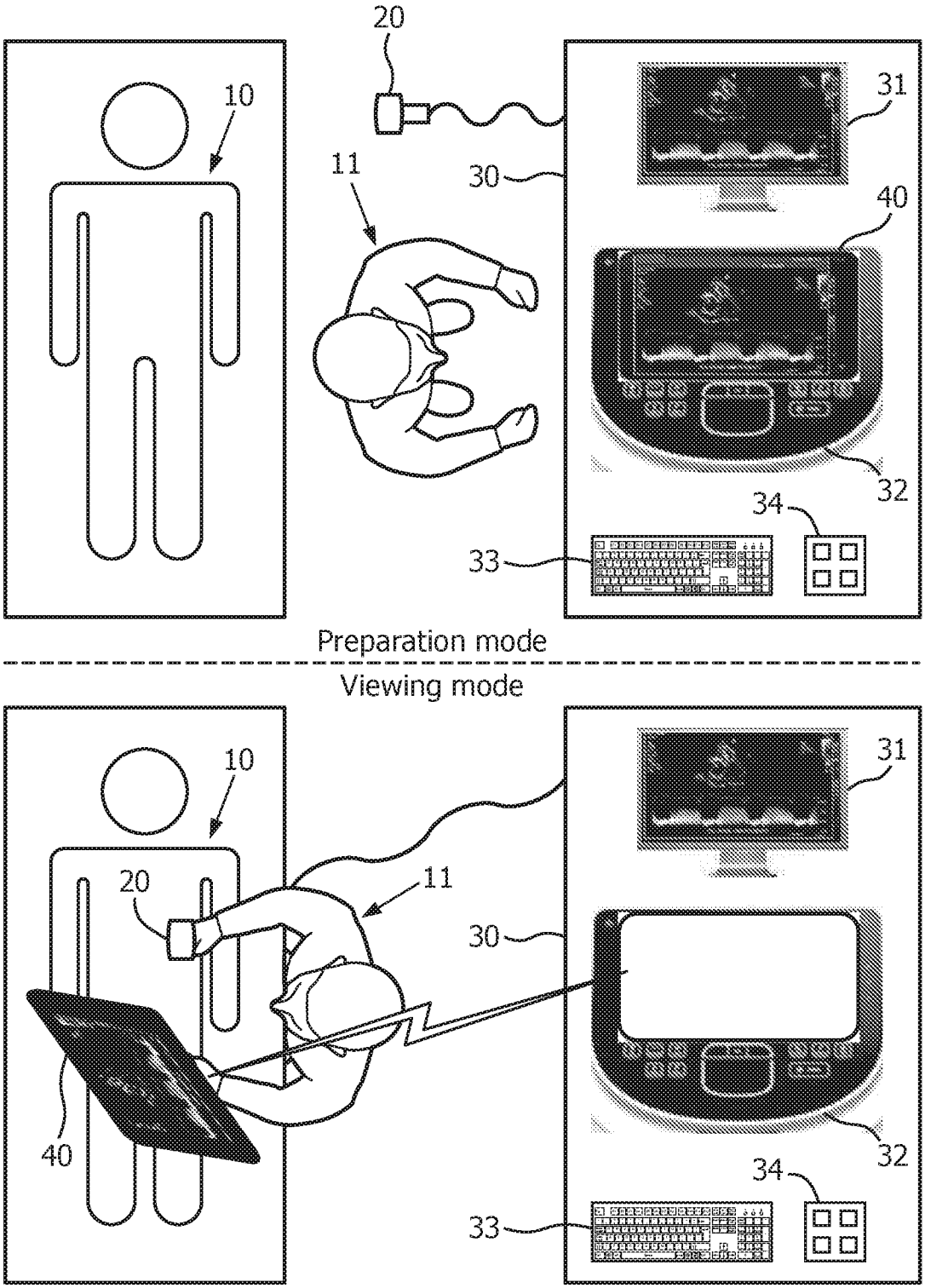
20
10
31
11
30
40
32
34
33
Preparation mode
Viewing mode
10
31
20
11
30
40
32
34
33

FIG. 1

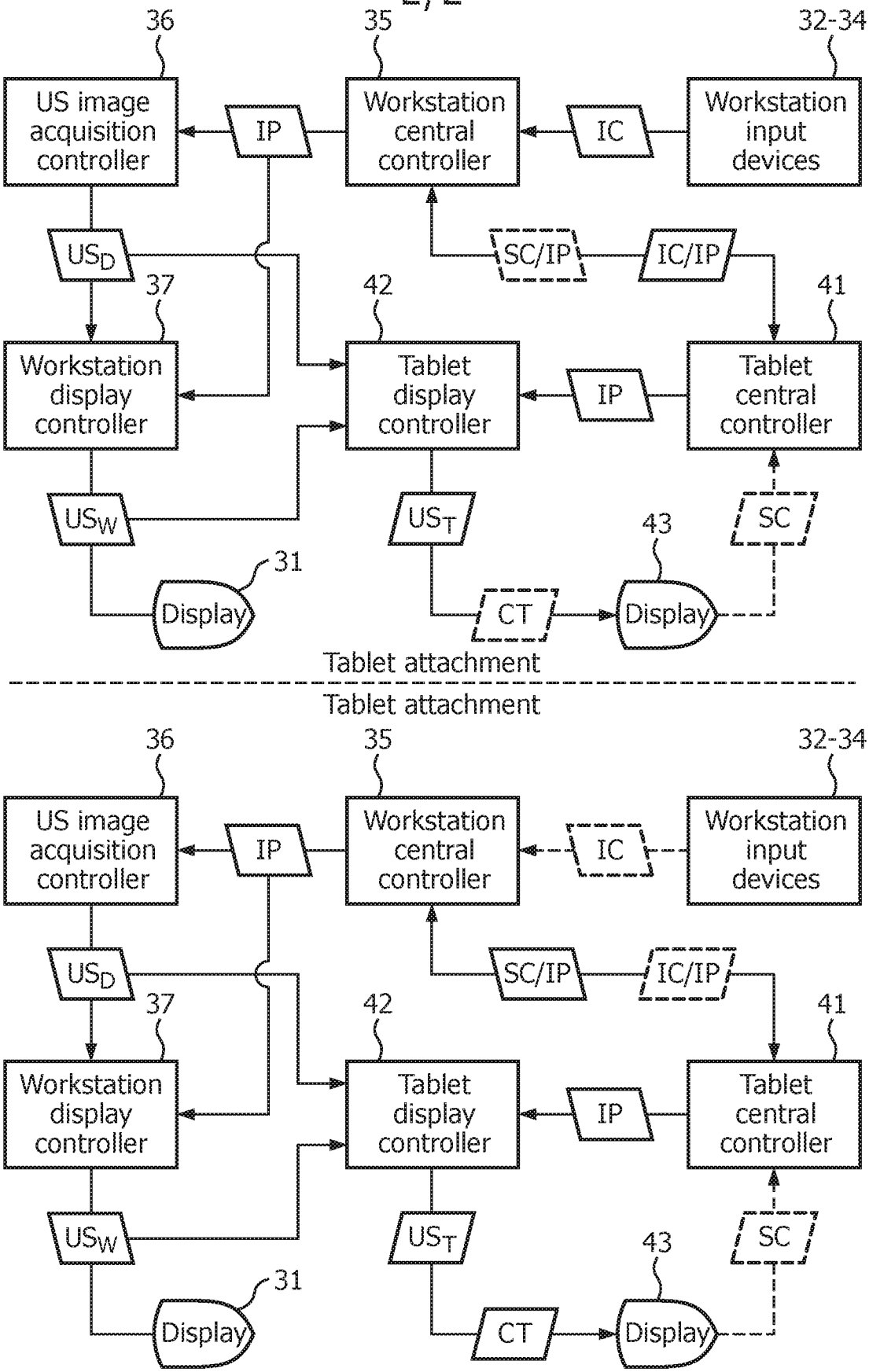
36
35
32-34
US image acquisition controller
IP
Workstation central controller
IC
Workstation input devices
USD
SC/IP
IC/IP
37
42
41
Workstation display controller
Tablet display controller
IP
Tablet central controller
USW
UST
SC
43
31
Display
CT
Display
Tablet attachment
Tablet attachment
36
35
32-34
US image acquisition controller
IP
Workstation central controller
IC
Workstation input devices
USD
SC/IP
IC/IP
37
42
41
Workstation display controller
Tablet display controller
IP
Tablet central controller
USW
UST
SC
43
31
Display
CT
Display

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/054978

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B8/00
ADD.

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

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	WO 2007/130526 A2 (U SYSTEMS INC [US]; WANG SHIH-PING [US]; SUMMERS DOUGLAS G [US]; ANDER) 15 November 2007 (2007-11-15) abstract paragraph [0063] - paragraph [0065] figures 18-20	2,8,13
X	WO 2014/041503 A1 (KONINKL PHILIPS NV [NL]) 20 March 2014 (2014-03-20) the whole document	1,3-7, 9-12,14, 15

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

[X] 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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 September 2015	30/09/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Artikis, T

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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1

INTERNATIONAL SEARCH REPORT

Information on patent family members

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