United States Patent Application Publication	20250255566
Kind Code	A1
Publication Date	August 14, 2025
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SYSTEMS AND METHODS FOR LATERAL TREATMENTS OF THE BREAST

Abstract

An adapter for securing a biopsy guidance module to a breast imaging system includes an adapter body which includes a first side and an opposite second side. An armature extends from the first side of the body. A latch mechanism is disposed proximate an end of the armature distal from the first side of the body. The latch mechanism includes an adapter latch and an actuator. The adapter latch is configured to engage an interface on the breast imaging system. The actuator is engaged with the adapter latch to move the adapter latch from an unlocked position to a locked position. In the locked position, the adapter latch is releasably engaged with the interface. A keeper is disposed on the second side of the body. The keeper is configured to receive a module latch from the biopsy guidance module.

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Appl. No.:	**19/104468**
Filed (or PCT Filed):	**August 29, 2023**
PCT No.:	**PCT/US2023/031396**

Related U.S. Application Data

us-provisional-application US 63401842 20220829

Publication Classification

Int. Cl.: **A61B6/50** (20240101); **A61B6/00** (20240101); **A61B6/04** (20060101); **A61B10/02** (20060101); **A61B90/11** (20160101); **A61B90/17** (20160101)

U.S. Cl.:

CPC **A61B6/502** (20130101); **A61B6/0414** (20130101); **A61B6/0421** (20130101); **A61B6/4447** (20130101); **A61B10/0233** (20130101); **A61B90/11** (20160201); **A61B90/17** (20160201);

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application is being filed on Aug. 29, 2023, as a PCT International application and claims priority to and the benefit of U.S. Provisional Application Ser. No. 63/401,842, filed Aug. 29, 2022, the disclosure of which is hereby incorporated by reference herein in its entirety.

BACKGROUND
[0002] Mammography is a well-established method of breast imaging which may be used for breast cancer screening and diagnosis. Screening mammograms are preferably obtained annually. Should masses or calcifications ("regions of interest") be identified during a screening mammogram, the patient may require further diagnosis. Such diagnosis may involve taking a biopsy of the region of interest and analyzing excised tissue.
[0003] Various imaging modalities have historically been used during breast biopsies. The imaging modalities include ultrasound imaging, x-ray imaging and magnetic resonance imaging. Performing a breast biopsy typically involves positioning the patient, visualizing the region of interest using the imaging equipment, targeting coordinates of the region and retrieving cells or tissue from the targeted region. Cells or tissue may be retrieved in a variety of ways, including through open surgery, fine needle aspiration, core needle biopsy, or vacuum-assisted biopsy. Open surgery, the most invasive procedure, is generally performed by a radiologist placing a wire into the breast during visualization of the region of interest, where the wire extends into the region that is to be excised. The patient is then transferred to surgery and tissue is retrieved using the wire to locate the region of interest.
[0004] Fine needle aspiration, core needle biopsies and vacuum assisted biopsies are less invasive than open surgery, allowing cells and tissue to be obtained without the need for open surgery. All are needle biopsies, with the size of the needle, and thus the corresponding size (and number) of the biopsied samples, being differentiators. In each procedure the patient is positioned, the region of interest is visualized, the needle of the biopsy device is advanced to the target region of interest and the tissue is retrieved. Fine needle aspiration and core needle biopsy devices typically retrieve one tissue sample and their advancement to the target may be monitored using an imaging modality such as ultrasound. Vacuum-assisted biopsy devices generally have larger needles and can extract multiple cores.
[0005] Subsequent to a biopsy procedure, biopsy site markers can be delivered to the biopsy site under image guidance (e.g., ultrasound, x-ray imaging, etc.). The markers can be used to target the lesion during in a follow-up biopsy or a surgical procedure. Also, other minimally invasive procedure such as, for example, cryoablation, can be performed under image guidance.
[0006] X-ray imaging in stereotactic mode is generally used for breast biopsies because it is desirable to visualize and target regions in a three-dimensional volume. Stereotactic biopsies obtain

volume information using x-ray images taken in at least two planes. The x-ray images are then processed to localize a target region of interest in three-dimensional space using the principal of parallax to determine the depth, or Z dimension, of the target region. This imaging modality may also be used for subsequent placement of biopsy site markers, as well as for procedures such as cryoablation.

SUMMARY

[0007] In one aspect, the technology relates to an adapter for securing a biopsy guidance module to a breast imaging system, the adapter includes an adapter body including a first side and an opposite second side; an armature extending from the first side of the body; a latch mechanism disposed proximate an end of the armature distal from the first side of the body, wherein the latch mechanism includes an adapter latch and an actuator, wherein the adapter latch is configured to engage an interface on the breast imaging system and wherein the actuator is engaged with the adapter latch to move the adapter latch from an unlocked position to a locked position, wherein in the locked position, the adapter latch is releasably engaged with the interface; and a keeper disposed on the second side of the body, wherein the keeper is configured to receive a module latch from the biopsy guidance module. In an example, the keeper includes a plurality of openings and wherein one of the plurality of openings is configured to receive the module latch. In another example, the adapter further includes a sensor disposed in the opening configured to receive the module latch, wherein the sensor is configured to detect a position of the module latch. In yet another example, the adapter further includes a first plurality of electrical contacts disposed to contact a second plurality of electrical contacts disposed on the biopsy guidance module. In still another example, the adapter further includes an umbilical cord extending from the adapter, wherein the umbilical cord is communicatively coupled to at least one of the first plurality of electrical contacts.

[0008] In another example of the above aspect, the keeper includes a pair of keepers, wherein each of the pair of keepers are disposed proximate opposite ends of the second side of the body. In an example, the adapter further includes a hanger disposed proximate the end of the armature for liftably engaging the adapter body with the interface of the breast imaging system. In another example, the latch mechanism includes an over-center mechanism.

[0009] In another aspect, the technology relates to a breast imaging system including: a gantry; an x-ray source rotatably coupled to the gantry; a breast immobilization structure rotatably coupled to the gantry independent of the x-ray source, wherein the breast immobilization structure includes: a breast support platform; a breast immobilization paddle movably coupled to a front side of the breast immobilization structure and movably engaged with the front side of the breast immobilization structure to move substantially orthogonally relative to the breast support platform; and an pair of interfaces on at least one of a rear side and two lateral sides of the breast immobilization structure for selectively operably connecting an adapter for a biopsy guidance module to the breast immobilization structure; and an x-ray detector disposed below the breast support platform. In an example, a first interface of the pair of interfaces is disposed on a rear side of the breast immobilization structure, on a first side of a dividing axis of the breast immobilization structure; and a second interface of the pair of interfaces is disposed on a rear side of the breast immobilization structure, on a second side of the dividing axis of the breast immobilization structure. In another example, the first interface includes a first plate facing towards a first lateral side of the two lateral sides of the breast imaging system, and wherein the second interface includes a second plate facing towards a second lateral side of the two lateral sides of the breast imaging system. In yet another example, each of the pair of interfaces includes an interface keeper for receiving an adapter latch on the adapter. In still another example, each of the pair of interfaces includes a hanger structure for selectively engaging the adapter with the interface.

[0010] In another example of the above aspect, hanger structure includes an opening in each of the pair of interfaces. In an example, the breast imaging system includes two substantially identical

umbilical ports.
[0011] In another aspect, the technology relates to a method of attaching a biopsy guidance module to a breast imaging system having a breast immobilization structure including a breast support platform, the method includes: positioning a breast immobilization structure in an adapter-mounting position; engaging an adapter with the breast immobilization structure at an interface of the breast imaging system; selectively latching the adapter to the interface; positioning the breast immobilization structure in a procedure-ready position; engaging the biopsy guidance module with the adapter; and selectively latching the biopsy guidance module to the adapter. In an example, positioning the breast immobilization structure in the procedure-ready position includes engaging an umbilical cord from the adapter with a port on the breast imaging system. In another example, in the procedure-ready position, the interface is substantially vertical; and in the adapter-mounting position, the interface is disposed at an angle to the procedure-ready position. In yet another example, the angle is approximately 90 degrees. In still another example, the method further includes disengaging the biopsy guidance module from a front side of the breast immobilization structure, prior to engaging the biopsy guidance module with the adapter. In another example, engaging the adapter with the breast immobilization structure comprises activating a supplemental lock.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0012] FIG. **1** depicts an x-ray imaging system incorporating a treatment guidance module.
[0013] FIG. **2** depicts an example of a treatment guidance module with a mounted biopsy device.
[0014] FIGS. **3**A and **3**B are partial perspective views of another x-ray imaging system and treatment guidance module.
[0015] FIG. **4** is a side view of the treatment guidance module.
[0016] FIG. **5** is a top view of the treatment guidance module.
[0017] FIGS. **6**A and **6**B are partial front perspective and front views, respectively, of an x-ray imaging system with a treatment guidance module in a lateral orientation.
[0018] FIGS. **7**A and **7**B are top and bottom perspective views, respectively, of an adapter for securing a treatment guidance module to an x-ray imaging system in a lateral orientation.
[0019] FIG. **8**A is a perspective view of an adapter for securing a treatment guidance module to an x-ray imaging system in a lateral orientation.
[0020] FIG. **8**B is a partial exploded perspective view of an interface of the x-ray imaging system and the adapter of FIG. **8**A, including a latch mechanism.
[0021] FIG. **8**C is an upright rear view of the latch mechanism of the adapter of FIG. **8**A.
[0022] FIG. **8**D is a top or bottom view of the adapter of FIG. **8**A.
[0023] FIG. **8**E is a front view of the adapter of FIG. **8**A.
[0024] FIG. **8**F is a partial exploded perspective view of a keeper of the adapter of FIG. **8**A and the module latch of a treatment guidance module.
[0025] FIG. **9** depicts a method of attaching a treatment guidance module to an x-ray imaging system.
[0026] FIGS. **10**A and **10**B depict rear partial perspective views of a breast immobilization structure of an x-ray imaging system, in an adapter mounting position and a procedure-ready position, respectively.
[0027] FIG. **11**A is a perspective view of another example of a biopsy guidance module.
[0028] FIG. **11**B is a perspective view of a quick-connect holster mount for a treatment guidance module.
DETAILED DESCRIPTION

[0029] Breast x-ray imaging systems such as tomosynthesis and mammography systems generally include an x-ray source mounted on a rotatable arm of a gantry and an x-ray detector positioned generally normal to the x-ray source when the x-ray source is at zero position. During tomosynthesis image acquisition, the x-ray source is rotated over a limited angular range. At various points in the x-ray source trajectory the source is activated and an image is captured by the detector. Each image captured at each point is referred to as a projection image. Computer programs are used to reconstruct a three-dimensional volume from the projection images and the three-dimensional volume is used for lesion detection.
[0030] Treatment guidance modules may be secured to x-ray imaging systems to enable image guided treatment of a patient breast. One such treatment is the performance of biopsy on the breast tissue. Biopsy is often performed such that the needle penetrates an upper surface of the breast. For particularly thin breasts, it may be desirable to enter the breast from a lateral position. Such a lateral approach may also be used on larger breasts, as required or desired for a particular application. Lateral breast biopsy typically requires additional components to enable mounting of a biopsy needle in a lateral position. This can lead to greater cost or confusion if such parts are misplaced within a breast imaging suite as such parts may be inadvertently damaged. Other treatments may include those that require specific image-guided targeting of treatment sites. Such treatments include, but are not limited to, the placement of biopsy site markers (usually performed subsequent to a biopsy), and cryoablation. For clarity and ease of description, biopsy procedures (and thus “biopsy guidance modules”) are described primarily herein, but it will be understood to a person of skill in the art that other treatments that benefit from targeted image-guided intervention may also be performed with the guidance systems described herein.
[0031] The technologies described herein incorporate an adapter with an x-ray imaging system, such that a biopsy guidance module (used for upright breast biopsy) may also be used for lateral breast biopsy. The adapter may be configured to provide automatic electrical connections to the biopsy guidance needle, allowing for quick communication with the x-ray imaging system, once mounted. The adapter may be mounted on either side of a breast immobilization structure, such that left or right lateral biopsy may be performed. The adapter may be secured to the x-ray imaging system while the breast immobilization structure thereof is in a variety of positions, though some positions described herein may be particularly advantageous.
[0032] FIG. **1** depicts an x-ray imaging system **100** (which may be a mammography, tomosynthesis, or combination system) incorporating a treatment guidance module. In the depicted configuration, the treatment guidance module incorporates a biopsy device. The x-ray imaging system **100** is shown to include an acquisition work station (AWS) **104** and gantry **101** supporting an x-ray imaging assembly **102**. Such an x-ray imaging system **100** is currently available from the common assignee under the trade name Selenia Dimensions, and is representative of merely one x-ray system on which the biopsy guidance module **110** described herein may be mounted. The gantry **101** supports a C-arm **103** that can move up or down along the gantry **101** to a selected height, driven by motor(s) controlled by technologist operating the system. C-arm **103** carries an x-ray tube **102***a* at an upper end and a breast support platform **102***b* at a lower end. Support platform **102***b* covers a flat panel x-ray image receptor **102***c*, spaced from the support platform **102***b* by a focused anti-scatter grid **102***d* (which may be retractable so that it can be removed from the space between support platform **102***b* and receptor **102***c*). The C-arm **103** also carries an immobilization paddle **102***e* that is between source **102***a* and breast support platform **102***b* and is motorized to move away from support platform **102***b* so a patient's breast can fit between support platform **102***b* and paddle **102***e*, and closer to support platform **102***b* so the patient's breast can be compressed and immobilized. Together, the portion of the C-arm **103** that carries the biopsy guidance module **110**, and the immobilization paddle **102***e*, along with the breast support platform **102***b* form a “breast immobilization structure”. The movement of paddle **102***e* is motorized and controlled by the health professional. Paddles **102***e* of different size and different configurations can be fitted on the gantry

101 to suit different breast sizes or to suit imaging needs (i.e., for screening or diagnosis). In addition, the technologist can move paddle **102***e* along the width of support platform **102***b* to a position in which paddle **102***e* matches the position of a breast that is not centered on support platform **102***b*, as in the Selenia system currently offered by the common assignee. The system **100** further includes other components, such as a control station **104** having interface devices such a keyboard **104***a* and trackball **104***b*, a display screen **104***c*, and control and image processing facilities. A biopsy guidance module **110** may easily be mounted in between the x-ray source and the x-ray detector of the imaging system **102** for upright biopsy procedures. Other examples of biopsy guidance modules are described herein, for example, in the context of FIG. **11**B.

[0033] FIG. **2** depicts an example of a treatment guidance module **210** with a mounted biopsy device **215**, although as noted above, treatment instruments such as cryoablation devices may be utilized. Support bracket **221** extends between handles **223***a* and **223***b*, which facilitate transport of the biopsy guidance module **210**. The biopsy guidance module **210** includes components for controlling the movement of the biopsy device **215**. The biopsy device may be, for example, an Eviva™ vacuum-assisted biopsy device manufactured and sold by Hologic, Inc. Fixed support arm **217** extends from the guidance module to connector **231**. In one embodiment connector **231** connects angular support arm **212** to the fixed support arm **217** at a fixed angle. Alternative embodiments which include adjustment mechanisms for varying the angle of displacement between the angular support arm **212** and the fixed support arm **217** may be substituted herein as equivalents. Holster mount **235** is moveably coupled to the angular support arm **212**. The linear movement may be mechanically controlled (i.e., via the associated motors and controllers) and/or may be manually controlled using either or both of the thumbwheel knobs **233***a* and **233***b*. The holster mount **235** includes an attachment mechanism **236** that is adapted to receive biopsy holster **213**. The biopsy device **215** sits within the biopsy holster **213**. A needle support **211** may advantageously be coupled to the holster mount **235** for needle stabilization. A control module **225** may be mounted to either of the handles, **223***b* or **223***a* via clamp **236**. In other examples, a control module **225***a* may be mounted so as to be visible in a number of different orientations of the biopsy guidance module (for example, on the support bracket **221**). In various embodiments, each handle **223***a*, **223***b* may include one or more electrical connectors which enable communication between the clamped control module **225** and the guidance module **219**, and the medical professional may move the control module to either handle **223***a*, **223***b* as a matter of preference. The control module **225** includes a user interface that enables the medical professional to control the biopsy procedure without the need to leave the patient. The control module **225** includes a display **228** for displaying a status or other information about the biopsy, and one or more buttons **227** for controlling the movement of the biopsy device **215** during the procedure. It is contemplated that the display may include a touch screen interface for controlling the display and/or movement of the biopsy device during the procedure.

[0034] FIGS. **3**A and **3**B are partial perspective views of another x-ray imaging system **300** and treatment guidance module **310**. An exemplary x-ray imaging system **300** may include a tube head **332** supporting a cone beam or other x-ray source, and a compression platform **330** encasing an x-ray detector. The tube head **332** is rotatably mounted so as to enable the tube head to rotate in along an angular trajectory generally designated by the dashed line **341** in FIG. **3**B. In one example the biopsy guidance module **310** includes clamps, hooks or other attachment elements (e.g., as depicted in FIG. **4**) for mounting the biopsy guidance module **310** to the C-arm **321** of the x-ray imaging system **300**.

[0035] In the example of FIGS. **3**A and **3**B, the holster **313** is coupled to the holster mount (not shown) on a fixed angle arm **312**, and the fixed angle arm **312** is fixedly mounted on the support arm **317** at an angle offset from normal by 10 degrees, although it is readily appreciated that the offset angle may vary as required or desired for a particular application. Angling the arm **312** (and by consequence the biopsy device **315**) allows the biopsy device **315** to be advanced to a desired

location within a biopsy target area (indicated generally by the target area **350**) without the biopsy device **315** and holster **313** introducing artifacts into the x-ray image. As shown in FIG. **3**B, the cone beam **340** will extend into the target area **350**, but the device **315** does not fall within the cone beam **340**. It should be noted that although a 10 degree fixed angle is disclosed, the present technology is not limited to any particular fixed angle and it is appreciated that the selected fixed angle may differ in response to particular geometries of the imaging systems and tissue removal tools. The tube head **332** may also rotate along an imaging scan angle **341** during, e.g., tomosynthesis imaging.

[0036] FIG. **4** is a side view of the treatment guidance module **310**. In FIG. **4**, line A is within a plane that is "normal" to the plane of the x-ray detector **330**. Line B illustrates the angular displacement of the biopsy device **315**, and therefore the device **315** is offset from the normal by an angular measure of X, depending on application, though 10 degrees, as described above, may be advantageous. As a result, the biopsy device will interfere with biopsy imaging.

[0037] Also shown in more detail in FIG. **4** are exemplary coupling elements **350***a* and **350***b* of the biopsy guidance module **310**. The coupling mechanisms **350***a* and **350***b* are adapted to mate with complementary features of the gantry-arm. Other types of coupling elements, including latches, hooks, slots, and the like may be readily substituted herein as equivalents. Further structure of the coupling elements **350***a*, **350***b* are described herein in the context of FIG. **7**F.

[0038] FIG. **5** is a top view of the treatment guidance module **310**. Only a subset of components are labeled for ease of reference. When viewing the biopsy guidance module **310** from this perspective, the displacement or reach N of the needle tip which results from the angular tilt of the biopsy guidance module **310** is readily apparent.

[0039] FIGS. **6**A and **6**B are partial front perspective and front views, respectively, of another example of x-ray imaging system **400** with a treatment guidance module **402** in a lateral orientation. FIGS. **6**A and **6**B are described concurrently and not every element or feature is depicted in each figure. The biopsy guidance module **402** is secured to the x-ray imaging system **400** via an adapter **404**. The adapter **404** allows the same biopsy guidance module **402** used in the upright biopsy configuration depicted in FIGS. **1-5** to be used in a lateral configuration. This has a number of advantages, in that the only a single biopsy guidance module **402** is needed. Prior lateral approaches require additional structure such as a lateral arm that is secured to the post of the biopsy guidance module **402** in order to perform lateral biopsy procedures. These lateral arms could be cumbersome, difficult to secured to the post, and less robust than the biopsy guidance module **402** itself. The biopsy guidance module **402** is secured to the adapter **404** by actuation of a module latch actuator **406**, two of which are depicted in FIG. **6**B (only one module latch actuator **406** is visible in FIG. **6**A).

[0040] FIGS. **6**A and **6**B depict a partial view of an x-ray imaging system, namely a breast immobilization structure including a breast support platform **408** and a breast immobilization paddle **410**, as well as a tube head. In FIGS. **6**A and **6**B, the components are described as "procedure ready," in that all necessary components are connected so as to enable performance of a breast treatment (e.g., a biopsy). Typically, treatments such as biopsies are performed when the imaging system **400** is in the depicted upright position (corresponding to a cranial caudal or CC orientation). In other examples, treatments may be performed in a mediolateral oblique or MLO orientation. In this procedure-ready position depicted in FIGS. **6**A and **6**B, the breast immobilization structure is in the upright position (e.g., such that a patient breast may rest on the breast support platform **408** and be immobilized by the breast immobilization paddle **408**). In the procedure-ready position, the biopsy guidance module **402** is connected to the adapter **404**, which is in turn connected to the x-ray imaging system **400**, as described herein. The biopsy needle **412** secured to the biopsy guidance module **402** is substantially parallel to an upper surface of the breast support platform **410**. In other examples, when the biopsy guidance module **402** is in the procedure-ready position of FIGS. **6**A and **6**B, the biopsy needle **412** may be substantially parallel

to a front face of the breast support platform **410**, which may abut the chest wall of the patient. As used in this context, "procedure-ready" means a position where a biopsy procedure may be performed on a patient breast, though some additional adjustments of the various components of the biopsy guidance module **402** and/or the x-ray imaging system **400** itself may be required, desired, or otherwise possible to target a region of interest in the breast. In another example, an umbilical cord **414** (containing power and/or control wiring) extending from the biopsy guidance module **402** may be connected to a port **416** on the x-ray imaging system **400** in the procedure-ready position.

[0041] FIGS. **7**A and **7**B are top and bottom perspective views, respectively, of an adapter **450** for securing a treatment guidance module to an x-ray imaging system in a lateral orientation. In this orientation, the adapter **450** may be described as "procedure-ready" as that term is defined herein. The imaging system may be a breast imaging system **100** such as depicted in FIG. **1** and elsewhere herein, while the treatment guidance module may be a biopsy guidance module **110** such as depicted in FIG. **1** and elsewhere herein. FIGS. **7**A and **7**B are described concurrently and not all features described are depicted in both figures. The adapter **450** includes a body or housing **452** that may be configured as required or desired for a particular application. The body or housing **452** may include one or more structures that act as handles to improve gripability, positioning, and movement thereof. For example, a handle **454** and a tie **456** may be gripped by a technologist as required. The tie **456** may span a pair of struts **458**, each configured to receive a keeper **460** that engages with a treatment guidance module. An armature **462** extends from a rear of the body or housing **452**. The armature **462** defines an engagement surface **464** from which extends a plurality of locking bolts **466** for locking the adapter **450** to an imaging system, as described elsewhere herein. The locking bolts **466** may be actuated by a lever arm **468** that, in this configuration, projects from the armature **462**. A supplemental lock **470** may fix a position of the lever **468** when in the locked position, so as to prevent inadvertent disengagement thereof. The supplemental lock **470** is depicted here as a button that may actuate an electromechanical locking element. In another example, the button may actuate a detent or other mechanical lock that engages with (or disengages from, or otherwise prevents movement of) the lever **470** or the locking structure to which the lever **470** is engaged. Other supplemental lock structures would be apparent to a person of skill in the art.

[0042] FIG. **8**A is a perspective view of an adapter **500** for securing a treatment guidance module to an x-ray imaging system in a lateral orientation. An outer body or housing **504** of the adapter **500** is depicted in dashed lines so as to depict more clearly the internal structures and components described herein. The housing **500***a* may have a form factor similar to that of the adapter depicted in FIGS. **7**A and **7**B, or may have different curvatures, surface textures, dimensions, structures, etc. As such, the housing **504** of the lateral adapter **500** is depicted as dashed in the following figures, while the internal components thereof are described in more detail. Other views of the adapter **500** or parts thereof are depicted in FIGS. **8**B-**8**F. As such, FIGS. **8**A-**8**F are generally described concurrently, and not every component depicted is visible or marked in every figure. Certain components are only described in the context of certain figures. In FIG. **8**A, the adapter **500** is positioned in a procedure-ready position, as described in more detail herein. In general, when the adapter **500** is in the procedure-ready position (further depicted above in the context of FIGS. **6**A and **6**B), keepers **502** are in a generally horizontal configuration. The adapter body **504** that may be configured as required or desired for a particular application (e.g., to attach to a particular x-ray imaging system or to have a particular biopsy guidance module attached thereto). The adapter **500** may also include an armature **506** extending from a rear side of the adapter body **504**. A handle **508** may also extend from the armature **506** or some other portion of the adapter body **504** to make lifting, moving, or connecting the adapter **500** to the x-ray imaging system easier. The keepers **502** are disposed at opposite ends of the adapter body **504**, and generally face towards the front side thereof, which is opposite the rear side. A latch mechanism **510** is disposed proximate an end of the armature **506** and is utilized to selectively connect the adapter **500** to an x-ray imaging system. The

adapter **500**, keepers **502**, handle **508**, latch mechanism **510**, and other components are generally configured so the adapter **500** may be secured on a first side or a second side of the breast immobilization structure of the x-ray imaging system.

[0043] FIG. **8**B is a partial exploded perspective view of an interface **512** of an x-ray system **516** and the adapter **500** of FIG. **8**A, including the latch mechanism **510**. The interface **512** may include a robust plate **514** or other structure rigidly secured to a robust structural element of the x-ray imaging system **516**, for example, to the breast immobilization structure **518**. The plate **514** defines a plurality of openings **520**, each having a receiving portion **520***a* and a retention portion **520***b*. The receiving portion **520***a* is configured to receive an associated bolt **522**, each of which include an enlarged head **522***a*. The enlarged head **522***a* is sized so as to be received on the receiving portion **520***a* of an opening **500**. Thereafter, the bolt **522** is set in the retention portion **520***b* of the opening **520**, where the enlarged head **522***a* prevents removal therefrom along an axis of the bolt **522**. A lever or actuator **524**, which in some examples may include an over-center mechanism, may then be actuated so as to draw the adapter **500** in tight contact with the interface **512** of the imaging system **516**. Other fixation implements such as bayonet mechanisms, robust electromagnets, or other systems may be utilized. A supplemental lock **530** (here in the form of a button) may be configured to engage with the latch mechanism **510** to prevent inadvertent disengagement thereof. FIG. **8**C is an upright rear view of the latch mechanism **510** of the adapter **500** of FIG. **8**A. In this figure, the difference in relative diameter or size of the enlarged head **522***a* as compared to the bolt **522** is readily discernible.

[0044] FIG. **8**D is a top or bottom view of the adapter **500** of FIG. **8**A. The adapter body **504** includes two keepers **502**, as described elsewhere herein, though only a single keeper is shown in this view. The keepers **502** are disposed such that a plurality of attachment element hook openings **502***a* are formed at the front side of the adapter **500**, along with at least one latch opening **502***b*. These openings **502***a*, **502***b* are configured to receive a corresponding number of components projecting from a biopsy guidance module (not shown) such as attachment elements (e.g., hooks) or latches. FIG. **8**E is a front view of the adapter **500** of FIG. **8**A and depicts more clearly depicts an electrical contact **526** at each of the two keepers **502**. As described in the context of FIG. **8**F, the electrical contacts **526** are configured to be communicatively coupled to corresponding contacts on the biopsy guidance module (not shown) when the biopsy guidance module is selectively engaged with the adapter **500**. This allows for the transmission of power and control signals between the biopsy guidance module and the imaging system (e.g., via the umbilical cord depicted in FIGS. **6**A and **6**B).

[0045] FIG. **8**F is a partial exploded perspective view of a keeper **502** of the adapter of FIG. **8**A and the latch module **600** of a treatment guidance module. In FIG. **8**F, only the relevant structural components are depicted for clarity (e.g., the adapter and biopsy guidance module are not shown). As described above, the keeper **502** includes at least one hook opening **502***a* and at least one latch opening **502***b*. An electrical contact pad **526** including a plurality of electrical contacts **526***a* is disposed on a front face of the keeper **502**. A physical switch, proximity sensor, or other sensor **528** is disposed at or near the latch opening **502***b*. The hook opening **502***a* is configured to receive a hook **600***a* extending from the latch module **600** of the biopsy guidance module. The latch opening **502***b* is configured to receive a latch **600***b* that is selectively extended from the latch module **600** by actuation of an actuator **602** thereon. Extending the latch **600***b* into the latch opening **502***b* draws the latch module **600** (and biopsy guidance module) tight to the keeper **502** (of the adapter), thus ensuring contact between the plurality of electrical contacts **526***a* and a corresponding number of contacts **604***a* on the latch module **600**. Although an equal number of contacts **604***a* are depicted in FIG. **8**F, a different number of contacts may be utilized, and may be contained in an exposed area **604** of the latch module **600**. Either or both sets of contacts **526***a*/**604***a* may be spring biased to ensure adequate contact therebetween.

[0046] FIG. **9** depicts a method **700** of attaching a treatment guidance module to a breast imaging

system. The imaging system may be as depicted herein, and include for example, a breast immobilization structure that includes a breast support platform. The breast imaging system may have secured to a central location of the front side of the breast immobilization structure, a biopsy guidance module or other treatment module. Such a configuration is depicted for example in FIG. **3**A. As such, the method **700** may begin with optional operation **702**, disengaging the biopsy guidance module from a front side of the breast immobilization structure. In examples, where the biopsy guidance module is not engaged with the imaging system, the method **700** may begin with operation **704**, positioning a breast immobilization structure in an adapter-mounting position. Such a position is depicted in FIG. **10**A, which depicts a partial rear view of the breast immobilization structure **750**. In the adapter-mounting position, the breast immobilization structure **750** is rotated such that the breast support platform (not shown in FIG. **10**A) is disposed at an angle to the horizontal. This angle may be about 90°, about 85°, about 80°, about 75°, or about 70° from the horizontal. In general, positioning the breast support platform at such an angle may make the interface plate **752** more readily accessible for attachment of the adapter and/or the biopsy guidance module. The position depicted in FIG. **10**A is particularly advantageous because the (relatively lightweight) adapter may be connected to the interface plate **752**, then the (somewhat heavier) biopsy guidance module may be held with the handles oriented vertically for easy attachment to the adapter. The breast immobilization structure **750** may be disposed in this position automatically, for example, by a technologist pressing a button on the breast imaging system, or the breast immobilization structure **750** may be selectively rotated to the desired position.

[0047] Thereafter, operation **706** is performed, which includes engaging the adapter with the breast immobilization structure **750** at an interface of the breast imaging system. This may be performed by a technologist by lifting the adapter and engaging the latch assembly thereon with the interface plate **752** and may optionally include engaging a supplemental lock to further secure the adapter. Once engaged, operation **708** is performed, selectively latching the adapter to the interface plate **752**, which robustly secures those two components. Thereafter, the breast immobilization structure **750** is positioned in a procedure-ready position, operation **710**, which is depicted in FIG. **10**B. As used herein, the term “procedure-ready” means a position where a patient may have her breast immobilized in the breast immobilization structure **750** and a procedure such as an imaging procedure or biopsy procedure or other treatment or procedure may be performed. Typically, imaging occurs prior to biopsy. In another example, positioning the breast immobilization structure **750** in the procedure-ready position may include operation **712**, engaging an umbilical cord from the adapter with a port on the breast imaging system.

[0048] The precise angular positions of the immobilization structure **750** when in the adapter-mounting position and the procedure-ready position may be as required or desired for a particular application. Further, the above description describes the positions in the context of the breast support platform. In another example, the adapter-mounting position and the procedure-ready position may be described in the context of a position of the interface plate **752**. For example, in the procedure-ready position, the interface plate **752** is substantially vertical, while in the adapter-mounting position, the interface plate **752** is disposed at an angle to the procedure-ready position. In examples, the angle may be about 90°, about 85°, about 80°, about 75°, or about 70°. The adapter-mounting position may be any position where the adapter may be more easily mounted to the breast immobilization structure. The method **700** continues with operation **714**, engaging the biopsy guidance module with the adapter. The biopsy guidance module may be selectively engaged to the adapter in operation **716**, thereby readying the system for further procedures on the breast of a patient.

[0049] FIG. **11**A is a perspective view of another example of a biopsy guidance module **900**. The biopsy guidance module **900** is similar to that depicted in the context of FIGS. **1-5**, and may be used in conjunction a biopsy device. The biopsy guidance module **900** may include a bracket **902** that is disposed on one or both sides of a housing **904** of the module **900**. In examples, the brackets

902 may be disposed near the handles **906**, but other locations are contemplated. By disposing a bracket **902** on both sides of the housing **904**, a biopsy controller **908** may be positioned on either side of the biopsy guidance module **900**, as required or desired for a particular procedure, and which side of a compression arm the biopsy guidance module **900** is mounted. The controller **908** may be se secured to an articulating arm **910** so as to enable further positioning by a technologist during biopsy procedures. A terminal end of the articulating arm **910** may include a mount **912** that may be removably engaged with either bracket **902**. The depicted configuration utilizing the bracket **902** may present certain advantages to the technologist, in that the brackets **902** are not disposed on the handles **906**, thus leaving those unobstructed to be gripped more easily. The biopsy guidance module **900** also includes a holster mount **920**, as described in FIG. **11**B.

[0050] FIG. **11**B is a perspective view of a quick-connect holster mount **920** for mounting a treatment device (not shown), such as a biopsy device. The mount **920** includes two registration pins **922** that may mate with two registration openings on the biopsy device. Once registers, a wheel **924** may be manually rotated by the medical professional. Rotation of the wheel **924** rotates a mating screw **926** connected thereto. The mating screw **926** engages with a threaded opening on the biopsy device for fast attachment thereof to the mount **920**.

[0051] Illustrative examples of the systems and methods described herein are provided below. An embodiment of the system or method described herein may include any one or more, and any combination of, the clauses described below:

[0052] Clause 1. An adapter for securing a biopsy guidance module to a breast imaging system, the adapter comprising: an adapter body comprising a first side and an opposite second side; an armature extending from the first side of the body; a latch mechanism disposed proximate an end of the armature distal from the first side of the body, wherein the latch mechanism comprises an adapter latch and an actuator, wherein the adapter latch is configured to engage an interface on the breast imaging system and wherein the actuator is engaged with the adapter latch to move the adapter latch from an unlocked position to a locked position, wherein in the locked position, the adapter latch is releasably engaged with the interface; and a keeper disposed on the second side of the body, wherein the keeper is configured to receive a module latch from the biopsy guidance module.

[0053] Clause 2. The adapter of clause 1, wherein the keeper comprises a plurality of openings and wherein one of the plurality of openings is configured to receive the module latch.

[0054] Clause 3. The adapter of clause 2, further comprising a sensor disposed in the opening configured to receive the module latch, wherein the sensor is configured to detect a position of the module latch.

[0055] Clause 4. The adapter of any of clauses 1-3, further comprising a first plurality of electrical contacts disposed to contact a second plurality of electrical contacts disposed on the biopsy guidance module.

[0056] Clause 5. The adapter of any of clauses 1-4, further comprising an umbilical cord extending from the adapter, wherein the umbilical cord is communicatively coupled to at least one of the first plurality of electrical contacts.

[0057] Clause 6. The adapter of any of clauses 1-5, wherein the keeper comprises a pair of keepers, wherein each of the pair of keepers are disposed proximate opposite ends of the second side of the body.

[0058] Clause 7. The adapter of any of clauses 1-6, further comprising a hanger disposed proximate the end of the armature for liftably engaging the adapter body with the interface of the breast imaging system.

[0059] Clause 8. The adapter of any of clauses 1-7, wherein the latch mechanism comprises an over-center mechanism.

[0060] Clause 9. A breast imaging system comprising: a gantry; an x-ray source rotatably coupled to the gantry; a breast immobilization structure rotatably coupled to the gantry independent of the

x-ray source, wherein the breast immobilization structure comprises: a breast support platform; a breast immobilization paddle movably coupled to a front side of the breast immobilization structure and movably engaged with the front side of the breast immobilization structure to move substantially orthogonally relative to the breast support platform; and an pair of interfaces on at least one of a rear side and two lateral sides of the breast immobilization structure for selectively operably connecting an adapter for a biopsy guidance module to the breast immobilization structure; and an x-ray detector disposed below the breast support platform.

[0061] Clause 10. The breast imaging system of clause 9, wherein: a first interface of the pair of interfaces is disposed on a rear side of the breast immobilization structure, on a first side of a dividing axis of the breast immobilization structure; and a second interface of the pair of interfaces is disposed on a rear side of the breast immobilization structure, on a second side of the dividing axis of the breast immobilization structure.

[0062] Clause 11. The breast imaging system of clause 10, wherein the first interface comprises a first plate facing towards a first lateral side of the two lateral sides of the breast imaging system, and wherein the second interface comprises a second plate facing towards a second lateral side of the two lateral sides of the breast imaging system.

[0063] Clause 12. The breast imaging system of any of clauses 9-11, wherein each of the pair of interfaces comprise an interface keeper for receiving an adapter latch on the adapter.

[0064] Clause 13. The breast imaging system of any of clauses 9-12, wherein each of the pair of interfaces comprise a hanger structure for selectively engaging the adapter with the interface.

[0065] Clause 14. The breast imaging system of clause 13, wherein hanger structure comprises an opening in each of the pair of interfaces.

[0066] Clause 15. The breast imaging system of any of clauses 9-14, wherein the breast imaging system comprises two substantially identical umbilical ports.

[0067] Clause 16. A method of attaching a biopsy guidance module to a breast imaging system having a breast immobilization structure comprising a breast support platform, the method comprising: positioning a breast immobilization structure in an adapter-mounting position; engaging an adapter with the breast immobilization structure at an interface of the breast imaging system; selectively latching the adapter to the interface; positioning the breast immobilization structure in a procedure-ready position; engaging the biopsy guidance module with the adapter; and selectively latching the biopsy guidance module to the adapter.

[0068] Clause 17. The method of clause 16, wherein positioning the breast immobilization structure in the procedure-ready position comprises engaging an umbilical cord from the adapter with a port on the breast imaging system.

[0069] Clause 18. The method of any of clauses 16-17, wherein: in the procedure-ready position, the interface is substantially vertical; and in the adapter-mounting position, the interface is disposed at an angle to the procedure-ready position.

[0070] Clause 19. The method of clause 18, wherein the angle is approximately 90 degrees.

[0071] Clause 20. The method of any of clauses 16-19, further comprising disengaging the biopsy guidance module from a front side of the breast immobilization structure, prior to engaging the biopsy guidance module with the adapter.

[0072] Clause 21. The method of any of clauses 16-20, wherein engaging the adapter with the breast immobilization structure comprises activating a supplemental lock.

[0073] This disclosure described some examples of the present technology with reference to the accompanying drawings, in which only some of the possible examples were shown. Other aspects can, however, be embodied in many different forms and should not be construed as limited to the examples set forth herein. Rather, these examples were provided so that this disclosure was thorough and complete and fully conveyed the scope of the possible examples to those skilled in the art.

[0074] Although specific examples were described herein, the scope of the technology is not

limited to those specific examples. One skilled in the art will recognize other examples or improvements that are within the scope of the present technology. Therefore, the specific structure, acts, or media are disclosed only as illustrative examples. Examples according to the technology may also combine elements or components of those that are disclosed in general but not expressly exemplified in combination, unless otherwise stated herein. The scope of the technology is defined by the following claims and any equivalents therein.

Claims

1. An adapter for securing a biopsy guidance module to a breast imaging system, the adapter comprising: an adapter body comprising a first side and an opposite second side; an armature extending from the first side of the body; a latch mechanism disposed proximate an end of the armature distal from the first side of the body, wherein the latch mechanism comprises an adapter latch and an actuator, wherein the adapter latch is configured to engage an interface on the breast imaging system and wherein the actuator is engaged with the adapter latch to move the adapter latch from an unlocked position to a locked position, wherein in the locked position, the adapter latch is releasably engaged with the interface; and a keeper disposed on the second side of the body, wherein the keeper is configured to receive a module latch from the biopsy guidance module.
2. The adapter of claim 1, wherein the keeper comprises a plurality of openings and wherein one of the plurality of openings is configured to receive the module latch.
3. The adapter of claim 2, further comprising a sensor disposed in the opening configured to receive the module latch, wherein the sensor is configured to detect a position of the module latch.
4. The adapter of claim 1, further comprising a first plurality of electrical contacts disposed to contact a second plurality of electrical contacts disposed on the biopsy guidance module.
5. The adapter of claim 1, further comprising an umbilical cord extending from the adapter, wherein the umbilical cord is communicatively coupled to at least one of the first plurality of electrical contacts.
6. The adapter of claim 1, wherein the keeper comprises a pair of keepers, wherein each of the pair of keepers are disposed proximate opposite ends of the second side of the body.
7. The adapter of claim 1, further comprising a hanger disposed proximate the end of the armature for liftably engaging the adapter body with the interface of the breast imaging system.
8. The adapter of claim 1, wherein the latch mechanism comprises an over-center mechanism.
9. A breast imaging system comprising: a gantry; an x-ray source rotatably coupled to the gantry; a breast immobilization structure rotatably coupled to the gantry independent of the x-ray source, wherein the breast immobilization structure comprises: a breast support platform; a breast immobilization paddle movably coupled to a front side of the breast immobilization structure and movably engaged with the front side of the breast immobilization structure to move substantially orthogonally relative to the breast support platform; and an pair of interfaces on at least one of a rear side and two lateral sides of the breast immobilization structure for selectively operably connecting an adapter for a biopsy guidance module to the breast immobilization structure; and an x-ray detector disposed below the breast support platform.
10. The breast imaging system of claim 9, wherein: a first interface of the pair of interfaces is disposed on a rear side of the breast immobilization structure, on a first side of a dividing axis of the breast immobilization structure; and a second interface of the pair of interfaces is disposed on a rear side of the breast immobilization structure, on a second side of the dividing axis of the breast immobilization structure.
11. The breast imaging system of claim 10, wherein the first interface comprises a first plate facing towards a first lateral side of the two lateral sides of the breast imaging system, and wherein the second interface comprises a second plate facing towards a second lateral side of the two lateral sides of the breast imaging system.

12. The breast imaging system of claim 9, wherein each of the pair of interfaces comprise an interface keeper for receiving an adapter latch on the adapter.
13. The breast imaging system of claim 9, wherein each of the pair of interfaces comprise a hanger structure for selectively engaging the adapter with the interface.
14. The breast imaging system of claim 13, wherein hanger structure comprises an opening in each of the pair of interfaces.
15. The breast imaging system of claim 9, wherein the breast imaging system comprises two substantially identical umbilical ports.
16. A method of attaching a biopsy guidance module to a breast imaging system having a breast immobilization structure comprising a breast support platform, the method comprising: positioning a breast immobilization structure in an adapter-mounting position; engaging an adapter with the breast immobilization structure at an interface of the breast imaging system; selectively latching the adapter to the interface; positioning the breast immobilization structure in a procedure-ready position; engaging the biopsy guidance module with the adapter; and selectively latching the biopsy guidance module to the adapter.
17. The method of claim 16, wherein positioning the breast immobilization structure in the procedure-ready position comprises engaging an umbilical cord from the adapter with a port on the breast imaging system.
18. The method of claim 16, wherein: in the procedure-ready position, the interface is substantially vertical; and in the adapter-mounting position, the interface is disposed at an angle to the procedure-ready position.
19. The method of claim 18, wherein the angle is approximately 90 degrees.
20. The method of claim 16, further comprising disengaging the biopsy guidance module from a front side of the breast immobilization structure, prior to engaging the biopsy guidance module with the adapter.
21. The method of claim 16, wherein engaging the adapter with the breast immobilization structure comprises activating a supplemental lock.