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(54) **ULTRASOUND PROBE WITH INTEGRATED NEEDLE ADVANCER**

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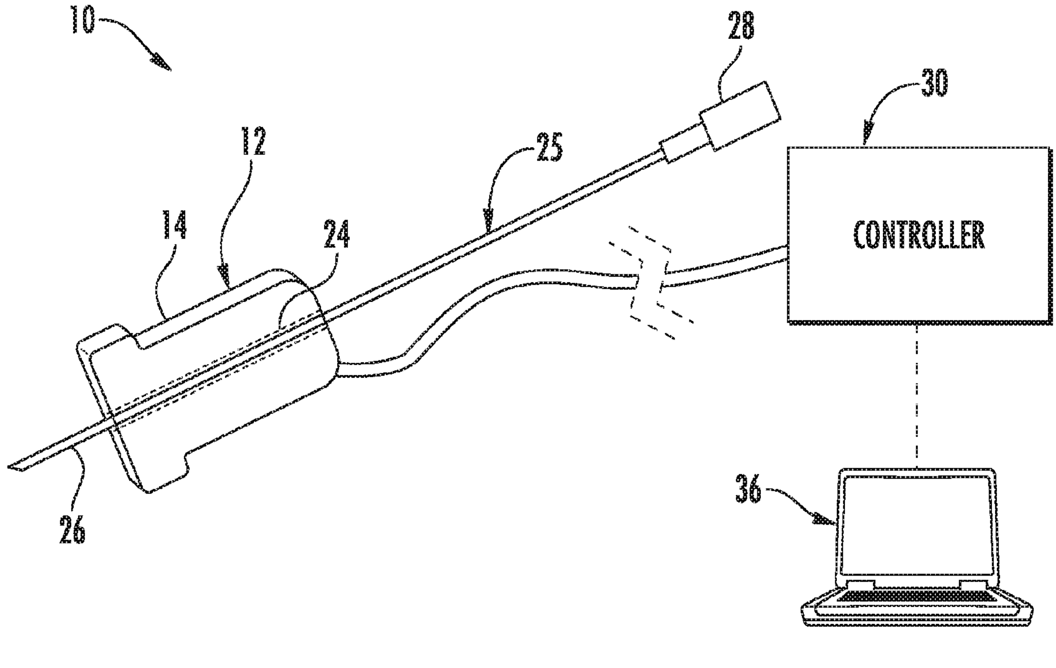
(57) **ABSTRACT**

The present disclosure is directed to an ultrasound imaging system with an integrated needle advancer. More specifically, the ultrasound imaging system includes an ultrasound probe having a transducer housing, a transducer transmitter, a needle assembly, and a controller. The transducer housing has a body that defines an internal cavity. The internal cavity includes a passageway extending from a proximal end to a distal end of the body. The needle assembly is configured within the passageway of the internal cavity. The transducer transmitter is configured within the distal end of the body. Further, the transducer transmitter is configured to emit and receive ultrasound beams. Thus, the controller is configured to generate an image from the ultrasound beams.



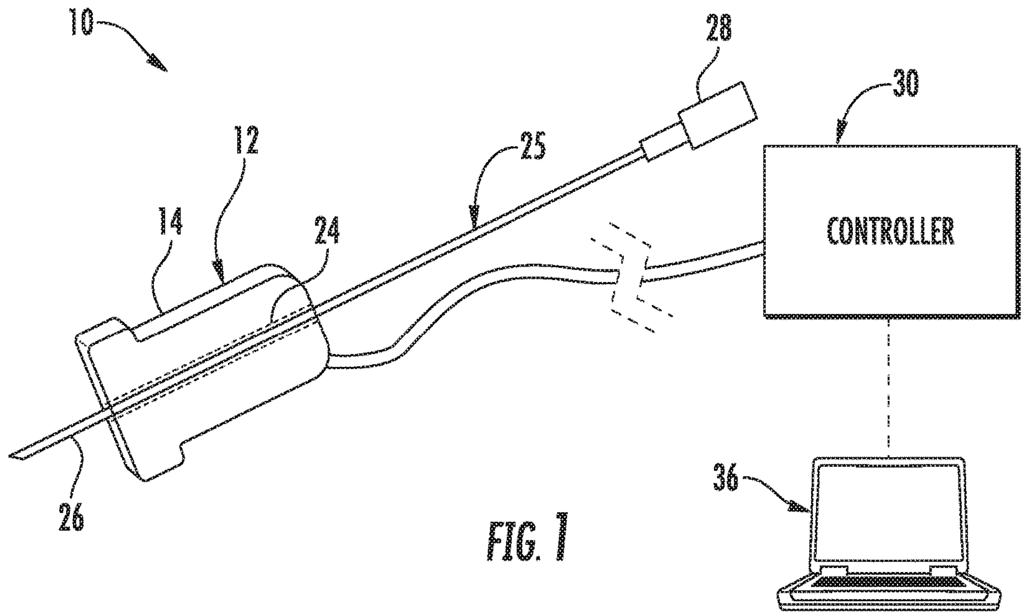

10
28
30
12
25
14
24
CONTROLLER
26
36

FIG. 1

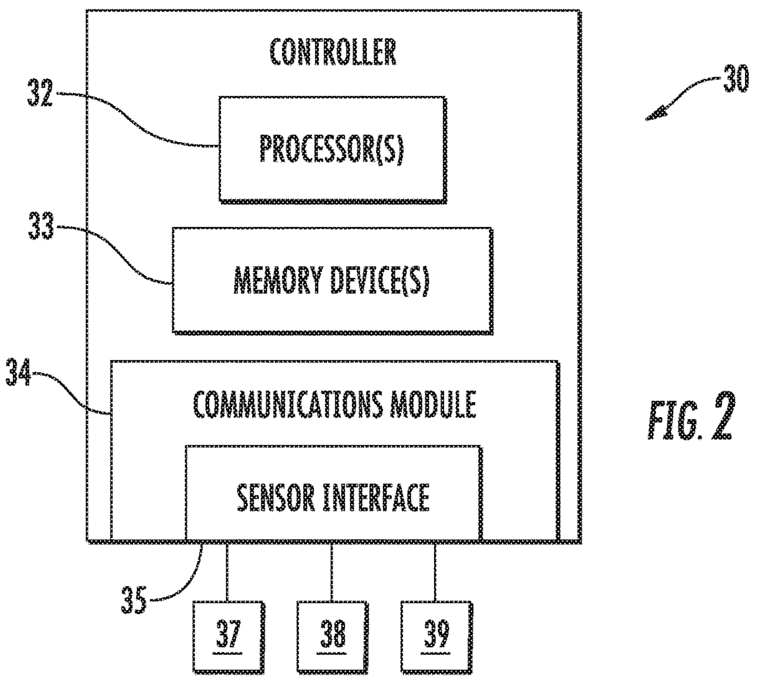

CONTROLLER
30
32
PROCESSOR(S)
33
MEMORY DEVICE(S)
34
COMMUNICATIONS MODULE
SENSOR INTERFACE
35
37
38
39

FIG. 2

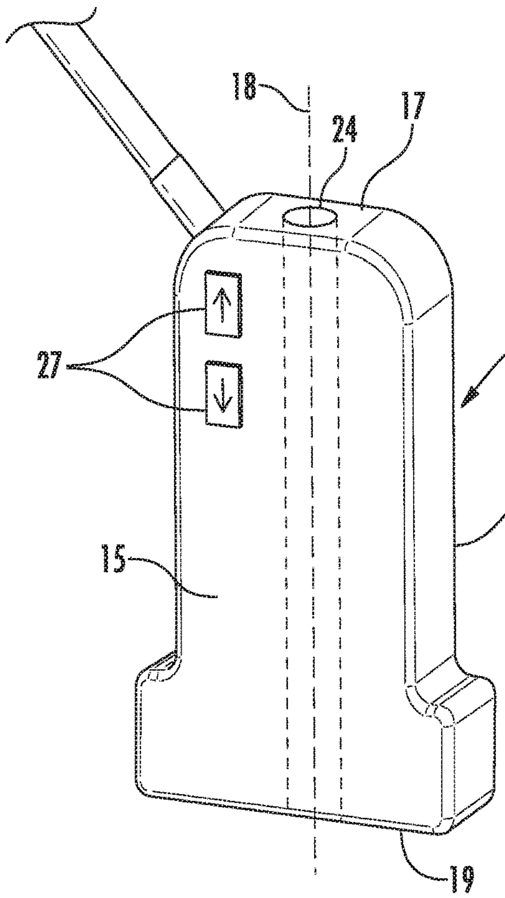


FIG. 3

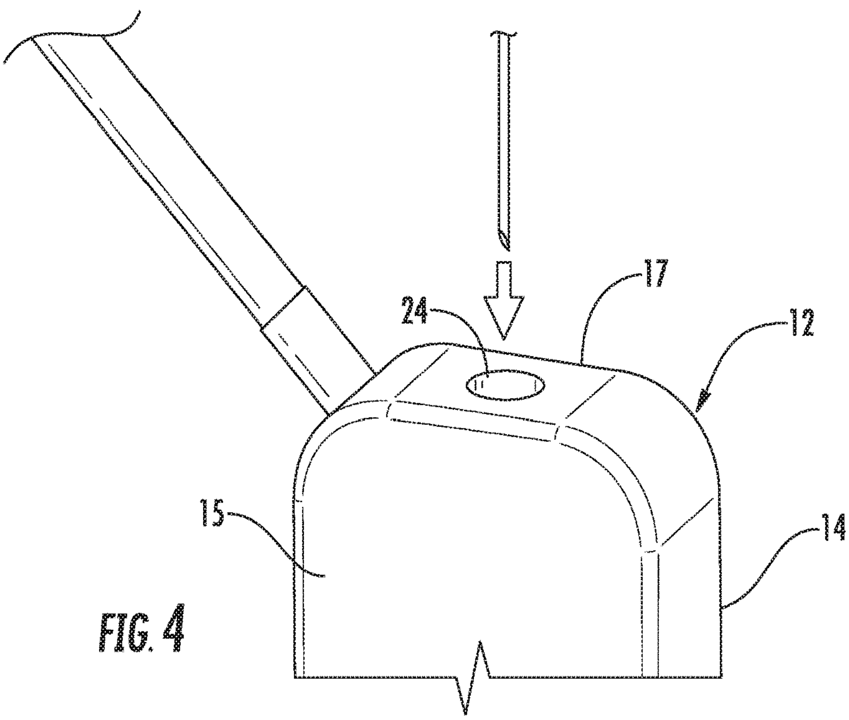


FIG. 4

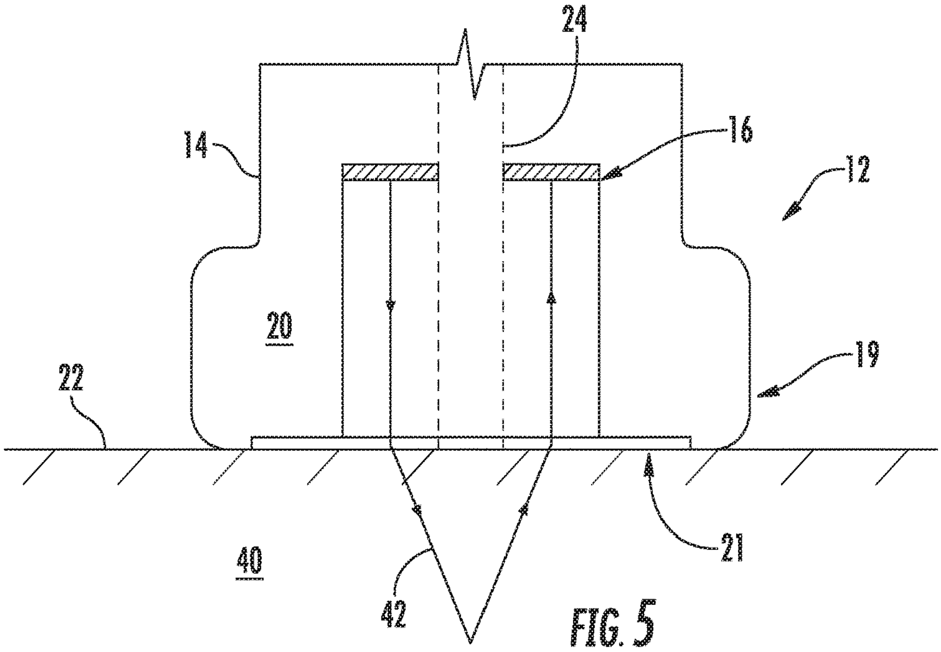


FIG. 5

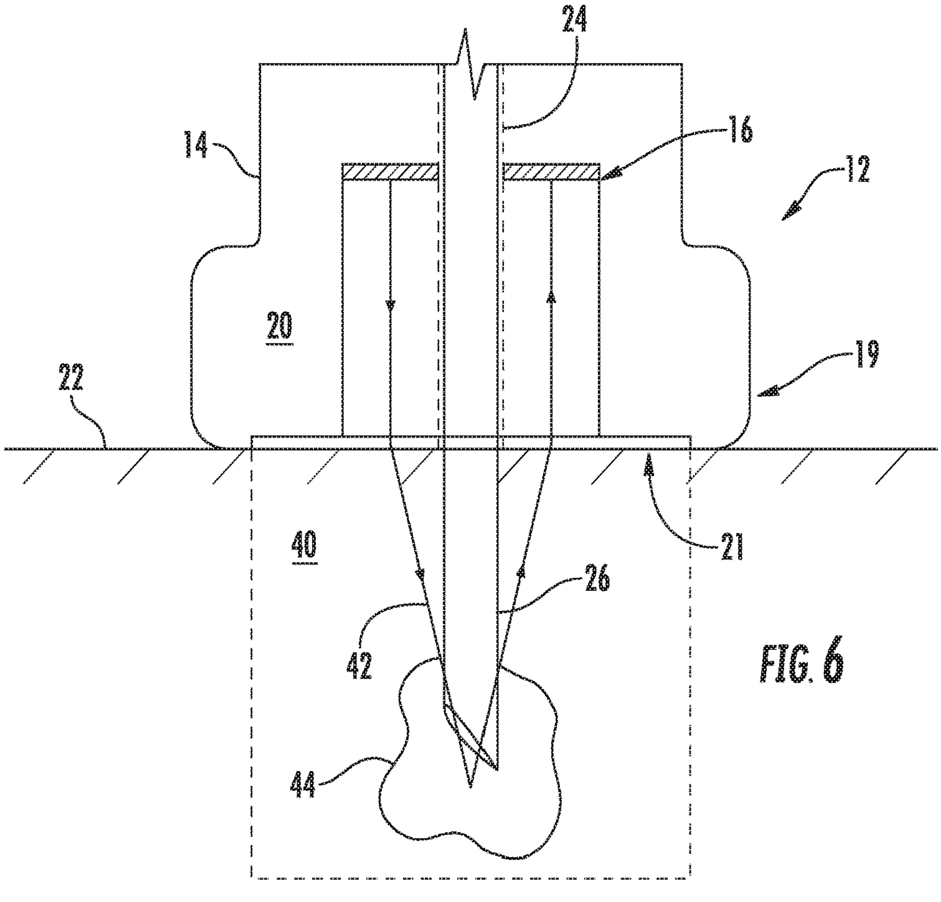


FIG. 6

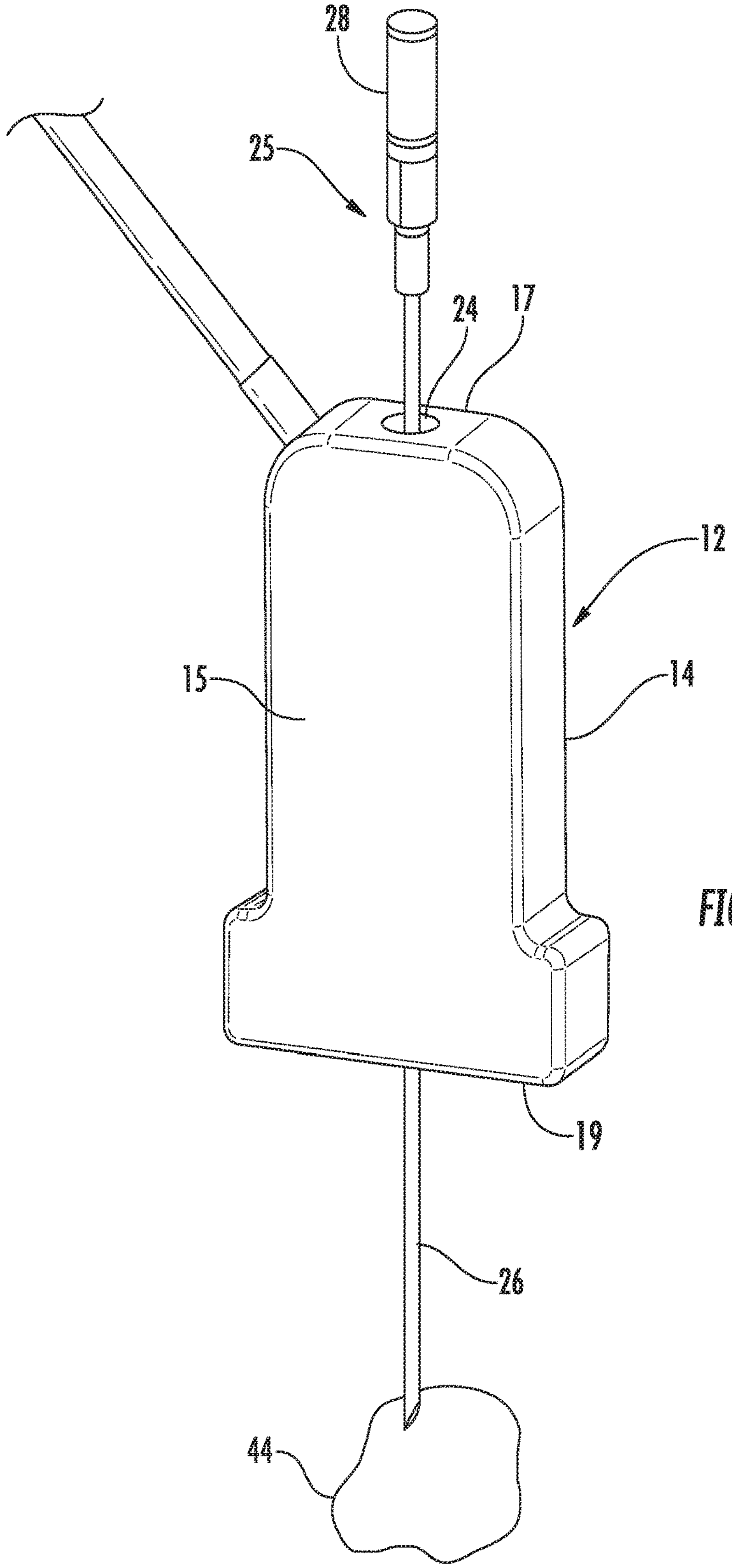


FIG. 7

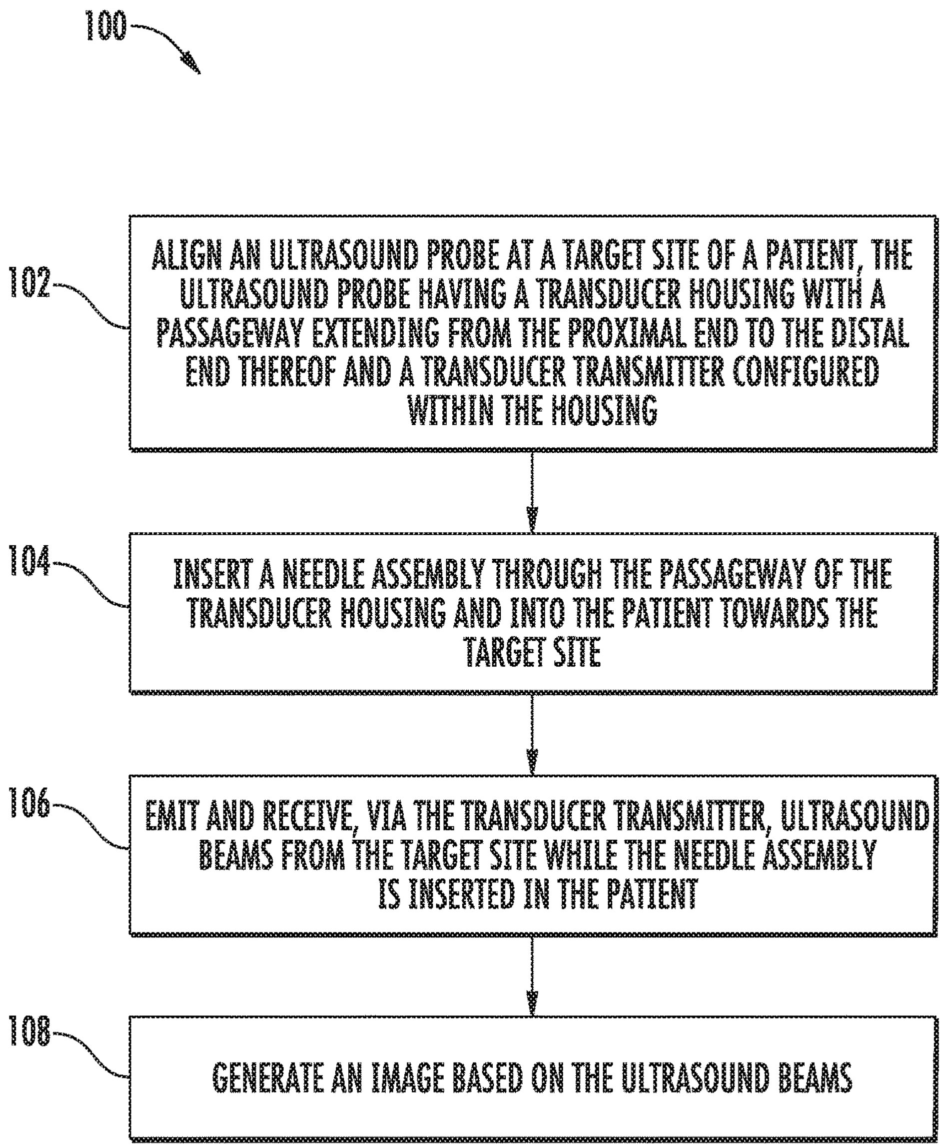

100
102
ALIGN AN ULTRASOUND PROBE AT A TARGET SITE OF A PATIENT, THE ULTRASOUND PROBE HAVING A TRANSDUCER HOUSING WITH A PASSAGEWAY EXTENDING FROM THE PROXIMAL END TO THE DISTAL END THEREOF AND A TRANSDUCER TRANSMITTER CONFIGURED WITHIN THE HOUSING
104
INSERT A NEEDLE ASSEMBLY THROUGH THE PASSAGEWAY OF THE TRANSDUCER HOUSING AND INTO THE PATIENT TOWARDS THE TARGET SITE
106
EMIT AND RECEIVE, VIA THE TRANSDUCER TRANSMITTER, ULTRASOUND BEAMS FROM THE TARGET SITE WHILE THE NEEDLE ASSEMBLY IS INSERTED IN THE PATIENT
108
GENERATE AN IMAGE BASED ON THE ULTRASOUND BEAMS

FIG. 8

ULTRASOUND PROBE WITH INTEGRATED NEEDLE ADVANCER

RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Applications No. 62/247,891, filed Oct. 29, 2015, which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates in general to ultrasound imaging systems, and more particularly to a medical ultrasound probe with an integrated needle advancer, particularly useful for nerve block applications.

BACKGROUND OF THE INVENTION

[0003] In conventional two-dimensional (2D) ultrasound imaging, a focused beam of ultrasound energy is transmitted into body tissues to be examined and the returned echoes are detected and plotted to form an image. Some modern ultrasound systems have three-dimensional (3D) capabilities that scan a pulsed ultrasound beam in two side-wards directions relative to a beam axis. Time of flight conversion gives the image resolution along the beam direction (range), while image resolution transverse to the beam direction is obtained by the side-wards scanning of the focused beam. With such 3D imaging, a user can collect volume ultrasound data from an object and visualize any cross-section of the object through computer processing. This enables selection of the best two-dimensional (2D) image planes for a diagnosis.

[0004] Thus, 2D or 3D ultrasound imaging is useful for numerous medical applications where visual aid is advantageous, e.g. nerve block applications. However, during some peripheral nerve block applications, it can be very difficult to keep both the nerve bundle and the needle in the plane with the ultrasound field. Thus, it can be very easy for the needle to be out of the ultrasound plane such that the ultrasound imaging cannot capture an image of the needle. When this happens, the needle cannot be seen, thereby creating a potentially dangerous situation for the patient if the needle is misplaced. In addition, the procedure can become very difficult for the anesthesiologist due to the requirement of having to hold, maintain, and operate multiple devices during the procedure.

[0005] Thus, the art is continuously seeking new and improved 2D or 3D ultrasound probes. More specifically, an ultrasound probe with 2D or 3D capabilities that has an integrated needle advancer that enhances the effectiveness of nerve block procedures would be advantageous.

BRIEF SUMMARY OF THE INVENTION

[0006] Aspects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention.

[0007] In one aspect, the present disclosure is directed to an ultrasound imaging system. The ultrasound imaging system includes an ultrasound probe having 2D and/or 3D capabilities. More specifically, the ultrasound probe has a transducer housing, a transducer transmitter, a needle assembly, and a controller. The transducer housing has a body that defines an internal cavity. The internal cavity includes a passageway extending from a proximal end to a distal end of the body. Thus, the needle assembly is configured within the passageway of the internal cavity. In addition, the transducer transmitter is configured within the distal end of the body so as to emit and receive ultrasound beams. As such, the controller is configured to generate an image from the ultrasound beams.

[0008] In one embodiment, the image may be a two-dimensional (2D) image generated by a 2D probe. Alternatively, the image may be a three-dimensional (3D) image generated by a 3D probe.

[0009] In another embodiment, the needle assembly includes a needle extending from a proximal end to a distal end with a hub configured at the proximal end of the needle. Thus, in particular embodiments, the needle fits within the passageway of the internal cavity via an interference fit.

[0010] In another embodiment, the needle may be centrally located within the transducer housing. Thus, in such embodiments, the needle is configured to align with the ultrasound plane of the ultrasound probe during operation such that the insertion depth of the needle can be automatically and/or manually controlled by a user. For example, in certain embodiments, the controller of the imaging system may be configured to automatically control movement of the needle within the passageway. More specifically, the transducer housing may include one or more sensors configured therein so as to determine an insertion depth of the needle within a patient. Thus, the sensor(s) are configured to send signals to the controller, the signals being indicative of the insertion depth of the needle. Accordingly, the controller is configured to automatically control the insertion depth of the needle based on the sensor signals.

[0011] In an alternative embodiment, the ultrasound probe may include manual control features. For example, in one embodiment, the manual control features may include one or more control buttons configured on the transducer housing. Further, the control buttons are communicatively coupled with the controller. As such, engagement of the control buttons (e.g. by pressing or lifting the buttons) is configured to control an insertion depth of the needle.

[0012] In another embodiment, the ultrasound imaging system may include a user interface configured to display the image, e.g. either a 2D or 3D image. More specifically, the user interface is configured to allow a user to manipulate the image according to one or more user preferences.

[0013] In further embodiments, the distal end of the body of the transducer housing may have a lens having a linear configuration. In such an embodiment, the transducer transmitter is configured adjacent to the lens. In additional embodiments, the distal end of the body of the transducer housing is wider than the proximal end.

[0014] In another aspect, the present disclosure is directed to an ultrasound probe for imaging. The ultrasound probe includes a transducer housing, a needle assembly, and a transducer transmitter. The transducer housing has a body that defines an internal cavity. The internal cavity has a passageway extending from a proximal end to a distal end of the body. Thus, the needle assembly is configured within the passageway of the internal cavity. Further, the transducer transmitter is configured within the distal end of the body and is configured to emit and receive ultrasound beams so to generate an image. It should be understood that the ultrasound probe may be further configured with any of the additional features as described herein.

[0015] In yet another aspect, the present disclosure is directed to a method of generating an ultrasound image during a nerve block procedure. The method includes aligning an ultrasound probe at a target site of a patient. As mentioned, the ultrasound probe may include a transducer housing having a passageway extending from a proximal end to a distal end thereof and a transducer transmitter configured within the housing. As such, the method also includes inserting a needle assembly through the passageway of the transducer housing and into the patient towards the target site. In addition, the method includes emitting and receiving, via the transducer transmitter, ultrasound beams from the target site while the needle assembly is inserted in the patient. Thus, the method also includes generating an image based on the ultrasound beams.

[0016] In one embodiment, as mentioned, the needle assembly may include a needle extending from a proximal end to a distal end with a hub configured at the proximal end of the needle. As such, the step of inserting the needle assembly through the passageway of the transducer housing and into the patient towards the target site may include inserting the needle of the needle assembly through a central location of the transducer housing, e.g. such that the needle aligns with an ultrasound plane during operation.

[0017] In another embodiment, the method may include automatically controlling, via the controller, movement of the needle within the passageway. For example, in such an embodiment, the method may include determining, via one or more sensors configured with the transducer housing, an insertion depth of the needle within the patient. More specifically, in certain embodiments, the method may include sending, via the one or more sensors, signals to the controller that are indicative of the insertion depth of the needle and automatically controlling the insertion depth of the needle based on the signals.

[0018] Alternatively, the method may include manually controlling the needle within the passageway. More specifically, in certain embodiments, the step of manually controlling the needle within the passageway may include engaging (e.g. by pressing or lifting) one or more control buttons configured on the transducer housing. As mentioned, the control buttons are communicatively coupled with the controller such that engagement of the control button(s) controls an insertion depth of the needle.

[0019] In another embodiment, the method may include displaying, via a user interface, the image to a user, e.g. either a 2D or 3D image. More specifically, in certain embodiments, the method may include allowing, via the user interface, a user to manipulate the image according to one or more user preferences.

[0020] These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

DESCRIPTION OF THE DRAWINGS

[0021] A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

[0022] FIG. **1** illustrates a schematic diagram of one embodiment of an ultrasound imaging system according to the present disclosure;

[0023] FIG. **2** illustrates a block diagram of one embodiment of suitable components that may be included in a controller of an ultrasound imaging system according to the present disclosure;

[0024] FIG. **3** illustrates a front, perspective view of one embodiment of an ultrasound probe of an ultrasound imaging system according to the present disclosure;

[0025] FIG. **4** illustrates a detailed view of the ultrasound probe of FIG. **3**;

[0026] FIG. **5** illustrates an internal, detailed view of one embodiment of an ultrasound probe of an ultrasound imaging system according to the present disclosure, particularly illustrating the probe located at a target site of a patient;

[0027] FIG. **6** illustrates an internal, detailed view of another embodiment of an ultrasound of an ultrasound imaging system according to the present disclosure, particularly illustrating the probe located at a target site of a patient and an integrated needle assembly configured therethrough;

[0028] FIG. **7** illustrates a front, perspective view of one embodiment of an ultrasound probe of an ultrasound imaging system according to the present disclosure, particularly illustrating an integrated needle assembly configured within a passageway of the transducer housing of the ultrasound probe; and

[0029] FIG. **8** illustrates a flow diagram of one embodiment of a method of generating an ultrasound image according to the present disclosure.

DETAILED DESCRIPTION

[0030] Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

[0031] Generally, the present disclosure is directed to an improved ultrasound probe with an integrated needle advancer. More specifically, the ultrasound probe has a transducer housing with a transducer transmitter configured therein, a needle assembly integrated within the transducer housing, and a controller. The transducer housing has a body that defines an internal cavity with a passageway extending from a proximal end to a distal end thereof. Thus, the needle assembly is configured within the passageway of the internal cavity. Further, the transducer transmitter is configured within the distal end of the body so as to emit and receive ultrasound beams. As such, the controller is configured to generate an image from the ultrasound beams. In addition, the controller is configured to control an insertion depth of the needle assembly.

[0032] Such a system can be particularly advantageous for various medical procedures, including for example, nerve block applications. More specifically, the ultrasound probe of the present disclosure can be placed at a target site of a patient (e.g. on an outer surface of the patient's skin where a nerve block procedure is to be performed at a nerve or nerve bundle therebeneath) and can remain in the same location as the needle assembly is advanced towards the nerve bundle and the transducer transmitter generates the ultrasound beams. As such, if desired, a user can manipulate the ultrasound probe and the needle with one hand. Further, the integrated needle remains in the ultrasound plane for easy viewing of a 2D or 3D image.

[0033] Referring now to the drawings, FIG. **1** illustrates a schematic diagram of one embodiment of an ultrasound imaging system **10** according to the present disclosure. As shown, the ultrasound imaging system **10** includes an ultrasound probe **12**. More specifically, as shown in FIGS. **3**-**7**, the ultrasound probe **12** has a transducer housing **14**, a transducer transmitter **16**, and a needle assembly **25** integrated within the housing **14**. Further, as shown in FIGS. **3**, **4** and **7**, the housing **14** generally has a body **15** extending from a proximal end **17** to a distal end **19** along a longitudinal axis **18** thereof. In certain embodiments, as shown generally in the figures, the distal end **19** of the body **15** of the housing **14** may be wider than the proximal end **17** of the body **15**, e.g. such that the proximal end **17** of the body **15** can be easily gripped by a user. Alternatively, the distal end **19** of the body **15** of the housing **14** may be narrower than the proximal end **17** of the body **15**. In still another embodiment, the proximal and distal ends **17**, **19** of the body **15** of the housing **14** may have substantially the same width along the longitudinal axis **18**.

[0034] In addition, as shown, the body **15** defines an internal cavity **20** having a passageway **24** extending from the proximal end **17** to the distal end **19** of the body **15**. In addition, as shown generally in the figures, the needle assembly **25** is configured within the passageway **24** of the internal cavity **20**. More specifically, as shown, the needle assembly **25** includes a needle **26** extending from a proximal end to a distal end with a hub **28** configured at the proximal end of the needle **26**. Further, in certain embodiments, the needle **26** is configured to fit within the passageway **24** of the internal cavity **20**, e.g. via an interference fit. Alternatively, as shown in FIG. **7**, the diameter of the needle **26** may be substantially less than the diameter of the passageway **24**.

[0035] In further embodiments, as shown in FIGS. **5** and **6**, the distal end **19** of the body **15** of the transducer housing **14** may also include a lens **21** having any suitable configuration. Thus, the lens **21** is configured to allow passage of the ultrasonic beams **42** therethrough. For example, as shown, the lens **21** may have a linear configuration. In further embodiments, the lens **21** may have a convex configuration. Thus, as shown, the transducer transmitter **16** may be configured adjacent to the lens **21**.

[0036] As is generally understood, the transducer transmitter **16** is configured to emit and/or receive ultrasound beams. Thus, the transducer transmitter **16** may have any suitable configuration now known or later developed in the art. More specifically, during operation, the probe **12** can be placed at a target site **22** of the patient and while maintaining the probe **12** in its initial position, the transducer transmitter **16** is configured to continuously emit and receive ultrasound beams **42** in an ultrasound plane **40**.

[0037] In further embodiments, as shown generally in the figures, the needle **26** may be centrally located within the transducer housing **14**. Thus, as shown in FIGS. **5** and **6**, the needle **26**, when inserted at a target site **22**, is aligned with the ultrasound plane **40** of the ultrasound probe **12** such that the insertion depth of the needle **26** can be automatically or manually controlled by a user. As such, the probe **12** can be particularly advantageous for nerve block applications. More specifically, as shown in FIGS. **1** and **2**, the ultrasound imaging system **10** may include a controller **30** (FIG. **2**) configured to automatically control movement of the needle **26** within the passageway **24**. For example, in certain embodiments, one or more sensors **37**, **38**, **39** (FIG. **2**) may be configured with the transducer housing **14** so as to determine a suitable insertion depth of the needle **26** within a patient at the target site **22**. Thus, the sensor(s) **37**, **38**, **39** are configured to send signals to the controller **30** that are indicative of the insertion depth of the needle **26**. Accordingly, the controller **30** is configured to automatically control the insertion depth of the needle **26** based on the sensor signals. In addition, the controller **30** is configured to receive and organize the ultrasound beams **42** generated by the transducer transmitter **16** in real-time and generate an ultrasound image based on the beams **42**.

[0038] Referring specifically to FIG. **2**, there is illustrated a block diagram of one embodiment of suitable components that may be included within the controller **30** in accordance with aspects of the present subject matter. As shown, the controller **30** may include one or more processor(s) **32** and associated memory device(s) **33** configured to perform a variety of computer-implemented functions (e.g., performing the methods, steps, and the like and storing relevant data as disclosed herein). Additionally, the controller **30** may also include a communications module **34** to facilitate communications between the controller **30** and the various components of the system **10**. Further, the communications module **34** may include a sensor interface **35** (e.g., one or more analog-to-digital converters) to permit signals transmitted from the probe **12** to be converted into signals that can be understood and processed by the processors **32**. In addition, as shown, the ultrasound imaging system **10** may also include a user interface **36** (FIG. **1**) configured to display the image, e.g. either a 2D or 3D image. More specifically, in certain embodiments, the user interface **36** may be configured to allow a user to manipulate the image according to one or more user preferences.

[0039] In an alternative embodiment, the ultrasound probe **12** may include manual control features. For example, in one embodiment, the manual control features may include one or more control buttons **27** configured on the transducer housing **14**. Further, the control buttons **27** may be communicatively coupled with the controller **30**. As such, engagement of the control buttons **27** is configured to control an insertion depth of the needle **26**, e.g. by moving the needle **26** up and down within the passageway **24**. In still additional embodiments, the ultrasound probe **12** may be controlled using a combination of manual and/or automatic features.

[0040] Referring now to FIG. **8**, a flow diagram of one embodiment of a method **100** of generating an ultrasound image is illustrated. As shown at **102**, the method **100** includes aligning an ultrasound probe **12** at a target site **22** of a patient, e.g. adjacent to an insertion point for a nerve block procedure. Further, as mentioned, the ultrasound probe **12** may be a 2D or a 3D probe. More specifically, as mentioned, the ultrasound probe **12** may include a transducer housing **14** having a passageway **24** extending from the proximal end **17** to the distal end **19** thereof and a transducer transmitter **16** configured within the housing **14**.

Thus, as shown at **104**, the method **100** includes inserting a needle assembly **25** through the passageway **24** of the transducer housing **14** and into the patient at the target site **22**, e.g. towards a nerve or nerve bundle **44** (FIGS. **6-7**). As shown at **106**, the method **100** includes emitting and receiving, via the transducer transmitter **16**, ultrasound beams **42** from the target site **22** while the needle assembly **25** is inserted in the patient. As shown at **108**, the method **100** includes generating an image based on the ultrasound beams **42**.

[0041] As mentioned, in one embodiment, the needle assembly **25** may include a needle **26** extending from a proximal end to a distal end with a hub **28** configured at the proximal end of the needle **26**. As such, the step of inserting the needle assembly **25** through the passageway **24** of the transducer housing **14** and into the patient towards the target site **22** may include inserting the needle **26** of the needle assembly **25** through a central location of the transducer housing **14**.

[0042] In another embodiment, the method **100** may include automatically controlling, via the controller **30**, movement of the needle **26** within the passageway **24**. For example, in such an embodiment, the method **100** may include determining, via one or more sensors **37**, **38**, **39** configured with the transducer housing **14**, an insertion depth of the needle **26** within the patient. More specifically, in certain embodiments, the method **100** may include sending, via the one or more sensors **37**, **38**, **39**, signals to the controller **30** that are indicative of the insertion depth of the needle **26** and automatically controlling the insertion depth of the needle **26** based on the signals, e.g. by moving the needle **26** up or down.

[0043] Alternatively, the method **100** may include manually controlling the needle **26** within the passageway **24**. More specifically, in certain embodiments, the step of manually controlling the needle **26** within the passageway **24** may include engaging (e.g. by pressing or lifting) one or more control buttons **27** configured on the transducer housing **14**. As mentioned, the control buttons **27** are communicatively coupled with the controller **30** such that engagement of the control button(s) **27** controls an insertion depth of the needle **26**.

[0044] In another embodiment, the method **100** may include displaying, via a user interface **36**, the image to a user, e.g. either a 2D or 3D image. More specifically, in certain embodiments, the method **100** may include allowing, via the user interface **36**, a user to manipulate the image according to one or more user preferences.

[0045] While various patents have been incorporated herein by reference, to the extent there is any inconsistency between incorporated material and that of the written specification, the written specification shall control. In addition, while the disclosure has been described in detail with respect to specific embodiments thereof, it will be apparent to those skilled in the art that various alterations, modifications and other changes may be made to the disclosure without departing from the spirit and scope of the present disclosure. It is therefore intended that the claims cover all such modifications, alterations and other changes encompassed by the appended claims.

1. An ultrasound imaging system, comprising:
an ultrasound probe comprising:
- a transducer housing comprising a body that defines an internal cavity, the internal cavity comprising a passageway extending from a proximal end to a distal end of the body;
- a needle assembly configured within the passageway of the internal cavity;
- a transducer transmitter configured within the distal end of the body, the transducer transmitter configured to emit and receive ultrasound beams; and
- a controller configured to generate an image from the ultrasound beams.

2. The ultrasound imaging system of claim **1**, wherein the needle assembly comprises a needle extending from a proximal end to a distal end and a hub configured at the proximal end of the needle.

3. The ultrasound imaging system of claim **2**, wherein the needle is centrally located within the transducer housing.

4. The ultrasound imaging system of claim **2**, wherein the needle fits within the passageway of the internal cavity via an interference fit.

5. The ultrasound imaging system of claim **1**, wherein the controller is configured to automatically control movement of the needle within the passageway.

6. The ultrasound imaging system of claim **1**, wherein the transducer housing further comprises one or more sensors configured to determine an insertion depth of the needle within a patient, wherein the one or more sensors are configured to send signals to the controller that are indicative of the insertion depth of the needle, wherein the controller is configured to automatically control the insertion depth of the needle based on the signals.

7. The ultrasound imaging system of claim **1**, wherein the ultrasound probe comprises manual control features, wherein the manual control features comprise one or more control buttons configured on the transducer housing, the one or more control buttons communicatively coupled with the controller, wherein engagement of the one or more control buttons controls an insertion depth of the needle.

8. The ultrasound imaging system of claim **1**, wherein the image comprises a two-dimensional (2D) image or a three-dimensional (3D) image.

9. The ultrasound imaging system of claim **1**, further comprising a user interface configured to display the image, wherein the user interface is configured to allow a user to manipulate the image according to one or more user preferences.

10. An ultrasound probe for imaging, comprising:
- a transducer housing comprising a body that defines an internal cavity, the internal cavity comprising a passageway extending from a proximal end to a distal end of the body;
- a needle assembly configured within the passageway of the internal cavity; and
- a transducer transmitter configured within the distal end of the body, the transducer transmitter configured to emit and receive ultrasound beams so to generate an image.

11. The ultrasound probe of claim **10**, wherein the needle assembly comprises a needle extending from a proximal end to a distal end and a hub configured at the proximal end of the needle.

12. The ultrasound probe of claim **11**, wherein the needle is centrally located within the transducer housing.

13. The ultrasound probe of claim **10**, wherein the needle fits within the passageway of the internal cavity via an interference fit.

14. The ultrasound probe of claim **10**, wherein the transducer housing further comprises one or more sensors configured to determine an insertion depth of the needle within a patient.

15. The ultrasound probe of claim **14**, wherein the one or more sensors are configured to send signals to a controller, the signals being indicative of the insertion depth of the needle, wherein the controller is configured to automatically control the insertion depth of the needle based on the signals.

16. The ultrasound probe of claim **10**, further comprising manual control features, wherein the manual control features comprise one or more control buttons configured on the transducer housing, the one or more control buttons communicatively coupled with a controller, wherein engagement of the one or more control buttons controls an insertion depth of the needle.

17. A method of generating an ultrasound image during a nerve block procedure, the method comprising:

aligning an ultrasound probe at a target site of a patient, the ultrasound probe having a transducer housing comprising a passageway extending from a proximal end to a distal end thereof and a transducer transmitter;

inserting a needle assembly through the passageway of the transducer housing and into the patient towards the target site, the needle assembly comprising a needle extending from a proximal end to a distal end;

emitting and receiving, via the transducer transmitter, ultrasound beams from the target site while the needle assembly is inserted in the patient; and

generating an image based on the ultrasound beams.

18. The method of claim **17**, wherein inserting the needle assembly through the passageway of the transducer housing and into the patient towards the target site further comprises inserting the needle of the needle assembly through a central location of the transducer housing.

19. The method of claim **17**, further comprising automatically controlling, via the controller, movement of the needle within the passageway.

20. The method of claim **17**, further comprising:

determining, via one or more sensors configured with the transducer housing, an insertion depth of the needle within the patient;

sending, via the one or more sensors, signals to the controller that are indicative of the insertion depth of the needle; and

controlling the insertion depth of the needle based on the signals.

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专利名称(译)	集成针推进器超声探头		
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摘要(译)

本公开涉及一种具有集成的针推进器的超声成像系统。更具体地，超声成像系统包括超声探头，该超声探头具有换能器壳体，换能器发射器，针组件和控制器。换能器壳体具有限定内腔的主体。内腔包括从主体的近端延伸到远端的通道。针组件配置在内腔的通道内。换能器发射器配置在身体的远端内。此外，换能器发射器配置成发射和接收超声波束。因此，控制器被配置为从超声波束生成图像。