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(54) ULTRASOUND PROBE

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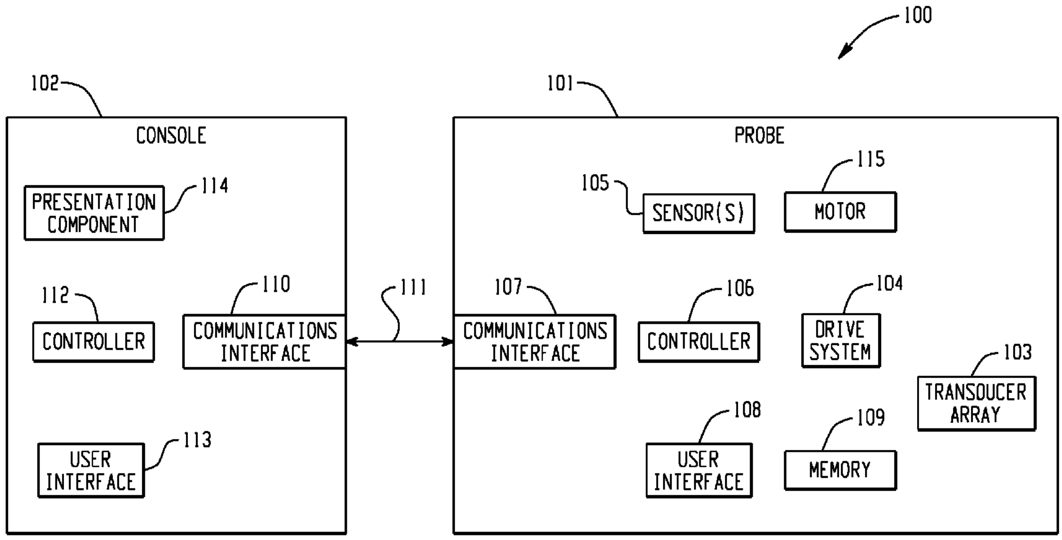
A61B 8/14 (2006.01)

(52) **U.S. Cl.** **600/461**; 600/459

(57) **ABSTRACT**

An ultrasound imaging probe (**101**) includes a communications interface (**107**), including one or more ports (**200-205**), corresponding to one or more different communication protocols, for communication with ultrasound consoles. The probe (**101**) also includes a controller (**106**) that configures the probe (**101**) for communication with an ultrasound console (**102**) over a port (**200-205**) based on a communication between the communications interface (**107**) and a communications interface (**110**) of the console (**102**).



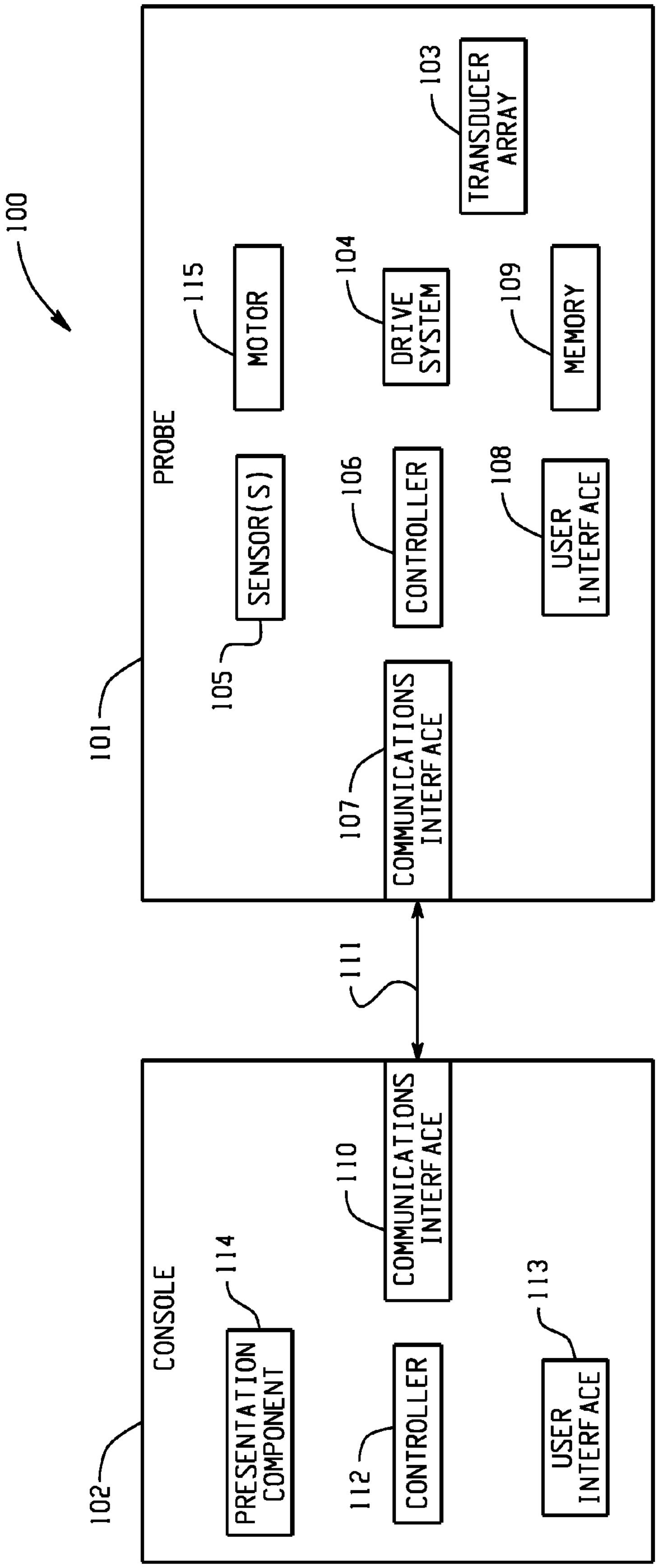

100
101
PROBE
TRANSDUCER ARRAY
103
MOTOR
115
DRIVE SYSTEM
104
MEMORY
109
SENSOR(S)
105
CONTROLLER
106
USER INTERFACE
108
COMMUNICATIONS INTERFACE
107
111
102
CONSOLE
COMMUNICATIONS INTERFACE
110
PRESENTATION COMPONENT
114
CONTROLLER
112
USER INTERFACE
113

Fig. 1

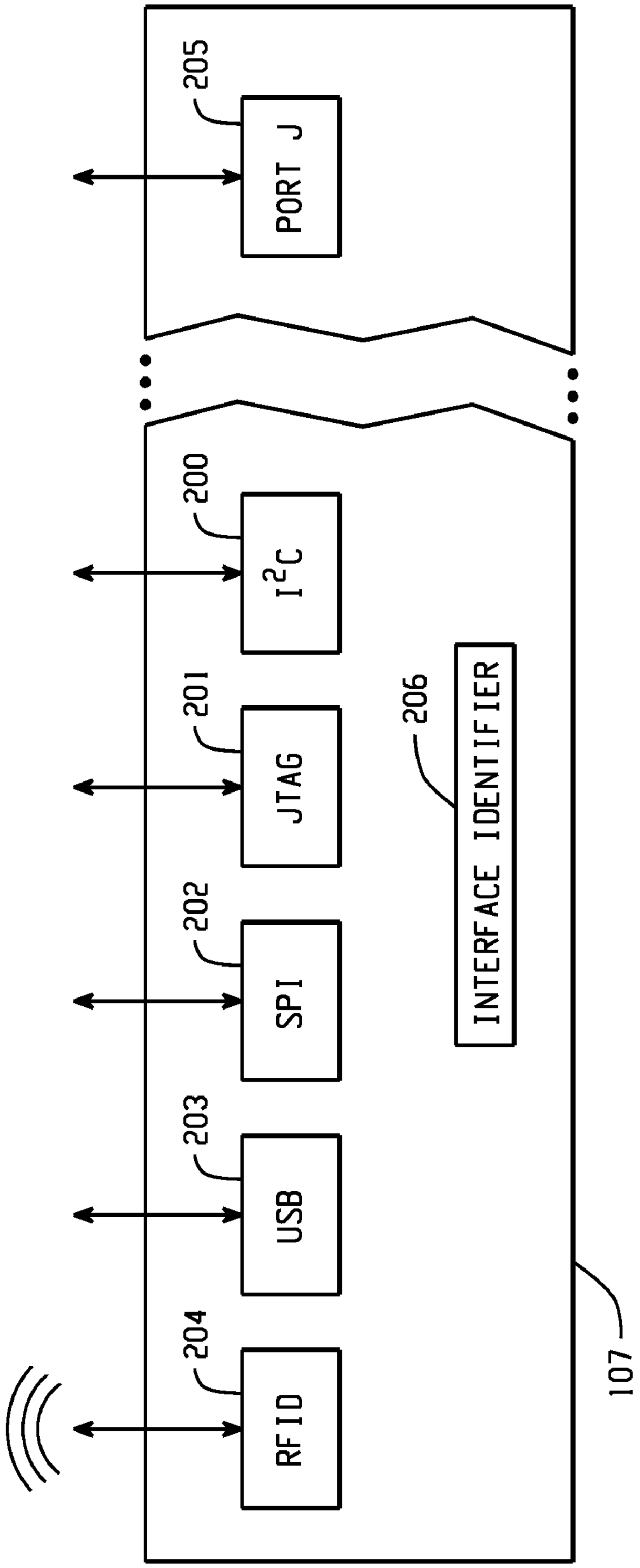

205
PORT J
200
I^2C
201
JTAG
202
SPI
203
USB
204
RFID
206
INTERFACE IDENTIFIER
107

Fig. 2

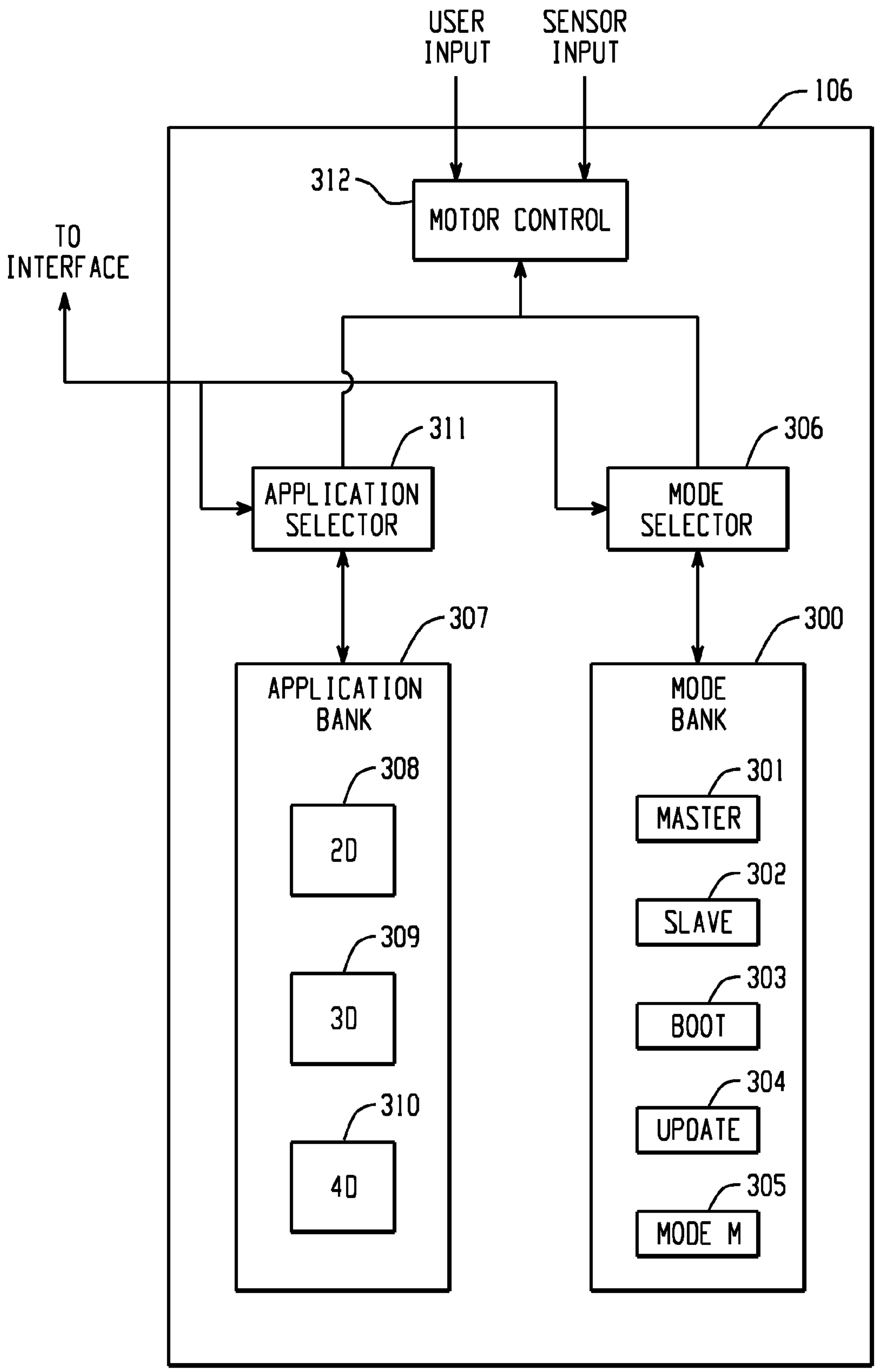

USER INPUT
SENSOR INPUT
106
312
MOTOR CONTROL
TO INTERFACE
311
APPLICATION SELECTOR
306
MODE SELECTOR
307
APPLICATION BANK
308
2D
309
3D
310
4D
300
MODE BANK
301
MASTER
302
SLAVE
303
BOOT
304
UPDATE
305
MODE M

Fig. 3

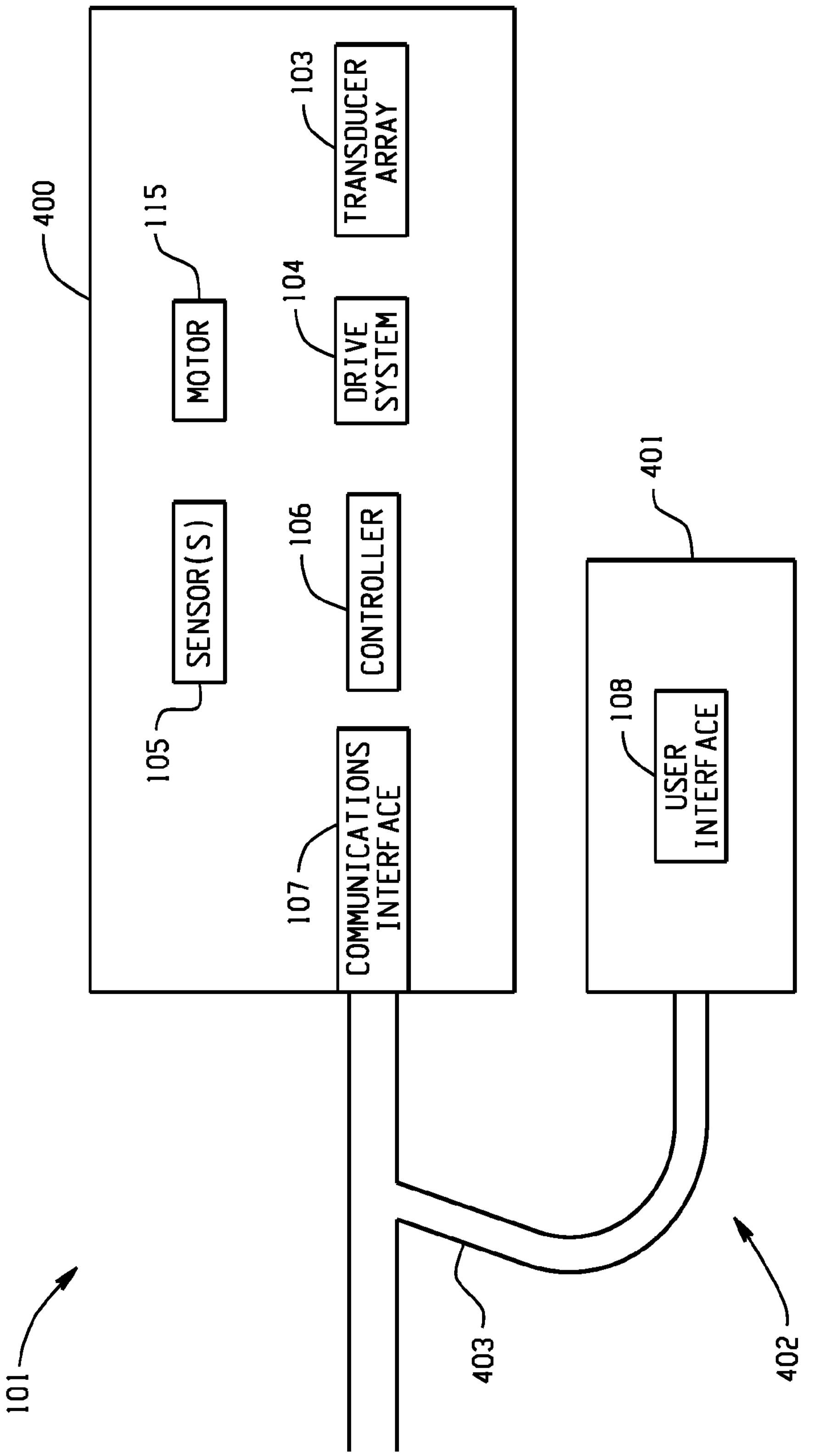

400
115
MOTOR
103
TRANSDUCER ARRAY
104
DRIVE SYSTEM
SENSOR(S)
105
106
CONTROLLER
107
COMMUNICATIONS INTERFACE
401
108
USER INTERFACE
101
403
402

Fig. 4

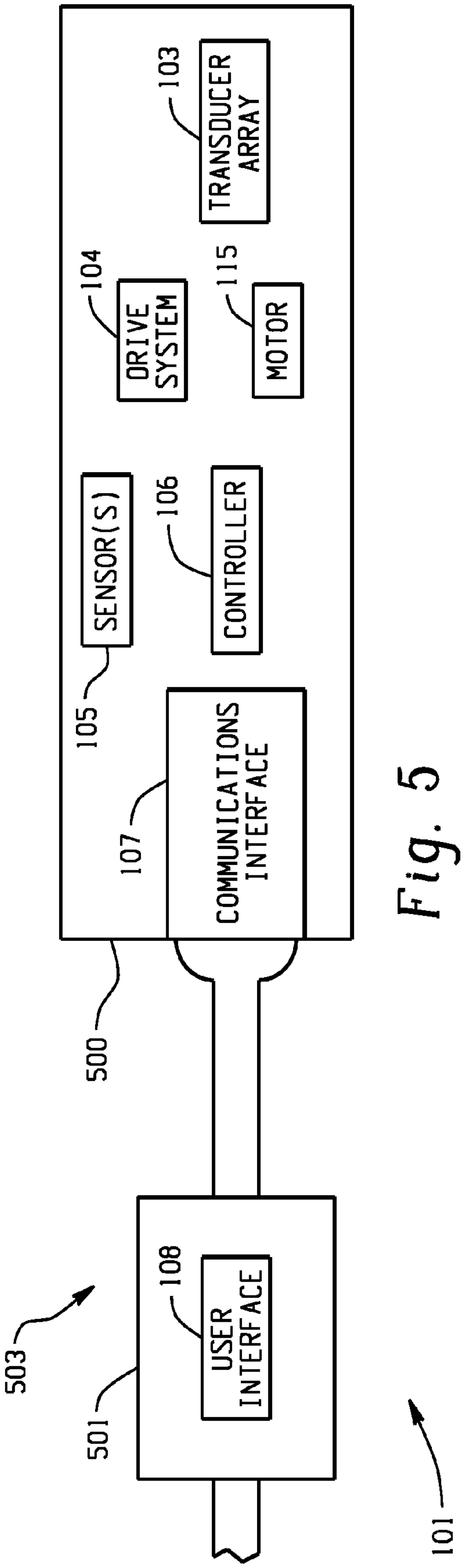

TRANSDUCER ARRAY
103
DRIVE SYSTEM
104
MOTOR
115
SENSOR(S)
105
CONTROLLER
106
COMMUNICATIONS INTERFACE
107
500
USER INTERFACE
108
501
503
101

Fig. 5

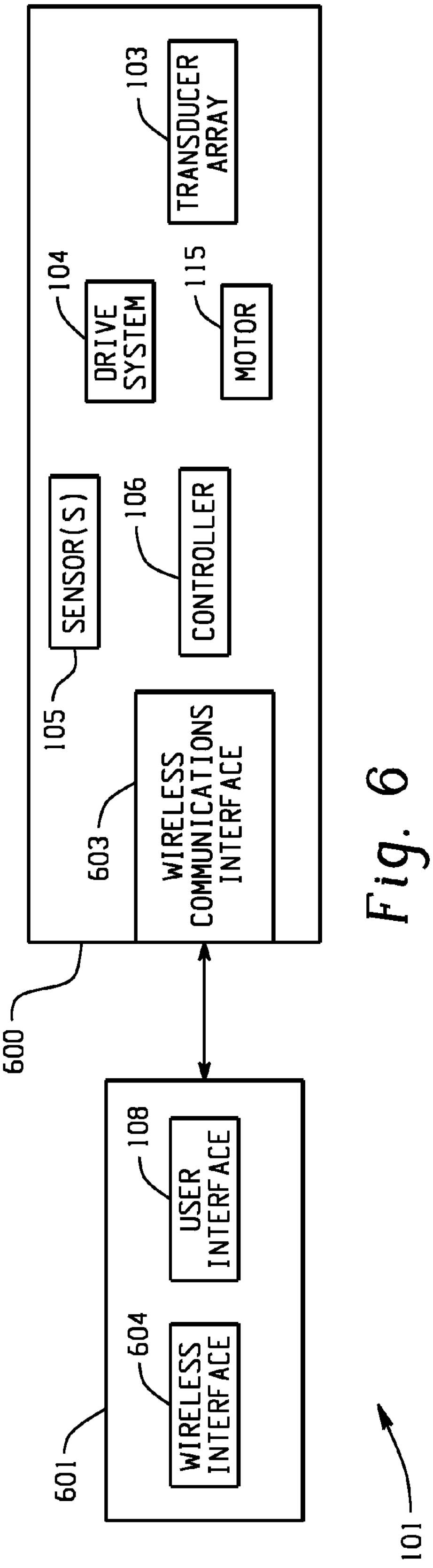

TRANSDUCER ARRAY
103
DRIVE SYSTEM
104
MOTOR
115
SENSOR(S)
105
CONTROLLER
106
WIRELESS COMMUNICATIONS INTERFACE
603
600
USER INTERFACE
108
WIRELESS INTERFACE
604
601
101

Fig. 6

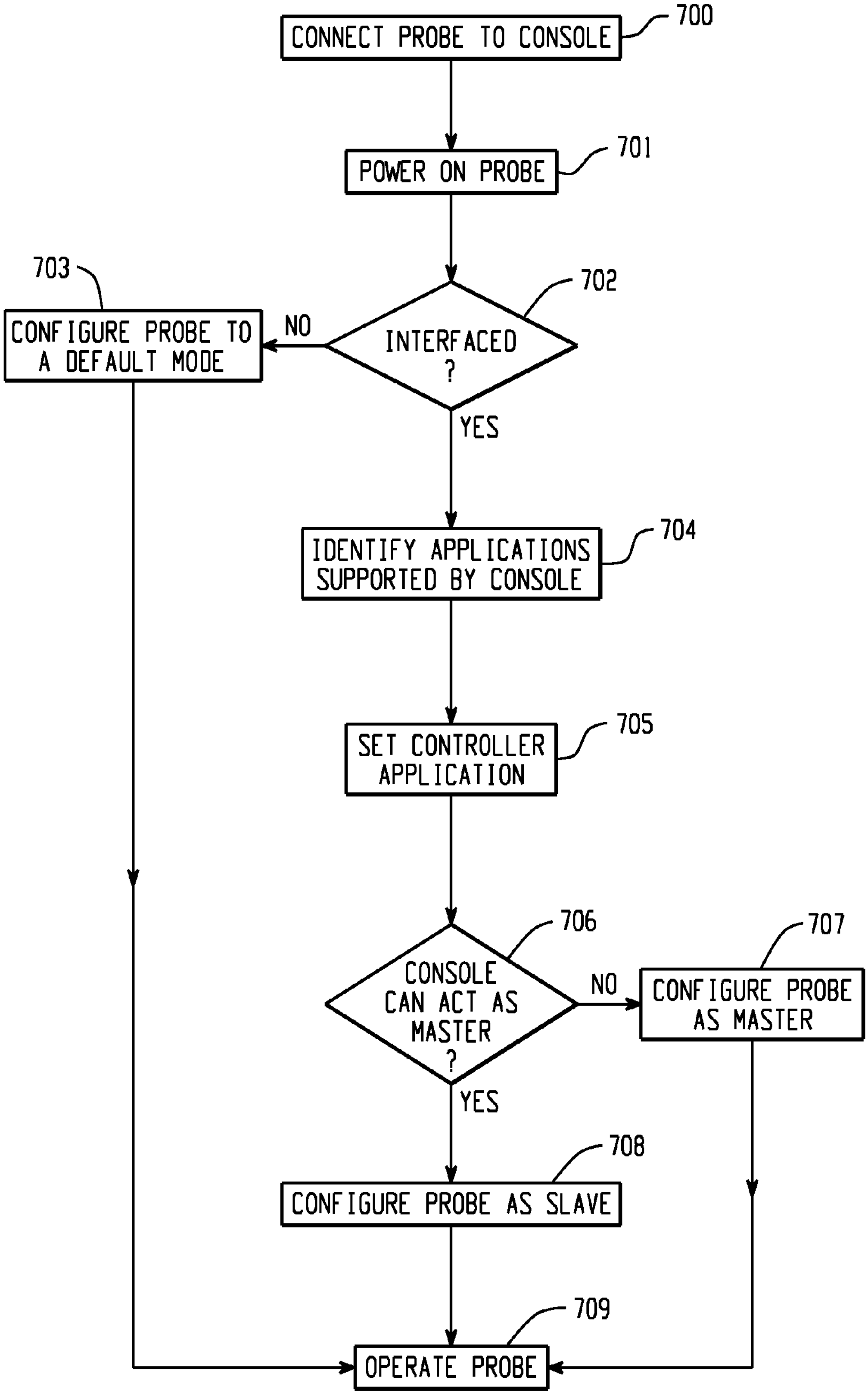

CONNECT PROBE TO CONSOLE
700
POWER ON PROBE
701
703
702
CONFIGURE PROBE TO A DEFAULT MODE
NO
INTERFACED ?
YES
IDENTIFY APPLICATIONS SUPPORTED BY CONSOLE
704
SET CONTROLLER APPLICATION
705
706
707
CONSOLE CAN ACT AS MASTER ?
NO
CONFIGURE PROBE AS MASTER
YES
708
CONFIGURE PROBE AS SLAVE
709
OPERATE PROBE

Fig. 7

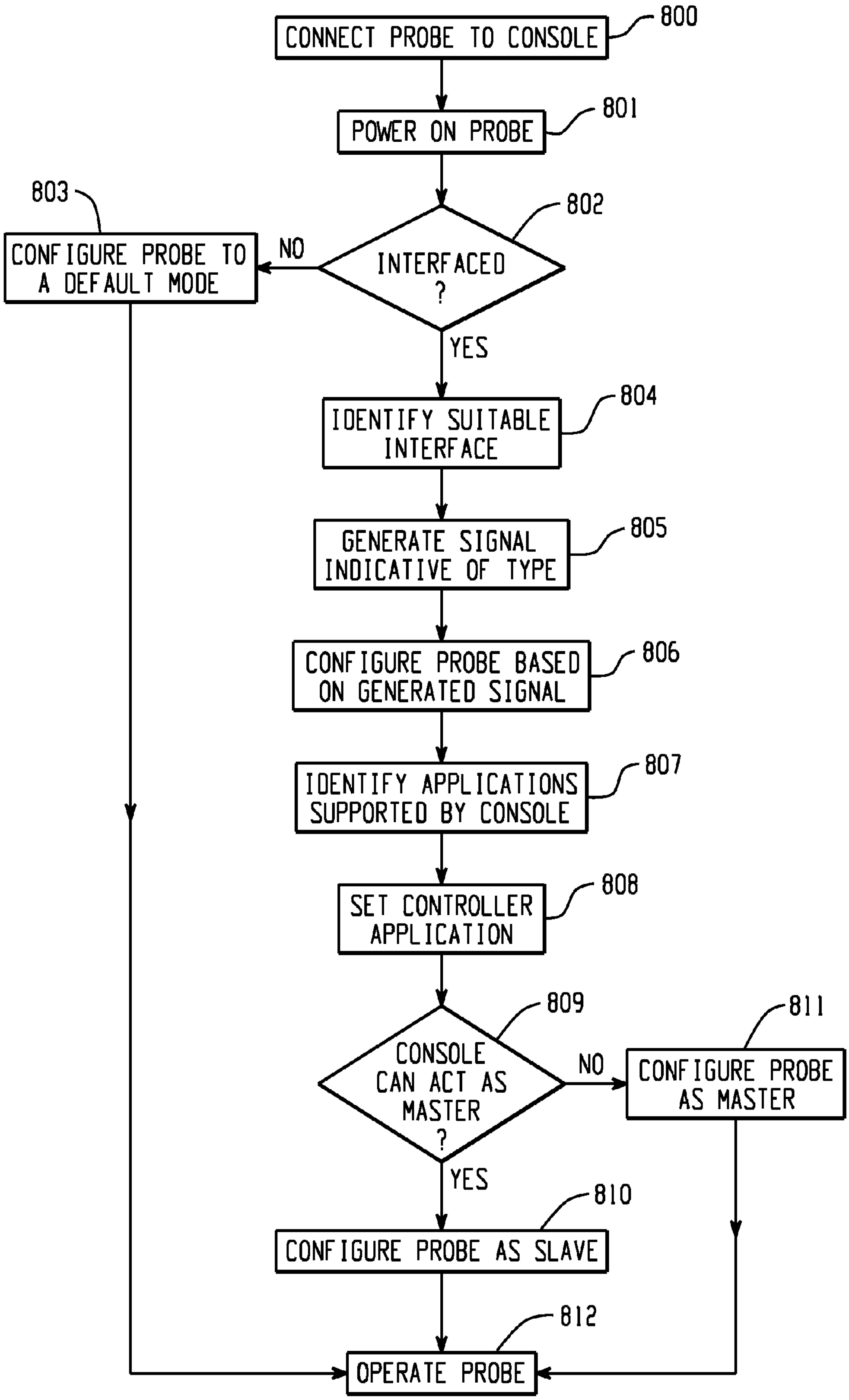

CONNECT PROBE TO CONSOLE
800
POWER ON PROBE
801
INTERFACED ?
802
NO
CONFIGURE PROBE TO A DEFAULT MODE
803
YES
IDENTIFY SUITABLE INTERFACE
804
GENERATE SIGNAL INDICATIVE OF TYPE
805
CONFIGURE PROBE BASED ON GENERATED SIGNAL
806
IDENTIFY APPLICATIONS SUPPORTED BY CONSOLE
807
SET CONTROLLER APPLICATION
808
CONSOLE CAN ACT AS MASTER ?
809
NO
CONFIGURE PROBE AS MASTER
811
YES
CONFIGURE PROBE AS SLAVE
810
OPERATE PROBE
812

Fig. 8

ULTRASOUND PROBE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority of provisional patent application Ser. No. 61/165,630, filed on Apr. 1, 2009, confirmation number 4363, and entitled "ULTRASOUND PROBE," which is incorporated herein in its entirety by reference.

TECHNICAL FIELD

[0002] The following generally relates to ultrasound probes and more particularly to ultrasound probes configured for multi-dimensional imaging.

BACKGROUND

[0003] An ultrasound imaging probe generally includes one or more transducer arrays, affixed to a distal end of a mechanical device or a handle, and can be used for imaging of anatomical structures or organs. Volumetric imaging can be performed by using two-dimensional transducer arrays with no moving parts or by electromechanically moving a one-dimensional transducer array within the probe. Volumetric imaging has been used to visualize three-dimensional structures within the human body such as the kidneys, the uterus, a fetus, etc.

[0004] For patient imaging, the probe (and hence the transducer elements) is moved on the surface of the body over the structure of interest. The transducer generates a signal that traverses skin, subcutaneous fat, and/or bone material, reflects off the structure of interest, and is received back and detected at the transducer. The detected information is used to generate an image of the structure of interest. With other ultrasound applications (e.g., transabdominal, endovaginal, and endorectal), the transducer is positioned in and moved within a body cavity to image anatomical structures.

[0005] Unfortunately, some ultrasound probes are controllable only through ultrasound imaging systems and configured such that they only work with specific ultrasound imaging systems. As a consequence, a probe configured for multi-dimensional imaging may not be able to be used for multi-dimensional imaging when employed with an ultrasound imaging system that does not support multi-dimensional imaging applications. In addition, a probe configured with a particular interface may not be able to be used with a console that does not have a complementary interface. In addition, a console may lack suitable circuitry for controlling various components of a probe in communication therewith.

SUMMARY OF THE INVENTION

[0006] Aspects of the application address the above matters, and others.

[0007] In one aspect, an ultrasound imaging probe includes a communications interface with one port or a plurality of ports corresponding to one or more different communication protocols for communication with ultrasound consoles. The probe also includes a controller that configures the probe for communication with an ultrasound console over a port based on a communication between the communications interface and a communications interface of the console.

[0008] In a further aspect, an ultrasound probe includes a transducer array, an electromechanical drive system, a motor, and a controller that controls the drive system and motor to drive the transducer array to at least one of translate or wobble.

[0009] In a further aspect, a method includes identifying a type of communications interface of an ultrasound console in communication with an ultrasound imaging probe and selecting a communications port of the probe for communication between the probe and the console based on the identified type of communications interface.

[0010] In a further aspect, an ultrasound probe for three and/or four dimensional ultrasound applications includes a controller that configures the probe for use with a console that does not support three and/or four-dimensional ultrasound applications.

[0011] Those skilled in the art will recognize still other aspects of the present application upon reading and understanding the attached description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** illustrates an example probe and console of an imaging system.

[0013] FIG. **2** illustrates an example communications interface of a probe.

[0014] FIG. **3** illustrates an example probe controller logic.

[0015] FIG. **4** illustrates an example probe with user controls in a dongle.

[0016] FIG. **5** illustrates an example probe with user controls in a cable.

[0017] FIG. **6** illustrates an example probe with wireless control.

[0018] FIG. **7** illustrates one method for using an example probe and console of an imaging system.

[0019] FIG. **8** illustrates a second method for using an example probe and console of an imaging system.

DETAILED DESCRIPTION

[0020] FIG. **1** depicts an ultrasound imaging system **100** including a probe **101** and a console **102**. The probe **101** is capable of multi-dimensional applications such as two, three and four-dimensional applications and includes a movable transducer array **103** having one or more transducer elements that transmit and detect signals. Non-limiting examples of suitable transducer elements include piezoceramic, MEMS and/or other transducer elements.

[0021] An electromechanical drive system **104** moves and/or orients the movable transducer array **103** through a motor **115**. In one instance, this includes converting rotational motion of the motor **115** into translational, rotational and/or wobbling movement of the ultrasound transducer array **103**. Suitable motors **115** may include but are not limited to a stepper motor, a DC motor, an ultrasonic motor, a piezoelectric motor, an electromagnetic motor, and/or other motor. The illustrated drive system **104** and motor **115** are configured to drive the transducer array **103** alternatively based on one or more predetermined and/or programmable movement patterns.

[0022] One or more sensors **105** sense information about the operating conditions of the probe **101**. Suitable sensors include an optical or magnetic encoder that senses probe orientation; a temperature sensor that detects a temperature of the drive system **104**, the transducer array **103** or one or more other components of the probe **101**; a needle guide sensor that senses a needle guide coupled to the probe **101**, and/or other sensor.

[0023] A controller **106** controls the drive system **104** and hence position of the transducer array **103**. In one instance, the controller **106** controls the drive system **104** based on a mode of operation including a master, a slave, a self-booting, software loading, and/or other mode of operation and an application mode such as a two, three or four dimensional application. As described in greater detail below, the controller **106** identifies a suitable mode of operation and application mode based on a communication with the console **102**. The controller **106** may also use the information sensed by the sensors **105** and/or user input to identify the mode and application.

[0024] A communications interface **107** is configured to receive and transmit information between the probe **101** and the console **102** and/or other device. As described in greater detail below, the interface **107** may be configured with a single communications port or with a plurality of communication ports for communicating with one or more different consoles **102** supporting different communication protocols. The interface **107** includes an analog portion for communication with analog components of the probe **101** and/or a digital portion for communication with digital components of the probe **101**. For example, where the transducer array **103** is an analog transducer array, the analog portion is used to communicate with the transducer array **103**, and where the drive system **104** is a digital drive system, the digital portion is used to communicate with the drive system **104**.

[0025] A user interface **108** accepts user input and presents operational and/or application information in a human readable format. Examples of input include signals representing a particular mode of operation and/or application mode. In one embodiment, the user interface **108** accepts user input through a touch pad and/or predetermined control buttons. Additionally or alternatively, the user interface **108** includes an audio input for accepting voice commands or other audio information.

[0026] Memory **109** provides storage for data and/or other information, for example, configuration and/or imaging data from the transducer array **103** and/or data from the ultrasound console **102**. The memory **109** may include software and/or firmware uploaded by a user. Such software and/or firmware may make the probe **101** specific to the user and/or supporting equipment.

[0027] It is to be appreciated that by incorporating the controller **106** in the probe **101** and allowing the configuration of different communication providing one or a plurality of different communication ports by the interface **107** allows the probe **101** to be used with essentially any console **102**. For example, where the controller **106** is omitted from the probe **101**, the probe **101** may only be employed with a console **102** having control circuitry compatible with or able to drive the drive system **104** and the motor **115** of the probe **101**. In another example, where the communication interface **107** only supports a single type of port, the probe **101** may only be employed with a console **102** supporting that type of port.

[0028] The console **102** includes a communication interface **110**. The probe **101** interfaces with the console **102** through the communication interface **110** over a channel **111**, which may be a wired or wireless channel. The console **102** also includes a controller **112**, which can send signals indicative of a selected mode of operation and/or application mode to the probe **101**. A user interface **113** allows a user to communicate with the probe **101** through the console **102**. A presentation component **114** presents image data.

[0029] With reference to FIGS. **1** and **2**, FIG. **2** illustrates an example of the communications interface **107** with a plurality of communication ports.

[0030] In the illustrated example, the communications interface **107** includes an Inter-Integrated Circuit (I^2C) port **200**, which generally is a multi-master serial bus used to attach low-speed peripherals to an embedded system. The communications interface **107** further includes a Joint Action Test Group (JTAG) port **201**, which is generally a test access port for debugging and probing printed circuit boards.

[0031] The communications interface **107** also includes a Serial Peripheral Interface (SPI) port **204**, which generally is a synchronous serial data link that allows a single master device. The communications interface **107** further includes a Universal Serial Bus (USB) port **203**, which is a standardized interface socket that generally allows connection of peripheral devices.

[0032] The communications interface **107** further includes a wireless port such as a Radio Frequency Identification (RFID) port **203**. The communications interface **107** may also include one or more other ports (PORT J) **205**.

[0033] An interface identifier **206** identifies the port in communication with the console **102** and generates a signal indicative thereof. The signal is provided to the controller **106**, which configures the probe **101** for communication over the identified port.

[0034] With reference to FIGS. **1** and **3**, FIG. **3** illustrates an example of the controller **106**.

[0035] The controller **106** includes a mode bank **300** with one or more predetermined modes such as a master mode **301**, a slave mode **302**, a boot mode **303**, an update mode **304**, and one or more other modes **305**. A mode selector **306** selects a mode of operation from the mode bank **300** based on various information.

[0036] The controller **106** also includes an application bank **307** with one or more predetermined application modes such as a two-dimensional mode **308**, a three-dimensional mode **309**, and a four-dimensional mode **310**. An application selector **311** selects an application mode from the application bank **307** based on various information.

[0037] As described herein, the controller **106** configures the probe **101** based on a selected mode of operation, a selected application mode, information sensed by the sensor (s) **105**, and a user input. In one instance, the controller **106** recognizes that the console does not support three or four-dimensional applications and configures the probe **101** so that the probe **101** can be used for three or four-dimensional applications using the user interface **108** of the probe **101**. In this instance, the multi-dimensional imaging data may be stored in a memory **109** for subsequent retrieval.

[0038] A motion controller **312** generates a control signal for the drive system **104** based on the one or more of the selected operation mode, application mode, user input and/or sensor input. The control signal is indicative of movement and/or orientation of the transducer array **103**.

[0039] FIGS. **4**, **5**, and **6** depict alternative embodiments of the probe **101**.

[0040] Initially referring to FIG. **4**, the probe **101** includes first and second portions **400** and **401**. The first portion **400** includes the transducer array **103**, the drive system **104**, the motor **115**, the sensors **105**, the controller **106**, and the interface **107**. The second portion **401** includes the user interface **108**. The second portion **401** is part of dongle **402** and is connected to the first portion **400** through a connection **403**, which can be a wired and/or wireless connection.

[0041] Turning to FIG. **5**, the probe **101** includes first and second portions **500** and **501**. The first portion **500** includes the transducer array **103**, the drive system **104**, the motor **115**, the sensors **105**, the controller **106** and the interface **107**, and the second portion **501** includes the user interface **103**. In this embodiment, the second portion **501** is integrated in or part of a cable **503**, which is used to connect the probe **101** to the console **102**.

[0042] In FIG. **6**, the probe **101** includes first and second portions **600** and **601**. The first portion **600** includes the transducer array **103**, the drive system **104**, the motor **115**, the sensors **105**, the controller **106**, and a wireless interface **603**. The second portion **601** includes the user interface **108** and a wireless interface **604**. In this embodiment, the first and second portions **600** and **601** communicate with each other through the wireless interfaces **603** and **604**.

[0043] In another embodiment, the controller **106** is located within a handle shield, which is formed as an external probe covering which acts also as a ground plane and heat distributor. In yet another embodiment, the controller **106** is incorporated within a handle in which in multiple components can be interchanged to provide a user or application specific probe. In still another embodiment, the controller **106** is part of independent circuitry which may be coupled to and employed with a plurality of different ultrasound probes, in conjunction with multiple different ultrasound imaging systems.

[0044] FIG. **7** illustrates a method in connection with FIGS. **1-3** where the probe **101** is configured to communicate with the console **102** through a single interface.

[0045] At **700**, the probe **101** is connected to the console **102**.

[0046] At **701**, the probe **101** is powered on. This can be achieved by activating a power switch or toggle of the user interface **108**.

[0047] At **702**, the probe **101** attempts communications with the console **102**.

[0048] At **703**, if the communication fails, the controller **106** places the probe **101** in a default mode, such as, the slave mode **302**. In this mode, an application is selected and the probe **101** is controlled through the console **102**.

[0049] At **704**, if the communications is successful, the controller **106** identifies applications (two, three and/or four dimensions) supported by the console **102**.

[0050] At **705**, the controller **106** configures itself based on the identified supported applications. This includes allowing the probe **101** to be operated by the console **102** based on the applications supported by the console **102** and/or operated by the probe **101**, including using applications that are not supported by the console **102**.

[0051] At **706**, the controller **106** determines whether the console **102** can act as a master device. At **707**, if not, the probe **101** configures the probe **101** as a master device.

[0052] At **708**, otherwise, the controller **106** configures the probe **101** as a slave device.

[0053] At **709**, the probe **101** is employed based on user input to the probe **101**, the console **102**, and/or information sensed by the sensors **105**.

[0054] FIG. **8** illustrates a method in connection with FIGS. **1-3** where the probe **101** is configured to communicate with the console **102** through one or a plurality of different interfaces.

[0055] At **800**, the probe **101** is connected to the console **102**.

[0056] At **801**, the probe **101** is powered on. This can be achieved by activating a power switch of the user interface **108**.

[0057] At **802**, the probe **101** attempts communications with the console **102**.

[0058] At **803**, if the communication fails, the controller **106** places the probe **101** in a default mode such as the master mode **301**. In this mode, an application is selected and the probe **101** is controlled through the user interface **108**.

[0059] At **804**, if the communications is successful, the interface identifier **206** identifies the type of interface through which the probe **101** and console **102** are connected.

[0060] At **805**, the interface identifier **206** generates a signal indicative of the identified type of interface.

[0061] At **806**, the controller **106** configures the probe **101** to communicate based on the identified type of interface.

[0062] At **807**, the controller **106** identifies applications (two, three and/or four dimensions) supported by the console **102**.

[0063] At **808**, the controller **106** configures itself based on the identified supported applications. This includes allowing the probe **101** to be operated by the console **102** based on the applications supported by the console **102** and/or operated by the probe **101**, including using applications that are not supported by the console **102**.

[0064] At **809**, the controller **106** determines whether the console **102** can act as a master device. At **810**, if so, the probe **101** configures the probe **101** as a slave device. Of course, the user can override this setting and/or the default settings may be that the probe **101** configures itself as the master device.

[0065] At **811**, otherwise, the controller **106** configures the probe **101** as the master device.

[0066] At **812**, the probe **101** is employed based on user input to the probe **101**, the console **102**, and/or information sensed by the sensors **105**. Obtained data may be stored within a memory **109** of the probe **101** or transferred to the ultrasound console **102** or transmitted to other computing devices.

[0067] The application has been described with reference to various embodiments. Modifications and alterations will occur to others upon reading the application. It is intended that the invention be construed as including all such modifications and alterations, including insofar as they come within the scope of the appended claims and the equivalents thereof.

1. An ultrasound imaging probe, comprising:

a user interface;

a communications interface, including one or more ports, corresponding to one or more different communication protocols, for communication with ultrasound consoles; and

a controller that configures the probe for communication with an ultrasound console over a port based on a communication between the communications interface and a communications interface of the console, and

an application selector that identifies application modes supported by the console,

wherein the controller configures the probe based on an identified supported application, and wherein the controller recognizes the console does not support three or four-dimensional applications and configures the probe for three or four-dimensional applications using the user interface of the probe.

2. The probe of claim **1**, further comprising:

a transducer array;

an electromechanical drive system; and

a motor, wherein controller controls the drive system and the motor to at least one of translate or wobble the transducer array.

3. The probe of claim **2**, wherein the console does not include circuitry for controlling the drive system and the motor.

4. The probe of claim **1**, wherein the one or more ports includes at least one of an Inter-Integrated Circuit port, a Joint Action Test Group port, a Serial Peripheral Interface port, a Universal Serial Bus port, and a Radio Frequency Identification port.

5. The ultrasound probe of claim **1**, wherein the communication identifies the communications interface of the console.

6. (canceled)

7. The probe of claim **1**, wherein the controller configures the probe to a default operation and/or application mode when the probe is not in communication with the console.

8. The probe of claim **1**, wherein the probe is configured for three and/or four-dimensional applications.

9. The probe of claim **1**, wherein the probe is a master device and the console is a slave device.

10. The probe of claim **1**, wherein the probe is a slave device and the console is a master device.

11. (canceled)

12. The probe (**101**) of claim **2**, wherein the electromechanical drive system is housed in a portion of the probe housing the motor.

13. (canceled)

14. The probe of claim **1**, wherein the controller configures the probe for default operation.

15. (canceled)

16. The probe of claim **1**, further comprising at least one sensor, wherein the controller configures the probe based on information sensed by the at least one sensor.

17. The probe of claim **16**, wherein the at least one sensor includes one or more of an optical and/or magnetic encoder that determines an orientation of the probe, a temperature sensor that determines a temperature of a component of the probe, and a needle guide sensor that senses a needle guide bracket mounted to the probe.

18. (canceled)

19. (canceled)

20. The ultrasound probe of claim **11**, further comprising: a communications interface, including one or more ports, corresponding to one or more different communication protocols, for communication with ultrasound consoles, wherein the controller configures the probe for communication with an ultrasound console over a port based on a communication between the communications interface and a communications interface of the console.

21. A method, comprising:

configuring a probe for communication with an ultrasound console over a port based on a communication between a communications interface of the probe and a communications interface of the console,

wherein the communications interface includes one or more ports that correspond to one or more different communication protocols for communication with ultrasound consoles,

identifying, via a application selector of the probe, application modes supported by the console; and

configuring, via a controller of the probe, the probe based on an identified supported application,

wherein the controller recognizes the ultrasound console does not support three or four-dimensional applications and configures the probe for three or four-dimensional applications using an user interface of the probe.

22-28. (canceled)

29. A method, comprising:

sending, via an ultrasound probe, a communication to an ultrasound console over a connection there between;

identifying, via an application selector of the probe, applications supported by the console; and

configuring the probe, via a controller of the probe, based on the identified supported applications.

30. The method of claim **29**, further comprising:

placing, via a controller of the probe, the probe in a default mode in response to the communication failing.

31. The method of claim **29**, further comprising:

determining, via the controller of the probe, if the console can act as a master device;

configuring, via the controller of the probe, the probe as the master device and the console as a slave device, in response to determining the console cannot act as a master device; and

configuring, via the controller of the probe, the probe as a slave device and the console as a master device, in response to determining the console can act as a master device.

32. The method of claim **29**, wherein the controller recognizes the ultrasound console does not support three or four-dimensional applications and configures the probe for three or four-dimensional applications under control of the probe.

33. The method of claim **29**, further comprising:

prior to identifying the applications supported by the console, identifying, via an interface identifier of the probe, a type of interface through which the probe and console are connected in response to the communication being successful; and configuring the probe, via the controller of the probe, to communicate based on the identified type of interface.

* * * * *

专利名称(译)	超声探头		
公开(公告)号	US20120022379A1	公开(公告)日	2012-01-26
申请号	US13/256447	申请日	2009-06-24
申请(专利权)人(译)	ANALOGIC CORPORATION		
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外部链接	Espacenet USPTO		

摘要(译)

超声成像探头（101）包括通信接口（107），其包括与一个或多个不同通信协议相对应的一个或多个端口（200-205），用于与超声控制台通信。探针（101）还包括控制器（106），其基于通信接口（107）与通信之间的通信来配置探针（101）以通过端口（200-205）与超声控制台（102）通信。控制台（102）的接口（110）。