US 20140039277A1

(19) United States
(12) Patent Application Publication
(10) Pub. No.: US 2014/0039277 A1
(43) Pub. Date: Feb. 6, 2014
Abraham

(54) REMOTE ULTRASOUND ASSESSMENT AND INTERVENTION SYSTEM

(71) Applicant: Theodore P. Abraham, Baltimore, MD (US)

(72) Inventor: Theodore P. Abraham, Baltimore, MD (US)

(21) Appl. No.: 13/973,476

(22) Filed: Aug. 22, 2013

Related U.S. Application Data

(63) Continuation of application No. 13/847,902, filed on Mar. 20, 2013, which is a continuation-in-part of application No. 11/871,282, filed on Oct. 12, 2007, now Pat. No. 8,403,859, which is a continuation-in-part of application No. 11/782,991, filed on Jul. 25, 2007, now Pat. No. 8,403,858.

(60) Provisional application No. 60/851,451, filed on Oct. 12, 2006, provisional application No. 60/851,451, filed on Oct. 12, 2006, provisional application No. 61/692,443, filed on Aug. 23, 2012.

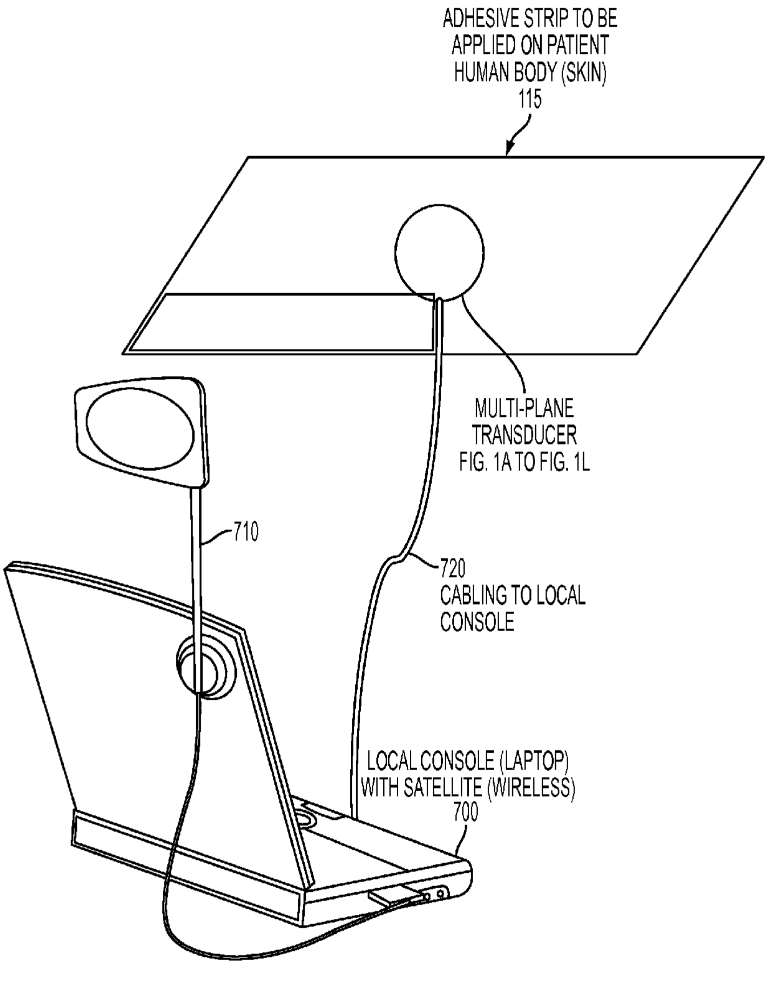
Publication Classification

(51) Int. Cl.
A61B 8/00 (2006.01)

(52) U.S. Cl.
CPC ***A61B 8/54*** (2013.01)
USPC **600/301**; 600/437

(57) **ABSTRACT**

A remote ultrasound assessment and intervention system comprises a console having a controller for an ultrasound imaging device attachable to a human skin surface or implantable in a human body cavity. Commands from a remote work station located, for example, at a hospital may remotely control a transducer of the device to move in x, y, z, rotate and tilt directions to remotely assess an injury to a victim, for example, of a war zone injury or terrorist attack. A first responder, who need not be medically trained, may be instructed via a communications link or via a predetermined controller program stored in computer memory to move the imaging device from one location to another on the human skin surface or in a human body cavity. Intervention is also remotely controlled, once an injury is assessed and diagnosed from the hospital work station via an image guided catheter manipulated by the first responder via commands received from the hospital work station.



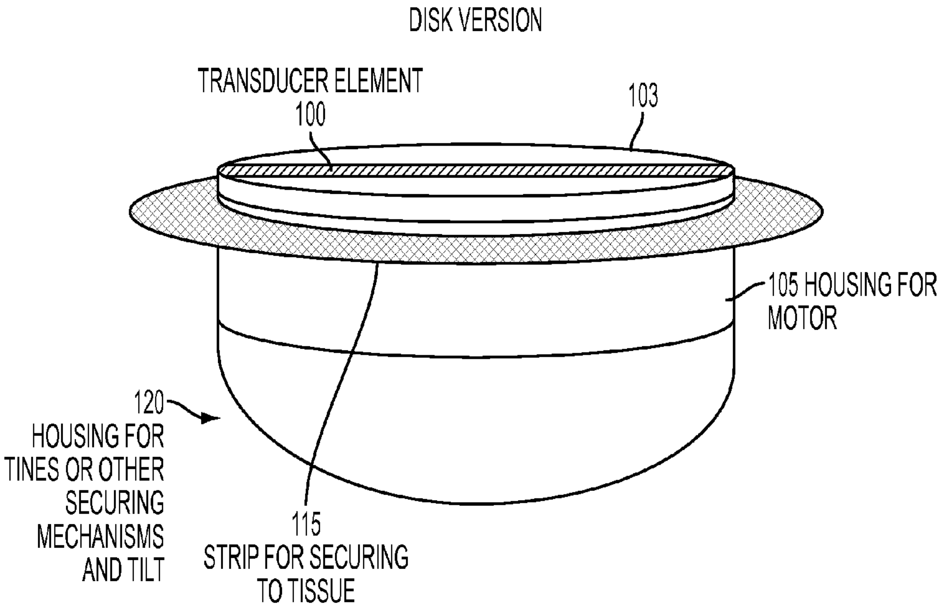

DISK VERSION
TRANSDUCER ELEMENT
100
103
105 HOUSING FOR
MOTOR
120
HOUSING FOR
TINES OR OTHER
SECURING
MECHANISMS
AND TILT
115
STRIP FOR SECURING
TO TISSUE

FIG. 1A

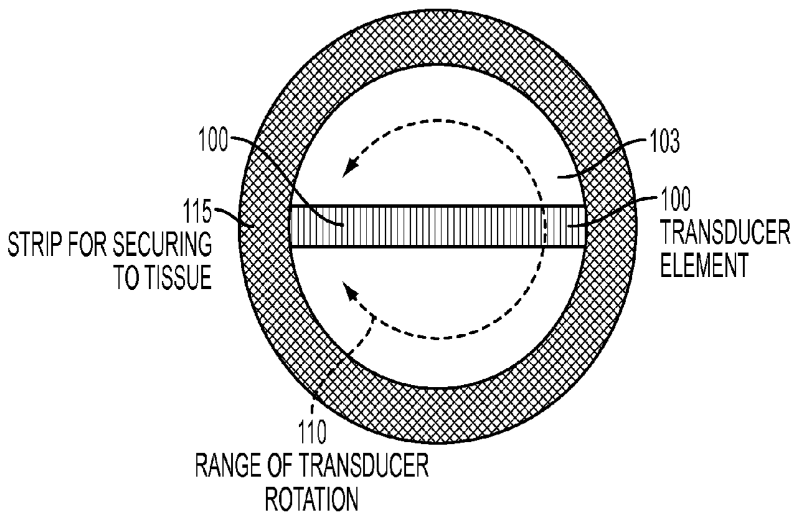

100
103
115
STRIP FOR SECURING
TO TISSUE
100
TRANSDUCER
ELEMENT
110
RANGE OF TRANSDUCER
ROTATION

FIG. 1B

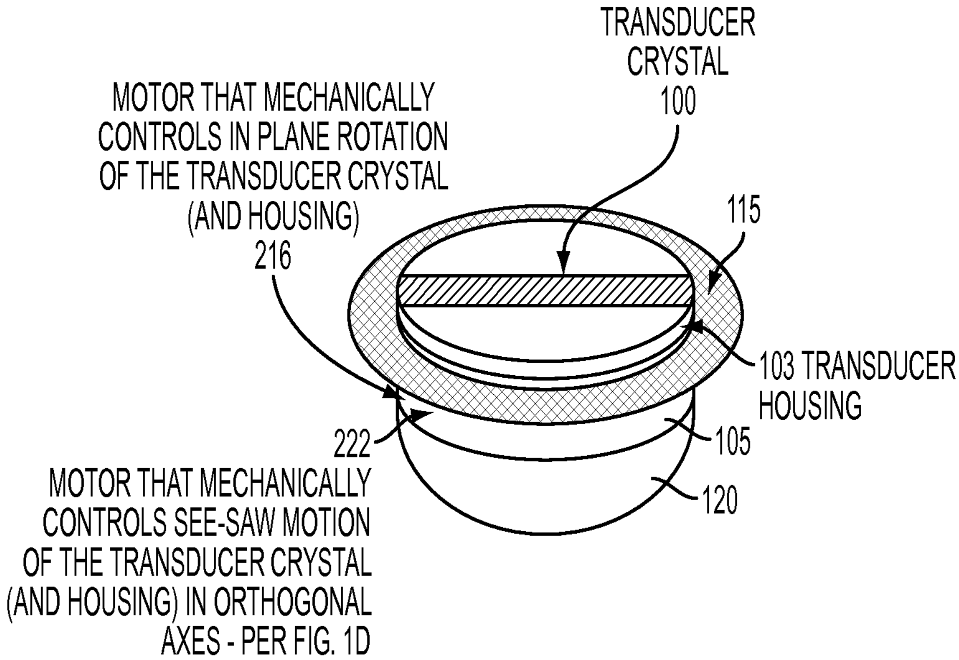

TRANSDUCER
CRYSTAL
100
MOTOR THAT MECHANICALLY
CONTROLS IN PLANE ROTATION
OF THE TRANSDUCER CRYSTAL
(AND HOUSING)
216
115
103 TRANSDUCER
HOUSING
105
120
222
MOTOR THAT MECHANICALLY
CONTROLS SEE-SAW MOTION
OF THE TRANSDUCER CRYSTAL
(AND HOUSING) IN ORTHOGONAL
AXES - PER FIG. 1D

FIG. 1C

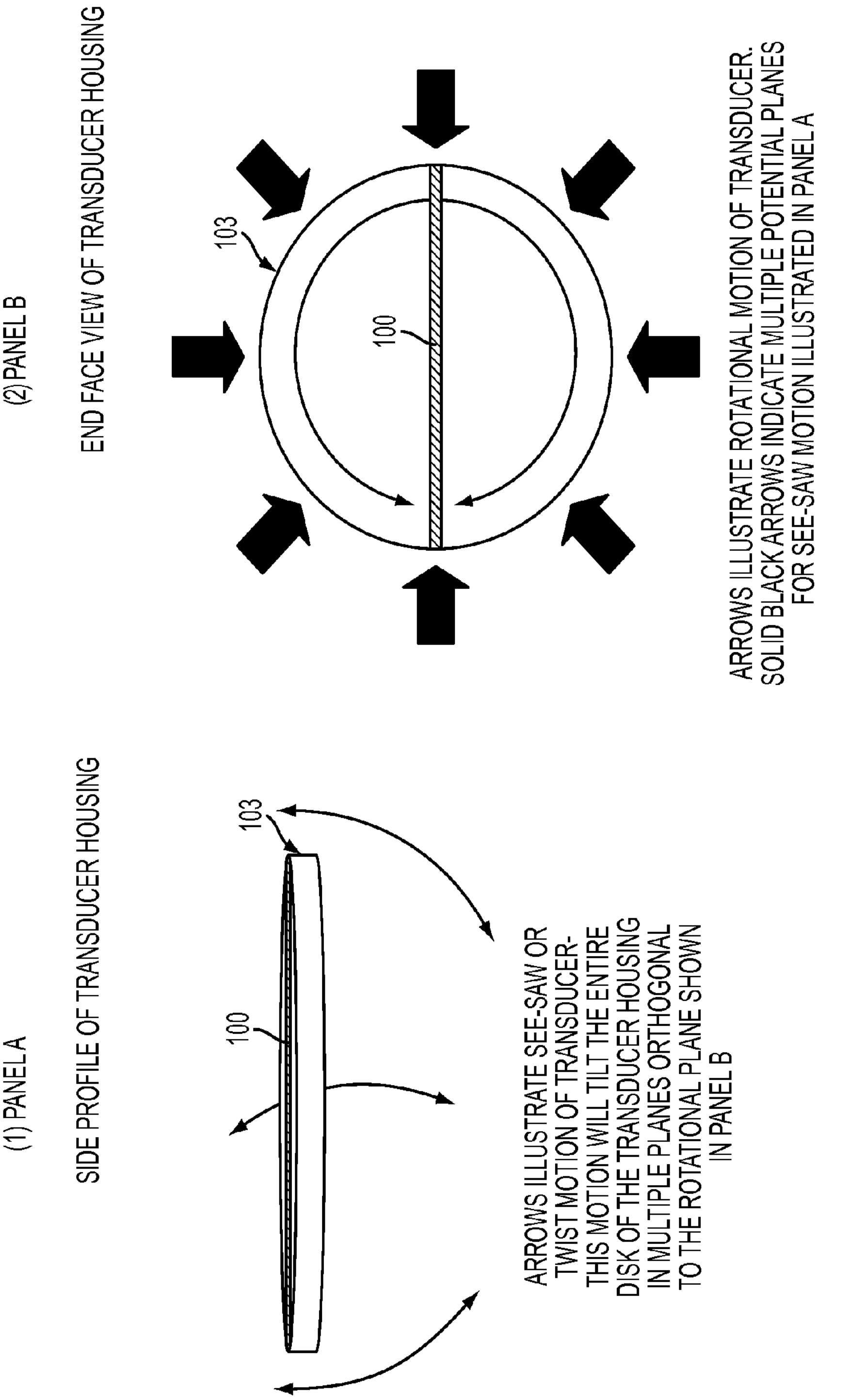

(1) PANEL A
SIDE PROFILE OF TRANSDUCER HOUSING
100
103
ARROWS ILLUSTRATE SEE-SAW OR TWIST MOTION OF TRANSDUCER- THIS MOTION WILL TILT THE ENTIRE DISK OF THE TRANSDUCER HOUSING IN MULTIPLE PLANES ORTHOGONAL TO THE ROTATIONAL PLANE SHOWN IN PANEL B
(2) PANEL B
END FACE VIEW OF TRANSDUCER HOUSING
103
100
ARROWS ILLUSTRATE ROTATIONAL MOTION OF TRANSDUCER. SOLID BLACK ARROWS INDICATE MULTIPLE POTENTIAL PLANES FOR SEE-SAW MOTION ILLUSTRATED IN PANEL A

FIG. 1D

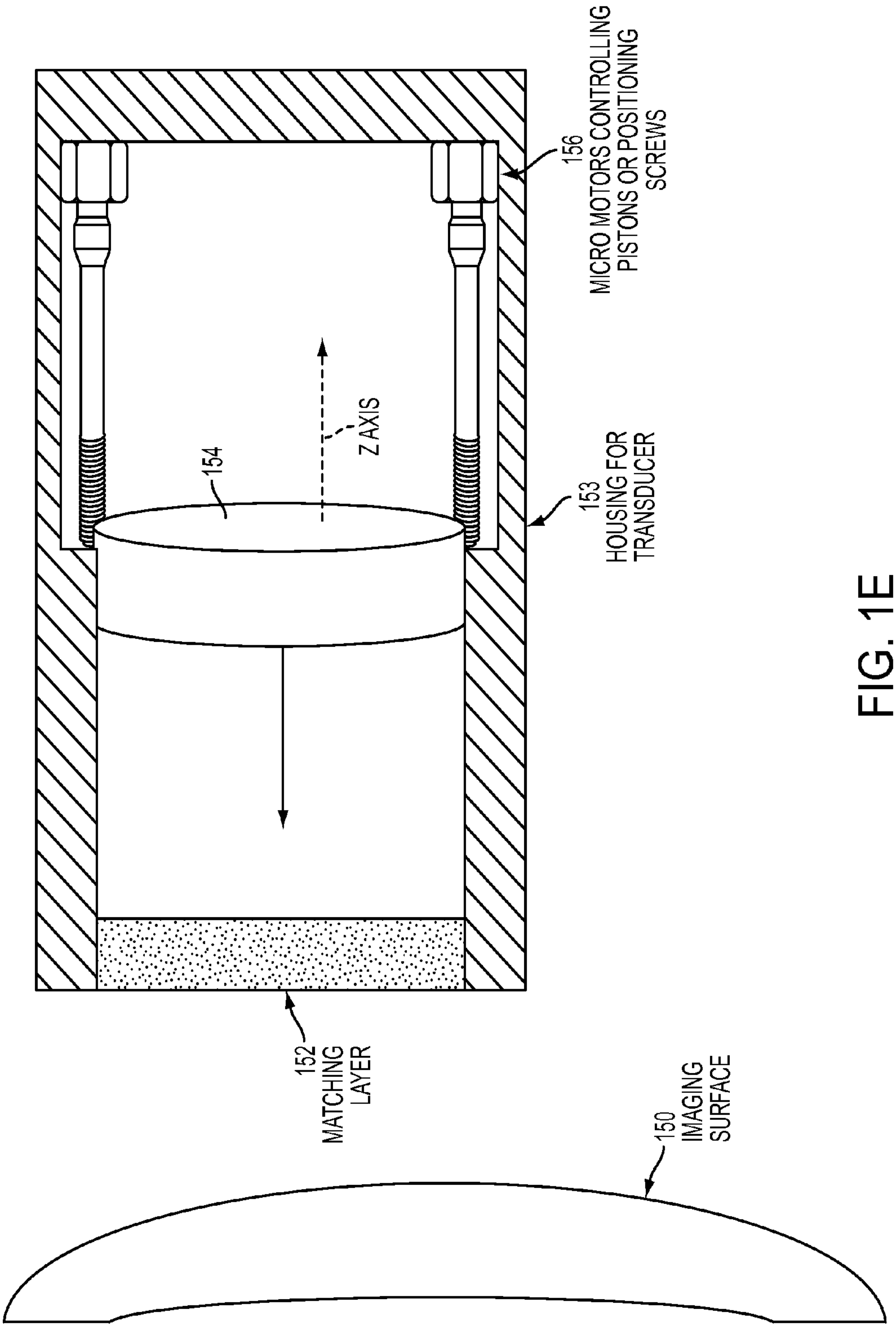

156
MICRO MOTORS CONTROLLING
PISTONS OR POSITIONING
SCREWS
154
Z AXIS
153
HOUSING FOR
TRANSDUCER
152
MATCHING
LAYER
150
IMAGING
SURFACE

FIG. 1E

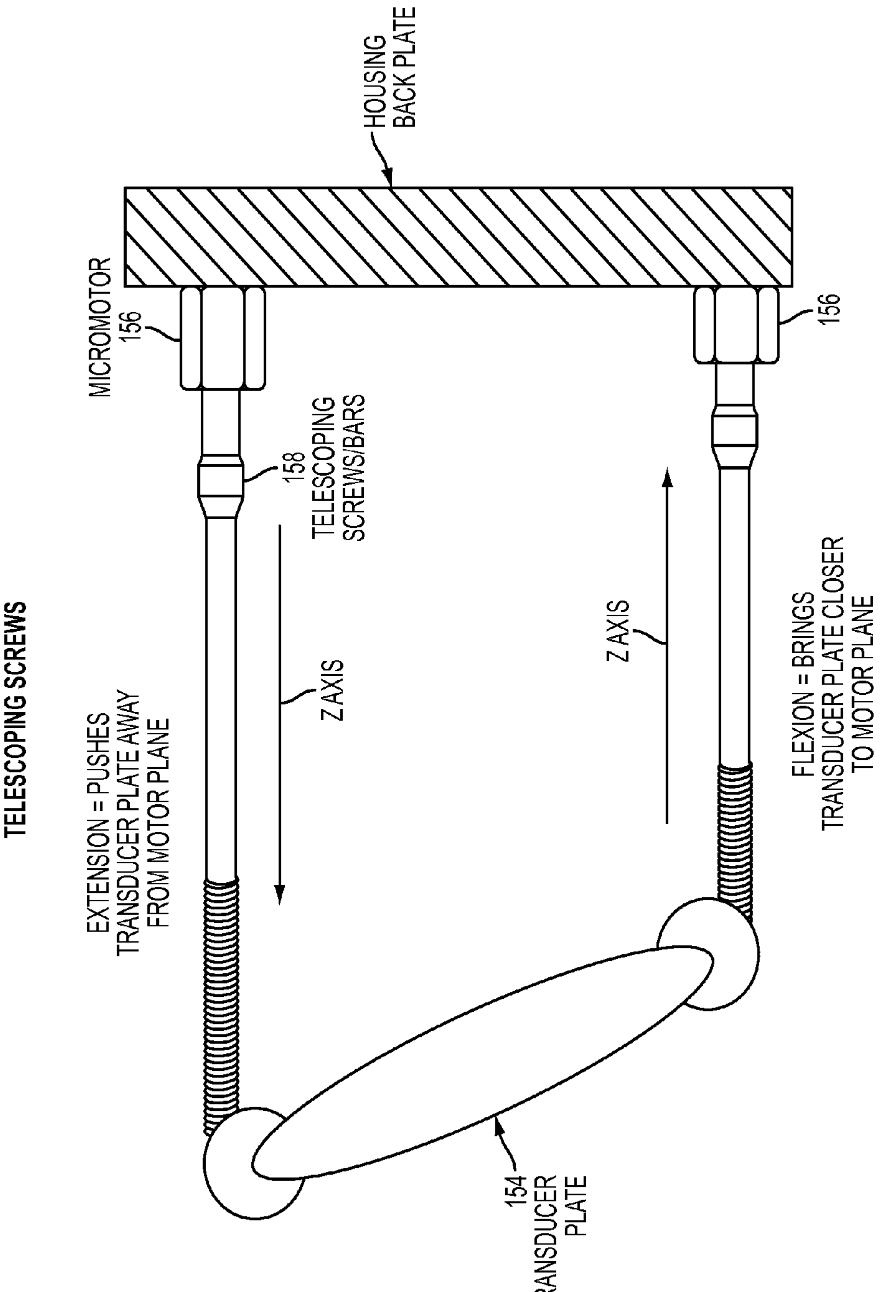

TELESCOPING SCREWS
HOUSING BACK PLATE
MICROMOTOR 156
158 TELESCOPING SCREWS/BARS
156
EXTENSION = PUSHES TRANSDUCER PLATE AWAY FROM MOTOR PLANE
Z AXIS
Z AXIS
FLEXION = BRINGS TRANSDUCER PLATE CLOSER TO MOTOR PLANE
154 TRANSDUCER PLATE

FIG. 1F

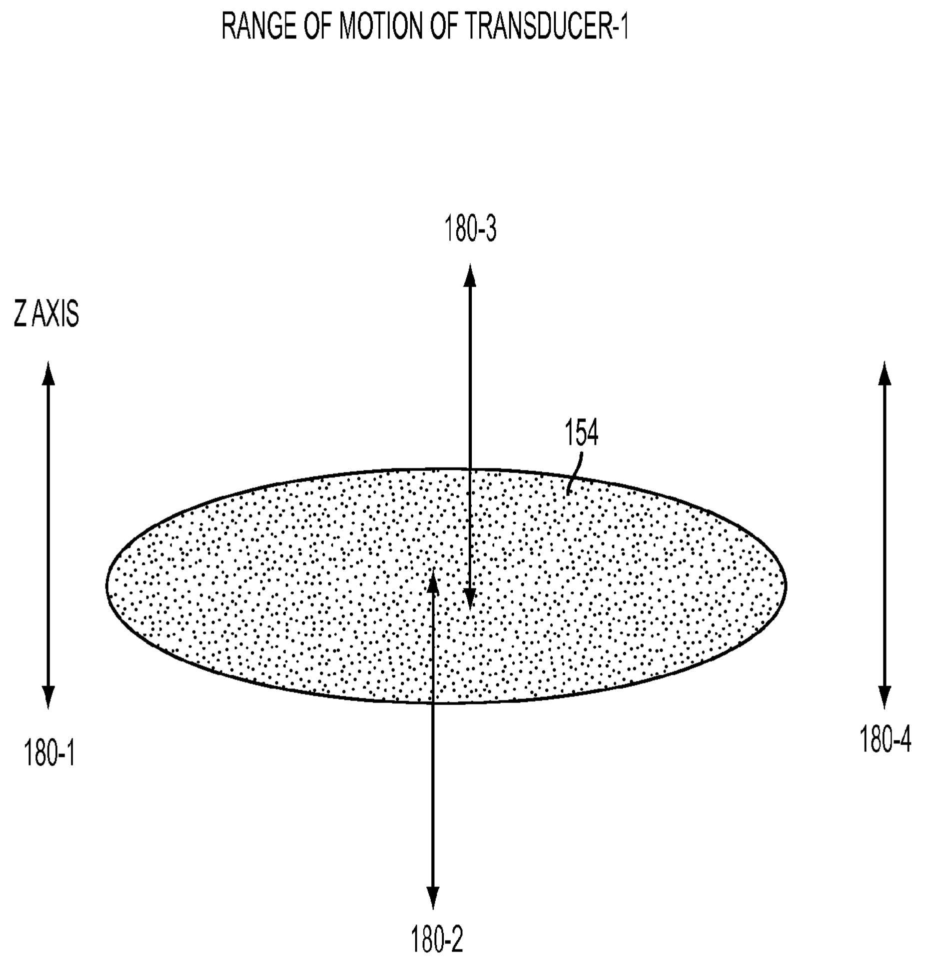

RANGE OF MOTION OF TRANSDUCER-1
180-3
Z AXIS
154
180-1
180-4
180-2

FIG. 1G

RANGE OF MOTION OF TRANSDUCER-2

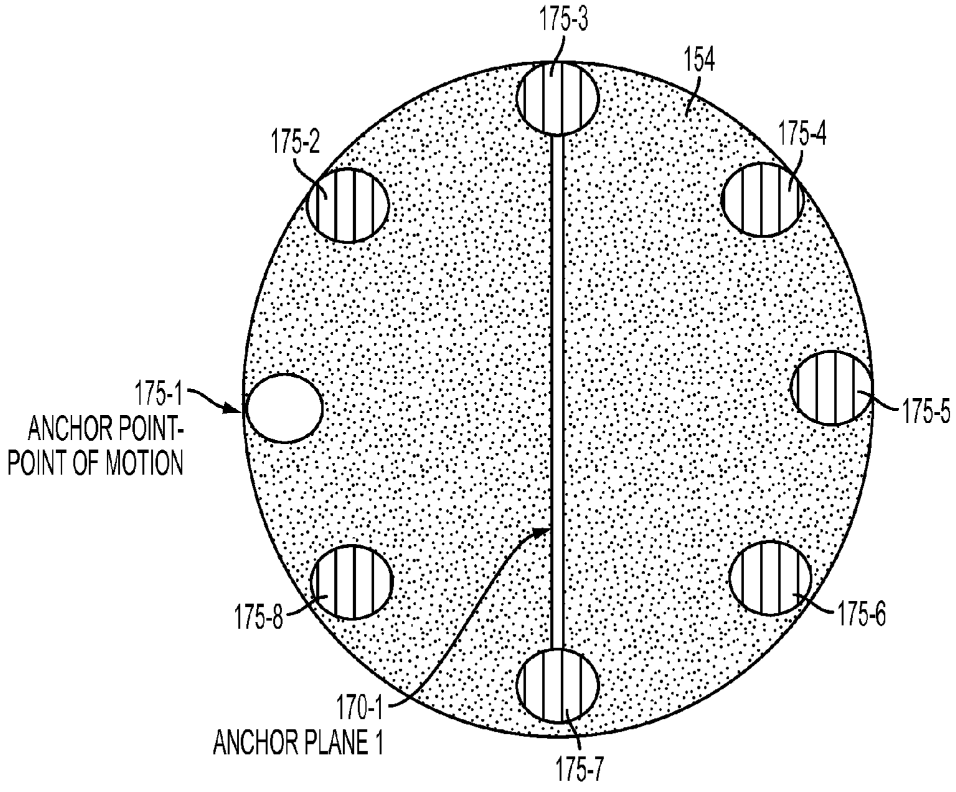


FIG. 1H

RANGE OF MOTION OF TRANSDUCER-3

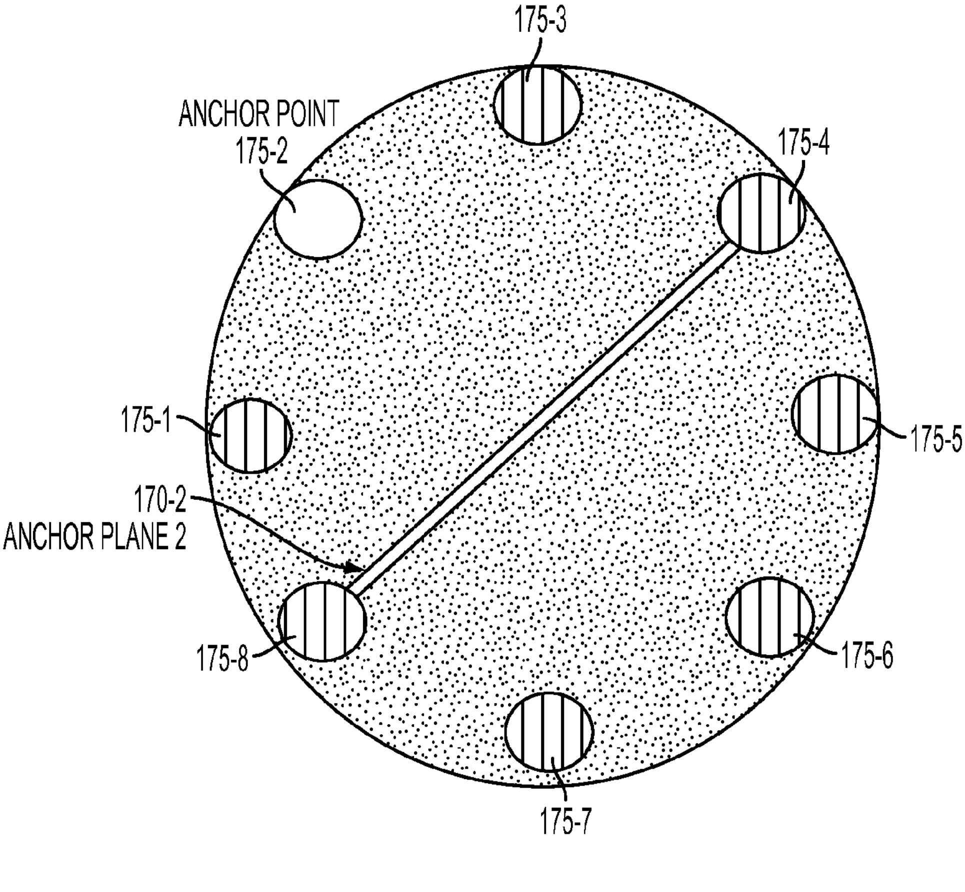


FIG. 1I

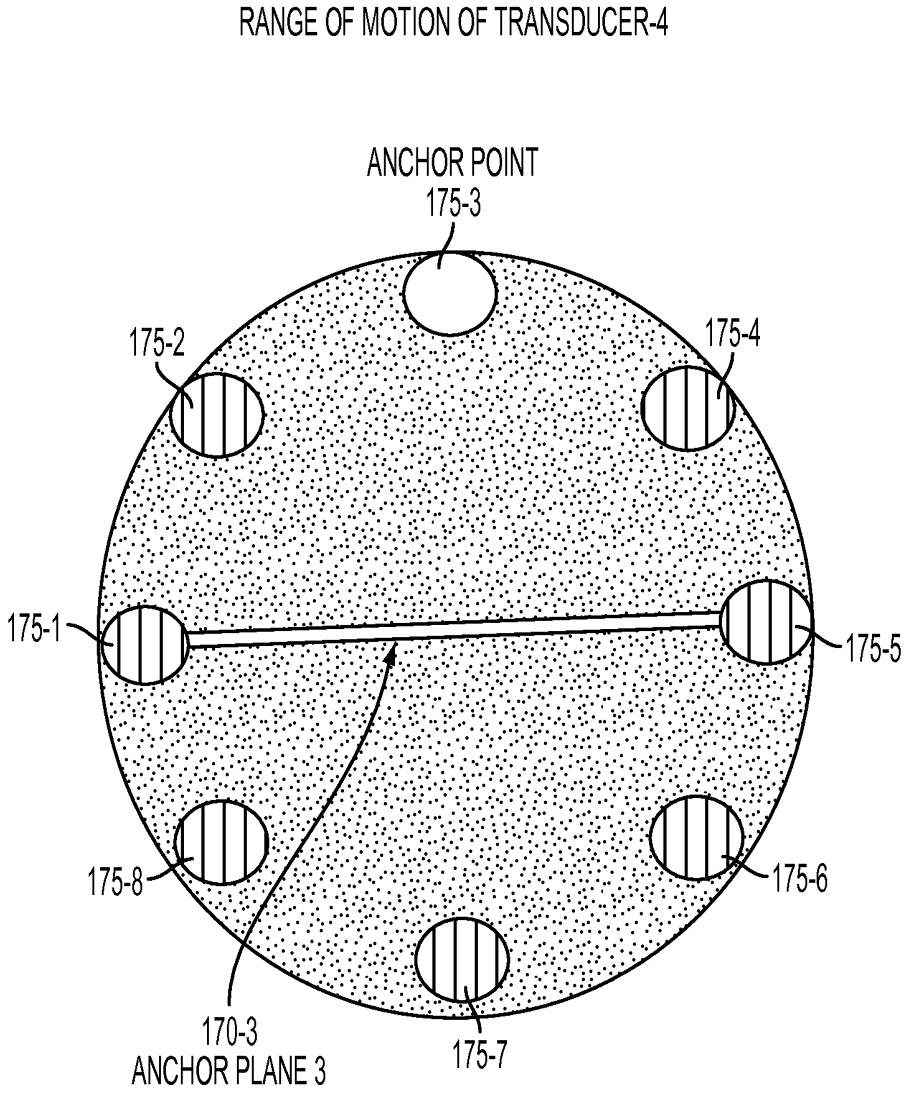

RANGE OF MOTION OF TRANSDUCER-4
ANCHOR POINT
175-3
175-2
175-4
175-1
175-5
175-8
175-6
175-7
170-3
ANCHOR PLANE 3

FIG. 1J

RANGE OF MOTION OF TRANSDUCER-5

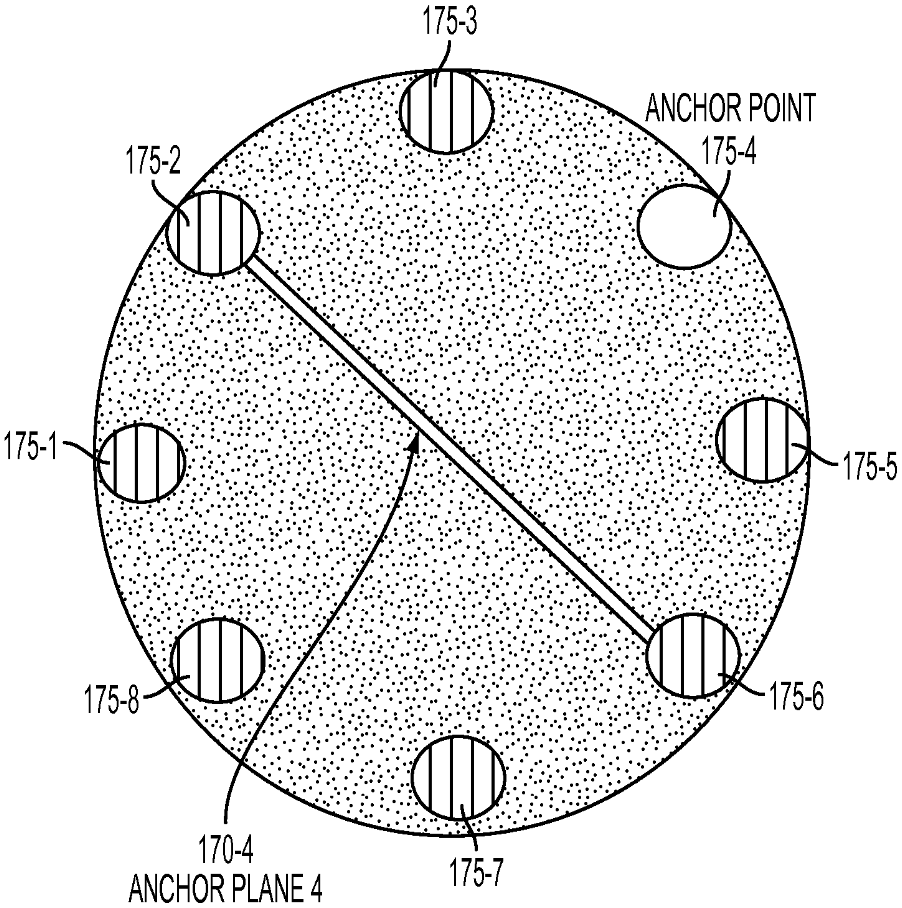


FIG. 1K

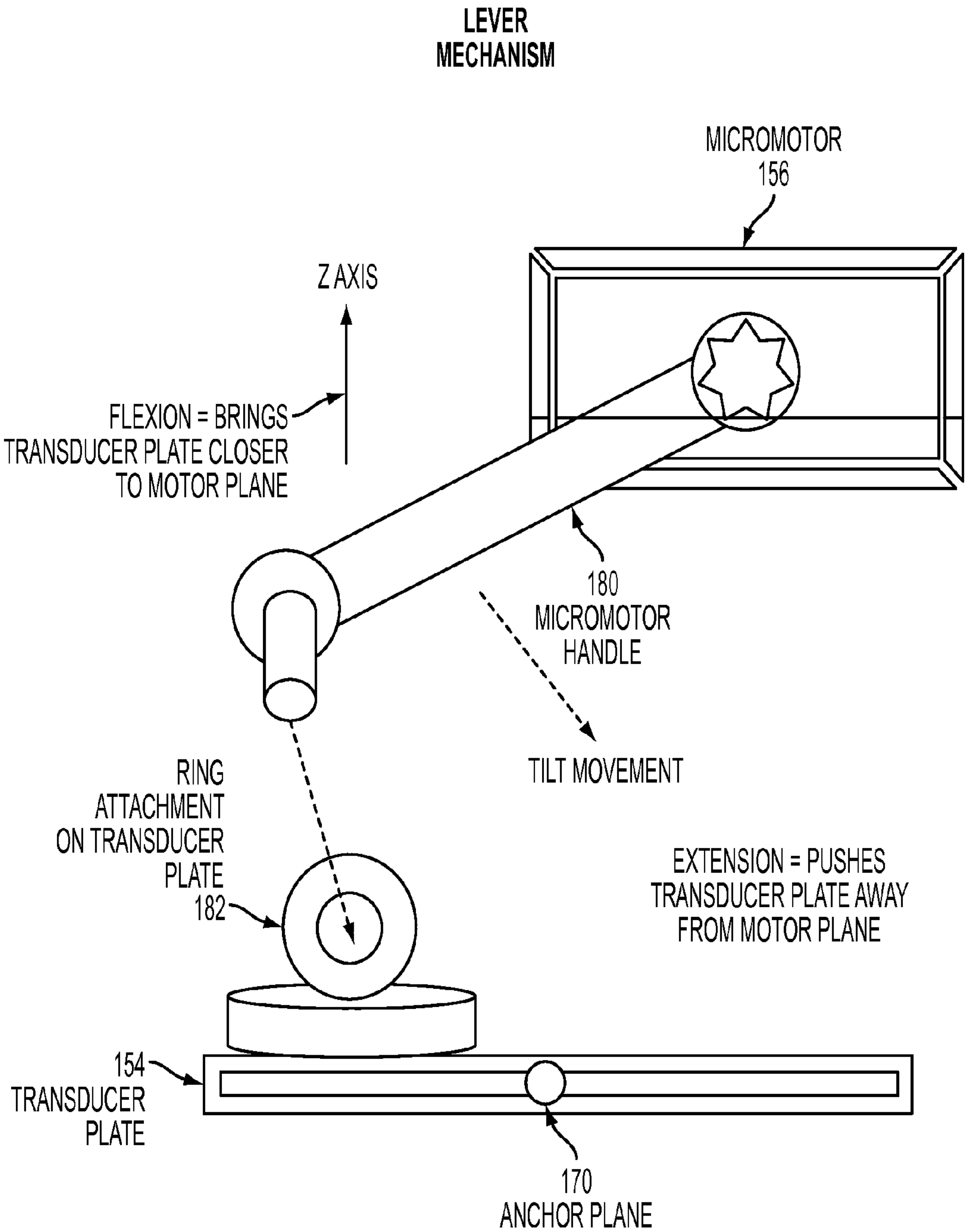

LEVER
MECHANISM
MICROMOTOR
156
Z AXIS
FLEXION = BRINGS
TRANSDUCER PLATE CLOSER
TO MOTOR PLANE
180
MICROMOTOR
HANDLE
TILT MOVEMENT
RING
ATTACHMENT
ON TRANSDUCER
PLATE
182
EXTENSION = PUSHES
TRANSDUCER PLATE AWAY
FROM MOTOR PLANE
154
TRANSDUCER
PLATE
170
ANCHOR PLANE

FIG. 1L

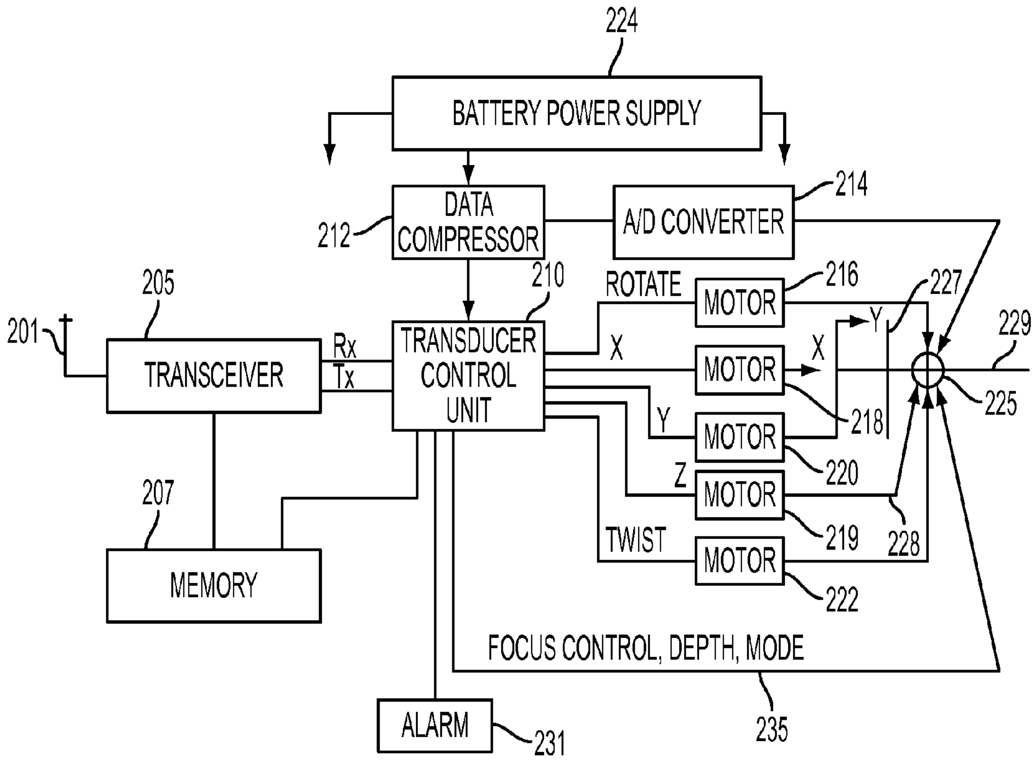

224
BATTERY POWER SUPPLY
DATA COMPRESSOR
212
A/D CONVERTER
214
205
201
TRANSCEIVER
Rx
Tx
TRANSDUCER CONTROL UNIT
210
ROTATE
MOTOR
216
X
MOTOR
Y
MOTOR
Z
MOTOR
TWIST
MOTOR
218
220
219
222
227
228
229
225
207
MEMORY
FOCUS CONTROL, DEPTH, MODE
235
ALARM
231

FIG. 2

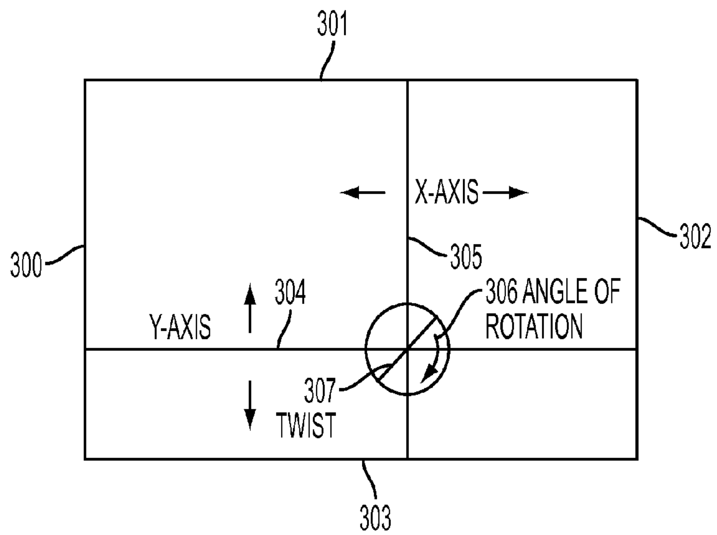

301
302
300
X-AXIS
305
Y-AXIS
304
306 ANGLE OF ROTATION
307 TWIST
303

FIG. 3

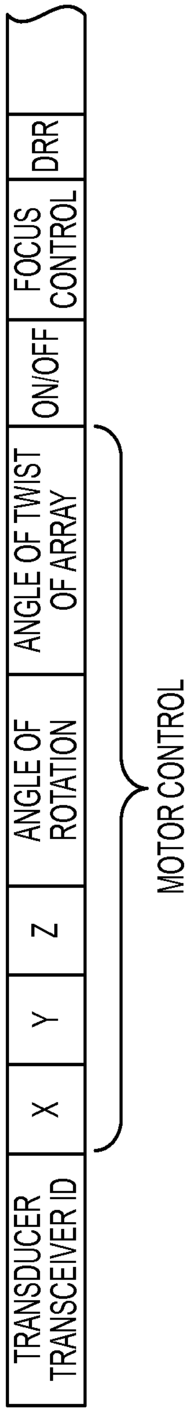

TRANSDUCER TRANSCEIVER ID
X
Y
Z
ANGLE OF ROTATION
ANGLE OF TWIST OF ARRAY
ON/OFF
FOCUS CONTROL
DRR
MOTOR CONTROL

FIG. 4A

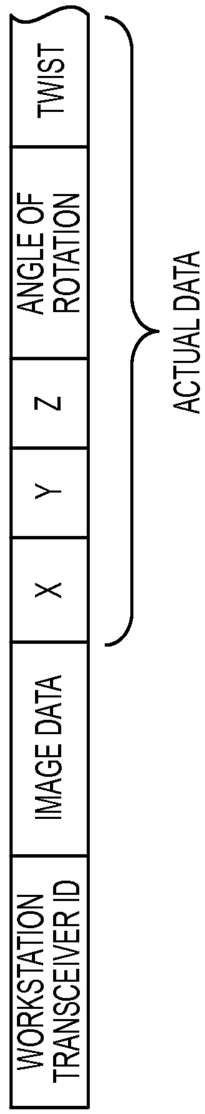

WORKSTATION TRANSCEIVER ID
IMAGE DATA
X
Y
Z
ANGLE OF ROTATION
TWIST
ACTUAL DATA

FIG. 4B

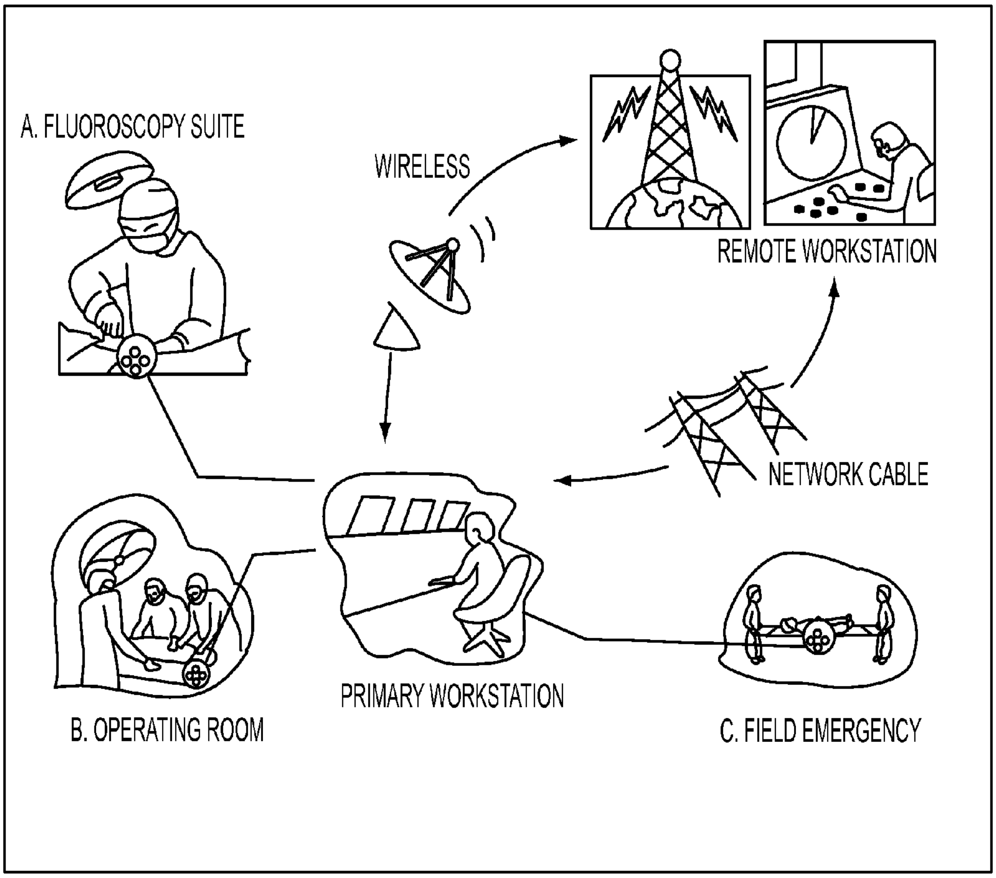

A. FLUOROSCOPY SUITE
WIRELESS
REMOTE WORKSTATION
NETWORK CABLE
B. OPERATING ROOM
PRIMARY WORKSTATION
C. FIELD EMERGENCY

FIG. 5

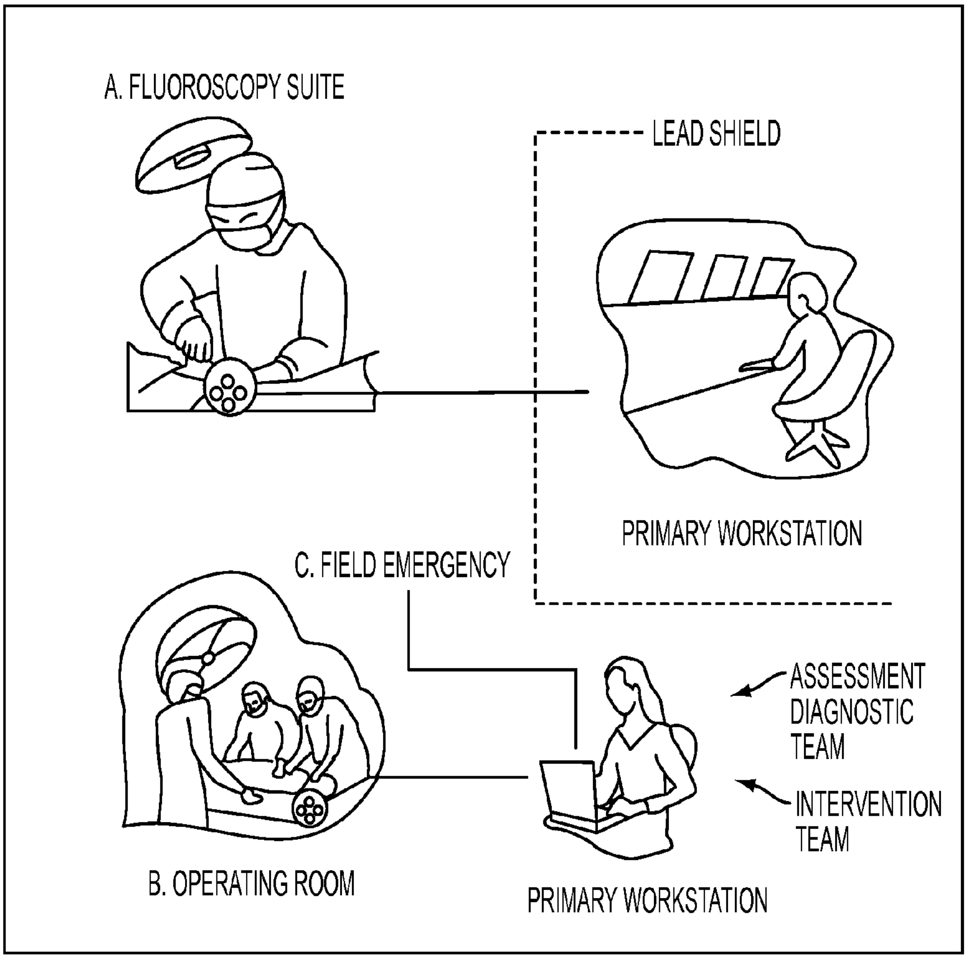

A. FLUOROSCOPY SUITE
LEAD SHIELD
PRIMARY WORKSTATION
C. FIELD EMERGENCY
ASSESSMENT
DIAGNOSTIC
TEAM
INTERVENTION
TEAM
B. OPERATING ROOM
PRIMARY WORKSTATION

FIG. 6

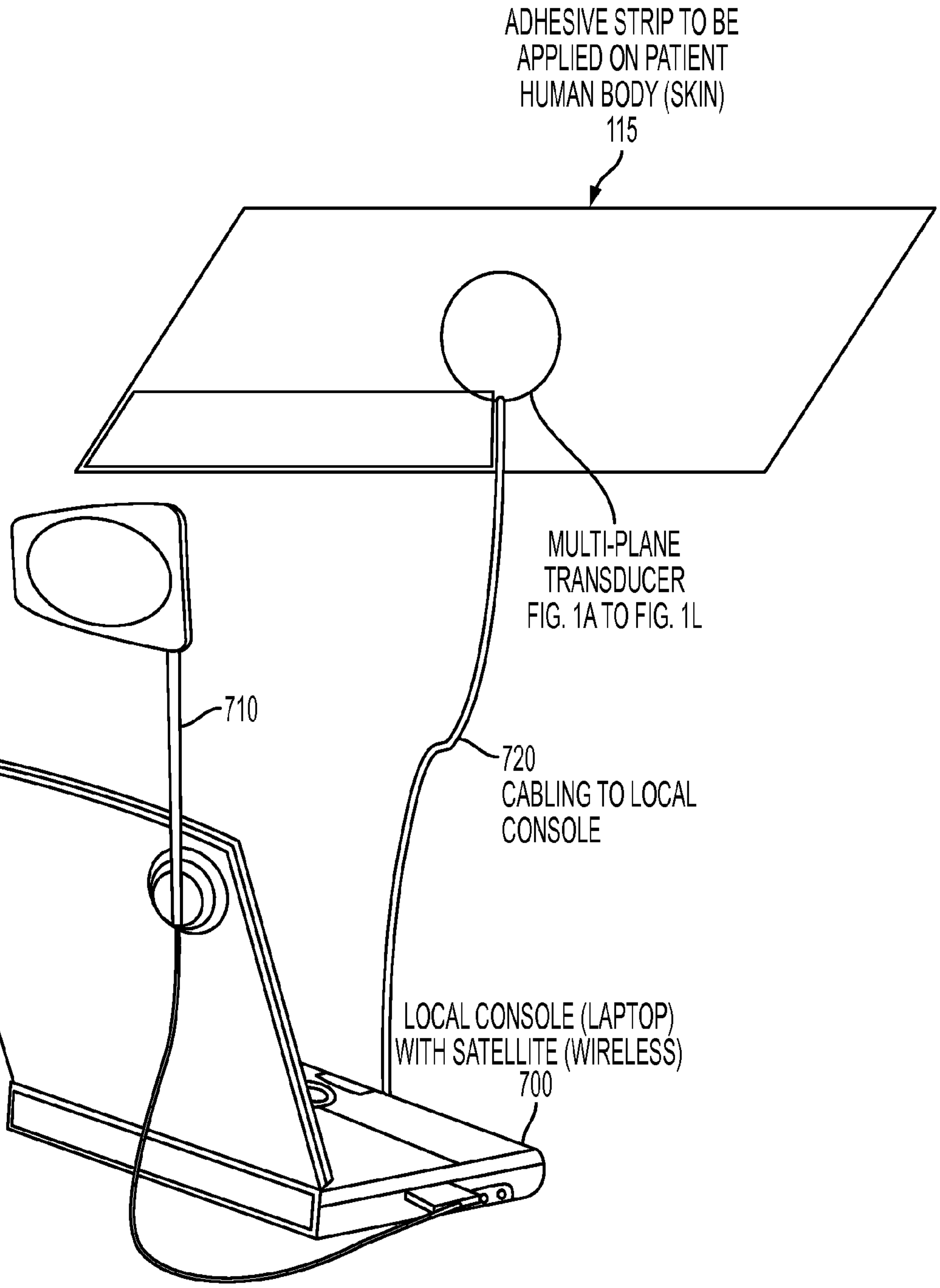

ADHESIVE STRIP TO BE
APPLIED ON PATIENT
HUMAN BODY (SKIN)
115
MULTI-PLANE
TRANSDUCER
FIG. 1A TO FIG. 1L
710
720
CABLING TO LOCAL
CONSOLE
LOCAL CONSOLE (LAPTOP)
WITH SATELLITE (WIRELESS)
700

FIG. 7A

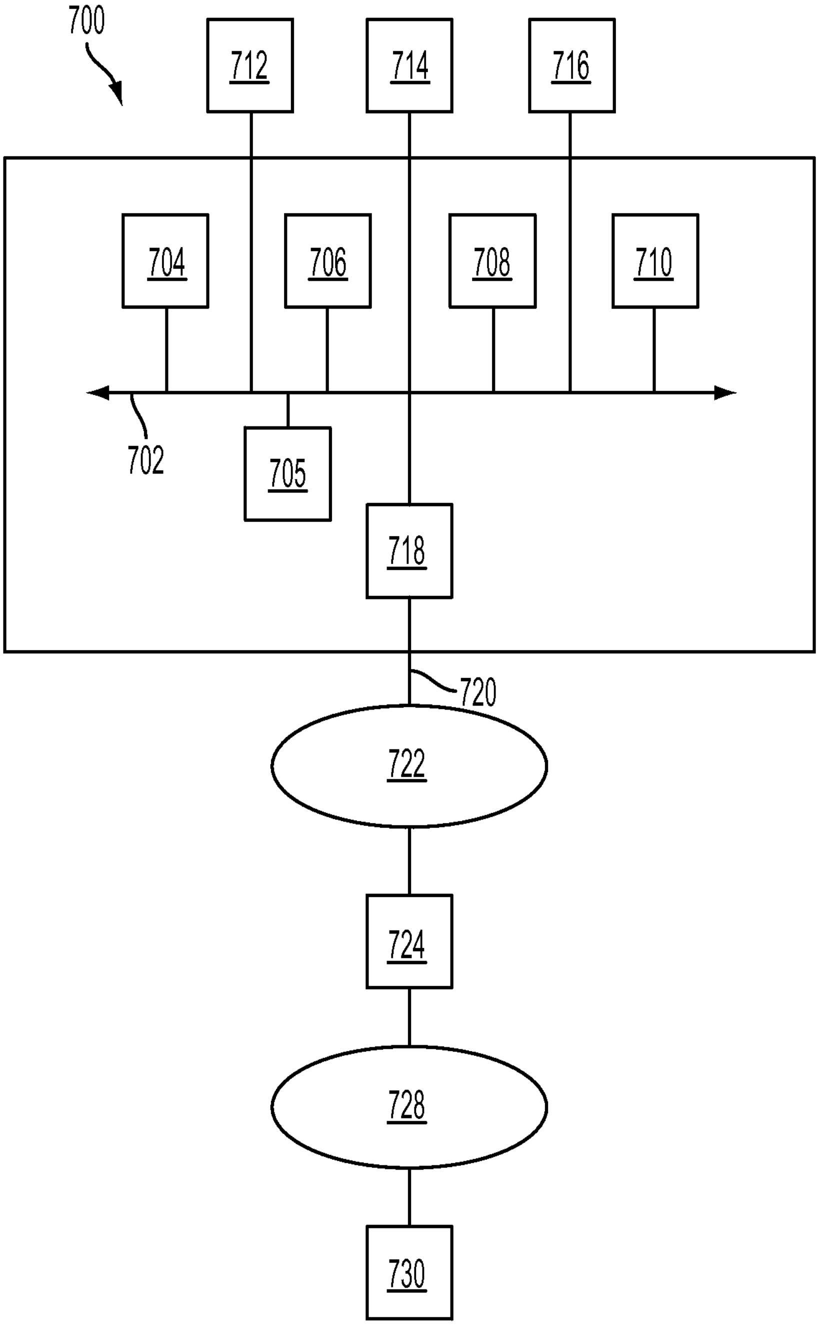


FIG. 7B

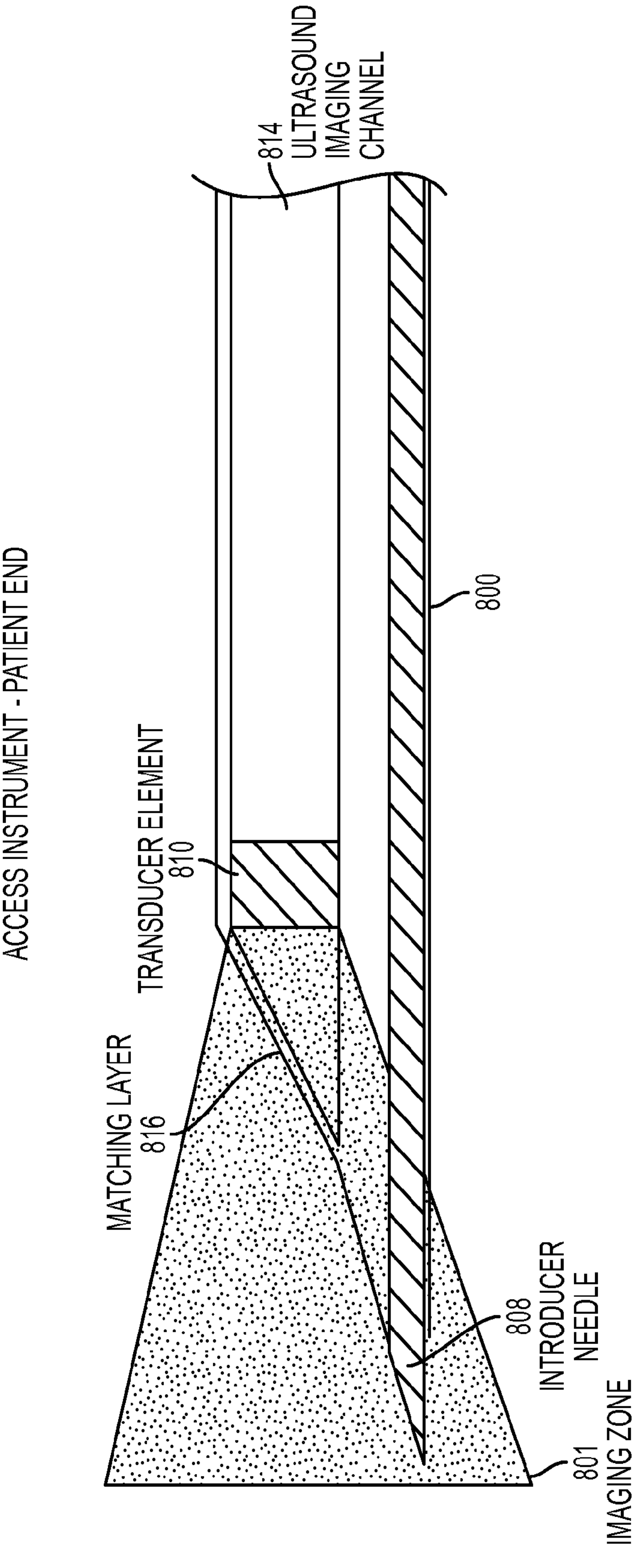

ACCESS INSTRUMENT - PATIENT END
814
ULTRASOUND
IMAGING
CHANNEL
TRANSDUCER ELEMENT
810
MATCHING LAYER
816
800
808
INTRODUCER
NEEDLE
801
IMAGING ZONE

FIG. 8A

ACCESS INSTRUMENT - OPERATOR END

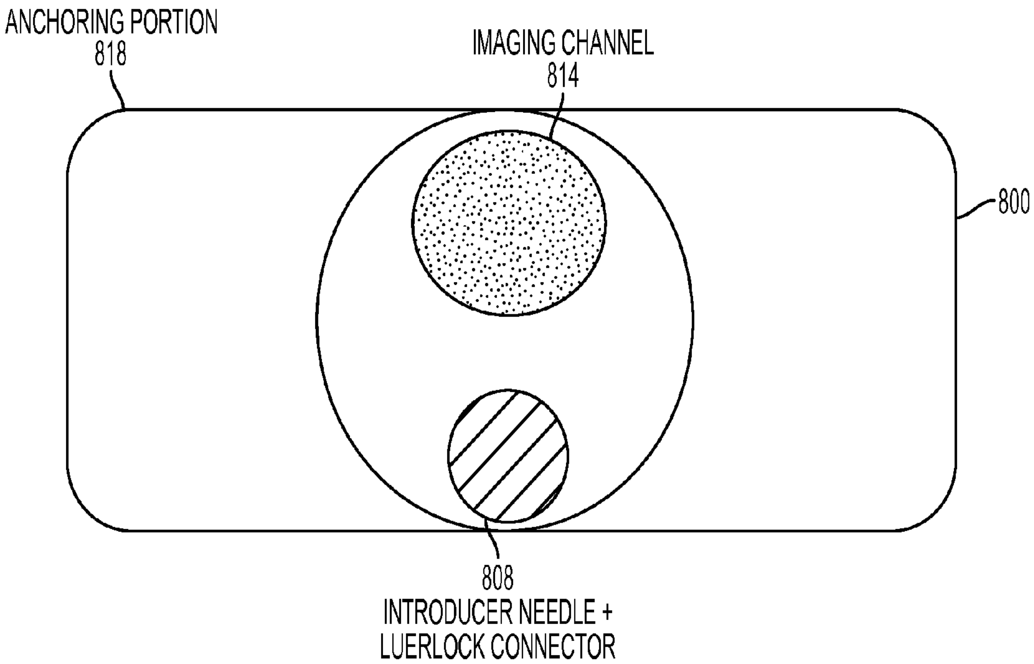


FIG. 8B

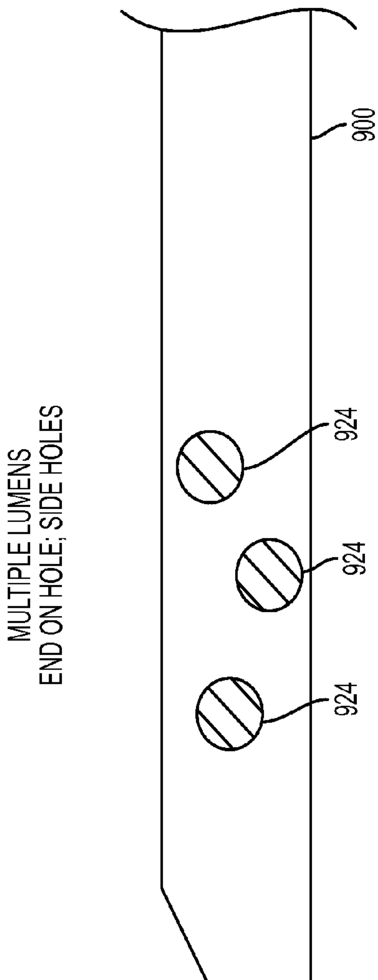

MULTIPLE LUMENS
END ON HOLE; SIDE HOLES
900
924
924
924

FIG. 9A

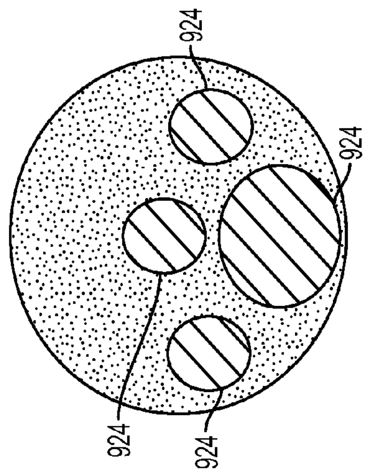

924
924
924
924
924

FIG. 9B

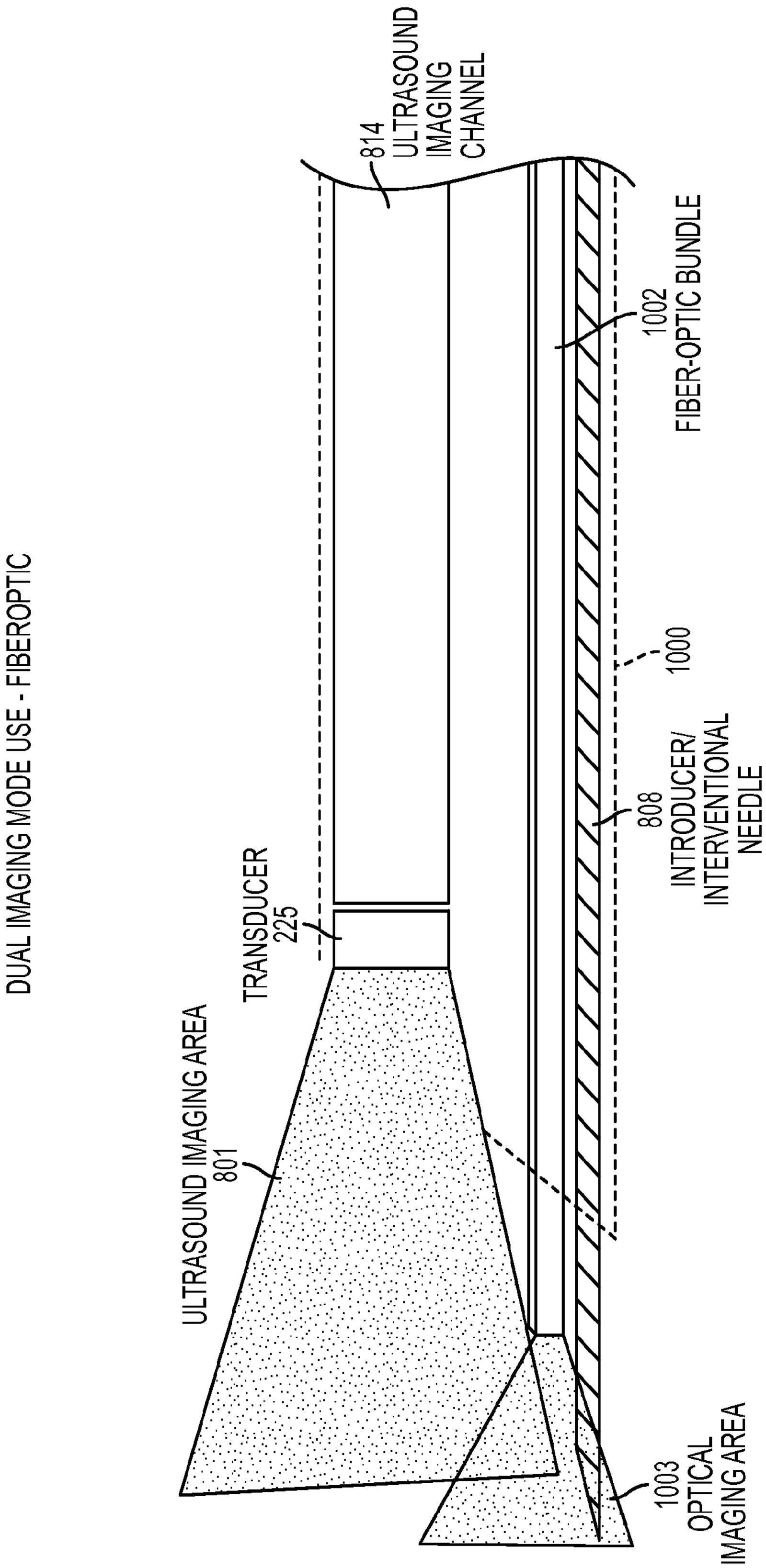

DUAL IMAGING MODE USE - FIBEROPTIC
814
ULTRASOUND
IMAGING
CHANNEL
1002
FIBER-OPTIC BUNDLE
1000
808
INTRODUCER/
INTERVENTIONAL
NEEDLE
TRANSDUCER
225
ULTRASOUND IMAGING AREA
801
1003
OPTICAL
IMAGING AREA

FIG. 10

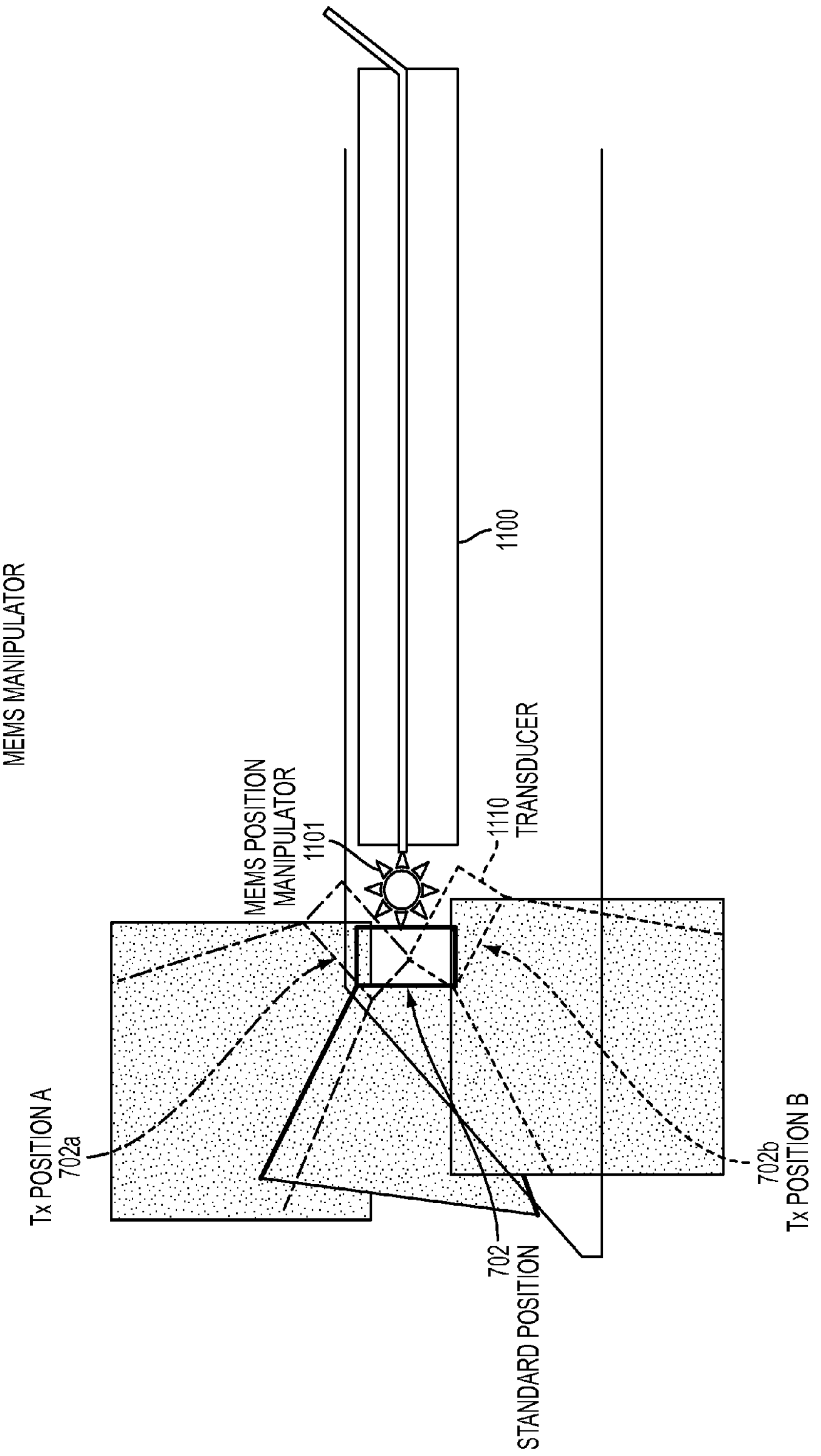

MEMS MANIPULATOR
1100
TRANSDUCER
1110
MEMS POSITION
MANIPULATOR
1101
Tx POSITION A
702a
702b
Tx POSITION B
702
STANDARD POSITION

FIG. 11

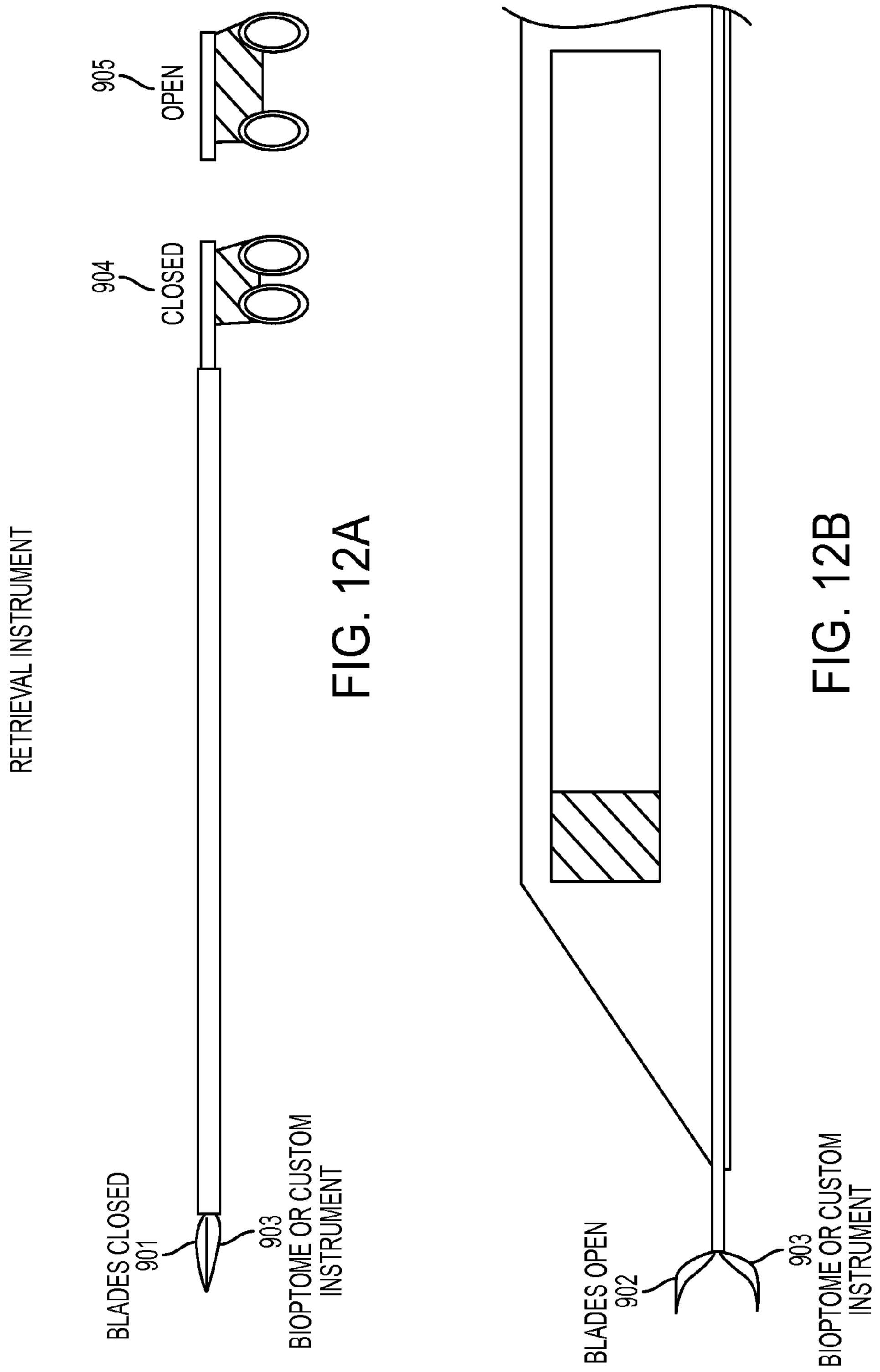


FIG. 12A

FIG. 12B

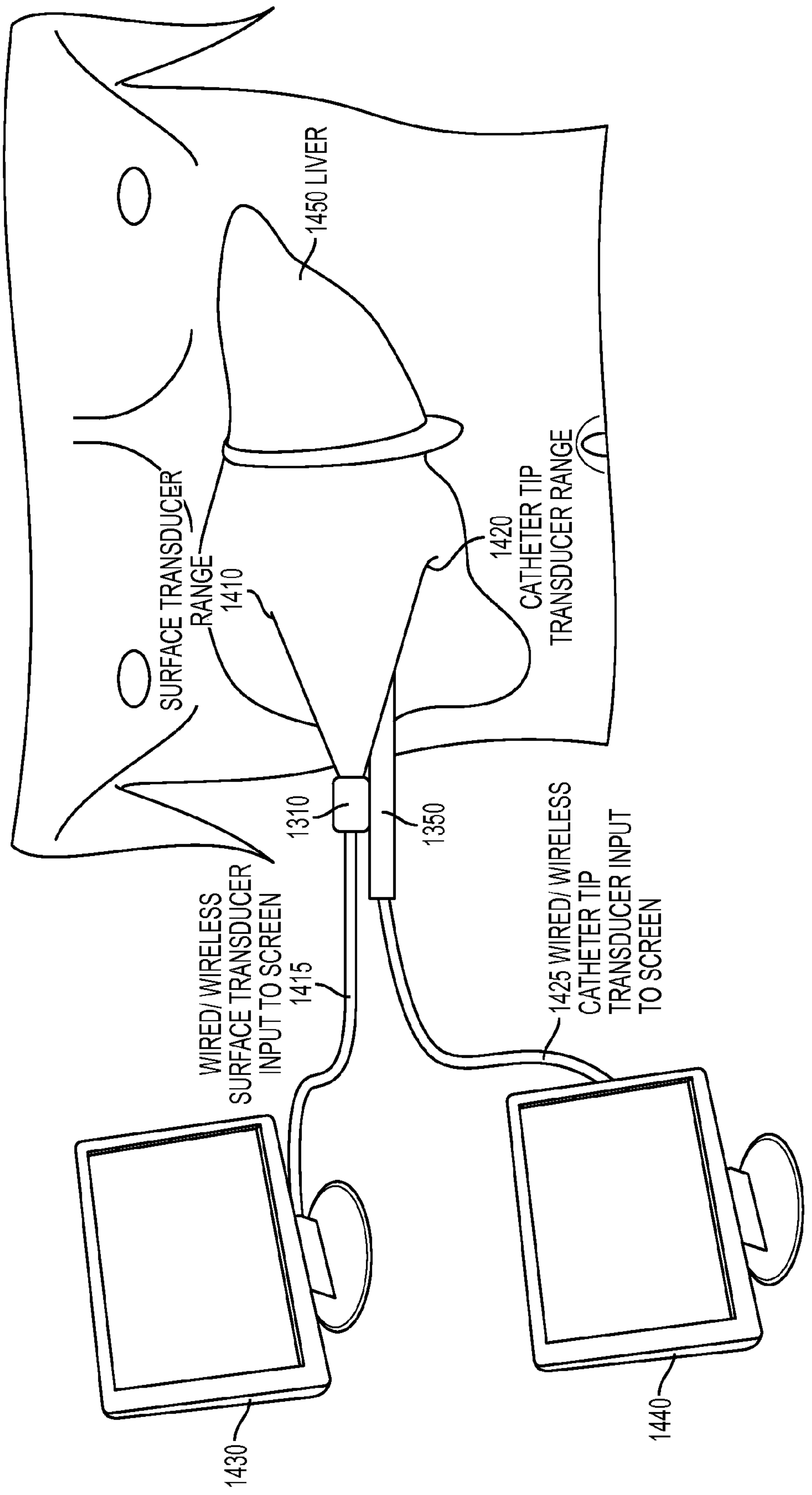

1450 LIVER
SURFACE TRANSDUCER RANGE
1410
1420
CATHETER TIP TRANSDUCER RANGE
1310
1350
WIRED/ WIRELESS SURFACE TRANSDUCER INPUT TO SCREEN
1415
1425 WIRED/ WIRELESS CATHETER TIP TRANSDUCER INPUT TO SCREEN
1430
1440

FIG. 13

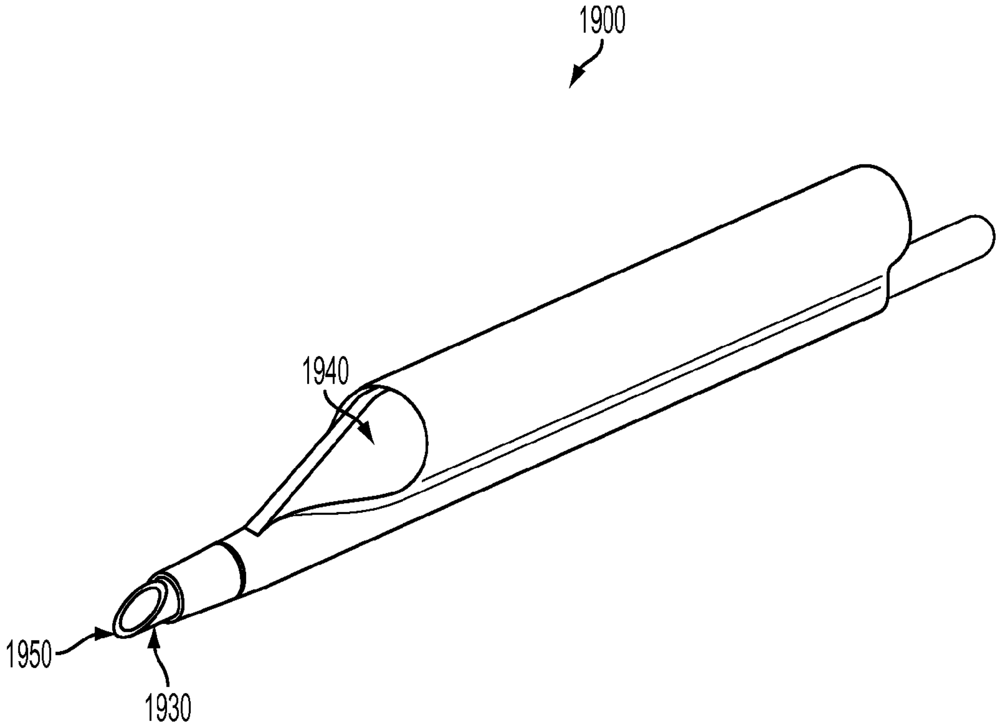


FIG. 14

REMOTE ULTRASOUND ASSESSMENT AND INTERVENTION SYSTEM

CROSS-REFERENCE

[0001] This application is a continuation-in-part of U.S. patent application Ser. No. 13/847,902, filed Mar. 20, 2013, which is a continuation of U.S. patent application Ser. No. 11/871,282, filed Oct. 12, 2007 (now U.S. Pat. No. 8,403,859, issued Mar. 26, 2013) and a continuation-in-part of U.S. patent application Ser. No. 11/782,991, filed Jul. 25, 2007 (now U.S. Pat. No. 8,403,858, issued Mar. 26, 2013), both of which patent applications claiming priority to provisional U.S. Application Ser. No. 60/851,451 filed Oct. 12, 2006, and this application further claims priority to U.S. provisional patent application Ser. No. 61/692,443, filed Aug. 23, 2012, entitled Remote Assessment System, all applications of the same inventor, the entire disclosures of which applications are hereby incorporated by reference into the present application.

BACKGROUND OF THE INVENTION

[0002] This invention relates to the technical field of remote assessment and intervention systems and, more particularly, to a remote assessment system for field use in which ultrasound imaging, in combination with other known diagnostic medical equipment for field/emergency use, may be utilized by unskilled personnel in the field, for example, remote from a hospital, under remote guidance of the hospital to assess, diagnose and alleviate field medical injury.

[0003] Reference is made to the following patents and published patent applications of Dr. Theodore P. Abraham: U.S. published application 2008/0091109 published Apr. 17, 2008, entitled "Image Guided Catheters and Methods of Use" (now U.S. Pat. No. 8,403,858 issued Mar. 26, 2013); U.S. published application 2008/0091104 published Apr. 17, 2008, entitled "Image Guided Catheters and Methods of Use" (now U.S. Pat. No. 8,403,859 issued Mar. 26, 2013); U.S. Pat. No. 8,038,622 issued Oct. 18, 2011 entitled "Wired and Wireless Remotely Controlled Ultrasonic Transducer and Imaging Apparatus"; U.S. Pat. No. 8,147,413 issued Apr. 3, 2012 entitled "Image Guided Catheter Having Deployable Balloons and Pericardial Access Procedure"; U.S. Pat. No. 8,147,414 issued Apr. 3, 2012 entitled "Image Guided Catheter Having Remotely Controlled Surface Mounted and Internal Ultrasound Transducers;" and U.S. Pat. No. 8,235,903 issued Aug. 7, 2012 and entitled "Remotely Controlled Implantable Transducer and Associated Displays and Controls." All U.S. patents and published U.S. Patent applications mentioned in the present application are deemed incorporated herein by reference as to their entire subject matter. In particular, U.S. Pat. Nos. 8,038,622; 8,147,414; and 8,235,903 relate to wireless remote ultrasound image guided catheters and related methods of use wherein an externally mounted (to the patient's skin surface) or an implantable device may be utilized so as to remotely communicate with a remote site and be remotely guided to obtain ultrasound imaging from a field emergency site at a remote hospital and so to assess and to diagnose a field injury or disease. The system may be further enhanced to provide some opportunity for relief using ultrasound energy alone or in combination with remotely guided ultrasound catheters and tools as described by U.S. Pat. Nos. 8,403,858 and 8,403,859, all of which may be utilized together as a remote ultrasound assessment and intervention system in real time to assess, diagnose and potentially alleviate the impact of a traumatic wound, injury or illness and begin a healing process in combination with other diagnosis devices and tools that may be available at the field emergency site. These patents followed on the catheter systems of Seward et al., U.S. Pat. Nos. 5,704,361 and 6,171,247, which relate to 3-dimensional imaging. Moreover, from U.S. Published Applications No. 2011/0206243 published Aug. 25, 2011; 2012/0102332 published Apr. 26, 2012; 2012/0148115 published Jun. 12, 2012 and 2013/0131994 published May 23, 2013, it is known to collect biometrics information, fingerprint and iris image information, DNA information and the like at an emergency site and identify unconscious victims (or victims capable of resuscitation via a defibrillator) from a remote site using an intelligent communication device.

[0004] Torso injuries involving the thorax and abdomen account for close to 20% of combat/terror attack injuries and represent a major portion of intervenable injuries from explosions and other field trauma. Most life-threatening injuries do not require a surgeon for immediate in-field stabilization. Hemothorax, tension pneumothorax, cardiac tamponade and abdominal bleeding are internal to a human body and are common causes of death that could potentially be intervened upon rapidly if recognized during a field assessment by a medically trained professional with appropriate diagnostic equipment. Telemedicine is generally known to provide such care and treatment from, for example, a hospital to a remote field site but is limited in its abilities to permit remote control of diagnostic and assessment equipment from the hospital to assess an internal injury or disease.

[0005] Whenever a patient is found unconscious, it is practically impossible to diagnose and alleviate a condition without the instructive advice of the patient. Of course, a communicative patient is capable of assisting a person on the scene, who may be referred to herein as a first responder or a good Samaritan—one who may or may not have any medical training. A communicative patient may be able to help themselves under guidance of medical personnel to assess and treat their injury. The internal injuries or diseases described above may have no visible symptoms and so may be incapable of assessment or diagnosis without some form of internal imaging and/or expression of pain location from a communicative patient.

[0006] While a portable ultrasound imaging apparatus is known, for example, from U.S. Patent Application Publication 2012/0203104 published Aug. 9, 2012 of Urness et al., the operation of the apparatus depicted in FIG. **6** presumes a trained ultrasound operator. Meijia er al., US 2008/0194950 published Aug. 14, 2008, provide further details of an ultrasound imaging remote control unit. Barnes et al., U.S. Pat. No. 7,819,807 issued Oct. 26, 2010, describe a hand held ultrasound system whereby a user may hold the system and operate at least one control element with the same hand. The user, however, is one skilled in ultrasound imaging.

[0007] Within a hospital setting, fluoroscopy suites may be separated from patient rooms and the like. Consequently, it is known from U.S. Patent Application Publication 2009/0292181 published Nov. 26, 2009 to Donaldson that, for example, an X-ray system, an ablation catheter, an ultrasound catheter and patient monitoring may be implemented at bedside with remote control from a remote location, for example, within the same hospital. According to FIG. **6**, three screens for navigation, operation and documentation may be provided in a hospital setting for real-time imaging (navigation), catheter steering (operation) and providing an integrated case report, review and log (documentation). Certainly, such a system is easily implemented in a hospital setting but is more difficult to achieve at a remote military location or scene of a terrorist attack.

The Current Need (to Reduce in-Field Deaths)

[0008] There are several factors contributing to the lack of change in in-field deaths in military operations, for example, military deaths from roadside bombs or generally deaths from terrorist attacks inside and outside the United States over the last several decades. These factors include: 1. Paucity and poor quality of medical data available immediately at the field site; 2. Lack of rapid medical input to trained medical personnel at a hospital or doctor's office; and 3. Unavailability of trained medical personnel on site.

[0009] Some factors such as trained medical personnel on site in the field and at a location of a military or terrorist incident cannot be easily addressed and will remain a challenge for the foreseeable future. While medical personnel may accompany a military unit going into a battle or be located at a dangerous remote site such as a mountainous region of Afghanistan, such medical personnel may not be readily available at the actual field site of a medical emergency or at the site of a terrorist attack, such as at the bombing attack that occurred at the Boston marathon in the fall of 2012 or at a roadside or military check point bomb attack.

[0010] There remains a need in the art for a remote assessment, diagnosis and intervention system that may be used by untrained personnel to assess and diagnose internal injuries and/or diseases occurring at a remote field location with remote hospital or other medical assistance.

SUMMARY OF THE INVENTION

[0011] The present invention seeks to address two factors above that may be addressed through use of a combination of patented and patent-pending on-site evaluation and alleviation ultrasound devices and systems and a remote evaluation and management system (for example, at a hospital) that may collectively comprise (at the field site) image data collecting devices including a patient attachable to skin surface or implantable in a human body cavity wireless remote ultrasound device for patient diagnosis and assessment and a more permanent implantable device (if the patient is so equipped per U.S. Pat. No. 8,235,903) along with some form of console such as a personal computer or other intelligent device equipped with a telecommunications or radio link to a hospital and ports or links to more conventional data collection devices. The system may further comprise for injury alleviation an ultrasound image-guided catheter that may be operated in conjunction with the attachable and/or implantable ultrasound device to, for example, remove a bullet or shrapnel, alleviate fluid in a body cavity or restore a collapsed lung to functionality. This device/system will allow immediate application of easy-to-use hardware on the patient subject, establish connectivity to a remote high-end medical management system (which may include a surgical team) that may be miles or continents away, and make available high-fidelity and sophisticated medical data not currently available to medical experts if available at the remote station at the emergency site. Moreover, such a device/system may be conveniently located at potential sites of emergencies such as at heart defibrillator locations in buildings or at street pedestal emergency locations or be portable and be carried with a military unit into a war or terrorist zone and connected to remote hospital facilities via emergency telecommunications or radio links.

[0012] A GHOST™ Remote Evaluation and Management System, (GHOST being a trademark of InnoScion LLC of Baltimore, Md.) according to an embodiment of the present invention, provides a multi-component, on-site diagnosis and management system. A GHOST Remote Evaluation and Management system has at least three components:

[0013] 1. Onsite (in-field) diagnosis and evaluation hardware

[0014] a. An ultrasound based imaging device (for example, a small disc shaped device attachable to a patient or implantable in a cavity of a patient) that can be applied by a non-medical person and connected by wired or wireless means to a GHOST system console and transceiver at a remote field emergency location, the transceiver having a unique identifier or telecommunications or internet or radio address. The technical operations of this system including area of focus, range, mode, depth, etc., can be controlled remotely via a telecommunications/radio system or, for example, an emergency radio system by remotely located, skilled medical personnel at, for example, a hospital facility or doctor's office. The device, if wireless, will have its own unique identification address for wireless communication with a GHOST REM system console or intelligent communication device. Reference may be made, for example, to FIGS. 8 and 9 of U.S. Pat. No. 8,038,622 and its attendant description for an example of remote use by a non-medical person whereby a hospital in Juneau, Ak. may communicate with a person attending a patient at a field location in Alaska, far removed from the hospital, for example, communicating with the hospital by satellite telephone. If an emergency mode of transportation is available, the present invention may be used on board to provide vital and image, data, current location and approximate time of arrival at a hospital, environmental data and the like via an accelerometer and global positioning system of the system console or intelligent device.

[0015] b. Vital data input—pulse, blood pressure (auto-measurement device input to a personal computer (PC) over time), pulse oximetry, digital thermometer and other diagnostic devices connectable to a PC or other intelligent device (the GHOST console) may provide valuable data, especially in the instance of an internal injury or a disease. Vital data input in an embodiment of the invention may include the attachable or implantable ultrasound imager, a. above, that may be successively secured and moved from one location on a patient body to another until an assessment and diagnosis may be determined via vital data input obtained in a hierarchal order such as head, neck, chest, abdomen and extremities of the injured patient. Multiple known data sources (blood pressure and other vitals detection) can be plugged in to the GHOST personal computer console (or other intelligent device) and communicate remotely with hospital or other medical personnel via the radio, satellite, internet or telecommunications link. Moreover, as necessary, the intelligent device may be equipped with external environmental data collectors including an accelerometer or be attachable to environmental sensors such as external temperature, altitude, humidity and atmospheric pressure sensors.

[0016] c. Video camera (conveniently available via a typical cell phone, intelligent device or the GHOST PC console)—focused on the subject patient and images transmitted via the GHOST console (separate on a cell phone, intelligent device or as a camera of PC GHOST console). Most intelligent devices incorporate a gyroscope, a magnetometer, a fingerprint (or iris) sensor, a camera and an accelerometer which may be used for collection of biometric and attitude data for camera placement. The camera may collect a live, real-time video sequence of images and sound via a microphone for broadcast from an emergency site to hospital personnel. In addition, a fiber optic imager may be provided in addition to ultrasound on an image-guided ultrasound catheter or imager (a. above) that may be utilized in conjunction with or integral to the attachable/implantable imaging device a. described above.

[0017] 2. Wireless bi-directional communication of data

[0018] a. A wireless system using satellite, wi-fi, wireless LAN, internet telephony or any available wireless or other radio protocol to transmit data to medical personnel, for example, at a hospital. The GHOST console (an intelligent communication device) will have a unique communication address for communication over a telecommunication, internet or radio network. Moreover, it is expected that a personal computer may comprise a plurality of USB or wireless ports for receiving data and images collected from peripheral devices coupled to it.

[0019] 3. Remote data evaluation and control

[0020] a. A remotely located control station, for example, at a hospital, that is able to control the operations of the GHOST console, movement of transducers on the patient body (rotation, tilt, x, y and z directional movement) and receive data input from the GHOST console, for example, at a field or more remote hospital. Moreover, there may be a communications link whereby the field personnel may be instructed by hospital personnel to move a remote ultrasound transponder from one location on a patient to another, for example, from head, to throat area, to chest area, to abdomen and to extremities, until a remote assessment or diagnosis may be made and intervention begun, for example, using an image guided catheter.

[0021] Medical information/intervention available through GHOST REM (remote console) includes but is not limited to:

[0022] 1. Ultrasound imaging of head and neck, heart, lungs, abdomen, pelvis, joints, limbs;

[0023] 2. Blood pressure—intermittent via standard cuff measurements; continuous via systems like FINAPRES if available at a field emergency site;

[0024] 3. Pulse oximetry;

[0025] 4. Electrocardiography;

[0026] 5. Video including sound of patient;

[0027] 6. Defibrillation;

[0028] 7. Temperature (thermometer)—preferably digital for periodic body temperature measurement; and

[0029] 8. Environmental data including altitude, atmospheric pressure, humidity and temperature.

[0030] Components of a GHOST Remote Evaluation Management System

[0031] 1. Ultrasound imager for securing successively to a patient body (attachable or implantable)

[0032] a. Ultrasound is inexpensive, highly versatile in multiple situations, non-radiating (not harmful to patient), is capable of miniaturization.

[0033] b. The GHOST REM attachable/implantable ultrasound imager will preferably be a disk or cylindrically shaped device that sits within a large adhesive patch (if attachable) or is used without the patch and inserted into a body cavity. Cables from the device, if needed, or wireless means will attach the imager to the GHOST personal computer console (or intelligent device) or directly to the hospital. The device will be placed by on-site non-medical personnel on particular, successive locations on a patient body under control of remote medical personnel. The device is capable, depending on size, of x, y and z linear movement, rotation and tilt over a whole area such as a patient abdomen or chest entirely under remote medical personnel control. The console screen may be split screen and may display locations for attachment/implant and provide explanatory instruction to make it easy for deployment by the untrained on-site personnel.

[0034] 2. GHOST console (intelligent device with a communication interface between peripheral devices and remote hospital)

[0035] a. This may be the program controlled computer at the site located 1-3 feet from the subject. Its camera or that of an intelligent device may capture an image of the subject or localize its image to a wound or injury area. The camera placement may benefit from an gyroscope, magnetometer and accelerometer on-board most intelligent devices for portrait/landscape and attitude data.

[0036] b. The overall size of a console may be that of a laptop personal computer (or smaller pad size or intelligent device) and the intelligent device may incorporate such applications as global positioning, gyroscope, accelerometer, magnetometer, display, microphone and speaker, keyboard, fingerprint/iris/DNA identification, camera and other known features and applications. In situations where the patient is unknown and unconscious, the fingerprint (or iris capture) and camera features or DNA collection and on site analysis among other features may be able to identify the patient and medical personnel retrieve a medical history for the patient. Environmental data may be via weather data determined using global positioning or peripheral weather devices attachable to the present system for temperature, humidity and atmospheric pressure and so connected to the console.

[0037] c. The console may have

[0038] i. Instructional screens displayed via a computer-implemented software application for on-emergency-site personnel—explaining how to attach cables, antennae and deploy remote ultrasound image and medical data collection devices;

[0039] ii. Ports for connections of peripheral devices—wired or wireless;

[0040] iii. A real-time clock and calendar program for time-stamping collected image and medical data;

[0041] iv. Video/audio camera (camera and fingerprint/iris sensor of a typical personal computer may be used to input data for uploading to remote hospital); microphone may record and speaker communicate sounds at the emergency field site or used during transport of the patient; and

[0042] v. Telecommunications/radio capability (communication interface) for connection to a remote hospital or other site of medical personnel.

[0043] 3. Remote control medical station

[0044] a. A high capacity workstation, for example, at a hospital, that will control operations of the GHOST console according to trained medical personal commands or via a software application actuated at the GHOST console.

[0045] b. Display screens at the hospital medical station will enable viewing of all data input—can be toggled between various windows, use split screen or multiple screens to determine either integrated input or focus on one particular input e.g. ultrasound image of a bullet or shrapnel or blood pressure or body temperature or oxygen delivery or other diagnostic/treatment device or combinations of data collection.

[0046] c. Voice/speaker option—audio connection with in-field console for first responder or good Samaritan control assistance. The on emergency site, untrained personnel including the patient if conscious may be asked to move the ultrasound device from one location on their body to another (no training required) and apply impedance matching gel between skin surface and the attachable unit as needed.

[0047] Other components that are optional may comprise, for example, intervention and/or further internal imaging apparatus including but not limited to an ultra-sound image guided catheter which may be operated in integrated form with a remotely controlled imager as described above. This device may be operated by non-medical first responders or good Samaritans under voice command of a medically trained person, for example, at a hospital via the remote control station and GHOSTconsole. Potential uses that come to mind include internal (chest or abdomen) cavity fluid drainage, alleviation of a collapsed lung; bullet or shrapnel location and removal and the like.

[0048] Moreover, the patient may already have an implanted wireless ultrasound transducer that may be remotely controlled via the remote control station and GHOST console. These may be implantable devices as described in U.S. Pat. No. 8,235,903.

[0049] These and other advantages of embodiments of the present invention will become clear from an appreciation of the drawings and subsequent detailed description of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0050] FIGS. **1**A-**1**D comprise a disc version of an attachable, implantable remotely controllable, implantable ultrasound transducer assembly connectable to an intelligent device (FIG. **7**A) and operable under automatic command control via a communications interface to a hospital.

[0051] FIG. **1**A is a perspective view of an embodiment of a disk version of a remotely controlled ultrasound imager with motors, screws and the like for x, y, z axis, rotation and tilt operation of the transponder to capture images of a selected region of a patient, for example, beginning with the head, neck, chest, abdomen and extremities in order of criticality to survival of the patient.

[0052] FIG. **1**B is a top view of the disk version of FIG. **1**A showing a securing strip for securing the disk version temporarily to the patient body at a desired initial location such as the head, the device being sized as small as possible to be attachable to a skin surface or implantable in a body cavity such as a nasal cavity, a mouth cavity, a cavity entered via an anus or other cavity, for example, caused by a bullet wound or shrapnel injury.

[0053] FIG. **1**C is a further perspective view of the disc version of FIG. **1**A showing a lengthwise transducer crystal **100**, securing strip **115**, housing **103** and motors **216** and **222**.

[0054] FIG. **1**D comprises panels A and B for showing directions of applying directional movement to cause rotation and tilt of the array **100**.

[0055] FIGS. **1**E-**1**L show further embodiments of an attachable, implantable ultrasound assembly using screws and/or levers and having Z axis movement for moving a transducer plate toward or away from a skin surface or internal surface of a body cavity.

[0056] FIG. **1**E comprises a further view of an embodiment having a transducer housing and micro-motors for driving positioning screws to provide tilt or z direction movement toward an imaging surface such as a head, neck, chest and so on.

[0057] FIG. **1**F comprises a further view showing how telescoping screws driven by micro-motors may change a transducer plate's orientation and forward-directed imaging; one screw being extended toward a transducer plate (pushes) and the other (pulling) the transducer plate.

[0058] FIG. **1**G comprises a figure demonstrating the range of motion of a first transducer about a pivot fulcrum. The transducer may be moved rotationally, in x, y and z directions and tilted by screws or moved in x and y directions by remote control in conjunction with other apparatus, for example, per FIG. **3**.

[0059] FIG. **1**H comprises a figure showing a range of motion of a second transducer about a fulcrum represented by anchor plane 1 and movement of the anchor point or point or point of motion via a screw or lever causing tilt about the fulcrum or anchor plane; FIG. **1**I, FIG. **1**J and FIG. **1**K show similar figures for third, fourth and fifth transducers.

[0060] FIG. **1**L comprises a figure showing how a lever mechanism may be alternatively used to move a transducer plate mounted at an anchor plane via, for example, an attachment of the transducer plate moved by a micro-motor and lever wherein a dashed arrow shows a pushing direction and a solid arrow shows a pulling or flexion movement of the transducer plate.

[0061] FIG. **2** provides a schematic block diagram for embodiments and aspects of a device as shown in FIG. **1**A to FIG. **1**L which may be wired or wirelessly connected to a console as per FIG. **7** which may be wireless (or wired) and further including a wireless transceiver in addition to a transducer control unit. Also shown are a battery power supply, at least one motor for rotating a linear transducer element array, one motor each moving the array in perpendicular X, Y and Z directions and at least one motor for twisting the transducer, a linear transducer element array, for example, along a diameter of a circular transducer plane and analog to digital circuitry for converting collected image data to digital form for transmission via the transceiver, for example, of the console of FIG. 7A.

[0062] FIG. **3** provides an overview of a mechanical arrangement to be contained within a housing of embodiments of a transducer assembly unit for manipulating a transducer or linear transducer array in two perpendicular directions, for example, along an x axis and a y axis across a large area such as a chest or abdomen, to provide an angle of rotation to permit multiple image planes and a twist angle to redirect a sound wave emitted by a transducer or linear array of transducer elements whereby it is envisioned that a footprint on a patient body surface is rectangular or square and relates to the embodiments and circuits of FIGS. **1** and **2**.

[0063] FIG. **4**A provides an exemplary signal content format from, for example, a hospital server to a console (FIG. **7**A, **7**B) or transducer unit of FIGS. **1**A to **1**D or FIGS. **1**E to **1**L for providing motor control of a remotely manipulatable transducer or transducer array of FIGS. **1**A to **1**D or **1**E to **1**L, in conjunction with x, y and z axis movement over a skin surface area per FIG. **2** or **3** in a transmission direction from a hospital work station to a remote wired or wireless transducer including a unique transducer transceiver identifier if wireless or telecommunications transmission is utilized. The format (FIG. **4**A or **4**B) also provides for known and herein introduced control such as on/off, focus, frequency of operation, depth (related to frequency), magnification, mode, time and date and the like. Moreover, image data may be transmitted as will be explained with reference to FIG. **4**B and subsequently received at the transceiver for verification with transmitted data stored in memory **207**.

[0064] FIG. **4**B provides an exemplary signal content format for providing a reply signal from a transducer or transducer array of FIGS. **1**A to **1**L, **2** or **3** in a direction from a remote wired or wireless transducer including a unique work station identifier if wireless or telecommunications transmission is utilized toward the work station (for example, at a hospital) or an associated server. The depicted format provides for feedback of actual location data of the position of the transducer or transducer array, time and date of image data (not shown), as well as image data collected for that location and time and date.

[0065] FIG. **5** shows a workflow scenario whereby the primary workstation or server and plurality of workstations is remote from a fluoroscopy suite A., operating room B. and the like (for example, at a hospital) and, if necessary, shielded from adverse impacts of radiation such as magnetic resonance; a field emergency C. is coupled via the primary workstation such as a GHOST console (intelligent communication device) (FIG. **7**A) and via wireless (satellite, telecommunications, radio, the internet) or network cable or both to a remote workstation at a hospital where an assessment, diagnosis or a surgical or intervention team may be present.

[0066] FIG. **6** shows another workflow scenario for describing, for example, remote field emergency use, operating room B., fluoroscopy suite use A. and primary and alternative work stations connected by a wireless or wired telecommunications network where a primary workstation having a plurality of displays may be shielded from adverse impacts of radiation or at the field location as per FIG. **7**A.

[0067] FIG. **7**A is a drawing showing an adhesive strip **115** for fastening, for example, a disk embodiment of FIG. **1**A-**1**D or cylindrical embodiments with z axis movement FIGS. **1**E to **1**L to a human patient body at successive locations such as head, neck, chest, abdomen; local cabling connects the disk embodiment to a local console or intelligent communication device which may be a laptop with a plurality of ports for other local peripheral devices such as an ultrasound image guided catheter for internal imaging, a blood pressure monitor, a body thermometer, environmental sensors and the like, the laptop equipped with a camera/microphone that may visually/audibly record the patient wherein the laptop may be replaced by another intelligent device such as a pad or intelligent cell phone; the laptop or intelligent communication device having wired port or LAN wireless connection to peripheral devices or satellite connection if located in a very remote, for example, mountainous or desert region.

[0068] FIG. **7**B illustrates an overall system block diagram of an assessment system hardware environment that may be used according to an illustrative embodiment of the invention including a console which may be an intelligent mobile telephone featuring a data collection and identification software application from various input devices including one or more attachable/implantable ultrasound devices, a communications interface, a program controlled controller, a computer bus, a remote hospital or medical server and the like.

[0069] FIG. **8**A shows an embodiment of an image guided catheter that may be used in conjunction with a patient body surface mounted disk embodiment of FIG. **1**A to FIG. **1**L to intervene in a diagnosed serious internal patient injury scenario having an introducer needle at a distal tip and imaging ultrasound transducer guidance of the catheter to a target area internal to the patient's body.

[0070] FIG. **8**B shows an embodiment of FIG. **8**A from a frontal view with an imaging channel to be ultimately seen by hospital personnel via FIG. **7** and the introducer needle at the distal tip.

[0071] FIG. **9**A shows that an embodiment of FIG. **8**A may further comprise side outlets for imaging to the side via ports for a transducer and FIG. **9**B shows a plurality of channels from an end view for tools, needles, imaging and the like for the embodiment of FIG. **8**A.

[0072] FIG. **10** shows an example of the use of ultrasound imaging in combination with fiber optic visual imaging in a modified embodiment of the image guided catheter of FIG. **8**A.

[0073] FIG. **11** shows an example of the use of a microelectronic motor system (MEMS) tool manipulator for performing injury alleviative measures at an internal patient site where the needle channel comprises a removable needle replaceable by the MEMS tool once at the internal patient target site.

[0074] FIGS. **12**A and **12**B show examples in a closed and open position of a retrieval instrument that may be used to grab and remove an object at a target site, an example, may be shrapnel or a bullet retrievable from an internal target site.

[0075] FIG. **13** shows a hospital end having at least first and second displays for ultrasound images of an ultrasound disk embodiment secured to a patient per FIGS. **1**A to **1**L and another image which may be an image generated by a console or cell phone camera, an ultrasound image generated by an image guided catheter of FIG. **8**A or **8**B or other imaging apparatus used at a field emergency scene, the skin mounted device **1310** being integrally coupled to an image guided catheter **1350** approaching a patient liver **1450**.

[0076] FIG. **14** shows an exemplary embodiment of an image guided catheter having a distal tip from which an introducer needle or other replacement tool may protrude and be imaged by ultrasound transducers **1940** mounted so as to capture an imaging zone including the introducer needle/tools and be mounted, for example, at the periphery of an elongated catheter body.

[0077] Embodiments and applications of a remote ultrasound assessment and intervention system will now be described in the detailed description of preferred embodiments with reference to the above briefly described drawings.

DETAILED DISCUSSION OF PREFERRED EMBODIMENTS

[0078] Embodiments of a remote ultrasound assessment and intervention system will now be discussed briefly by introducing several components shown in the drawings. In the drawings, similar reference numerals are used to denote similar elements. Starting at the patient end, there is provided, for example, a wired or wireless remotely controlled, for example, disk or cylindrically shaped unit which may be utilized by a first responder or a good Samaritan at a field emergency site under control of medical personnel. This disk or cylindrical unit is intended for successive attachable or implantable placement on or in a patient's body until an internal injury or disease is assessed and diagnosed. According to triage principles, intervention may be applied to a more serious internal injury first. The field emergency site may be remote such as in a mountainous region of Afghanistan or a snow field in a remote location in Alaska. On the other hand, the field emergency site may be located proximate an emergency pedestal such as a pedestal location on a busy street in Boston or in a building where first aid supplies and telecommunications outlets are available, for example, for immediate communication to a hospital assessment, diagnosis and surgical team. In other words, potential applications of a remote ultrasound assessment and intervention system may include war zones or potential areas of terrorist activity or more normal locations where a medical emergency may occur such as at an airport or train station. An embodiment of a remote ultrasound assessment and intervention system may be portable, accompany an emergency vehicle from a remote site to a hospital and provide periodic location and time of arrival estimates.

[0079] Referring first to FIG. **7**A, it is envisioned that an adhesive strip **115** coupled to a remotely controllable ultrasound device per FIGS. **1**A to **1**L may be used by a good Samaritan or first responder to successively be applied to a head, neck, chest, abdomen and extremities of a patient found at a field emergency scene in response to a protocol displayed on a display of personal computer **700** or other intelligent telecommunications device having a display. Adhesive tape may be used for attachment and an ultrasound impedance gel used between skin surface and device. The device may also be implantable in a body cavity under direction of remote medical personnel. Collected medical data and visual images and sound of the patient from the emergency scene may be assessed by remote medical personal at a hospital or doctor's office. An object of the application of a disk-like device to a patient is to provide a view (ultrasound or fiber optic) of an internal injury or disease that may be remotely controlled by input commands from remote hospital personnel remote from the medical emergency site. Such medical personnel may input commands to move the ultrasound device so as to rotate, tilt and even move in orthogonal x and y directions on the patient's skin surface and toward or away from the skin surface (a Z axis) under remote control (FIG. **3**) at the medical emergency site. A z direction of movement in certain embodiments is used to locate the transducer with respect to the patient's skin surface which may be naturally curved (an example being a curved surface of an abdomen of a pregnant woman).

[0080] In the event of a bullet wound, for example, or shrapnel attack, the remotely controllable ultrasound imaging device according to FIGS. **1**A to **1**L may be placed proximate the entry (or the exit wound if one exists) and scan a region of interest internal to the patient body. Similarly, a collapsed lung or the collection of fluid in a chest or abdomen cavity may be assessed and diagnosed.

[0081] Any intelligent device may replace the personal computer **700** including a cell phone, an intelligent I-phone, a 4G intelligent communications device and pad-type intelligent devices. These are typically equipped with several of the following, a compass, a gyroscope, an accelerometer, a magnetometer, a camera (still and/or video), a global positioning system for determining a location of the device, a time of day clock and calendar and several ports for receiving medical and environmental data from other devices that may be at the field emergency scene. These may include, for example, a blood pressure meter, a thermometer, a heart defibrillator, a first aid kit with bandages and antiseptic and a further image guided catheter instrument as per FIG. **8**A that may work integral with or in conjunction with the attachable/implantable device of FIGS. **1**A-**1**L to perform intervention at the injury site.

[0082] In many locations, not as remote as a mountainous region of Afghanistan, normal telecommunications lines may link the apparatus with a remote hospital diagnosis or surgical team per FIG. **5** or FIG. **6**. In such remote regions as a camp of Eskimos in Alaska, a satellite radio or telecommunications link **710** including a transceiver and antenna may be used as may be known from telemedicine embodiments to link a hospital in Juneau, Ak. or Walter Reed hospital in Washington, D.C., United States via satellite to communicate with the remote field emergency site of an injured patient and the first responder or good Samaritan (mostly needed to set up the intelligent device and ultrasound unit by fixing the device using ultrasound gel and pointing a camera of the intelligent device). If the patient is conscious, the patient may operate on their own body to collect medical data and assess their situation under direction of a remote medical team. The field emergency site itself may be the result of a terrorist attack or a military war zone injury by way of example.

[0083] FIG. **1**A to FIG. **1**D comprise a disk version and include a top view (FIG. **1**A) and side view (FIG. **1**B) of a first plurality of embodiments and aspects of the disk version multi-plane transducer assembly unit of FIGS. **1**A and **1**C comprising, for example, a rotatable linear array **100** of transducer elements mounted on a, for example, circular transducer plane **103**, including a housing **105**, the array **100** adapted for forming a beam of ultrasonic energy (directed upward and reflected downward in FIG. **1**A) and receiving a reflected beam at primary and harmonics of the transmitted frequency. FIGS. **1**B and **1**C provide further details of rotational and tilt or twist motor movement of a transducer element or array **100** of, for example, piezocomposite or crystal material of housing **105** via rotation and tilt motors (to be discussed further, for example, with reference to FIGS. **2** and **3**). Vermon of France's US subsidiary, Vermon, USA of Lewistown, Pa., provides piezoelectric composite transducers **100** that may be customized for a particular purpose.

[0084] FIG. 1D provides further details of rotation and seesaw or tilt/twist movement to capture multiple image planes per panel A (side profile) and B (end face view) of transducer plane **103** of disk housing **105**. The housing **105** comprising transducer elements **100** may be mounted by securing material **115** to an animal (human) body of, for example, a patient or victim (not shown) or comprise securing portion **115**. The housing may also be used without securing material **115** or be used with tines as an implantable device in a patient cavity (for example, nose, mouth and abdomen via the anus). The transducer array or element **100** may be remotely controllably rotated and otherwise remotely controlled by wired or wireless signals transmitted toward the transducer **100** or array from a remote workstation; (see FIGS. **5**, **6**, **7**A). An ultrasound or other imaging operator need not be proximate the patient's body to manipulate or control the transducer elements **100** or movement of housing **105**. Transducer **100** may comprise a single transducer element for ultrasonic transmission and reception of reflected sound waves or, for example, a linear or other shaped array **100** of transducer elements mounted, for example, in a circular manner from a top perspective as a diameter of the circle or at the center of the circle comprising housing **105**. An arrow of FIG. **1**B indicates an angle of rotation in a clockwise or counterclockwise direction of the transducer element **100** or a transducer array within housing **105**. Housing **105** of FIG. **1**C includes a motor for rotation **216** and motor for see-saw or tilt motion **222** per FIG. **1**D. Typically, an angle of rotation of 180 degrees when used with a transducer array **100** will permit the collection of a plurality of image planes, for example, of the heart or other target area of concern over which the transducer array **100** within housing **105** may be located and fixed to the body surface by a fixing adhesive band or non-adhesive wrap at **115**, in this case, a preferably cylindrical or disc-shaped housing **105** as seen from top and side views forming a circular footprint on the patient body skin surface. The shape of the housing can be preferably contoured to any shape for easy insertion and implant into a body cavity (as appropriate and if requested by remote medical personnel). The housing **105** may be fixed to the skin surface, for example, of a human patient body at a field emergency site, for example, in a position at the center of the chest to monitor the heart immediately below; (see embodiment of FIG. **1**E). The top surface of the side view (FIG. **1**C) shows transducer crystal **100** or transducer array which may rotate at the surface of the housing **103**. It may further comprise an x, y plane assembly shown in FIG. **3** for x, y movement over an entire surface of a human body such as a chest or abdomen monitor. The top surface of housing **105** intended to be fixed to a patient may be preferably covered by an impedance matching substance which may be complimentary to the application of a suitable impedance matching gel. The embodiments of FIGS. **1**E to **1**L permit z axis movement (toward or away from skin surface) to improve imaging and impedance gel matching, for example, at a curved body surface. Fastening or securing material **115** is shown in top and side views for fixing the housing **105** in combination with an x, y assembly per FIG. **3**, for example, to a human body skin surface with the transducer/impedance matching surface facing the human body surface. The securing material **115** may be a band or elastic band that wraps around the body or, in an alternative embodiment, an article of clothing or form part of anchoring portion or comprise an adhesive strip. Within the housing **105** is also contained at least one motor, in the embodiment of FIG. **1**B, for example, a motor **216** for rotating a transducer element or linear array **100** and/or rotating the array about another array, for example, an image-guided catheter/sheath (FIG. **8**A, FIG. **13**). Motor **222** provides tilt so the transducer may be tilted to point toward regions outside its immediate imaging zone if pointed straight ahead. Also located within the housing **105**, for example, in the vicinity of the motor may be a wireless transceiver and antenna (see, for example, FIG. **2**, **7**A) for controlling the motor, a transducer control unit **210**, and other circuitry as necessary for receiving and processing motor control signals and other known control signals such as on/off, mode of operation (such as color Doppler versus conventional gray scale), depth of field, brightness, contrast, focal length, sweep speed, magnification, frequency of operation, focus, focal length, Doppler velocity measurement and the like. Also, shown in FIG. **2** is a battery or power system **224** for powering the motors, personal computer **700**, radio/telecommunications transceiver and other circuits requiring power. Alternatively to a wireless device, housing **105** may have a control cable or wire for transducer output control via console **700** (FIG. **7**), providing power, motor control and the like.

[0085] Cable may lead from an input data or imaging device (camera or ultrasound) to, for example, a USB port or LAN transceiver of a workstation console **700**, preferably located proximate to the patient emergency site for telecommunication connection to a hospital server communicating with a plurality of workstations (FIG. **5**, **6**A). These operate in a similar manner to known cables used with devices such as a Toshiba PowerVision™ ultrasound machine, the difference being that the depicted cable further includes a rotation, twist, linear direction or other motor control lead or leads or a data line of such cable further incorporates rotation, direction and twist motor control data in a serial data stream on a single data lead. In an embodiment per FIG. **3**, there may be further x, y and z axis motor control data leads of the cable. Alternatively, another manufacturer of ultrasound workstations is Analogic Corporation and, in particular, B-K Medical A/S of Herlev, Denmark. Per FIG. **1**C, cable may include at least motor **216** control wiring connected to rotation motor **216** for control and power purposes and tilt motor **222**. Cable may further comprise transducer wiring for power, transducer control and image collection purposes.

[0086] As will be described herein and as illustrated by FIG. **2** and FIG. **3**, further motors **216**, **222** such as motors **218**, **219**, **220** may be provided for twisting linear array **307** to permit a different direction of sound wave emission and/or reception of reflected sound waves. Further motors **218**, **219**, **220** in conjunction with assembly (FIG. **3**) provide three directions, for example, lengthwise and widthwise (x and y) axis as well as depthwise (z axis) movement in the plane of the human body surface and according to how a rectangularly shaped assembly (FIG. **3**) constructed of flexible or body surface conforming rods per FIG. **3** is placed on the body, i.e. an x, y and z axis are considered in relation to the housing **105**. The housing **105** may be mounted at an angle or other manner most comfortable for the patient, yet effective. Motor **222** may comprise an optional gear, screw or lever assembly (FIG. **1**E, **1**F, **1**L) for more accurate, for example, incremental movement of transducer array **100** in x, y and z directions as well as provide tilt. Motor **222** and other depicted micromotors are preferably a micro or miniature linear motor known in the art for turning a rotor for twisting an array **100**, operating screws and levers and associated optional gear assembly for rotating the coupled transducer element **100** or linear array at incremental steps such as one degree steps from a vertical or horizontal orientation (vertical shown) through a 180 degree range—clockwise or counterclockwise. In this manner, a linear array **100** may capture up to 180 different planes of view of, for example, a heart, lung, liver, kidney, stomach or other organ under observation, and a moving three dimensional (4D) view may be constructed using known software data analysis processes. Of course, the three dimensional analysis is improved and made stereoscopic if pairs (or more than two arrays) of devices at different observation locations (head, neck, chest, abdomen and extremities as well as body cavities) may be used as necessary.

[0087] A transceiver **205** (FIG. **2**) and antenna **201** (as also seen as antenna **710** in FIG. **7**) or a cable may report the actual rotation position of the transducer array **100** to a remote hospital workstation (not shown) as a value, for example, between 0 and 180 degrees. The physical location of the transducer **225** at a given time may be calculated by detecting a known body part, such as a heart, lung, kidney or liver (FIG. **13**), and from the x, y, depth, rotation, twist, frequency of operation and other control data received at the workstation from the transceiver **205** calculate the physical position of a given housing **105** on the skin surface of an injured patient. In an alternative embodiment, the electronic circuit of FIG. **2** may comprise an input keyboard or selector (personal computer **700** keyboard, for example) for selecting one of a plurality of locations on the body, such as chest or abdomen, and/or a target organ, such as one of two lungs, the liver or the heart.

[0088] Typical sizes for a cylindrical disk version transducer housing **105** as shown in FIGS. **1**A to **1**D or FIGS. **1**E to **1**L may be from 0.5 cm in diameter to 3 cm in diameter. The height of the cylindrical housing may be similar or less than 1.5 cm. The size of a housing **105** is directly related to the components it contains. In embodiments intended to be placed in body cavities, the housing **105** may be sized to conform to the cavity. Certainly, the trend in the electronic arts including mechanical motor arts is toward further miniaturization and integration. Consequently, notwithstanding the given dimensions, it is not inconceivable that a housing **105**, for example, may be reduced in height or thickness to the range of millimeters or even micrometers within the next twenty years. The ultrasound imaging device is intended to be disposable and be inexpensive or may be contained in a protective covering of dispensable material. The housing **105** may support the additional movement of an OCT, infrared or other medical imaging device known in the art if the housing **105** is so equipped. The size of the footprint on the human body or whether the device is used internally in a body cavity may relate to the particular application and not necessarily to the sizes suggested above for housing **105**.

[0089] If a housing **105** is assembled per FIG. **2**, **3** to provide x and y movement, it may have a rectangular shape or footprint which may be concave to fit a neck or the surface of a pregnant woman, for example, for observation of a fetus. The embodiments of FIG. **1**E to FIG. **1**L provide for z axis movement toward or away from a curved skin surface to provide improved imaging over a large area of curved skin surface. The rectangular shape of the assembly of FIG. **2**, FIG. **3** may be on the order of size of 10 to 20 cm by 12 to 30 cm and be adjustable, in which case, linear motors are provided for two directions, for example, x and y axis manipulation of the transducer array in these larger dimensions in addition to rotation and twist. Referring briefly to FIG. **3**, the surface proximate to the body of a housing shown as rotation **306**, twist **307** circle may comprise a rectangular shape. Linear motors may move small flexible rods carrying, for example, a transducer array of an embodiment of FIG. **1**A to **1**D or **1**E to **1**L to a particular x, y coordinate ranging, for example, from 0 to 10 cm in one direction to 0 to 12 cm in the other direction within its footprint on the body surface in incremental steps, for example of 5 mm. In a further embodiment as described above, a motor **222**, **307** may be provided and mounted to twist a linear array as well as provide an incremental angle of rotation via rotation motor **216**, **306**, again, within a range of 0 to 180 degrees with a default position at 90 degrees, or directly pointing sound waves into the human body; (see FIG. **2**, **3**). In an alternative application, for example, to image a human heart, the x and y motors **218** and **220** may be actuated to improve imaging by moving a location of transducer or transducer array **225** to another location removed from a partially obstructed ultrasound path or one including undesired reflections, for example, caused by an implanted device or an invasive device used in the vicinity of the heart region of interest.

[0090] Referring now to FIG. **1**E, there is shown a cylindrical embodiment having a transducer housing **153**. The transducer resides within the housing **153** on a plate and the housing **153** contains all the mechanics to move the transducer (which may sit on the transducer plate **154**). Further figures for such a cylindrical embodiment include FIGS. **1**F to **1**K for screws or pistons and FIG. **1**L for a lever application. Per FIG. **1**H, for example, the anchor plane **170-1** is maintained by a particular set of two screws **175-7** and **175-3** keeping their position steady. The resultant effect of moving point of motion anchor point **175-1** is a tilting of the transducer in the plane of the anchor point and screw points **175-7** and **175-3** forming a fulcrum. The transducers may mounted to a circular plane **154** adjusted by micro-motors **156** controlling pistons or positioning screws (shown). A matching layer **152**, as discussed above, may be covered with imaging and impedance matching gel and coupled to an imaging surface **150** of a patient body (also typically covered with gel).

[0091] FIG. **1**F shows extension and flexion via the micro-motors **156** and, for example, telescoping screws or bars **158** where a transducer plate **154** may tilt to one side or the other within the housing of FIG. **1**E. The transducer plate may further move in a Z axis direction toward or away from a skin surface (or interior surface of a body cavity if implantable). A number of transducers may be mounted on the transducer plate **154** and controlled by a plurality of anchor points **175-1** to **175-8** as will be described with reference to FIGS. **1**H to **1**K to provide a range of tilt motion without rotation per FIG. **1**G. While 8 anchor points are shown, 4, 16 or 32 points may be used to some advantage or any other number so long as a tilt and synchronous motor operation may cause all such anchor points to form, for example, an anchor plane from oppositely located anchor points and a point of motion anchor point as will be discussed further herein. In FIG. **1**G, there is shown, by way of example, z axis anchor points **180-1**, **180-2**, **180-3** and **180-4** for moving a transducer plate **154** where each opposing pair of anchor points may be moved by an orthogonally located anchor point of motion. When all four anchor points move simultaneously in the same z axis direction, the plate **154** moves toward or away from the skin surface.

[0092] The anchor plane may be kept constant so that the motion of an anchor point will result in a tilt of at least one transducer mounted on the circular transducer plate **154**. Per FIG. **1**L, the anchor plane may be controlled by a motor driven lever in place of a screw or piston. Telescoping screws or pistons or bars **158** are shown in FIG. **1**F for a tilt motion of plate **154** or motion in a z axis direction toward or away from a skin surface.

[0093] Referring, for example, to FIGS. **1**H to **1**K there are shown in FIG. **1**H a first anchor plane 1 **170-1** or fulcrum that may be moved at a point of motion or anchor point **175-1**. Eight different anchor points **175-1** to **175-8** are shown and successive anchor planes **170-2** and so on are shown orthogonal to and provide a fulcrum for the transducer plate **154** to tilt in any direction for forward-directed imaging. To freeze a certain plane, two anchor points with associated levers or screws/pistons/bars may remain fixed and an orthogonally located anchor point fixed after movement to a desired angle of tilt. Depending on the particular anchor point **175** being moved, there could be one of four (or more) anchor planes **170** being frozen or fixed in a desired position via a screw/lever. Anchor point **175** motion may be controlled by a motor driven lever **180** (FIG. **1**L) or by the telescoping screws/bars **158**. Extension or flexion (retraction) of individual levers or screws may change the position of the anchor point thus tilting the remote assessment transducer plate **154**.

[0094] The transducer plate **154** may also move toward a skin surface or away from the skin surface. This forward and backward z axis movement of a transducer plate **154** may be especially surface if a large curved skin surface area is to be covered by the housing **153** as it moves in x and y axis directions per FIG. **3**, for example, to cover an abdomen.

[0095] Per FIG. **1**L, there is shown an alternative lever mechanism driven by a micro-motor **156** for flexion, bring the plate closer to the motor plane and extension, push the transducer plate **154** away from the motor plane and toward the patient. The transducer plate **154** is shown having a ring attachment **182** by way of example to the lever/handle **180** so as to tilt the transducer plate **154** about the anchor plane **170** (FIGS. **1**H to **1**K). The anchor plane **170** is maintained by a particular set of two levers keeping their position steady (similarly to the screw embodiment) with the resulting effect being a tilting of the transducer in the plane of the anchor point, point of motion. Similarly to the screw embodiment, there may also be z axis movement toward or away from the skin surface.

[0096] FIG. **2** provides a schematic block diagram for embodiments and aspects of a wireless device as shown in FIG. **1** including a transceiver **205** (which may be a wireless telecommunications transceiver), a transducer control unit **210** which may comprise a microcomputer, a battery **222**, at least one motor for rotating a linear transducer element array, the linear transducer element array **225** and analog to digital circuitry **214** for converting collected image data to digital form for transmission via the transceiver **205**. In FIG. **2**, a wireless embodiment of a remotely manipulatable ultrasound transducer is assumed. Battery supply unit **224** is preferably a rechargeable lithium battery known in the art that powers all units requiring power within a housing **105** (not shown in FIG. **2**).

[0097] Transceiver **205** is an alternative data transceiver to a control and data cable for transmitting and receiving information and may receive and transmit a digital data signal generally in keeping with FIGS. **4**A and **4**B via antenna **201**, **710**. While these figures depict what may be construed as a serial data stream, the depicted data may be sent in parallel or serial format and in any order including the order shown. Moreover, the depicted data transmitted in each direction may be supplemented by other known control or imaging data and other unit identification data such as server address data. Known telecommunications protocols may be utilized if the transceiver **205** or cable transmits and receives by radio frequency signal such as WiFi, blue tooth, Wimax and the like for a wireless local area network or optical signal via a dual mode optical fiber. As is known in the art, infrared and ultrasound may be used as well as other light frequencies than infrared as may transmission in the microwave band. On the other hand, light waves are typically incapable of penetrating through walls and require a line of site transmission path. Yet, by way of example, light wave transmission is feasible; for example, a light wave transceiver connected to a work station may be mounted, for example, in the ceiling of an operating arena and a unit mounted to a patient facing upward may communicate with the ceiling mounted unit in a line of sight. As described above, since a cable may provide a direct link to a remote hospital work station or to a server (FIGS. **5**, **6**) communicating with a remote work station (FIG. **7**A), cable need not necessarily transmit data uniquely indicative of a given transmitter, transducer or work station because the cable may comprise a direct link (once called a private telecommunications line) between known devices.

[0098] Alternatively, the data of FIGS. **4**A and **4**B may additionally comprise a unique server address if a server is host to a plurality of client work stations or secondary back-up work stations. Moreover, the workstation ID of FIG. **4**B may be a primary work station and the data signal further comprise an address for one or more secondary work stations. If any other device is connected to cable **104**, then addressing using a unique address (or telephone number) or other identifier should be used for a connected device. Transceiver **205** may receive a data signal from a work station, demodulate the signal and output a demodulated baseband data signal including data per FIG. **4**A to transducer controller **210** which may be a microprocessor, application specific integrated circuit or other control circuit which may be designed and fabricated in a manner well known in the art. Transducer controller **210** may run a real time clock and date program synchronized periodically with a real time clock at an associated work station. In the other direction of transmission, the transceiver **205** may receive image data for one or more planes or sequential images and other signal including actual position data (for example, x and y coordinates, magnification, depth, rotation angle, twist angle, real time and date and the like) per FIG. **4**B from transducer controller **210** for transmission to a uniquely identified remote work station. Further collected and transmitted data may include and is not limited to include GPS location data, blood pressure, temperature, pulse and the like data collected at the emergency site.

[0099] Following the path of a received signal at antenna **205**, the received signal may be received at radio frequency at transceiver **205** (or via cable at RF, optical frequency or baseband), demodulated, if necessary, and a Rx data output signal passed to controller **210** for processing. Controller **210** authenticates the signal as directed to it by means of the transmitted unique transducer identification code of FIG. **4**A. In addition, the signal may require processing in accordance with well known protocols for decompression, decryption, parity and other data error detection and correction algorithms and the like (not shown). In one embodiment, for example, for multi-planar imaging purposes, the transducer array **225** is linear (along a diameter per FIG. **1**A) and may be rotated and tilted. A rotate signal which may indicate an angle between 0 and 180 degrees in incremental steps of, for example, one to five degrees can indicate rotation in a clockwise or counterclockwise direction or indicate an angle to which the transducer array or element is to be rotated (for example, from 90 degrees, actual present position, to 120 degrees, desired position) is received and passed to linear motor **216** having a rotor for rotation using, possibly, an optional gear assembly **109** for turning the linear array **102** to a desired angle of rotation.

[0100] In an alternative embodiment, for example, for therapeutic purposes, a direction of sound wave propagation, frequency of transducer operation (if variable), depth (dependent on frequency) and the like signal are received and reported to actuate twist motor **222** to a desired angle of twist in addition to a desired angle of rotation via motor **216** to, for example, deliver a therapeutic sound wave to a given body organ or sub-tissue layer at a given transmitted depth, for example, represented by a sound wave power level, within the patient's body from the transducer **100**, **225**. In an embodiment paired with another unit, the angle of twist and rotation may be synchronized so that one transducer array **100** may cooperate with another transducer array as sound wave transmitter and sound wave receiver for together providing image data either individually or together. Also, a therapeutic transducer (operating at a lower ultrasound frequency range) and an imaging transducer (operating within a higher ultrasound frequency range) may be mounted to the same movement system **300** per FIG. **3** within the same or different housings **105**.

[0101] In a further alternative embodiment, the transducer array **100**, **225** or transducer element may be manipulated in two directions, perpendicular to one another, along the patient's body surface, denoted an x direction and a perpendicular y direction or axis as shown in FIG. **3**. If used inside a body cavity such as a nasal, oral, ear or other body cavity, a cylindrically shaped housing may contain a transducer which may rotate 360° and be moved by separate motors along the length of the cylindrical housing **105** shaped for the cavity to different lengthwise, axial positions. The transceiver **205** outputs such transducer control data to controller **210** which then actuates motors **218** for x axis movement, **219** for z axis movement and **220** for y axis movement, **216** for rotation and **222** for twist of transducer element or transducer array **102**, **225** as shown in FIG. **3**. Also shown in FIG. **2** are x, z and y axis **227**, **228**, **229** which are controlled by motors **218**, **219**, **220**. When arriving at the x, y, z position of interest, the transducer **102**, **225** may be rotated or twisted or rotation and/or twisting/rotation may occur en route to the x, y, z position of interest. Feedback to the remote work station may be provided via actual data indicating all parameter values of interest, on/off, focus level, depth, magnification, ultrasound frequency, x axis, y axis, z axis, angle of rotation and angle of twist (most of which are shown in FIGS. **4**A and **4**B) as well as image data and work station address or identification.

[0102] Also, controller **210** may be in receipt of motor control, off/on, focus control, mode, magnification, frequency of operation, depth and other control data which is passed to transducer **100**, **225** for proper operation, for example, to regulate the amount of power delivered to transducers for sound wave emission or for focusing the array. This control lead or collection of leads is shown as data line **235**. If more than one transducer is provided for, for example, simultaneous imaging and therapeutic purposes, then, a selection bit for selecting one or the other transducer or array may be included in the data of FIG. **4**A.

[0103] The output of transducer array **100**, **225** may be raw image (reflected sound wave) data similar to that obtained by a hand-held transducer array known in the art. It may be in analog form and provided to an A/D converter **214** for sampling at an appropriate sampling level, for example, depending on desired image resolution. The data signal output of A/D converter **214** may be further compressed at data compressor **212** prior to formatting at controller **210** for transmission at transceiver **205** and/or storage at memory **207**, for example, according to FIG. **4**B. These circuits **214** and **212** are shown as separate circuits but may, together with controller **210** be in the form of a single application specific integrated circuit (ASIC) or provided as separate circuits. Memory **207** may be on board a microprocessor chip or provided separately. In one embodiment, memory **207** may comprise a removable memory for uploading, for example, imaging data collected over time to a device for telecommunications transmission. The image and other data prior to transmission or for long term storage may be temporarily or more permanently stored in memory **207**. Similarly, memory **207** may be utilized for temporarily storing control data as received from transceiver **205** and prior to being operated on by controller **210**. In one embodiment as will be described herein, there is no data transmission via cable or wireless means.

[0104] Image and associated position data and the like for a given image along with time of day and date may be stored in a fanny pack or personal remote control device worn or otherwise carried by the patient. This assumes a time of day and date clock associated with controller **210** or the time and day may be periodically updated via a transmission to the unit of FIG. **2**. In, for example, a therapeutic embodiment of a remotely manipulatable transducer array, the patient wearing or carrying the device may control delivery of therapeutic sound waves via a transducer array **102** and control the direction and depth of transmission. For example, ultrasound has been found to assist in relieving arthritis and other pain, for example, in a hip, shoulder, knee or other joint.

[0105] In one embodiment where the circuitry and motors are contained in a housing and in accordance with FIGS. **1**A-**1**L, **2**, **3** and **4**A and **4**B, the housing is temporarily fixed to a person. An alarm may indicate a point in time when a memory **207** is full of un-transmitted images, and the wearer or first responder must change the memory card of memory **207** or report to a work station or other telecommunications facility for image data upload.

[0106] In a further embodiment according to FIG. **2**, there may be provided a wired remote control for use by a wearer to apply therapeutic ultrasound energy and so control x and y axis and twist motors and control ultrasonic frequency range to deliver therapeutic treatment, for example, in the event that a workstation operator is out of wireless contact with the wearer or the wearer has been pre-instructed as to a particular therapeutic treatment that may correct a given complication. The priority of control of an assembly according to FIG. **3** is surgeon, hospital workstation operator, first responder and patient. Ultrasound waves are for the most part harmless. On the other hand, a user may be provided only limited control over, for example, frequency and intensity while a surgeon will have unlimited control especially in emergency intervention situations.

[0107] FIG. **3** provides an overview of a mechanical rectangular or square assembly arrangement to contain a housing **105** to provide x, y movement of embodiments of a transducer unit for manipulating a transducer or linear transducer array in two directions, for example, along an x axis and a y axis and to provide an angle of rotation and a twist angle at a desired x, y coordinate pair to redirect a sound wave emitted by a transducer or linear array of transducer elements whereby it is envisioned that a footprint on a patient body surface is likewise rectangular or square and relates to the embodiments and circuits of FIG. **2**. Assume the rectangle housing comprises flexible guide wires or rods **300**, **301**, **302** and **303** that may be adjusted to a desired length on which are provided y-axis rod **304** which may be moved in an up and down direction shown via a corresponding motor **220** and gear assembly not shown to incremental steps along the y axis. Similarly, there is provided x-axis rod **305** which may be moved to the left or the right direction shown via corresponding motor **218** and a gear assembly not shown. X-axis rod **305** and Y-axis rod intersect at a desired point where an array or element may be affixed via further motors **216**, **222**. For example, rotor **306** of motor **216** (in combination with an optional gear assembly **109**) provides rotation of a mounted transducer array **100**, **225** or transducer element to a predetermined or desired angle of rotation. Motor **222** provides twist **307** to linear array or element **100**, **225** to change direction of sound wave transmission or reception with 90 degrees—straight down—being a default position for twist.

[0108] FIG. **4**A provides an exemplary signal content format for providing motor control of a transducer or transducer array of FIGS. **1**A-**1**L, **2** and/or **3** in a direction from a work station to a remote wired or wireless transducer including a unique transducer transceiver identifier if wireless transmission is utilized. The format also provides for known control such as on/off, focus, depth, mode and the like. According to various embodiments, motor control data may comprise an x direction or a longitudinal axis direction, a perpendicular or y direction, a z direction value, an angle of rotation, an angle for twist of a transducer or array as depicted. There is also a DRR field that may be used for all other control mentioned herein including but not limited to: magnification, depth, frequency range, transducer select data or a plurality of transducers, an indicator of a controlling work station or user or other control indicator that may be included in this field. Other control or other data to be transmitted in a direction from work station or other user towards an identified transducer assembly may come to mind of one of ordinary skill in the art of ultrasound apparatus such as to control automatic collection of environmental or movement or location or estimated time of hospital arrival data. Motor control data may be transmitted, for example, in the form of ultimate desired position or as an incremental step from an actual position or other way that may come to mind of one of skill in the art.

[0109] FIG. **4**B provides an exemplary signal content format for providing a reply signal from a transducer or transducer array of FIG. **1**A-**1**L, **2** or **3** in a direction from a remote wired or wireless transducer including a unique work station identifier if wireless transmission is utilized. The wireless transmission may be directed via a hospital server and a server identification provided (not shown) serving one of a plurality of workstations identified by workstation identifier. The format provides for feedback of actual location data of the position of the transducer or transducer array. The actual location data may comprise an x axis or longitudinal axis dimension, a perpendicular y axis dimension, a depth or z axis location of the transducer plan in relation to the end face of the disc/cylinder, an angle of rotation, an angle of twist as well as image data. There may be an indicator as to the transducer or transducer array associated with the image data and a time and date indicator provided by the real time clock program of the transducer control unit for the time and date of collection of the image. In an embodiment including a therapeutic transducer, the frequency of operation and the level or magnitude of transmission and a measure of the reflected wave may be signaled as well as an image of the region of interest, for example, a blood clot. The actual location data may be compared to a desired location to determine if the remotely manipulatable transducer or transducer array has reached a desired position so that imaging may begin. Moreover, the imaging and control data may be collectively utilized by a work station to determine the location of the transducer assembly of FIG. **1**A-**1**L, **2** or **3**, for example, on the skin surface or within a body cavity.

[0110] FIG. **5** shows a workflow scenario whereby the primary workstation is remote from a A. fluoroscopy, B. operating room, C. field emergency and the like and, if necessary, shielded from adverse impacts of radiation such as magnetic resonance. One further limitation of using ultrasound in an operating suite is electrocautery procedures which may degrade collected image signal quality when the electrocautery apparatus is in use. Referring to FIG. **5**, there may be situations where the ultrasound operator at a primary work station be optimally protected, for example, in a fluoroscopy suite where the operator is exposed to radiation and would otherwise need a heavy lead suit. Even with the lead suit, the operator would typically have to move a 400 or 500 pound ultrasound machine back and forth from along side the operating table to away from the table when a C arm is being used. According to FIG. **5**, the ultrasound operator may sit at a remote primary work station after the unskilled first responder places the remotely manipulatable transducer or transducer array on or in the emergency patient at field emergency site C. Then, a hospital person may sit behind a lead shield or not to remotely manipulate and operate the transducer or linear transducer array from their primary hospital work station.

[0111] Note that a plurality of displays are provided at the primary work station as depicted for providing multiple views, stereoscopic views and the like obtainable from multiple transducers **1310**, **1330** of FIG. **13** or other transducers not shown. Also, there is typically inadequate space in an operating room for an ultrasound operator, for example, next to a surgical operating table, the emergency field site or an emergency transport vehicle location of a remote patient. At an emergency field site C., the operator or surgeon may instruct a first responder or good Samaritan or the patient place the transducer of FIG. **1**A-**1**L and then remotely manipulate and control and view images from the remotely manipulatable transducer or apply therapeutic treatment. Their work station can be located anywhere in a hospital and the operator communicates by telecommunications means with the patient or first responder at a field site C. or an emergency transport vehicle (not shown).

[0112] Also shown in FIG. **5** is a remote work station which may be a back-up for a primary workstation and communicate in a wireless or by wired (cable) to a primary workstation. The remote work station may be in telecommunications contact with the primary work station and with the surgeon of a fluoroscopy suite or an operating room. Primary and remote work stations may communicate with a diagnostician or surgical team via a hospital server for coordinating field emergency service C to a patient at an emergency site per FIG. **7**A with a console **700** for ultrasound/fiber optic internal and video camera imaging and medical data collection. If the primary work station is dealing with an ongoing operation, a medical field emergency may occur. A first responder may be guided to apply one or more remotely manipulatable transducer assemblies (FIGS. **1**A to **1**L) to an emergency patient and that patient be provided with therapeutic or imaging from a primary or remote workstation to assess a field injury and to provide relief.

[0113] FIG. **6** shows another workflow scenario for describing, for example, remote field emergency use, operating room, fluoroscopy suite use and primary and alternative work stations connected by a wireless or wired network such as a telecommunications network. Regardless of the patient location, even if the patient is considered a field emergency, the remotely manipulatable transducer may be placed by an emergency first responder or the patient themselves, remotely manipulated to a desired location on the patient body surface and internal image and medical data remotely transmitted to a hospital remote work station. The emergency first responder or patient at an emergency site can respond to simple commands to appropriately place or relocate one or more transducers on the victim, for example, via a telecommunications channel or guided under software control. For example, first responder personnel at a remote location in Alaska where there is a medical emergency can be remotely guided by a hospital in Juneau to properly place a remotely manipulatable transducer or transducer array at a location on the body surface (for example, staring with head, then neck, then chest, then abdomen and then extremities, and the internal ultrasound and visual image data and medical data from peripheral devices may be conveyed by satellite telecommunications to Juneau as control data is transmitted on the reverse path from a remote operator/manipulator (per FIG. **4**B). A second communications channel may used by the hospital operator to guide the first responder as to the proper successive placement of the one or more remotely manipulatable transducers or transducer arrays or to set up a camera of an intelligent device **700** (FIG. **7**). Thereafter, the hospital remote operator in Juneau may move the array remotely and control the injury/disease assessment and diagnostic, therapeutic or interventional imaging and treatment.

[0114] Referring now to FIG. **7**A, there is shown an emergency site and associated equipment including an adhesive strip **115** to be applied on a patient human body (skin) for assessment purposes. The strip **115** has a multi-plane transducer per FIG. **1**A to FIG. **1**L supported by the strip. If a wide area is to be assessed such as the chest or abdomen, the multi-plane transducer may comprise an x, y assembly as per FIG. **3** so that a hospital operator may remotely move the transducer within the area determined by x, y coordinates. There may be cabling **720** cabling the remotely controllable transducer (or other medical peripheral data collection devices) to a console or intelligent device **700**. A camera and microphone of the device **700** may be pointed by a local first responder or the patient toward the patient site or the injury. The local console **700** may be equipped with a display and a keyboard for making selections of an area of potential immediate concern (such as the chest or abdomen) and receiving guidance such as instructions or a diagram showing how to cover a selected surface with ultrasound gel, where to place a device on a patient's chest (or abdomen or other selected location) and how to set x and y maximum area coverage for certain individuals of different sizes. A further cable may be required in a very remote location such as a location only accessible by direct satellite connection via cable **710** to a depicted satellite antenna.

[0115] Referring now to FIG. **7**B, there is provided a general overall block diagram of an assessment, diagnosis and intervention system according to the present invention. Comparison may be done manually or, according to a computer-implemented algorithm on a computer system according to FIG. **7**B encompassing an intelligent device, at least an attachable/implantable ultrasound device and a remote hospital server system for receiving command input from a medical assessment and, as appropriate, a medical surgery team. Methods of the first embodiment and subsequent embodiments of an intelligent device **700** may be utilized in connection with computer readable media which may be provided for temporary or permanent storage in a personal computer, intelligent telecommunications device or other computer or computer system **700** comprising one or more parallel processors known in the art. FIG. **7**B is a block schematic diagram that illustrates a computer system **700** upon which at least one embodiment of the invention may be implemented. Computer system **700** may include a bus **702** or other communication mechanism for communicating information, and at least one device **704** such as an attachable/implantable ultrasound device coupled with bus **702** for receiving, processing and forwarding collected data information for remote transmission to a hospital server. Other devices **704** may comprise and are not limited to comprising a blood pressure meter, a pulse meter, a thermometer, an image guided catheter for intervention, a camera, a GPS system, a gyroscope, an accelerometer, a magnetometer, a fingerprint reader (or iris scanner), environmental data sensors, real-time of day and date stamping, location and movement sensing and reporting and other known devices, for example, of a typical personal computer and medical devices for collecting data.

[0116] Computer system **700** also includes a main memory **706**, such as a random access memory ("RAM") or other dynamic storage device, coupled to bus **702** for storing information and instructions to be executed by a controller processor **705**. Main memory **706** also may be used for storing temporary variables or other intermediate information during execution of instructions to be executed by processor **705** such as a biometric data collection, ultrasound image and identification software application or a disaster victim identification software application. Computer system **700** may further include a read only memory ("ROM") **708** or other static storage device coupled to bus **702** for storing static information and instructions for processor **704**. A storage device **710**, such as a magnetic disk, optical disk, solid-state memory, or the like, may be provided and coupled to bus **702** for storing biometric information, ultrasound image data and computer instructions. A storage device or any device coupled to the bus **702** may be removable using a coupling mechanism such as a universal serial bus (USB) or other hardware specific to the type of storage hardware, such as a CompactFlash, SD, or microSD card reader or port (or the port may be local such as a wireless LAN). A removable storage device may be utilized to transfer information to or from computer system/intelligent device **700**. Any of memories **706**, **708**, **710** may retain program instructions according to any embodiment of data collection software and analysis hypothetically related to a wounded individual, for collecting identity profile data, for example, when the patient is unconscious (camera data, fingerprint data, iris image, DNA analysis, biometrics). (Military dog tags and other identification found with an unconscious victim may provide an untrained first responder with victim identity clues reportable to the hospital for medical record retrieval).

[0117] Computer system **700** may optionally be coupled via bus **702** to a display **712**, such as a cathode ray tube ("CRT"), liquid crystal display ("LCD"), plasma display, television, small intelligent mobile telephone display or the like, for displaying information about the victim or command instructions from the hospital or predetermined command instructions to a medically untrained computer user (or the patient themselves). Display **712** may provide a virtual keyboard for data input, a real keyboard, a joystick and selector, a fingerprint reader or a one or two dimensional bar code reader via a camera or a touch screen. Display **712** may provide a split screen image comprising a vitals section, first and second ultrasound image sections, a visual camera image section, a section providing an ordered command set selectable for different possible internal injuries and the like.

[0118] Alternatively, information may be delivered to or collected from a hospital computer user or another computer system or computer program using a communication interface **718** or removable storage device. Communication interface **718** can function as an interface between computer system **700** and additional devices for collection of information, such as a fingerprint reader, a camera, an iris scanner and light source, a DNA analyzer, a heart defibrillator, a blood pressure meter, a thermometer, a pulse meter, or other devices **904** as are well-known in the field in addition to an attachable/implantable ultrasound device or image guided catheter. Communication interface **718** can enable communication using wires, wirelessly (e.g., Bluetooth or WiFi) optical fiber, infrared light-emitting diode and photo reception, carrier wave, or other technologies well-known in the art. There may be more than one communication interface **718** (for example, satellite and land-based RF). An input device **714**, which may include a physical or virtual keyboard including alphanumeric and other keys, may be coupled to bus **702** for communicating information and command selections to processor **705** and for storage in memory. An optional type of user input device is cursor control **716**, such as a mouse, trackball, stylus, or cursor direction keys, for example, as may be found on some personal data assistants (PDA's) for communicating direction information and command selections to processor **705** and for controlling cursor movement or the display on display **712**. This input device typically has two degrees of freedom in two axes, a first axis (e.g., x) and a second axis (e.g., y), that allows the device to specify positions in a plane. This input device may be combined with a display device such as a LCD with a touch screen, commonly found on mobile telephones or other telecommunications or presentation devices such as the Apple iPad or a computer tablet using the Android operating system. Alternatively, information and command selections may be communicated to processor **705** using a communication interface **718**. Optionally, separate communication interfaces (maybe a WLAN) may be used to deliver information to a computer user or another computer system such as a remote server or computer program, and to communicate information and command selections to processor **705**.

[0119] The invention is related to the use of computer system **700** for remote and automated decision support with respect to a medical emergency, for collection of biometric and ultrasound image data and, if necessary fingerprint/iris/DNA data at a disaster site, crime or military zone site. Such biometric and image data may be read into main memory **706** from another computer-readable medium, such as storage device **710** or via keyboard. Execution of the sequences of instructions contained in main memory **706** causes processor **705** to perform the process steps described herein. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions to implement embodiments of the invention. For example, a field-programmable gate array (FPGA) or application-specific integrated circuit (ASIC) may be used. Such a device can, for example, implement associative memory to aid in indexing, search, and retrieval of biometric information stored in a database to identify an unconscious victim and provide assessment instructions. Thus, embodiments of the invention are not limited to any specific combination of hardware circuitry and software.

[0120] The term "computer-readable medium" as used herein refers to any medium that participates in providing instructions to processor **705** for execution or storing information in a form that can be accessed by the processor. Such a medium may take many forms, including but not limited to, non-volatile media, volatile media, and transmission media. Non-volatile media includes, for example, optical or magnetic disks, solid state memories, and the like, such as storage device **710**. Volatile media includes dynamic memory, such as main memory **706**. Such a medium is non-transitory, i.e., it is intended to store data and computer instructions and does not output data to transmission media unless requested. Transmission media may include coaxial cables, copper wire, radio frequency, fiber optics and antennae. Transmission media can also take the form of acoustic or light waves, such as those generated during satellite radio wave and land-based radio and telecommunications data communications.

[0121] Common forms of computer-readable media include, for example, a floppy disk, a flexible disk, hard disk, magnetic tape, or any other magnetic medium, a CD-ROM, any other optical medium, solid-state memory, punch cards, paper tape, any other physical medium with patterns of holes, a RAM, a PROM, and EPROM, a FLASH-EPROM, any other memory chip or cartridge, or any other medium from which a computer, controller or processor can read. Various forms of computer readable media may be involved in outputting one or more sequences of one or more instructions to processor **705** for execution.

[0122] Computer system **700** may include one or more communication interfaces **718** coupled to bus **702**. Communication interface **718** provides a two-way data communication coupling to a network link **720** that may be preferably connected to a local area hospital network **722**. For example, communication interface **718** may be an integrated services digital network ("ISDN") or digital subscriber line ("DSL") card or a modem to provide a data communication connection to a corresponding type of telephone line or wireless link. Preferably, communications transmitted over such a link are encrypted or otherwise protected according to known encryption schemes and/or watermarking algorithms to uniquely identify a source, for example, of a fingerprint capture device or camera or ultrasound image or other input source. As another example, communication interface **718** may be a network card (e.g., an Ethernet card) to provide a data communication connection to a compatible local area network ("LAN") or wide area network ("WAN"), such as the Internet or a private network. Wireless links are implemented in the about-to-be-described example of running a mobile disaster patient identification and assessment algorithm on an intelligent telecommunications device using, for example, WiFi, Bluetooth, or third generation ("3G") or fourth generation ("4G") wireless technologies such as WiMax or LTE. In any such implementation, communication interface **718** sends and receives electrical, electromagnetic or optical signals that carry digital data streams representing various types of information between hospital and a data collection device (patient medical data or image data, sound or environmental data). For example, an assessment and diagnosis may require a data communication connection to a biometric information database comprising for example, fingerprint data, DNA profile data, cornea/iris data or other biometric and medical records information once a victim is identified at the site of FIG. **7**A. A second example is use of one or more data communication connection(s) to access at least one database at remote medical server used to store medical, biometric and other medical history information. Portions of the computations associated with the collection and identification of biometric and medical data as described herein may be distributed across multiple computer systems **700** which may communicate using one or more communication interfaces **718**.

[0123] Network link **720** typically provides data communication through one or more networks to other data devices. For example, network link **720** may provide a connection through local network **722** to a host computer **724** or hospital server or to data equipment operated by an Internet Service Provider or private network service provider ("ISP"). Such a service provider may operate in a "cloud" computing environment such that it is a web accessible service for, for example, identifying a victim of a terrorist or military attack. An ISP in turn provides data communication services through a packet data communication network such as the worldwide network commonly referred to as the "Internet" **728**, an extranet, an intranet or other private or public network. An example of a private network is a secure data network linking military and medical agencies and used for transmission of medical information, commands and data. Local network **722** and Internet **728** both use electrical, electromagnetic or optical signals that carry digital data streams. The signals through the various networks and the signals on network link **720** and through communication interface **718**, which carry the digital data to and from computer system **700**, are exemplary forms of carrier waves transporting the information.

[0124] Computer system **700** can send messages, commands and data and receive messages, commands and data, including program code, through the network(s), network link **720** and communication interface **718**. In the Internet example, a hospital server **730** (e.g. remote hospital assessment or diagnosis or intervention server) might transmit a requested code for an application program (bullet wound, shrapnel, internal injury from an explosion and the like) through Internet **728**, host computer **724**, local network **722** and communication interface **718** to console and apparatus per FIG. **7**A. In accordance with the invention, one such downloaded application provides a method of assessing an internal injury and providing a diagnosis as likely related the remote emergency patient/victim.

[0125] Hospital server **730** may have associated clients, not shown, for assessment, diagnosis, intervention control and medical records retrieval and patent identification. Hospital device **730** may comprise an identical or very similar range of components as system **700** located at a remote site. For example, display screen **712** of a remote emergency console or intelligent device **700** may be a screen split into four or comprise four difference screens. A similar screen may be associated with hospital device **730** not shown (device **720** may have keyboard entry, a camera, memory of various types and the like connected by a bus). The screen **712** on either device **700** or **730** may show views from ultrasound attachable/implantable device **704**, a section showing commands displayed at either end and views and data inputs from other data collection devices coupled to console **700** which may be remotely operable by hospital medical personnel.

[0126] The received medical assessment code may be executed by processor **705** as it is received, and/or stored in storage device **710**, or other tangible computer-readable medium (e.g., non-volatile storage) for later execution. In this manner, computer system **700** may obtain application code and/or data and store it in the form of an intangible computer-readable medium as received via a carrier wave, modulated data signal, or other propagated signal.

[0127] Computer system **700** can be configured using the methods of this invention to provide services across a network to medical personnel having client computers or intelligent telecommunications devices capable of connection to a network or other communication interface. Such services can include assistance in identification of patients, their medical histories, assessment and diagnosis of injury and intervention about known individuals as well as unconscious victims. These services can also be provided to other software, located in either computer system **700** or a separate computer system such as remote server or a cloud service connected by a network, network link, or communication interface to computer system **700**. The services can be protected using methods of authentication and/or encryption and/or watermarking that are known in the fields of computer science and computer security in order to ensure data are neither compromised nor disclosed and to trace all accesses to the data. The computer system **700** and other associated information storage and communication components can be protected using devices and methods that are known in the fields of computer science and computer security, such as with firewalls, physical access controls, power conditioning equipment, and backup or redundant power sources. The protection devices and methods, embodied as hardware, software or a combination of hardware and software, may be incorporated in computer system **700** or exist as separate components typically connected by a network or other communications hardware. The information stored by computer system **700** and computer-readable media can be further protected using backup or redundant information storage systems, such as those that are well-known in the art at the medical computer **730**. Examples include tape storage systems and RAID storage arrays.

[0128] Referring now to FIG. **8**A and FIG. **8**B, an image guided catheter **800** may be used integral with or as a separate tool imaged by the attachable and remotely controllable device of FIGS. **1**A-**1**L, **2** and **3** and used for intervention after assessment and diagnosis. One such device **800** is shown in FIG. **8**A, side view, FIG. **8**B end on view, FIG. **9**A (with side ports), FIG. **9**B with additional channels and FIG. **14**. In such an embodiment, an ultrasound image guided catheter device

800 can be adapted for use in procedures including but not limited to myocardial, brain, muscle, lung, liver, kidney, uterus and ovary, esophagus, stomach, intestine, tumor (anywhere), or other procedure of potentially abnormal zones in any of the above items (e.g., ultrasound guided surgery to remove shrapnel in the liver or kidney with the present catheter will allow access to the area, identification of shrapnel by automatically deploying the ultrasound instrument to the specific area of interest, for example, via the assembly of FIG. **8**). As such, device **800** can, in some cases, be in the form of a catheter or sheath-like device that is insertable through a small incision in a patient body by introducer needle **808**. The device **800** could include one or more lumen **814** through which a tool could be inserted such as a retrieval instrument shown in FIG. **12**A or **12**B or MEMS tool. Transducer element **810** provides an imaging zone **801** which includes introducer needle **808** located at a distal tip of device **800**. Transducer element **810** is connected by two way channel **814** to an external wired or wireless connection to GHOST console over which channel is received actuating signals and imaging data for imaging zone **801** returned to the console or intelligent device. Device **800** could be provided along its length and at its distal tip with one or more ultrasound transducers **810** per FIGS. **9**A, **9**B along with the other components or tools required to provide intervention to relieve an internal injury as well as ultrasound imaging using the transducers **810**. FIG. **8**B shows a view including an optional anchoring portion **818** for anchoring the device **800** at a location on the skin surface for continuous viewing of a zone of interest as well as introducer needle and Luer lock connector **808** and imaging channel **814**.

[0129] In another case, device **800** could itself be a retrieval or MEMS tool (either a minimally invasive tool that is insertable through a channel that is directly insertable within the body). In this embodiment, for example, as shown in FIGS. **8**A-**8**B, the distal portion of the tool could include the mechanism for obtaining a bullet or piece of shrapnel as well as one or more transducers **810**, along with the other components required to provide ultrasound imaging using the transducers **810** as discussed herein. As shown in FIG. **11**, a MEMS manipulator **1101** in an open position can be disposed, for example, in a lumen of device **1100**. Transducer **1110** may have a standard position **702** for a frontal imaging zone or may follow the MEMS if it works towards the top of the figure from position **702***b* or the bottom from position **702***a*. As seen in FIGS. **8**A and **8**C, an introducer needle **808** can be inserted into the body. The needle **808** may be removed and replaced with a retrieval instrument **903** per FIGS. **12**A and **12**B and then closed about a piece of shrapnel and the device **800** removed. FIG. **8**A further shows an imaging zone **801** of transducer **810** and an impedance matching layer **816** such that the imaging zone **801** may capture a target zone and the introducer needle as, under remote guidance, the untrained person operating the device **800** may be guided by remote personnel to approach the shrapnel.

[0130] In another embodiment, such as is shown in FIGS. **9**A and **9**B, device **800**, **900** can include end-on holes or channels **924** per FIG. **9**B as a channel for a retrieval instrument in combination another custom instrument. FIG. **9**A shows device **900** equipped with side holes and associated channels for, for example, side viewing via a separate channel or for use with a flexible tool that may be emitted from a side port **924**.

[0131] Referring to FIG. **10**, there is shown a device **1000** which may comprise a transducer **225**, an ultrasound imaging channel **814** and an ultrasound imaging channel **814**, the ultrasound transducer having an ultrasound imaging area including introducer/interventional needle **808** (for example, for relieving fluid). Device **1000** also comprises a fiber optic bundle **1002** for creating an optical imaging area **1003** which also may view introducer needle **808**. In use, as seen in FIGS. **12**A and **12**B, a retrieval instrument having a bioptome or custom instrument **903** can be in closed position **901** at a distal end and associated closed grasping position **904** at a proximal end to assist in inserting the instrument into the area of interest, and then can be placed into an open position **902** at the distal end (and open position **905** by a user) so that the undesired shrapnel or bullet can be retrieved for injury relief, examination or testing.

[0132] For example, a transducer at one frequency may provide one type of imaging capability such as lower-frequency, lower-resolution ultrasound imaging at greater depth, which may be useful to place the device, whereas higher-frequency, higher-resolution ultrasound imaging at a shorter distance may be more desirable once the device is in place and treatment begins. Alternatively, ultrasound at an even lower-frequency than that used to guide the device to the target site may be desirable for therapeutic uses, such as to provide heat to tissue or to permit ablation of tissue from the target site.

[0133] In another embodiment, a second, replacement transducer can have other different properties than the first one. For example, the second transducer can be of different dimensions, in length, in diameter, or both, than the first transducer, as may be appropriate for use at the treatment site. Alternatively, the second transducer can be made of a different material having different properties. For example, the second transducer can be of a smaller diameter and/or more flexible than the first as may be appropriate to permit the device to be placed at the target site.

[0134] In addition, it can be appreciated that a device **800**, **900**, **1000** (FIG. **10**), **1100**, **903**, **1350**, **1900** can become damaged or contaminated by body fluids during use and therefore be discarded after the procedure. The device may be protectable by a removable and disposable protective coating.

[0135] FIG. **11** shows a device with a tool such as micro-electronic motor system (MEMS) manipulator **1101** viewed by transducer **1110** in standard position **702** and other transmit positions **702***a* and **702***b*. MEMS manipulator **1101** is one example of a tool that may be remotely operated by medical personnel at a hospital to intervene and repair a diagnosed internal injury. FIG. **12**A shows a retrieval instrument tool or custom device **903** with clasps **904** and **905** that may be used, for example, to grasp a bullet lodged internal to a body and remove it via a channel through the device or via the device of FIG. **8**A or **9**B or **10**.

[0136] Referring now to FIG. **13**, there is shown a remote emergency site and patient imaged via a remotely controlled imager **1310** coupled to an image guided catheter, for example, per FIG. **8**A **1350** showing imaging range **1410** to **1420** of the device **1310** and one image for device **1310** displayed on a hospital monitor **1430** while the liver **1450** image captured by the transducer of inserted device **1350** is displayed at monitor **1440**.

[0137] FIG. **14** shows a preferred embodiment of an image guided catheter **1900** of FIG. **8**A wherein a transducer or plurality of transducers **1940** are mounted at a peripheral and proximal location in respect to a distal tip **1930** from which an introducer needle **1950** may project from a channel and is imaged by the transducer **1940** along with a larger imaging zone intended to include a location of an internal injury.

Field Use Example

[0138] A victim receives a bullet or shrapnel or other impact wound at a remote emergency site remote from a hospital. There may be a pedestal close by or a first responder having a remote assessment and intervention system per FIG. **7**A. The first responder may have no medical training. The first responder sets up the console **700** or other intelligent device and points the camera thereof to face the victim using accelerometer, gyroscope and magnetometer features of an intelligent device. Time of day, calendar date and location are automatically reported to the hospital via intelligent device features. If the victim is unconscious, a fingerprint scanner may be used to identify the victim (and assist medical personnel at a hospital to retrieve medical records). The first responder then begins an assessment process under remote control of a remote hospital work station not shown in FIG. **7** but reachable, for example, by satellite radio, telecommunications or other radio link. A medically trained hospital team may provide guidance on where to begin an assessment, for example, to start with the chest and then the abdomen if no injury is apparent to the head, throat or extremities that is life threatening. Alternatively, a predetermined computer program may be run selectable by a responder that may guide the responder, for example, to place the attachable/implantable unit of FIG. **1**A to **1**L proximate the wound site without contaminating the injury. Ultrasound gel is dispensed at the selected location and the attachable unit fixed by adhesive tape or otherwise to the victim's skin.

[0139] Assessment begins when the remote hospital personal are able to utilize ultrasound and visual imaging to view the damage caused by the bullet/shrapnel or explosion impact. If appropriate, the first responder may be asked to move the attachable unit to another location on or in the victim's body. The transducer may be remotely controlled to rotate, twist and move in x, y and z directions to image the damage. Assessment may result for example in the diagnosis of a bullet or shrapnel wound or other internal injury.

[0140] Intervention may involve hospital personnel assisting a first responder to utilize an image guided catheter instrument **800** and a retrieval instrument per FIG. **12**A or **12**B via a channel of instrument **800** such as the introducer needle channel to grasp the invading bullet/shrapnel and remove with a minimally invasive procedure. The instrument may be used to remove fluid from an internal body cavity or alleviate a collapsed lung or perform an emergency tracheotomy.

[0141] These and other features of embodiments and aspects of a remotely manipulatable ultrasound transducer or transducer array may come to mind from reading the above detailed description and any claimed invention should be only deemed limited by the scope of the claims to follow.

What I claim is:

1. A remote assessment system comprising

a radio transceiver with a communications interface to satellite or ground-based telecommunications for communicating with a remote work station at a hospital, the radio transceiver having a unique identification code;

a controller, coupled to the radio transceiver, for controlling operation of a remotely controlled ultrasound image device,

the remotely controlled ultrasound image device having x, y, rotation, tilt and depth coordinate control for remotely controlled movement via input from the remote work station at the hospital of an ultrasound imaging transducer, the ultrasound imaging transducer having variable frequency for achieving varying resolution and for selectively providing therapeutic ultrasound frequencies, the device adapted to be located on the surface of a human body and fixed to the body for remote movement over the surface of the body in at least the x and y directions,

the controller further coupled to external medical equipment comprising one of a blood pressure meter, a thermometer, a defibrillator and a pulse meter;

the radio transceiver for receiving command data for remotely manipulating the location of the device on the surface of the human body and the direction and resolution of imaging of the ultrasound image device such that the radio transmitter transmits ultrasound images of a target location within the human body for remote medical assessment purposes.

2. The remote assessment system of claim **1** wherein the remotely controlled imaging device comprises a housing and a transducer plane adapted to be remotely controlled in a z axis direction toward a skin surface, the transducer plane coupled to at least a first and second screw at opposite anchor points and an orthogonally located third screw for a point of motion so that movement of the three screws together comprises z axis movement and by maintaining the first and second screws and moving the third screw results in a tilt movement of the transducer plane.

3. The remote assessment system of claim **2** further comprising a rectangular assembly comprising x axis and y axis motors for moving rods supporting the remotely controlled ultrasound image device.

4. The remote assessment system of claim **1** wherein the controller is coupled to a camera for imaging a medical emergency.

5. The remote assessment system of claim **4** wherein the camera is coupled to an accelerometer, a gyroscope and a magnetometer for proper camera orientation.

6. The remote assessment system of claim **1** wherein the controller is coupled to a global positioning system for locating a site of a medical emergency.

7. The remote assessment system of claim **6**, the global positioning system and an accelerometer being coupled to a controller for calculating a location and an estimated time of arrival at a hospital.

8. The remote assessment system of claim **1** further comprising environmental data collection devices including data for collecting external temperature and barometric pressure from the human body.

9. The remote assessment system of claim **1** wherein the controller is coupled to a blood pressure meter, a human temperature thermometer and a pulse meter for automatic transmission of medical data from the controller to the remote work station at the hospital.

10. A remote assessment and diagnostic system comprising

a communications interface to one of satellite or ground-based telecommunications for communicating with a remote work station at a hospital, the communications interface having a unique identification code;

a controller, coupled to the communications device, for controlling operation of a remotely controlled ultrasound image device adapted for attachment or implant to an emergency patient at a remote location,

the remotely controlled ultrasound image device having rotation, tilt and z axis depth coordinate control for remotely controlled movement via input from the remote work station at the hospital of the ultrasound imaging transducer, the ultrasound imaging transducer having a cylindrical housing and a circular transducer plate for movement towards and away from an end surface adapted to be coupled to the emergency patient,

the controller further coupled to external medical equipment comprising one of a blood pressure meter, a thermometer, a defibrillator and a pulse meter;

the communications device for receiving command data from the remote hospital work station for remotely manipulating the location of the device towards or away from a surface of the emergency patient such that the radio transmitter transmits ultrasound images of a target location within the human body for remote medical assessment purposes,

the controller further coupled to a fingerprint sensor and a camera for determining the identity of the emergency patient, the controller for outputting an assessment of the emergency patient and a diagnosis.

11. The remote assessment and diagnostic system of claim **10** further comprising a global positioning system input and a clock coupled to the controller, the global positioning system for outputting a location on the world's surface of a present location of the emergency patient and the clock for providing time and date data for association with imaging data, medical data and other data collected from the emergency patient.

12. The remote assessment and diagnostic system of claim **10** further comprising a rectangular assembly comprising x axis and y axis motors for moving rods supporting the remotely controlled ultrasound image device.

13. The remote assessment and diagnostic system of claim **12**, the rods being flexible of adjustable to lengths from zero meters to 30 centimeters, the rectangular assembly adapted to be fixed to a surface area of the emergency patient, the assembly comprising x and y axis motors for moving the remotely controlled ultrasound image device having rotation, tilt and z axis depth coordinate control in x and y coordinate directions as well as rotation, tilt and z axis depth under remote control from the remote hospital work station.

14. The remote assessment and diagnostic system of claim **10** wherein the communications interface communicates using an encrypted communications link.

15. The remote assessment and diagnostic system of claim **14** wherein the camera is adapted to transmit images via the controller and the communications link to the remote work station of the hospital, the remote work station having access to patient records, the patient records of the emergency patient being accessed by one of fingerprint identification and camera image data.

16. The remote assessment and diagnostic system of claim **15**, the remote work station of the hospital for receiving control input for emergency patient assessment and diagnosis.

17. The remote assessment and diagnostic system of claim **15**, the remote work station of the hospital for receiving control input for emergency patient system intervention responsive to assessment and diagnosis.

18. A remote assessment and diagnostic system comprising

a communications interface to one of satellite or ground-based telecommunications for communicating with a remote work station at an emergency site, the communications interface having a unique identification code;

a controller of a remote hospital work station coupled to the communications device, the controller for receiving command information input by medically trained personnel, the command information for controlling operation of a remotely controlled ultrasound image device adapted for attachment or implant to an emergency patient at a remote location,

the remotely controlled ultrasound image device having rotation, tilt and z axis depth coordinate control for remotely controlled movement via input from the remote work station at the hospital of the ultrasound imaging transducer, the ultrasound imaging transducer having a cylindrical housing and a circular transducer plate for movement towards and away from an end surface adapted to be coupled to the emergency patient,

the controller of the remote hospital work station further coupled via the communications interface to medical equipment comprising one of a blood pressure meter, a thermometer, a defibrillator and a pulse meter;

the communications device for transmitting command data from the remote hospital work station for remotely manipulating the location of the remotely controlled ultrasound device device towards or away from a surface of the emergency patient such that the radio transmitter transmits ultrasound images of a target location within the emergency patient for remote medical assessment purposes,

the controller further coupled to a remote fingerprint sensor and a camera via the communications interface for determining the identity of the emergency patient, the controller for outputting an assessment of the emergency patient and a diagnosis.

19. The remote assessment and diagnostic system of claim **18** wherein the communications interface communicates using an encrypted communications link.

20. The remote assessment and diagnostic system of claim **18** wherein the remote work station of the hospital for receiving control input for emergency patient assessment and diagnosis responsive to retrieved emergency patient medical records.

* * * * *

专利名称(译)	远程超声评估和干预系统		
公开(公告)号	US20140039277A1	公开(公告)日	2014-02-06
申请号	US13/973476	申请日	2013-08-22
[标]申请(专利权)人(译)	亚伯拉罕THEODORE P		
申请(专利权)人(译)	亚伯拉罕，THEODORE P.		
当前申请(专利权)人(译)	亚伯拉罕，THEODORE P.		
[标]发明人	ABRAHAM THEODORE P		
发明人	ABRAHAM, THEODORE P.		
IPC分类号	A61B8/00		
CPC分类号	A61B8/54 A61B8/0808 A61B8/0841 A61B8/12 A61B8/445 A61B8/4483 A61B8/565 A61B8/582		
优先权	60/851451 2006-10-12 US 61/692443 2012-08-23 US		
外部链接	Espacenet USPTO		

摘要(译)

远程超声评估和介入系统包括控制台，该控制台具有用于超声成像设备的控制器，该超声成像设备可附接到人体皮肤表面或可植入人体腔体中。来自位于例如医院的远程工作站的命令可以远程控制设备的换能器在x，y，z，旋转和倾斜方向上移动以远程评估对受害者的伤害，例如战争区域伤害或恐怖袭击。可以通过通信链路或通过存储在计算机存储器中的预定控制器程序来指示不需要医学训练的第一响应者，以将成像装置从人体皮肤表面或人体腔中的一个位置移动到另一个位置。一旦通过由第一响应者通过从医院工作站接收的命令操纵的图像引导导管从医院工作站评估和诊断伤害，也可以远程控制干预。