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(54) SPATIAL ARRAY OF SENSORS MOUNTED ON A TOOL

RÄUMLICHE ANORDNUNG VON AUF EINEM WERKZEUG MONTIERTEN SENSOREN

RÉSEAU SPATIAL DE DÉTECTEURS MONTÉS SUR UN OUTIL

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Description

TECHNICAL FIELD

[0001] The embodiments of the present disclosure generally relate to hand tools and more particularly relate to mounting an array of sensors on an end of a hand tool.

BACKGROUND

[0002] As opposed to open surgery in which a surgeon cuts a relatively large incision in the skin of a patient for accessing internal organs, minimally invasive surgical procedures are performed by making relatively small incisions and then inserting tools through the incisions to access the organs. Minimally invasive surgery usually results in shorter hospitalization times, reduced therapy requirements, less pain, less scarring, and fewer complications.

[0003] During minimally invasive surgery, a surgeon can introduce a miniature camera through an incision. The camera transmits images to a visual display, allowing the surgeon to see the internal organs and tissues and to see the effect of other minimally invasive tools on the organs and tissues. In this way, the surgeon is able to perform laparoscopic surgery, dissection, cauterization, endoscopy, telesurgery, etc. Compared to open surgery, however, minimally invasive surgery can present limitations regarding the surgeon's ability to see and feel the patient's organs and tissues. Surgical hand tools for performing minimally invasive tissue examination, comprising the features of the preamble of claim 1 are disclosed in DE 43 32 580 A1. DE 195 27 957 C1 discloses a laparoscopic surgical tool with an optoelectronic tactile pressure sensor. Other documents WO 02/07617 A2, US 5 989 199 A, and US 2002/143275 A1 disclose tools with a handle, an end portion, an array of sensors mounted to the end portion to sense a property of an object and a processing device configured to process the data sensed by the array of sensors and configured to communicate the information to the handle.

[0004] WO2005/094672 A2 discloses a system for non-invasively and continuously monitoring blood pressure comprising a transducer array and associated circuitry for processing signals from the array for measuring and/or tracking the blood pressure waveform. Complex measurements can be executed, such as spatially and/or timely distributed measurements to determine characteristics of blood flow in a blood vessel.

SUMMARY

[0005] The invention is disclosed in claim 1 with preferred embodiments of the invention disclosed in the dependent claims. The present disclosure describes a number of embodiments in which an array of sensors is positioned on an end of a tool. Specifically, in the embodiment according to the present invention, a tool is defined as having a handle configured to be manipulated by a user. The tool includes an end portion arranged in mechanical communication with the handle. An array of sensors is mounted on the end portion and is configured to sense a property of an object. The tool also comprises a processing device configured to process the properties of the object sensed by the array of sensors and to obtain spatial information of the object. The processing device is further configured to communicate the spatial information to the handle.

[0006] The tool is a laparoscopic tool and the object is a patient. The processing device is configured to obtain spatiotemporal information of the patient and communicate the spatiotemporal information to the handle; wherein the spatiotemporal information comprises information about a direction of a fluid flowing through a luminal structure of the patient, wherein the fluid flowing through the luminal structure is blood flowing through a blood vessel. The tool comprising an output device for presenting the spatiotemporal information about the direction of blood flow through the blood vessel of the patient to the user.

[0007] The embodiments described in the present disclosure may include additional features and advantages, which may not necessarily be expressly disclosed herein but will be apparent to one of ordinary skill in the art upon examination of the following detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The components of the following figures are illustrated to emphasize the general principles of the present disclosure and are not necessarily drawn to scale. Reference characters designating corresponding components are repeated as necessary throughout the figures for the sake of consistency and clarity.

FIG. 1 is a diagram of a surgical hand tool having a sensor array, according to one embodiment.

FIG. 2 is a diagram of the sensor array shown in FIG. 1, according to one embodiment.

FIG. 3 is a block diagram of a system for communicating sensed properties to a user, according to a first embodiment.

FIG. 4 is a block diagram of a system for communicating sensed properties to a user, according to a second embodiment.

FIG. 5 is a flow diagram illustrating an exemplary method for operating an array of sensors on a tool, which does not form part of the present invention.

DETAILED DESCRIPTION

[0009] Although minimally invasive surgical procedures involving small incisions include many advantages over open surgery, minimally invasive surgery can still create challenges to a surgeon. For example, the surgeon must typically rely on a camera to view the patient's internal organs and see how the movement and operation of the tools affects the organs. Also, the surgeon is usually unable to palpate or receive tactile feedback with respect to the stiffness and/or pulsation of organs. To overcome the inherent limitation regarding touch, it can be beneficial to re-introduce the surgeon to the concept of palpation by providing tactile or haptic feedback in some manner in order to communicate better the sensation and feel of the patient's organs to the surgeon.

[0010] The present disclosure describes examples that include any type of tools that can be manipulated by a user. According to the embodiments of the invention, the tools described in the present disclosure include a handle portion that mechanically controls an end portion of the tool. Mounted on the end portion is an array of sensors for sensing a property of an object that interacts with the tool. Using the information from the multiple sensors, additional properties of the object can be determined. For instance, the spatial relationship of the different sensors can be used to determine spatial information. Likewise, both spatial and temporal relationships of the sensed properties at the different sensors over time can also be used to determine specific information about the object.

[0011] Although the embodiments of the present disclosure relate to surgical hand tools, such as minimally invasive surgical tools, it should be understood that the present disclosure also encompasses other exemplary types of tools as well, which are not part of the claimed invention. In addition, although the embodiments herein relate to a surgical patients and how the organs and tissues of the patient interact with the surgical tools, it should also be understood that the present disclosure also includes other objects, which are normally intended to interact with the respective tools, which are not part of the claimed invention. Other features and advantages will be apparent to one of ordinary skill in the art upon reading and understanding the general principles of the present disclosure.

[0012] FIG. 1 illustrates an embodiment of a surgical tool 10. In this diagram, surgical tool 10 is shown as a hand-held laparoscopic tool, which is configured to be inserted through a small incision in the abdomen of a patient. Surgical tool 10 in this embodiment includes a handle 12, a shaft 14, and an end portion 16. Shaft 14 is designed to connect handle 12 to end portion 16 and to communicate mechanical actions of handle 12 to end portion 16. Shaft 14 is further designed to communicate electrical signals from end portion 16 back to handle 12 as explained in more detail below. According to the embodiment of FIG. 1, end portion 16 includes a tip 18 and a sensor array 20 formed on tip 18. As shown, tip 18 is a grasper. However, it should be understood that end portion 16 may include any suitable type of tip having any suitable functionality. Also, in other alternative embodiments, sensor array 20 may be connected a portion of end portion 16 other than tip 18. According to some examples of the embodiment of FIG. 1, shaft may be about 20 cm to 30 cm in length and tip 18 may be about 10 mm to 15 mm in length.

[0013] By manipulating handle 12, a user can insert end portion 16 into the abdomen of the patient and control tip 18 of end portion 16. When end portion 16 is inserted, the surgeon can further manipulate handle 12 to control the location and orientation of tip 18 such that sensor array 20 is able to contact certain regions of the patient. Sensor array 20 can measure or test any desired property or parameter of the patient, such as, for example, pulse. In some embodiments in which sensor array 20 does not necessarily need to contact a particular region, tip 18 can be controlled to position sensor array 20 to accomplish certain contactless sensing.

[0014] FIG. 2 is a diagram illustrating an embodiment of sensor array 20 shown in FIG. 1. Sensor array 20 includes a number of sensors 22 connected to a substrate 24, which is configured to hold sensors 22 in a pattern having a predetermined pitch between sensors 22. As shown in this diagram, sensor array 20 includes seven rows and two columns of sensors 22 from the perspective of handle 12 (FIG. 1). It should be understood, however, that sensor array 20 can be arranged to include any number of rows and columns. In some embodiments, sensors 22 may be arranged in a pattern that does not particularly resemble a rectangular array. For example, sensors 22 can be positioned is a staggered pattern, circular pattern, etc.

[0015] Although sensors 22 are illustrated as being square, sensors 22 may include any suitable shape, e.g., rectangular, circular, elliptical, etc. According to the embodiment of FIG. 2 in which sensors 22 are square, sensors 22 may have widths and lengths of about 2 mm and may be separated by a distance of about 0.5 mm. In some embodiments, the size of sensors 22 may be smaller to allow a greater number of sensors to be positioned in sensor array 20. The size and number of sensors 22 may depend, for example, on the ability to miniaturize the particular type of sensor while keeping the integrity and usefulness of the sensor. If miniaturization techniques are used, the array of sensors 22 may include dozens of rows and columns of sensors 22. Sensors 22 may also be of any size and shape on substrate 24.

[0016] Sensors 22 can be configured to sense any suitable property of the object under test. For instance, sensors 22 can be configured as pressure sensors using resistive or capacitive pressure sensing technologies. Alternatively, sensors 22 can include strain gauges, piezoelectric sensors, stiffness sensors, etc. As strain gauges, sensors 22 can provide additional information about contact force to finely tune a generally course measurement of force. As piezoelectric sensors, sensors 22 can generate ultrasound signals that reflect off portions of the object. In this case, echo signals can be detected by sensors 22 to determine the location of objects. The ultrasound emission and echo measurement technique may be particularly useful for sensing the location of luminal structures and for tumor tissue identification. Sensors 22 can also be configured as stiffness sensors that can detect nodules, e.g., tumors, or other stiff regions. By processing the number of sensors 22 contacting the stiff region, a calculation can be made regarding the size of the nodules. In this respect, the number of sensors 22 that sense relative stiffness can be used to determine the size of the nodule and thereby increase or decrease an output signal provided to the user to communicate the size.

[0017] By using multiple sensors 22, greater accuracy can be assured of a property being measured than if only a single sensor were used. This also can increase the confidence when adjacent sensors 22 provide the same or similar outputs. Also, sensor array 20 can provide information indicative of the size of a particular feature, e.g., nodule, of the patient.

[0018] Substrate 24 may include any suitable structure for supporting sensors 22 on tip 18 (FIG. 1). Depending on the size, shape, and rigidity of tip 18, substrate 24 may be rigid or flexible to conform to tip 18. Also, substrate 24 may be planar or curved depending on the structure of tip 18. In the embodiment of FIG. 1 in which tip is a metal grasper with a curved bottom jaw, substrate 24 may be curved to conform to the curved shape of the bottom jaw. Also, since the jaw is substantially rigid, substrate 24 does not necessarily need to be rigid to provide needed support for sensors 22 and therefore can be flexible.

[0019] FIG. 3 is a block diagram illustrating an embodiment of a system 30 for communicating spatial information about an object to a user. In this embodiment, system 30 includes a sensor array 32, processing device 34, and output devices 36. In some embodiments, system 30 contains sensor array 32, processing device 34, and output devices 36 on a hand-held tool or device. Particularly, sensor array 32 may be positioned on a portion of a tool, e.g., a tool used for probing an object. Sensor array 32 is configured to include any type of sensing mechanisms to sense any suitable characteristic of the object. The sensed information from each sensor is communicated to processing device 34, which is configured to process the information according to specific algorithms. Depending on the type of sensing mechanisms of sensor array 32 and the type of properties being measured, the algorithms of processing device 34 can determine various characteristics of the object. Processing device 34 may then communicate the processed information to output device 36, which is designed to present the information to the user in any suitable manner.

[0020] Sensor array 32 may represent any suitable sensor array positioned on an end of a tool for detecting one or more specific properties of an object. For instance, sensor array 32 may be the same as or similar to sensor array 20 described with respect to FIGS. 1 and 2. Particularly, sensor array 32 includes a plurality of sensors, each capable of measuring properties of an object at predefined locations with respect to the other sensors. Based on spatiality of sensors of sensor array 32, processing device 34 can determine or infer spatial information about the object. Processing device 34 may include different types of algorithms for extracting the particular information needed to calculate the spatial information.

[0021] According to one example, a surgeon may use a tool having sensor array 32 positioned on the tool for measuring pulse. When pulse information is detected along a row of sensors in the array but no pulse information is detected on the other sensors, then processing device 34 may be configured to deduce that a blood vessel is positioned or oriented in that particular direction including that row of sensors where the pulse is detected. On the other hand, if pulse information is detected along a column or across a diagonal, then the position or orientation of a blood vessel can be inferred accordingly.

[0022] Furthermore, in addition to spatial inferences, processing device 34 can also use any changes of the sensed information over time to extract temporal information. Particularly, the signals can be detected in real time to allow the processing of time-related signals. For example, processing device 34 may be able to detect peaks in the signals to determine when the signal is at its highest or lowest point. Also, processing device 34 can detect phase differences, etc. In embodiments according to the claimed invention, processing device 34 is configured to use the spatial and temporal information to detect not only the orientation of blood vessels, but also the direction in which the blood flows through the vessels. For example, pulse information can be detected at one instance of time and detected again along the path of the vessel at a later instance.

[0023] It has also been observed that when a blood vessel is pulsating, the sensors against which the blood vessel is in contact can sense the pulse. In addition, the sensors adjacent to those sensors that are in contact with the vessel can experience a loss of contact with tissue due to the lifting action of the pulsing vessel on the contacted sensors. In this case, the adjacent sensors may produce a signal that is 180 degrees out of phase with the pulse detecting sensors. Processing device 34 can be configured to detect this phenomenon to determine the location of blood vessels and for detecting pulse information.

[0024] Processing device 34 may be a general-purpose or specific-purpose processor or microcontroller for processing the signals detected by sensor array 32. In some embodiments, processing device 34 may include a plurality of processors for performing different functions with respect to system 30. In some embodiments, processing device 34 may be associated with a memory device (not shown) for storing data and/or instructions. In this regard, the memory may include one or more internally fixed storage units, removable storage units, and/or remotely accessible storage units, and the various storage units may include any combination of volatile memory and nonvolatile memory. Logical instructions, commands, and/or code can be implemented in software, firmware, or both, and stored in memory. In this respect, the logic code may be implemented as one or more computer programs that can be executed by processing device 34.

[0025] In other embodiments, logical instructions, commands, and/or code can be implemented in hardware and incorporated in processing device 34 using discrete logic circuitry, an application specific integrated circuit ("ASIC"), a programmable gate array ("PGA"), a field programmable gate array ("FPGA"), etc., or any combination thereof. In yet other embodiments, logical instructions, commands, and/or code can be implemented in both hardware in processing device 34 and software/firmware stored in the memory.

[0026] Output devices 36 may include one or more mechanisms for communicating to a user information sensed by sensor array 32 and processed by processing device 34. Output devices 36 may include any suitable combination of display screens, speakers, tactile actuators, haptic effect devices, or other notification devices. Thus, output devices 36 may include any number of feedback mechanisms in any number of modes for providing any type of visual, audible, and/or tactile output to the user. In the embodiments regarding surgical tools, output devices 36 may be used to provide feedback to the surgeon so that the surgeon can reposition the tool as necessary to align, orient, or position the tool to allow the sensing of a more reliable signal, to reduce pressure on particular organs, etc.

[0027] In some embodiments, output devices 36 can include haptic actuators, which is able to generate a vibration on handle 12. The haptic actuators, for example, can include one or more force applying mechanisms that are configured to apply a vibrotactile force to a user of surgical tool 10 or other device. The haptic actuators may include electromagnetic actuators, eccentric rotating mass ("ERM") actuators in which an eccentric mass is moved by a motor, linear resonant actuator ("LRA") in which a mass attached to a spring is driven back and forth, a "smart material" such as piezoelectric, electroactive polymers or shape memory alloys, or other suitable type of actuating device.

[0028] FIG. 4 illustrates a system block diagram for a computer-assisted hand tool in which palpation algorithms can be deployed in an exemplary embodiment. The computer-assisted hand tool includes a plurality of sensors 40, which could include accelerometers for detecting and measuring the acceleration of a tool, and a pressure sensor array for detecting pulses during movement of the tip of the tool on the tissue being palpated. Processor 42 receives signals from sensors 40 and processes the received signals based on instructions stored in memory 44, which may include, among other things, palpation algorithms 46.

[0029] Based on a "state" of a tool determined during execution of palpation algorithms 46, processor 42 can cause an actuator 48 of the tool to play a haptic effect. It should be noted that the term "haptic effect" can refer to a tactile effect, tactile feedback, haptic feedback, force feedback, vibrotactile feedback, haptic cues, thermal feedback, kinesthetic feedback, etc. Generally, haptic effect can include the representation of any physical properties (e.g., stiffness, viscosity, etc.). The haptic effect played is characterized by one or more of the magnitude, frequency, and duration of the effect. The haptic effect can be dynamic based on a changing level of stiffness or deformation of the tissue being examined.

[0030] In some embodiments, processor 42 can be a laptop or personal computer that is electrically coupled to the tool. The laptop or personal computer can have a graphical user interface (GUI) 50 that enables the user to select optional processing steps for the palpation algorithms. Memory 44 can be any type of storage device or computer readable medium capable of storing the instructions for palpation algorithms 46. Memory 44 can include random access memory, read-only memory, etc. In some embodiments, processor 42 can be an application specific integrated circuit (ASIC) that is a component of the tool. In other embodiments, the instructions for palpation algorithms 46 can be embedded in processor 42.

[0031] In some embodiments, sensor array 40 can include a 2X7 array of pressure transducers. Each pressure transducer can be in contact with the tissue being palpated, therefore, each transducer is processed for pulses received. Each transducer can detect zero or more pulses in a predetermined time window. Actuator 48 can generate a vibration on the handle of the tool. More specifically, the actuator 48 can include a force applying mechanism that applies a vibrotactile force to the tool based on a level of stiffness or deformation of the tissue being examined. One parameter of the actuator that can be used in some embodiments is the peak voltage applied during the playing of haptic effects.

[0032] FIG. 5 is a flow diagram of an example of a method of operating a tool having a sensor array, which does not form part of the invention. As indicated in block 52, a user is allowed to manipulate a tool according to a normal use of the tool. For example, the user may manipulate a handle, buttons, or other feature on the tool to control a functional portion of the tool. The controlled portion may be a portion that is positioned on an opposite end from the handle. The controlled portion can be probed around to contact an object being tested or to be placed in proximity to the object being tested, depending on the particular type of parameter being measured.

[0033] As indicated in block 54, a parameter of the object is sensed at multiple locations. Particularly, the multiple locations may represent the positioning of a number of sensors mounted on or relative to the tool, such as sensors that may be positioned on or near the controlled portion of the tool. In some embodiments, the sensing locations may form a predefined pattern, such as a rectangular array having rows and columns. In other embodiments, the sensing locations may include any other suitable pattern.

[0034] According to block 56 of the method of FIG. 4, the sensed properties are processed to obtain spatial information about the object being tested. Based on the properties sensed at the multiple locations and based on a predetermined knowledge of the location and orientation of the sensors, spatial information can be obtained. In some embodiments in which the object being tested is a surgical patient, the sensed properties may be related to the blood of the patient. For example, if pulse information is detected at some sensor locations, the sensed information can be processed to determine the location and orientation of blood vessels of the patient.

[0035] Furthermore, the spatial information can also be obtained by processing the information at regular time intervals, allowing both spatial and temporal information to be obtained. Again referring to the blood of a patient, the spatiotemporal information can be used to determine not only the location and orientation of the blood vessels, but also the direction in which the blood flows through the blood vessels. In this respect, a signal may be strong at one sensor location at one time and, after a short delay, the signal may be strong at another sensor location, thereby indicating the flow direction. The processing associated with block 46 is able to decode the sensed information from the multiple locations at multiple times to compute the spatial and/or spatiotemporal information.

[0036] As indicated in block 58, an output is provided to the user to indicate the spatial information. As suggested above, when spatiotemporal information is also calculated, this information can also be output to the user. The output may be presented in any suitable form. For example, the output may be a haptic or tactile effect imposed on the user. In some embodiments, the output may be haptic, audible, and/or visual. Any suitable combination of output mechanisms or actuators can be used to present the output. With respect to some embodiments, haptic actuators can be arranged in an array or other pattern resembling the array or pattern of the sensors. In this case, the sensed signals can be mapped to provide a haptic effect to represent the spatial information sensed by the sensors.

[0037] It should be understood that the routines, steps, processes, or operations described herein may represent any module or code sequence that can be implemented in software or firmware. In this regard, these modules and code sequences can include commands or instructions for executing the specific logical routines, steps, processes, or operations within physical components. It should further be understood that two or more of the routines, steps, processes, and/or operations described herein may be executed substantially simultaneously or in a different order than explicitly described, as would be understood by one of ordinary skill in the art.

Claims

1. A tool (10, 30) comprising:

a handle (12) configured to be manipulated by a user;

an end portion (16) arranged in mechanical communication with the handle (12);

an array of sensors (20, 32, 40) mounted on the end portion (16), the array of sensors (20, 32, 40) configured to sense a property of an object;

a processing device (34, 42) configured to process the property of the object sensed by the array of sensors (20, 32, 40) and to obtain information of the object, the processing device (34, 42) further configured to communicate the information to the handle (12);

wherein the tool (10, 30) is a surgical tool and the object is a patient, and wherein the tool (10, 30) is a laparoscopic tool, **characterized in that** the processing device (34, 42) is further configured to obtain spatiotemporal information of the patient and communicate the spatiotemporal information to the handle (12); and

wherein the spatiotemporal information comprises information about a direction of a fluid flowing through a luminal structure of the patient, wherein the fluid flowing through the luminal structure is blood flowing through a blood vessel, the tool (10, 30) comprising an output device (36) for presenting the spatiotemporal information about the direction of blood flow through the blood vessel of the patient to the user.

2. The tool of claim 1, wherein the information comprises at least a pulse.

3. The tool of claim 1, wherein the end portion (16) comprises a rigid substrate (24) on which the array of sensors (20, 32, 40) is mounted or wherein the end portion (16) comprises a flexible substrate (24) on which the array of sensors (20, 32, 40) is mounted.

4. The tool of claim 1, wherein the array of sensors (20, 32, 40) comprises at least two rows of sensors (22) and at least two columns of sensors (22) arranged in a substantially rectangular pattern.

5. The tool of claim 1, wherein at least one sensor (22) of the array of sensors (20, 32, 40) is configured to sense pressure or is configured to sense stiffness of the object or is a piezoelectric sensor.

6. The tool of claim 5, wherein the at least one piezoelectric sensor is configured to emanate ultrasound radiation and measure echo information.

7. The tool of claim 1, further comprising a haptic actuator (48) configured to impose a haptic effect on the user, the haptic effect being related to the information obtained by the processing device (34, 42).

8. The tool of claim 7, wherein the haptic actuator is configured to impose vibrotactile feedback to the user.

9. The tool of claim 1, wherein the tool (10, 30) is a hand-held tool and the processing device (34, 42) resides in the hand-held tool.

Patentansprüche

1. Werkzeug (10, 30) mit:

einem Griff (12), der ausgelegt ist, von einem Benutzer manipuliert zu werden;
ein Endbereich (16), der in mechanischer Kommunikation mit dem Griff (12) angeordnet ist;
eine am Endbereich (16) angebrachte Sensoranordnung (20, 32, 40), wobei die Sensoranordnung (20, 32, 40) ausgelegt ist, eine Eigenschaft eines Objekts zu erfassen;
ein Verarbeitungsgerät (34, 42), das ausgelegt ist, die von der Sensoranordnung (20, 32, 40) erfasste Eigenschaft zu verarbeiten und Information des Objekts zu erhalten, wobei das Verarbeitungsgerät (34, 42) des Weiteren ausgelegt ist, die Information an den Griff (12) zu kommunizieren;
wobei das Werkzeug (10, 30) ein chirurgisches Werkzeug ist und das Objekt ein Patient ist,
und wobei das Werkzeug (10, 30) ein laparoskopisches Werkzeug ist, **dadurch gekennzeichnet, dass**
das Verarbeitungsgerät (34, 42) des Weiteren dazu ausgelegt ist, raum-zeitliche Information des Patienten zu erhalten und die raum-zeitliche Information an den Griff (12) zu kommunizieren; und
wobei die raum-zeitliche Information Information über eine Richtung einer eine Lumenstruktur des Patienten durchströmenden Flüssigkeit umfasst, wobei die die Lumenstruktur durchströmende Flüssigkeit durch ein Blutgefäß fließendes Blut ist,
wobei das Werkzeug (10, 30) eine Ausgabevorrichtung (36) zur Darstellung der raumzeitlichen Information über die Richtung des Blutflusses durch das Blutgefäß des Patienten für den Benutzer umfasst.

2. Werkzeug nach Anspruch 1, wobei die Information mindestens einen Puls umfasst.

3. Werkzeug nach Anspruch 1, wobei der Endbereich (16) ein unelastisches Substrat (24) umfasst, auf welchem die Sensoranordnung (20, 32, 40) angebracht ist, oder wobei der Endbereich (16) ein elastisches Substrat (24) umfasst, auf welchem die Sensoranordnung (20, 32, 40) angebracht ist.

4. Werkzeug nach Anspruch 1, wobei die Sensoranordnung (20, 32, 40) mindestens zwei Reihen an Sensoren (22) und mindestens zwei Spalten an Sensoren (22) umfasst, welche in einem im Wesentlichen rechteckigen Muster angeordnet sind.

5. Werkzeug nach Anspruch 1, wobei der mindestens eine Sensor (22) der Sensoranordnung (20, 32, 40) ausgelegt ist, Druck zu erfassen, oder ausgelegt ist, eine Steifigkeit des Objekts zu erfassen, oder ein piezoelektrischer Sensor ist.

6. Werkzeug nach Anspruch 5, wobei der mindestens eine piezoelektrische Sensor ausgelegt ist, Ultraschallstrahlung auszustrahlen und Echoinformation zu messen.

7. Werkzeug nach Anspruch 1, welches des Weiteren einen haptischen Aktuator (48) umfasst, welcher ausgelegt ist, eine haptische Wirkung auf den Benutzer auszuüben, wobei die haptische Wirkung mit der Information in Zusammenhang steht, welche das Verarbeitungsgerät (34, 42) erhalten hat.

8. Werkzeug nach Anspruch 7, wobei der haptische Aktuator ausgelegt ist, dem Benutzer vibrotaktiles Feedback zu geben.

9. Werkzeug nach Anspruch 1, wobei das Werkzeug (10, 30) ein Handwerkzeug ist und das Verarbeitungsgerät (34, 42) sich in dem Handwerkzeug befindet.

Revendications

1. Outil (10, 30) comprenant :

une poignée (12) configurée pour être manipulée par un utilisateur ;
une partie d'extrémité (16) agencée en communication mécanique avec la poignée (12) ;
un réseau de détecteurs (20, 32, 40) monté sur la partie d'extrémité (16), le réseau de détecteurs (20, 32, 40) étant configuré pour détecter une propriété d'un objet ;
un dispositif de traitement (34, 42) configuré pour traiter la propriété de l'objet détecté par le réseau de détecteurs (20, 32, 40) et pour obtenir des informations de l'objet, le dispositif de traitement (34, 42) étant en outre configuré pour communiquer les informations à la poignée (12) ;
l'outil (10, 30) étant un outil chirurgical et l'objet étant un patient,
et l'outil (10, 30) étant un outil laparoscopique,

caractérisé en ce que le dispositif de traitement (34, 42) est en outre configuré pour obtenir des informations spatio-temporelles du patient et communiquer les informations spatiotemporelles à la poignée (12) ; et
les informations spatio-temporelles comprenant des informations concernant une direction d'un fluide s'écoulant à travers une structure luminale du patient, le fluide s'écoulant à travers la structure luminale étant du sang s'écoulant à travers un vaisseau sanguin,
l'outil (10, 30) comprenant un dispositif de sortie (36) pour présenter les informations spatio-temporelles concernant la direction du flux sanguin à travers le vaisseau sanguin du patient à l'utilisateur.

2. Outil selon la revendication 1, les informations comprenant au moins une impulsion.

3. Outil selon la revendication 1, la partie d'extrémité (16) comprenant un substrat rigide (24) sur lequel le réseau de détecteurs (20, 32, 40) est monté ou la partie d'extrémité (16) comprenant un substrat souple (24) sur lequel est monté le réseau de détecteurs (20, 32, 40).

4. Outil selon la revendication 1, le réseau de détecteurs (20, 32, 40) comprenant au moins deux rangées de détecteurs (22) et au moins deux colonnes de détecteurs (22) agencées selon un motif sensiblement rectangulaire.

5. Outil selon la revendication 1, au moins un détecteur (22) du réseau de détecteurs (20, 32, 40) étant configuré pour détecter une pression ou étant configuré pour détecter la rigidité de l'objet ou étant un détecteur piézoélectrique.

6. Outil selon la revendication 5, le ou les détecteurs piézoélectriques étant configurés pour émettre un rayonnement ultrasonore et mesurer des informations d'écho.

7. Outil selon la revendication 1, comprenant en outre un actionneur haptique (48) configuré pour imposer un effet haptique à l'utilisateur, l'effet haptique étant lié aux informations obtenues par le dispositif de traitement (34, 42).

8. Outil selon la revendication 7, l'actionneur haptique étant configuré pour imposer une rétroaction vibrotactile à l'utilisateur.

9. Outil selon la revendication 1, l'outil (10, 30) étant un outil manuel et le dispositif de traitement (34, 42) résidant dans l'outil manuel.

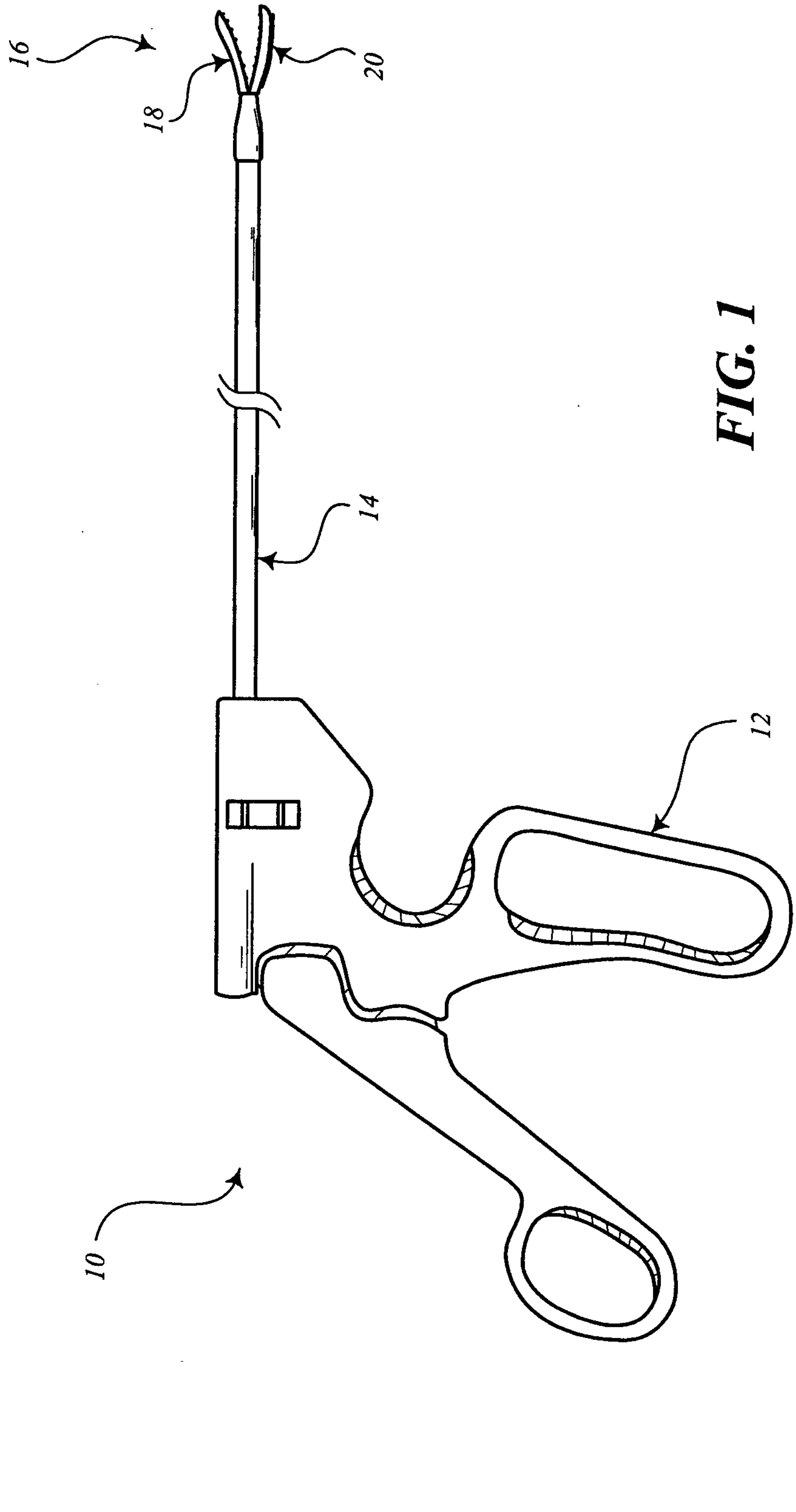

FIG. 1

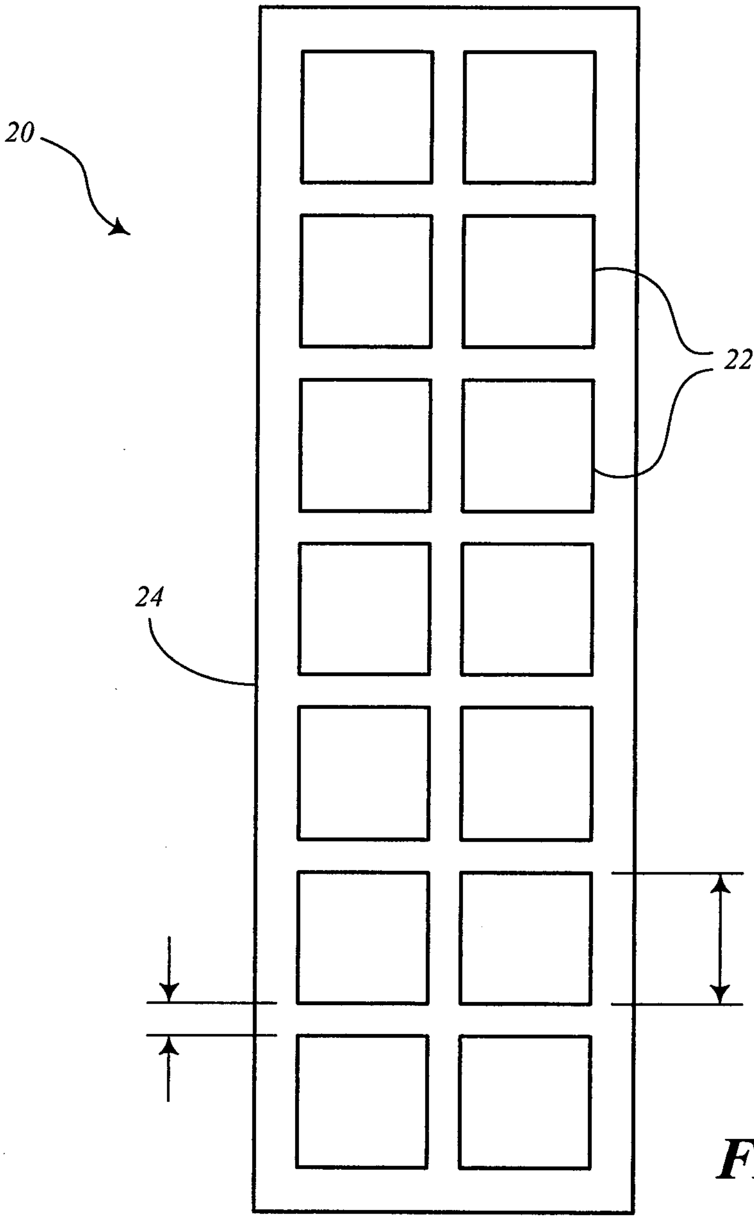
20
22
24

FIG. 2

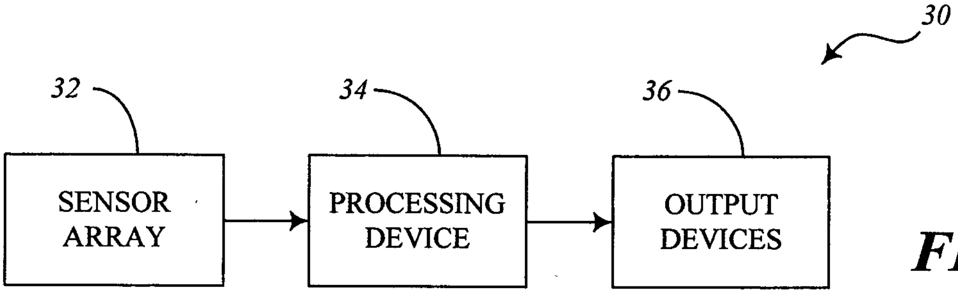
30
32
34
36
SENSOR ARRAY
PROCESSING DEVICE
OUTPUT DEVICES

FIG. 3

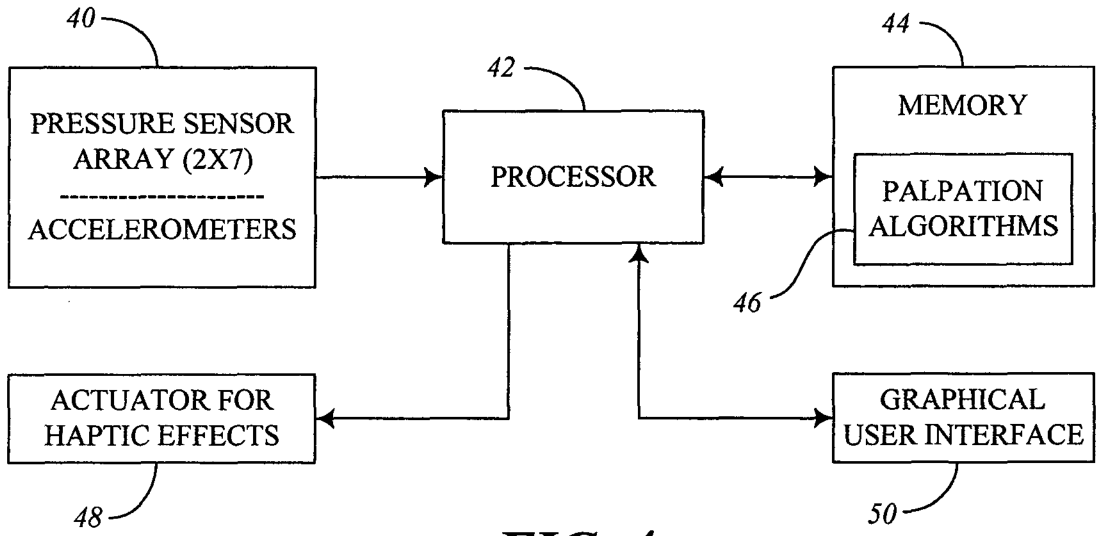
40
PRESSURE SENSOR ARRAY (2X7)
ACCELEROMETERS
42
PROCESSOR
44
MEMORY
PALPATION ALGORITHMS
46
ACTUATOR FOR HAPTIC EFFECTS
48
GRAPHICAL USER INTERFACE
50

FIG. 4

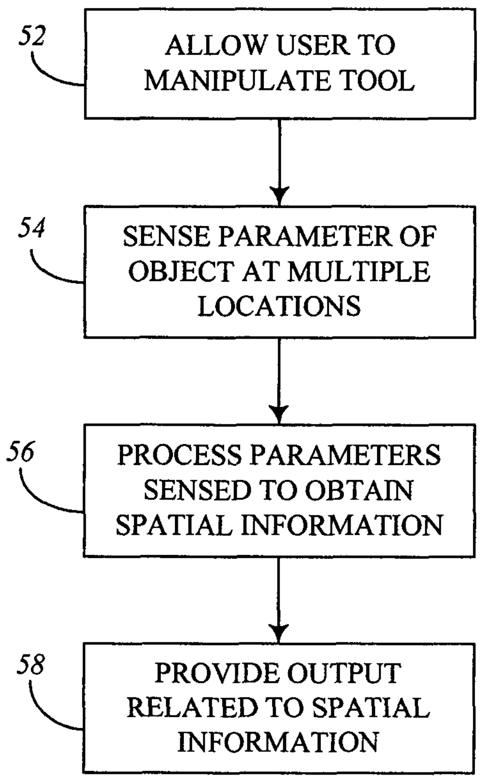
52
ALLOW USER TO MANIPULATE TOOL
54
SENSE PARAMETER OF OBJECT AT MULTIPLE LOCATIONS
56
PROCESS PARAMETERS SENSED TO OBTAIN SPATIAL INFORMATION
58
PROVIDE OUTPUT RELATED TO SPATIAL INFORMATION

FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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patsnap

专利名称(译)	安装在工具上的空间传感器阵列		
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优先权	12/333600 2008-12-12 US		
其他公开文献	EP2355709A1		
外部链接	Espacenet		

摘要(译)

本文描述的系统和方法包括定位在工具上的传感器阵列。在一个实施例中，工具包括被配置为由用户操纵的手柄。该工具还包括设置成与手柄机械连通的端部。另外，该工具包括安装在端部上的传感器阵列，其中传感器阵列被配置为感测物体的特性。该工具还包括处理装置，该处理装置被配置为处理由传感器阵列感测的对象的属性并获得对象的空间信息。处理设备还被配置为将空间信息传送到句柄。

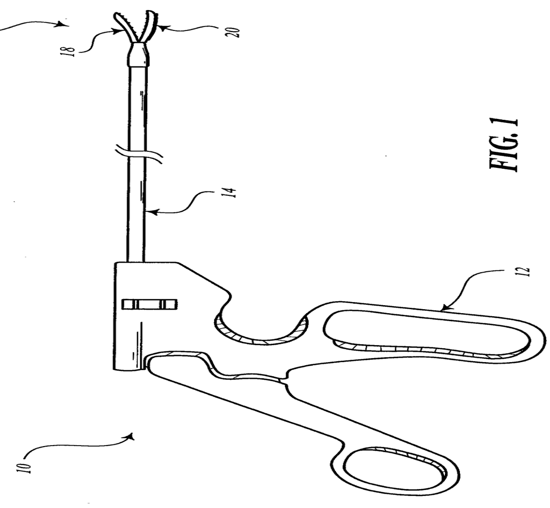

FIG. 1