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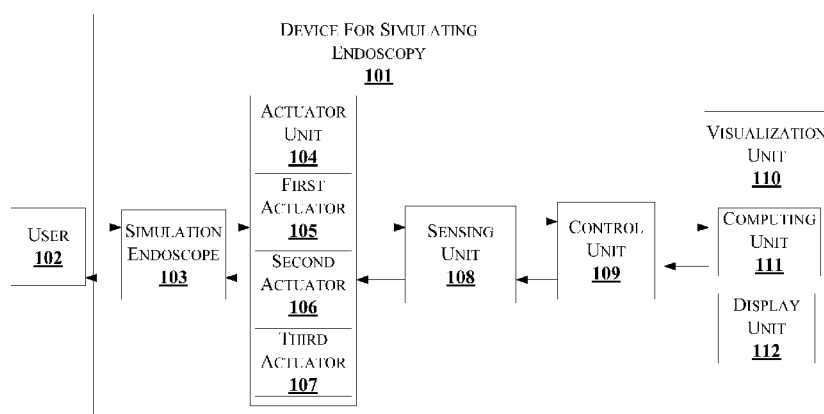


Figure 1

(57) **Abstract:** Embodiments of the present disclosure relate to device and a method for simulating endoscopy. The device comprises a simulation endoscope, a guide member, a first actuator, a second actuator and a control unit with a mechanism to simulate radial movement of the simulation endoscope. The guide accommodates the simulation endoscope which is connectable to the first actuator for simulating rotational movement of the simulation endoscope. The second actuator simulates linear movement of the simulation endoscope and the third actuator simulates radial movement of the simulation endoscope. The control unit is interfaced with the first, second and third actuators regulate actuations based on movement of simulation endoscope detected by a sensing unit in the device. The system for simulating endoscopy comprises the device operated by a user and a visualization unit which visualizes the operation of the simulation endoscope in a simulated environment.

“A DEVICE FOR SIMULATING ENDOSCOPY AND A SYSTEM THEREOF”**TECHNICAL FIELD**

The present invention generally relates to a medical apparatus, and more particularly relates to a device for simulating endoscopy.

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BACKGROUND

Endoscopy is a minimally invasive procedure where a flexible tube is inserted through a digestive tract for medical examination and for surgical procedures. User of an endoscope during the examination is required to have high degree of hand-eye coordination and experience gained from a large variety of cases.

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One of conventional systems describes a gastro-endoscopy, which is a medical tool for both surgical and diagnostic procedures in digestive organ system. The gastro-endoscopy is performed by inserting an endoscope, which is a flexible tube, into the Gastro-Intestinal (GI) tract, through one of mouth and rectum of the subject. The tube is manipulated by a trained professional or physician through a device with special controls. The end of the tube which is inserted into the subject contains a camera and one or more surgical tools, such as a clipper for removing tissue samples from the gastrointestinal system. The physician maneuvers the tube according to images of the gastrointestinal system received from the camera and displayed on a display. The lack of direct visual and force feedback from the gastrointestinal system is one factor which renders endoscopy a complex and difficult procedure to master. Also, due to the lack of feedback it is difficult to have hand-eye coordination and correct manipulation of the endoscopic device. Thus, flexible gastro-endoscopy is a difficult procedure to both perform and to learn.

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Currently, trainees are trained to perform flexible gastro-endoscopy using the conventional or traditional methods for medical education, where the trainees observe and assist experienced physicians. However, such observation alone cannot provide the necessary training for such complicated medical procedures. The trainees may also perform procedures on animals and human cadavers, neither of which replicates the visual and tactile sensations

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of a live human patient. Thus, conventional medical training is not adequate for modern technologically complex medical procedures.

In other conventional systems, to provide more realistic medical training, simulation devices are developed which attempt to replicate tactile sensations and visual feedback for training procedures. The simulation devices disclose to provide improved medical training without endangering human patients. In one of known arts, a device is a box containing simulated human organs. One or more surgical procedures may be performed on the simulated organs. The visual feedback is provided by a system of mirrors. However, the system of both visual and tactile feedback is primitive in the device, and does not provide a true representation of the visual and tactile sensations which would accompany the surgical procedures in a human patient. Furthermore, the box is not a realistic representation of three-dimensional structure of a human patient. Thus, the device has some drawbacks in lacking important aspects and fails to meet the needs of a medical simulation device.

Also, with the recent developments, there exist virtual and non-virtual simulators on which basic-surgical skills are practiced. Most virtual simulators rely on sophisticated haptic sensors and software integrated with large computer systems that are immobile and often extremely expensive. Therefore, training for the trainees often have restricted access and limited times to practice surgical techniques using virtual simulators.

Additionally, many virtual training environments require the observation of skill performance in a two-dimensional environment on a planar video monitor screen that fails to provide a realistic three-dimensional environment required for initial learning and practice of basic surgical skills. Non-virtual surgical-simulator tools which are presently uses are without feedback whenever excessive forces are applied. The limitations of existing devices includes, but not limited to, brake-like force feedback with limited active force control, one of fewer degree of freedom (DoF) and the DoF coupled to one another, and use of gears and belt drives, which cannot reproduce forces with high fidelity in haptics.

SUMMARY

One or more shortcomings of the prior art are overcome and additional advantages are provided through the present disclosure. Additional features and advantages are realized through the techniques of the present disclosure. Other embodiments and aspects of the disclosure are described in detail herein and are considered a part of the claimed disclosure.

The present disclosure relates to a device for simulating endoscopy which comprises a simulation endoscope accommodated in a guide member supported by a frame. The device further comprises a first actuator supported by the frame which is connected to a carriage. The first actuator facilitates translatory motion of the carriage to simulate linear movement of the simulation endoscope. Further, the device comprises a second actuator provisioned in the guide member which is connectable to the simulation endoscope. The second actuator fixed to the carriage, imposes torque on the simulation endoscope to simulate rotational movement of the simulation endoscope. Further, the device provides a mechanism to simulate radial movement of the simulation endoscope. The mechanism is supported by the frame and is actuated by a third actuator. Furthermore, the device comprises a control unit interfaced with the first, second and third actuators to regulate actuations of the first, second and third actuators based on movement of simulation endoscope which is detected by a sensing unit in the device.

Further, the present disclosure relates to a method for simulating endoscopy, which includes detecting the movements of a simulation endoscope by the sensing unit of the device. Also, the method includes computing the actuations to be performed by at least one actuator in the device based on the movement. Further, the method includes providing the actuations to at least one actuator for simulating endoscopy.

Furthermore, the present disclosure relates to a system for simulating endoscopy, which comprises the device for simulating endoscopy and a visualization unit to provide visualization of operation of the simulation endoscope in a simulated environment based on the movement and the actuations.

The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects and features described above, further aspects,

and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE FIGURES

The novel features and characteristic of the disclosure are set forth in the appended
5 claims. The embodiments of the disclosure itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings. One or more embodiments are now described, by way of example only, with reference to the accompanying drawings.

10 **Figure 1** shows a block diagram of a system for simulating endoscopy, in accordance with some embodiments of the present disclosure;

15 **Figure 2** shows a device for simulating endoscopy, in accordance with some embodiments of the present disclosure;

Figure 3 illustrates a first actuator in the device to simulate linear movement of the simulation endoscope, in accordance with some embodiments of the present disclosure;

20 **Figure 4** illustrates a second actuator in the device to simulate rotational movement of the simulation endoscope with a snap fit mechanism, in accordance with some embodiments of the present disclosure;

25 **Figure 5** illustrates a snap fit mechanism in the second actuator for insertion and removal of the simulation endoscope, in accordance with some embodiments of the present disclosure;

Figure 6 illustrates an embodiment of a rotary member with plurality of linkages, in accordance with some embodiments of the present disclosure;

30 **Figure 7** shows a pin joint assembly of the plurality of linkages in the rotary member, in accordance with some embodiments of the present disclosure;

Figure 8 illustrates a third actuator in the device to simulate radial movement of the simulation endoscope, in accordance with some embodiments of the present disclosure; and

Figure 9 illustrates a block diagram of an exemplary computer system for implementing some embodiments consistent with the present disclosure.

The figures depict embodiments of the disclosure for purposes of illustration only. One skilled in the art will readily recognize from the following description that alternative embodiments of the structures and methods illustrated herein may be employed without departing from the principles of the disclosure described herein.

DETAILED DESCRIPTION

The foregoing has broadly outlined the features and technical advantages of the present disclosure in order that the detailed description of the disclosure that follows may be better understood. Additional features and advantages of the disclosure will be described hereinafter which form the subject of the claims of the disclosure. It should be appreciated by those skilled in the art that the conception and specific aspect disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present disclosure.

In the present document, the word "exemplary" is used herein to mean "serving as an example, instance, or illustration". Any embodiment or implementation of the present subject matter described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments.

While the disclosure is susceptible to various modifications and alternative forms, specific embodiment thereof has been shown by way of example in the drawings and will be described in detail below. It should be understood, however that it is not intended to limit the disclosure to the particular forms disclosed, but on the contrary, the disclosure is to cover all modifications, equivalents, and alternative falling within the spirit and the scope of the disclosure.

The terms "comprises", "comprising", or any other variations thereof, are intended to cover a non-exclusive inclusion, such that a setup, device or method that comprises a list of

components or steps does not include only those components or steps but may include other components or steps not expressly listed or inherent to such setup or device or method. In other words, one or more elements in a system or apparatus proceeded by “comprises... a” does not, without more constraints, preclude the existence of other elements or additional elements in the system or apparatus.

The present disclosure relates to a device for simulating endoscopy which comprises a simulation endoscope, a guide member, a snap-fit mechanism, a first actuator, a second actuator and a control unit with a mechanism to simulate radial movement of the simulation endoscope. The guide member is supported by a frame which accommodates the simulation endoscope. The first actuator is connectable to the simulation endoscope and simulates rotational movement of the simulation endoscope. The second actuator simulates linear movement of the simulation endoscope and the third actuator simulates radial movement of the simulation endoscope. The control unit is interfaced with the first, second and third actuators regulate actuations of the first, second and third actuators based on movement of simulation endoscope detected by a sensing unit in the device. Further, a system for simulating endoscopy is disclosed which comprises the device operated by a user and a visualization unit which visualizes the operation of the simulation endoscope in a simulated environment.

In the following detailed description of the embodiments of the disclosure, reference is made to the accompanying drawings that form a part hereof, and in which are shown by way of illustration specific embodiments in which the disclosure may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the disclosure, and it is to be understood that other embodiments may be utilized and that changes may be made without departing from the scope of the present disclosure. The following description is, therefore, not to be taken in a limiting sense.

Figure 1 shows a block diagram of a system for simulating endoscopy, in accordance with some embodiments of the present disclosure;

As shown in Figure 1, a system for simulating endoscopy comprises a device 101 for simulating endoscopy operated by a user 102 and further comprises a visualization unit 110. The device 101 comprises a simulation endoscope 103, an actuator unit 104, a sensing unit 108 and a control unit 109. The user 102 operates the simulation endoscope 103 as in real endoscopy procedure. The user 102 may be a trainee who is trained to maneuver operation of an endoscope. The simulation endoscope 103 may be one of similar to the endoscope and the endoscope itself. The actuator unit 104 helps in movement of the simulation endoscope 103 and comprises one or more actuators which include but not limited to a first actuator 105, a second actuator 106 and a third actuator 107. The first actuator 105 simulates linear movement of the simulation endoscope 103. The second actuator 106 simulates rotational movement of the simulation endoscope 103 and the third actuator 107 simulates the radial movement of the simulation endoscope 103. The sensing unit 105 comprises one or more sensors (not shown in Figure 1) to detect movement of the simulation endoscope 103 caused due to operation performed by the user 102 on the simulation endoscope 103. In one embodiment, a snap-fit mechanism is implemented in the device 101 that enables insertion and removal of the simulation endoscope 103 from the device 101. The control unit 109 is interfaced with the actuators to compute actuations which are to be performed by the actuators and the actuations are based on the movements of the actuators. Further, the control unit 109 provides the actuations to the actuators as feedback for simulating endoscopy. The visualization unit 110 comprises a computation unit 111 and a display unit 112 interfaced with the device 101. The visualization unit 110 computes and displays visualization of the operation of the simulation endoscope 103 in a simulated environment. The computing of the visualization is performed by the computation unit 111 and is displayed on the display unit 112.

Figure 2 shows the device for simulating endoscopy, in accordance with some embodiments of the present disclosure;

The device 101 for simulating endoscopy comprises the simulation endoscope 103 accommodated by a guide member 212 which is supported by a frame 214. The simulation endoscope 103 is connectable to the device 101 through a snap fit mechanism 209. The first actuator 105 in the device 101 is supported by the frame 214 and connected to a carriage 211.

The first actuator 105 may be one of rotary actuator and a linear actuator. Translatory motion of the carriage 211 is facilitated by the first actuator 105 to simulate linear movement 202 of the simulation endoscope 103. The translatory motion of the carriage 211 is carried over a rail guide 207 which driven by capstan drive driven by a DC motor 208. In one embodiment, the motion of carriage 211 over the rail guide 207 is of predefined length. The second actuator 106 which is connectable to the simulation endoscope 103 is provisioned in the guide member 212. Torque is imposed on the simulation endoscope 103 by the second actuator 106 comprising a direct drive motor 210 which is fixed to the carriage 211 and the torque simulates rotational movement 203 of the simulation endoscope 103. The direct drive motor 210 is mounted on the carriage 211, travels with linear movement to provide continuous rotational movement 203 of the simulation endoscope 103. The third actuator 107 provides a mechanism 206 which is supported by the frame 214 to simulate radial movement 201 of the simulation endoscope 103. The mechanism 206 may also be referred as a circumferentially actuated mechanism, which is driven by a capstan drive. In one embodiment, the mechanism 206 consists of eight triangular elements, a circular disc which facilitates a simulation of guiding the simulation endoscope 103 into the food-pipe of a subject avoiding the wind-pipe through the radial movement of the simulation endoscope 103. The mechanism 206 is configured to be actuated by a fixed motor 205. The device 101 is implemented on a base plate 204 to carry out simulating endoscopy.

Figure 3 illustrates a first actuator in the device to simulate linear movement of the simulation endoscope, in accordance with some embodiments of the present disclosure;

The linear movement 202 of the simulation endoscope 103 is performed by the first actuator 105 which facilitates the translator motion of the carriage 211 actuated by a capstan drive 301, moving on a rail guide 207. The carriage 211 is connected to the first actuator 105 through a strand 302. Figure 3 illustrates the capstan drive 301 for the linear movement 202 of the simulation endoscope 103. In an embodiment, rotation of motor for capstan drive 301 causes the strand on the motor to wind the motor the strand 302 from one side and unwind from the other side with the help of a pulley 213. Since the strand 302 is connected to the carriage 211, the winding 303 and unwinding causes the carriage 211 to move linearly along the rail guide 207. The translator motion of the carriage 211 thereby causes linear movement

of the simulation endoscope 103. In one embodiment, the motor for capstan drive 301 may be one or more DC motors, which further may be Maxon DC motors. The linear movement 202 of the simulation endoscope 103 is sensed by the sensing unit 108 of the device 101. The control unit 109 computes the actuation which is to be performed by the first actuator 105
5 based on the linear movement 202 sensed by the sensing unit 108. In one embodiment, the control unit comprises one or more encoders to encode the linear movement 202 of the simulation endoscope 103 and one or more driver circuits which are used to supply controlled current to the motor. In one embodiment, a proportional-derivative (PD) controller is implemented for the motor.

10 **Figure 4** illustrates a second actuator in the device to simulate rotational movement of the simulation endoscope with a snap fit mechanism, in accordance with some embodiments of the present disclosure;

15 In an endoscopy, rotational movement of an endoscope provides change in view angle. Rotation of the endoscope allows viewing regions of an organ of a subject that are not accessible to the endoscope. This is an important maneuver that needs to be captured for a realistic simulation. The rotational movement 203 of the simulation endoscope 103 in the device 101 is simulated by the second actuator 106. The second actuator 106 is provisioned in
20 the guide member 212 and is connectable to the simulation endoscope 103. The second actuator 106 may be a rotary actuator with the direct drive motor 210 on the carriage 211 placed on the rail guide 207. The rotational movement 203 of the simulation endoscope 103 is sensed by the sensing unit 108 of the device 101. The control unit 109 computes the actuation which is to be performed by the second actuator 106 based on the rotational movement 203
25 sensed by the sensing unit 108. In one embodiment, the control unit 109 comprises one or more encoders to encode the rotational movement of the simulation endoscope 103 and one or more driver circuits which are used to supply controlled current to the direct drive motor 210. In one embodiment, a proportional-derivative (PD) controller is implemented for the direct drive motor 301.

30 Further, in one embodiment, the simulation endoscope 103 is connected to the second actuator 106 by the snap fit mechanism 209. The snap fit mechanism 209 is illustrated in

Figure 4 in accordance with some embodiments of the present disclosure. The requirement for removal and re-insertion of the simulation endoscope 103 is provided for by the snap fit mechanism 209. In one example embodiment, when the simulation endoscope 103 is inserted into the device 101, the snap fit mechanism 209 makes the simulation endoscope 103 latch on to the shaft of the motor 211 with help of one or more strips 402 and socket 401 which is connected to the motor 211. The snap fit mechanism 209 prevents relative rotation between the simulation endoscope 103 and the motor 211, thus, ensuring transfer of the torque imposed by the second actuator 106 to the simulation endoscope 103.

Figure 5 illustrates a snap fit mechanism in the second actuator for removal of the simulation endoscope, in accordance with some embodiments of the present disclosure;

Provision for insertion and removal of the simulation endoscope 103 is achieved by the snap fit mechanism 209 in an example embodiment. The one or more strips 402 which are flexible allow the insertion of the simulation endoscope 103 into the socket 401 on the direct drive motor 210. Upon insertion of the simulation endoscope 103 on to the second actuator 106, the strips 402 are provided around the simulation endoscope 103. For the removal of the simulation endoscope 103 from the second actuator 106, the strips 402 are to be pressed inwards which releases the simulation endoscope 103. Mechanism for removal of simulation endoscope 103 is illustrated in Figure 5. The mechanism further involves a funnel 501 at entrance of the device 101 as shown in Figure 5 which ensures easy release from the second actuator 106 and removal from the device 101.

Figure 6 illustrates an embodiment of a rotary member with plurality of linkages, in accordance with some embodiments of the present disclosure;

Figure 7 shows a pin joint assembly of the plurality of linkages in the rotary member, in accordance with some embodiments of the present disclosure;

The radial movement 201 of the simulation endoscope 103 is achieved by a mechanism 206 supported in the device 101 by the frame 214 at starting of the device 101. The mechanism 206 is actuated by the third actuator 107. The mechanism 206 along with the radial movement 201 of the simulation endoscope 103 provides a circumferential movement

to the simulation endoscope 103. In an endoscopy, there exists a need to guide to an endoscope into the food pipe of the subject avoiding the wind-pipe. The simulation of resistance required to guide the simulation endoscope 103 is provided by the mechanism 206. When the simulation endoscope 103 is operated to insert through narrow passage at entry of the food-pipe, the mechanism 206 closes gap to apply radial forces which may be achieved by the linear movement 202 of the simulation endoscope 103.

In one embodiment, the third actuator 107 may be a rotary actuator. Further, the mechanism 206 comprises a rotary member 602 which is rotated by the third actuator 107. Plurality of linkages 601 are connected to the rotary member 602 and are configured to move in radially inward and outward directions depending on the direction of rotation of the rotary member 602. In one embodiment, the mechanism 206 is referred as circumferentially actuated ring-mechanism. In one example embodiment, the plurality of linkages 601 may be at least one of triangular elements and rhombus shaped linkages that fold radially inwards applying radial forces on the simulation endoscope 103 as illustrated in Figure 6. The plurality of linkages 601 is driven by a capstan drive with a motor 205 in accordance with an embodiment of the present disclosure. The plurality of linkages 601 are assembled using a pin joint assembly with help of pin joints 703 and circlips 701 to keep the linkages 601 in place and in contact with each other as illustrated in Figure 7. Support to the linkages is provided by the rotary member 602 and a fixed ring 604. The linkages are placed to rotate about joint 603 to enable the radial movement 201 of the simulation endoscope 103.

Figure 8 illustrates a third actuator in the device to simulate radial movement of the simulating endoscope, in accordance with some embodiments of the present disclosure; and

The radial movement 201 of the simulation endoscope 103 simulates the guiding of the simulated endoscope 103 into the food-pipe avoiding the wind-pipe of the subject. Figure 8 illustrates one example embodiment of the third actuator 107. The third actuator 107 may be one of rotary actuator and linear actuator. The plurality of linkages 601 is supported by the rotary member 602 and the fixed ring 604 and a capstan drive comprising the fixed motor 205 is connected to the rotary member 602 through a strand 803. A threaded cylinder 801 is wound with the strand 803 forming windings 802, which is mounted on shaft of the fixed motor 205. In one embodiment, the fixed motor may be a DC motor. In one example

embodiment, when the fixed motor shaft rotates, the rotary member 602 is rotated and thereby causes the plurality of linkages 601 to move radially inwards and thereby, apply force on the simulation endoscope 103. The radial movement 203 of the simulation endoscope 103 is sensed by the sensing unit 108 of the device. The control unit 109 computes the actuation
5 which is to be performed by the third actuator 107 based on the rotational movement 201 sensed by the sensing unit 108. In one embodiment, the control unit 109 comprises one or more encoders to encode the rotational movement of the simulation endoscope 103 and one or more driver circuits which are used to supply controlled current to the direct drive motor 210. In one embodiment, a proportional-derivative (PD) controller is implemented for the fixed
10 motor 301.

Further, the mechanism 206 for radial movement 201 of the simulation endoscope 103 detects angle of insertion of the simulation endoscope 103. When the simulation endoscope 103 enters embodiment of the third actuator 107 at an irrelevant angle, the simulation
15 endoscope 103 tip with the snap-fit mechanism 209, displaces gripping pads of the mechanism 206. A threshold is set for this displacement of the gripping pads beyond which the visualization unit 110 simulates incorrect entry into the food-pipe.

In the present disclosure, in one embodiment, the user, maneuvers the operation of an
20 endoscope with the help of the device 101 disclosed in the present disclosure. In one embodiment of the device 101, most upper Gastro Intestinal (GI) endoscopy procedures, which is located at approximately 0.7 - 0.8 m from mouth of a subject is simulated. The visualization unit 110 comprising of the computing unit 111 and the display unit 112 provides the representation of visualization of operation of the simulated endoscope in a simulated
25 environment based on the movements and the actuations of the actuators. The computing unit 111 receives current positions of the actuators and velocity information from the control unit to perform the computation required for the visualization. In one embodiment, a physics-based computation model is implemented as the computing unit 111 to provide one or more reaction forces and global deformation using real-time finite element analysis (FEA). Also, in
30 one embodiment a 2-D linear FEA is implemented in the device. In one embodiment, the device and the visualization unit 110 communicate through a serial port interface.

Figure 9 illustrates a block diagram of an exemplary computer system for implementing embodiments consistent with the present disclosure.

Variations of computer system 901 may be used for implementing all the computing systems that may be utilized to implement the features of the present disclosure. Computer system 901 may comprise a central processing unit (“CPU” or “processor”) 903. Processor 903 may comprise at least one data processor for executing program components for executing user- or system-generated requests. The processor may include specialized processing units such as integrated system (bus) controllers, memory management control units, floating point units, graphics processing units, digital signal processing units, computing units, control units etc. The processor 903 may include a microprocessor, such as AMD Athlon, Duron or Opteron, ARM’s application, embedded or secure processors, IBM PowerPC, Intel’s Core, Itanium, Xeon, Celeron or other line of processors, etc. The processor 903 may be implemented using mainframe, distributed processor, multi-core, parallel, grid, or other architectures. Some embodiments may utilize embedded technologies like application-specific integrated circuits (ASICs), digital signal processors (DSPs), Field Programmable Gate Arrays (FPGAs), etc.

Processor 903 may be disposed in communication with one or more input/output (I/O) devices via I/O interface 902. The I/O interface 902 may employ communication protocols/methods such as, without limitation, audio, analog, digital, monoaural, RCA, stereo, IEEE-1394, serial bus, universal serial bus (USB), infrared, PS/2, BNC, coaxial, component, composite, digital visual interface (DVI), high-definition multimedia interface (HDMI), RF antennas, S-Video, VGA, IEEE 802.n /b/g/n/x, Bluetooth, cellular (e.g., code-division multiple access (CDMA), high-speed packet access (HSPA+), global system for mobile communications (GSM), long-term evolution (LTE), WiMax, or the like), etc.

Using the I/O interface 902, the computer system 901 may communicate with one or more I/O devices. For example, the input device 904 may be an antenna, keyboard, mouse, joystick, (infrared) remote control, camera, card reader, fax machine, dongle, biometric reader, microphone, touch screen, touchpad, trackball, sensor (e.g., accelerometer, light sensor, GPS, gyroscope, proximity sensor, or the like), stylus, scanner, storage device,

transceiver, video device/source, visors, etc. Output device 905 may be a printer, fax machine, video display (e.g., cathode ray tube (CRT), liquid crystal display (LCD), light-emitting diode (LED), plasma, or the like), audio speaker, etc. In some embodiments, a transceiver 905 may be disposed in connection with the processor 903. The transceiver may facilitate various types of wireless transmission or reception. For example, the transceiver may include an antenna operatively connected to a transceiver chip (e.g., Texas Instruments WiLink WL1283, Broadcom BCM4750IUB8, Infineon Technologies X-Gold 618-PMB9800, or the like), providing IEEE 802.11a/b/g/n, Bluetooth, FM, global positioning system (GPS), 2G/3G HSDPA/HSUPA communications, etc.

In one embodiment, the processor 903 may be disposed in communication with a communication network 918 via a network interface 907. The network interface 907 may communicate with the communication network 918. The network interface 907 may employ connection protocols including, without limitation, direct connect, Ethernet (e.g., twisted pair 10/40/400 Base T), transmission control protocol/internet protocol (TCP/IP), token ring, IEEE 802.11a/b/g/n/x, etc. The communication network 918 may include, without limitation, a direct interconnection, local area network (LAN), wide area network (WAN), wireless network (e.g., using Wireless Application Protocol), the Internet, etc. Using the network interface 907 and the communication network 918, the computer system 901 may communicate with sources 920. These devices may include, without limitation, personal computer(s), server(s), fax machines, printers, scanners, various mobile devices such as cellular telephones, smartphones (e.g., Apple iPhone, Blackberry, Android-based phones, etc.), tablet computers, eBook readers (Amazon Kindle, Nook, etc.), laptop computers, notebooks, gaming consoles (Microsoft Xbox, Nintendo DS, Sony PlayStation, etc.), or the like. In some embodiments, the computer system 901 may itself embody one or more of these devices.

In some embodiments, the processor 903 may be disposed in communication with one or more memory devices (e.g., RAM 910, ROM 909, etc.) via a storage interface 908. The storage interface may connect to memory devices including, without limitation, memory drives, removable disc drives, etc., employing connection protocols such as serial advanced technology attachment (SATA), integrated drive electronics (IDE), IEEE-1394, universal

serial bus (USB), fiber channel, small computer systems interface (SCSI), etc. The memory drives may further include a drum, magnetic disc drive, magneto-optical drive, optical drive, redundant array of independent discs (RAID), solid-state memory devices, solid-state drives, etc.

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The memory 911 may store a collection of program or database components, including, without limitation, an operating system 917, user interface application 916, web browser 915, mail server 914, mail client 913, user/application data 912 (e.g., any data variables or data records discussed in this disclosure), etc. The operating system 917 may facilitate resource management and operation of the computer system 901. Examples of operating systems include, without limitation, Apple Macintosh OS X, UNIX, Unix-like system distributions (e.g., Berkeley Software Distribution (BSD), FreeBSD, NetBSD, OpenBSD, etc.), Linux distributions (e.g., Red Hat, Ubuntu, Kubuntu, etc.), IBM OS/2, Microsoft Windows (XP, Vista/7/8, etc.), Apple iOS, Google Android, Blackberry OS, or the like. User interface 916 may facilitate display, execution, interaction, manipulation, or operation of program components through textual or graphical facilities. For example, user interfaces may provide computer interaction interface elements on a display system operatively connected to the computer system 901, such as cursors, icons, check boxes, menus, scrollers, windows, widgets, etc. Graphical user interfaces (GUIs) may be employed, including, without limitation, Apple Macintosh operating systems' Aqua, IBM OS/2, Microsoft Windows (e.g., Aero, Metro, etc.), Unix X-Windows, web interface libraries (e.g., ActiveX, Java, Javascript, AJAX, HTML, Adobe Flash, etc.), or the like.

In some embodiments, the computer system 901 may implement a web browser 915 stored program component. The web browser may be a hypertext viewing application, such as Microsoft Internet Explorer, Google Chrome, Mozilla Firefox, Apple Safari, etc. Secure web browsing may be provided using HTTPS (secure hypertext transport protocol), secure sockets layer (SSL), Transport Layer Security (TLS), etc. Web browsers may utilize facilities such as AJAX, DHTML, Adobe Flash, JavaScript, Java, application programming interfaces (APIs), etc. In some embodiments, the computer system 901 may implement a mail server 914 stored program component. The mail server may be an Internet mail server such as Microsoft Exchange, or the like. The mail server may utilize facilities such as ASP, ActiveX, ANSI

C++/C#, Microsoft .NET, CGI scripts, Java, JavaScript, PERL, PHP, Python, WebObjects, etc. The mail server may utilize communication protocols such as internet message access protocol (IMAP), messaging application programming interface (MAPI), Microsoft Exchange, post office protocol (POP), simple mail transfer protocol (SMTP), or the like. In
5 some embodiments, the computer system 901 may implement a mail client 913 stored program component. The mail client may be a mail viewing application, such as Apple Mail, Microsoft Entourage, Microsoft Outlook, Mozilla Thunderbird, etc.

In some embodiments, computer system 901 may store user/application data 912, such
10 as the data, variables, records, etc. as described in this disclosure. Such databases may be implemented as fault-tolerant, relational, scalable, secure databases such as Oracle or Sybase. Alternatively, such databases may be implemented using standardized data structures, such as an array, hash, linked list, struct, structured text file (e.g., XML), table, or as object-oriented databases (e.g., using ObjectStore, Poet, Zope, etc.). Such databases may be consolidated or
15 distributed, sometimes among the various computer systems discussed above in this disclosure. It is to be understood that the structure and operation of the any computer or database component may be combined, consolidated, or distributed in any working combination.

20 In one embodiment, the present disclosure provides simulating endoscopy with actuations with respect to movements provided by user to the device with enables a realistic system.

In one embodiment, the present disclosure provides high fidelity and transparency by
25 detecting even the smaller movements of the actuators.

In one embodiment, the present disclosure provides actuators using capstan drives with strands which provide provision for a cog less back drivable transmission.

30 In one embodiment, the present disclosure discloses a device for simulating endoscopy by reducing cost, and size making the device less complex, portable and easy to use.

However a person skilled in art can envisage other application in medical field in which the current disclosure can be used. Further, the instant disclosure can be readily adopted in similar application with minor modification without departing from the scope of the present disclosure.

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The terms "an embodiment", "embodiment", "embodiments", "the embodiment", "the embodiments", "one or more embodiments", "some embodiments", and "one embodiment" mean "one or more (but not all) embodiments of the disclosure(s)" unless expressly specified otherwise.

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The terms "including", "comprising", "having" and variations thereof mean "including but not limited to", unless expressly specified otherwise.

15

The terms "a", "an" and "the" mean "one or more", unless expressly specified otherwise.

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When a single device or article is described herein, it will be readily apparent that more than one device/article (whether or not they cooperate) may be used in place of a single device/article. Similarly, where more than one device or article is described herein (whether or not they cooperate), it will be readily apparent that a single device/article may be used in place of the more than one device or article or a different number of devices/articles may be used instead of the shown number of devices or programs. The functionality and/or the features of a device may be alternatively embodied by one or more other devices which are not explicitly described as having such functionality/features. Thus, other embodiments of the disclosure need not include the device itself.

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The foregoing description of various embodiments of the disclosure has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It is intended that the scope of the disclosure be limited not by this detailed description, but rather by the claims appended hereto. The above specification, examples and data provide a complete description of the manufacture and use of the composition of the disclosure. Since many embodiments of the disclosure can be made

without departing from the spirit and scope of the disclosure, the disclosure resides in the claims hereinafter appended.

Finally, the language used in the specification has been principally selected for
5 readability and instructional purposes, and it may not have been selected to delineate or
circumscribe the inventive subject matter. It is therefore intended that the scope of the
disclosure be limited not by this detailed description, but rather by any claims that issue on an
application based here on. Accordingly, the disclosure of the embodiments of the disclosure is
intended to be illustrative, but not limiting, of the scope of the disclosure, which is set forth in
10 the following claims.

With respect to the use of substantially any plural and/or singular terms herein, those
having skill in the art can translate from the plural to the singular and/or from the singular to
the plural as is appropriate to the context and/or application. The various singular/plural
15 permutations may be expressly set forth herein for sake of clarity.

In addition, where features or aspects of the disclosure are described in terms of
Markush groups, those skilled in the art will recognize that the disclosure is also thereby
described in terms of any individual member or subgroup of members of the Markush group.

20 While various aspects and embodiments have been disclosed herein, other aspects and
embodiments will be apparent to those skilled in the art. The various aspects and embodiments
disclosed herein are for purposes of illustration and are not intended to be limiting, with the
true scope and spirit being indicated by the following claims.

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Referral Numerals:

20

Reference Number	Description
101	device for simulation endoscopy
102	user
103	simulation endoscope
104	actuator unit
105	first actuator
106	second actuator

107	third actuator
108	sensing unit
109	control unit
110	visualization unit
111	computing unit
112	display unit
201	radial movement of simulation endoscope
202	linear movement of simulation endoscope
203	rotational movement of simulation endoscope
204	base plate
205	fixed motor
206	mechanism for third actuator
207	rail guide
208	DC motor
209	snap fit mechanism
210	direct drive motor
211	carriage
212	guide member

213	pulley
214	frame
301	capstan drive
302	strand in first actuator
303	winding in first actuator
401	socket
402	one or more strips
501	funnel
601	plurality of linkages
602	rotary member
603	joint
604	fixed ring
701	circlip
702	pin
703	pin joint
801	thread cylinder
802	winding in third actuator
803	strand in third actuator
901	computer system
902	I/O interface

5	903	processor
	904	input devices
	905	output devices
	906	transceivers
	907	network interface
	908	storage interface
10	909	ROM
	910	RAM
	911	memory
	912	user/application data
15	913	mail client
	914	mail server
	915	web browser
	916	user interface
20	917	operating system
	918	network
	919	device(s)

We claim:

1. A device for simulating endoscopy, comprising:

A simulation endoscope;

a guide member for accommodating the simulation endoscope, wherein the
5 guide member is supported by a frame;

a first actuator supported by the frame, and connected to a carriage , wherein
the first actuator facilitates translatory motion of the carriage to simulate linear
movement of the simulation endoscope;

a second actuator provisioned in the guide member, and connectable to the
10 simulation endoscope, wherein the second actuator imposes torque on the simulation
endoscope to simulate rotational movement of the simulation endoscope, wherein the
carriage is fixed to the second actuator ;

a mechanism to simulate radial movement of the simulation endoscope,
wherein the mechanism is supported by the frame, and is actuated by a third actuator;
15 and

a control unit interfaced with the first, second and third actuators, the control
unit is configured to regulate actuations of the first, second and third actuators based
on movement of simulation endoscope detected by a sensing unit in the device.

- 20 2. The device as claimed in claim 1, wherein the second and third actuators are rotary
actuators.

3. The device as claimed in claim 1, wherein the first actuator is at least one of rotary
actuator and linear actuator.

4. The device as claimed in claim 1, wherein the third actuator simulates guiding the
simulation endoscope into food-pipe of a subject, avoiding wind pipe.

5. The device as claimed in claim 1, wherein the mechanism comprises:

a rotary member, wherein the rotary member is configured to be rotated by the
third actuator; and

a plurality of linkages connected to the rotary member, wherein the plurality of linkages are configured to move in radially inward and outward directions depending on the direction of rotation of the rotary member.

5 6. The device as claimed in claim 5, wherein the linkages are at least one of triangular linkages, and rhombus shaped linkages.

7. The device as claimed in claim 1, wherein the carriage is connected to the first actuator through a strand.

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8. The device as claimed in claim 1, wherein the carriage is adapted to move on a guide rail.

9. The device as claimed in claim 8, wherein the guide rail is supported by the frame.

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10. The device as claimed in claim 1, wherein the sensing unit comprises one or more sensors.

11. A method for simulating endoscopy, comprising:

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detecting, by a sensing unit of a device, movements of a simulation endoscope, wherein the simulation endoscope is connectable to the device for simulating endoscopy;

computing, by a control unit of the device, actuations to be performed by at least one actuator in the device based on the movements; and

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providing, by the control unit of the device, the actuations to at least one actuator for simulating endoscopy.

12. The method as claimed in claim 11, further comprising:

representing, by a visualization unit, visualization of operation of the simulation endoscope in an simulated environment based on the detected movements and the actuations.

5 13. The method as claimed in claim 11, wherein the sensing unit comprises one or more sensors.

14. The method as claimed in claim 11, wherein the visualization unit comprises a computation unit and a display unit.

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15. The method as claimed in claim 11, wherein at least one actuator comprises a first actuator, a second actuator and a third actuator.

15 16. The method as claimed in claim 15, wherein linear movement of the simulation endoscope is simulated by the first actuator.

17. The method as claimed in claim 15, wherein rotational movement of the simulation endoscope is simulated by the second actuator.

20 18. The method as claimed in claim 15, wherein radial movement of the simulation endoscope is simulated by the third actuator.

19. The method as claimed in claim 18, wherein the third actuator simulates guiding the simulation endoscope into food-pipe of a subject, avoiding wind-pipe.

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20. A system for simulating endoscopy, comprising:

a device for simulating endoscope, wherein the device comprises:
a simulation endoscope;

a guide member for accommodating the simulation endoscope, wherein the guide member is supported by a frame;

a first actuator supported by the frame, and connected to a carriage , wherein the first actuator facilitates translatory motion of the carriage to simulate linear movement of the simulation endoscope;

a second actuator provisioned in the guide member, and connectable to the simulation endoscope, wherein the second actuator imposes torque on the simulation endoscope to simulate rotational movement of the simulation endoscope, wherein the carriage is fixed to the second actuator ;

a mechanism to simulate radial movement of the simulation endoscope, wherein the mechanism is supported by the frame, and is actuated by a third actuator; and

a control unit interfaced with the first, second and third actuators, the control unit is configured to regulate actuations of the first, second and third actuators based on movement of the simulating endoscope detected by a sensing unit in the device; and

a visualization unit to provide visualization of operation of the simulation endoscope in a simulated environment based on the movement and the actuations.

21. The system as claimed in claim 20, wherein the first actuator is at least one of rotary actuator and linear actuator.

22. The system as claimed in claim 20, wherein the second and third actuators are rotary actuators.

23. The system as claimed in claim 20, wherein the third actuator simulates guiding the simulation endoscope into food-pipe of a subject, avoiding wind pipe.

24. The system as claimed in claim 20, wherein the mechanism comprises:

a rotary member, wherein the rotary member is configured to be rotated by the third actuator; and

a plurality of linkages connected to the rotary member, wherein the plurality of linkages are configured to move in radially inward and outward directions depending on direction of rotation of the rotary member.

5 25. The system as claimed in claim 24, wherein the linkages are at least one of triangular linkages, and rhombus shaped linkages.

26. The system as claimed in claim 20, wherein the carriage is connected to the first actuator through a strand.

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27. The system as claimed in claim 20, wherein the carriage is adapted to move on a guide rail.

28. The system as claimed in claim 27, wherein the guide rail is supported by the frame.

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29. The system as claimed in claim 20, wherein the sensing unit comprises one or more sensors.

30. The system as claimed in claim 20, wherein the visualization unit comprises a
20 computation unit and a display unit.

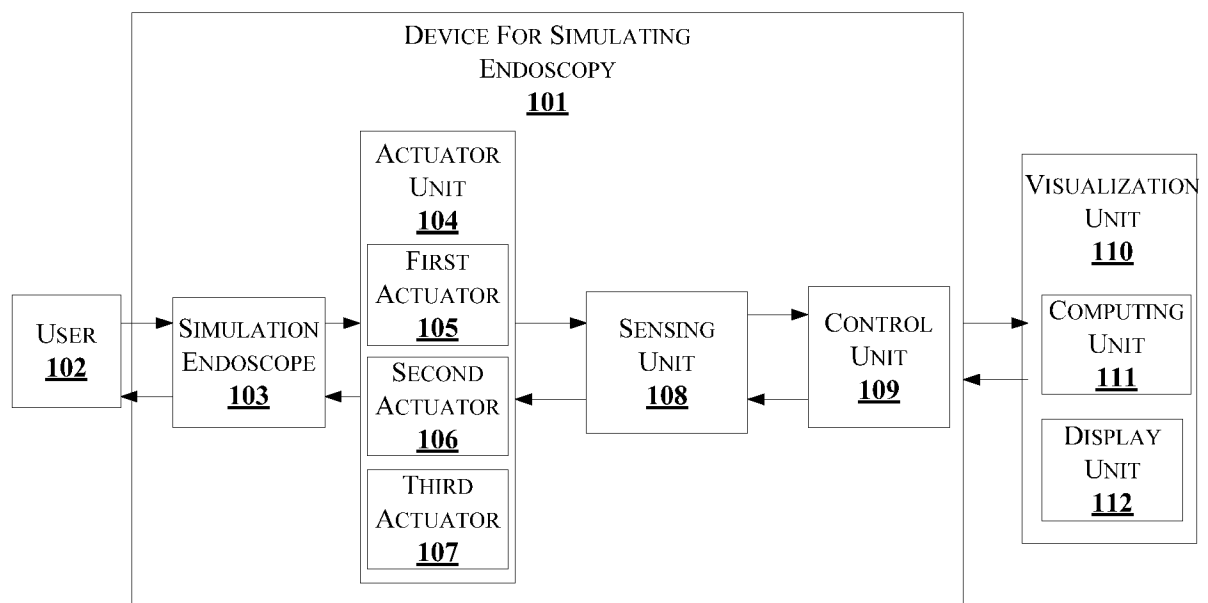


Figure 1

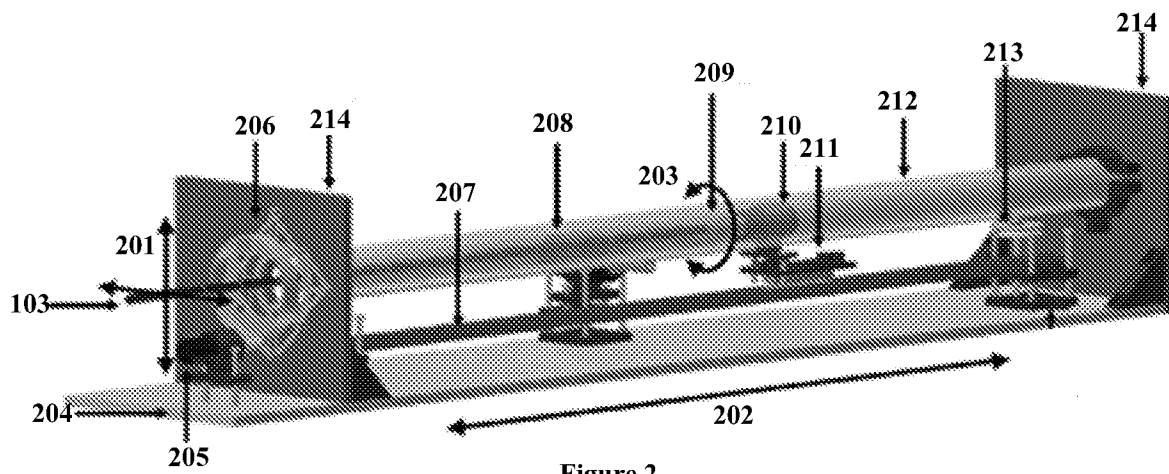
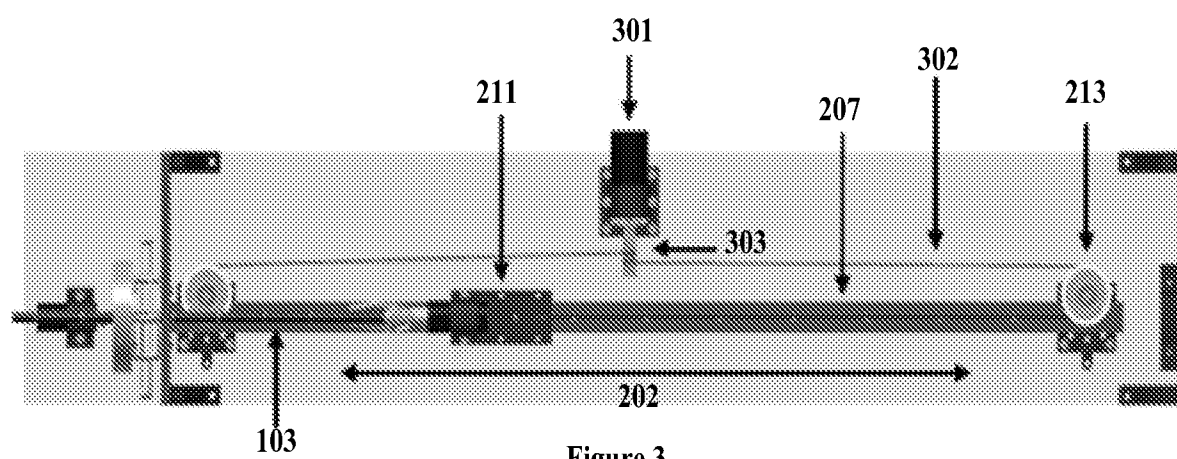


Figure 2



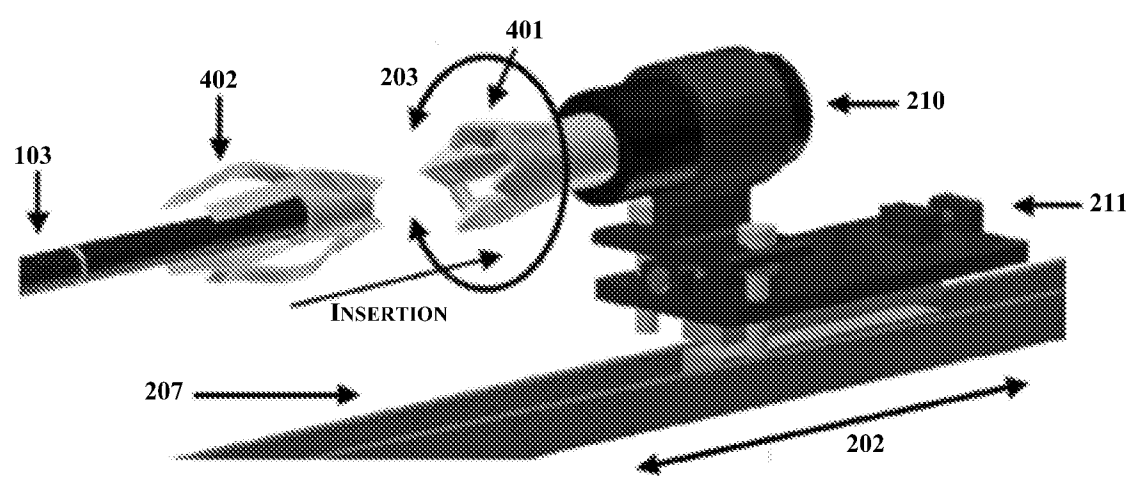


Figure 4

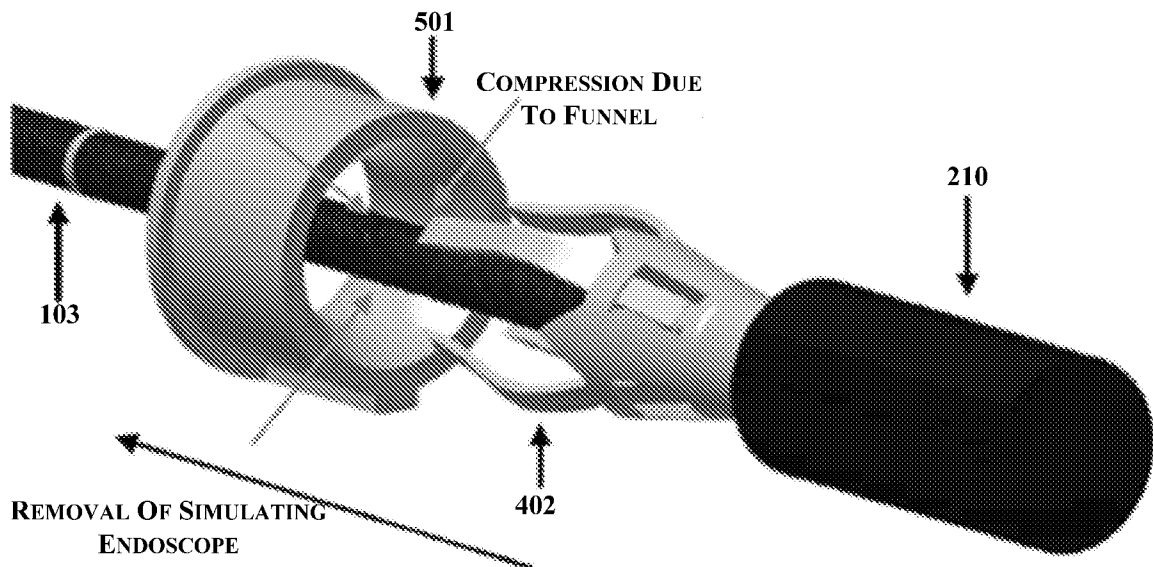


Figure 5

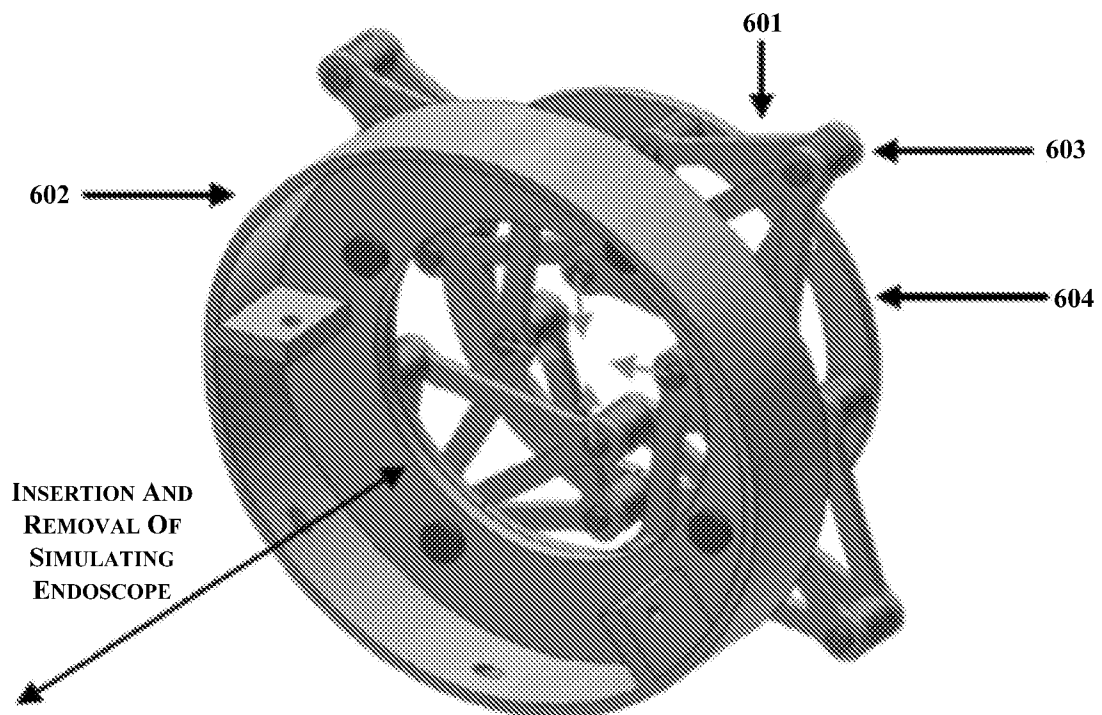


Figure 6

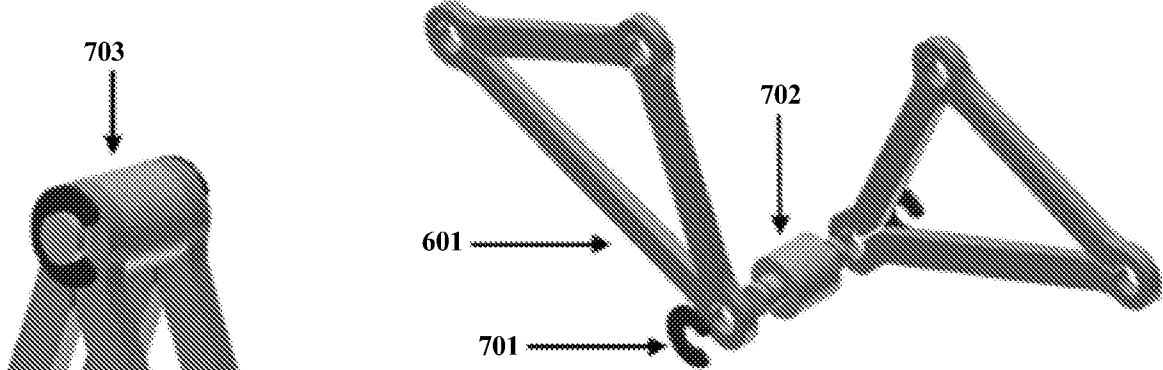


Figure 7

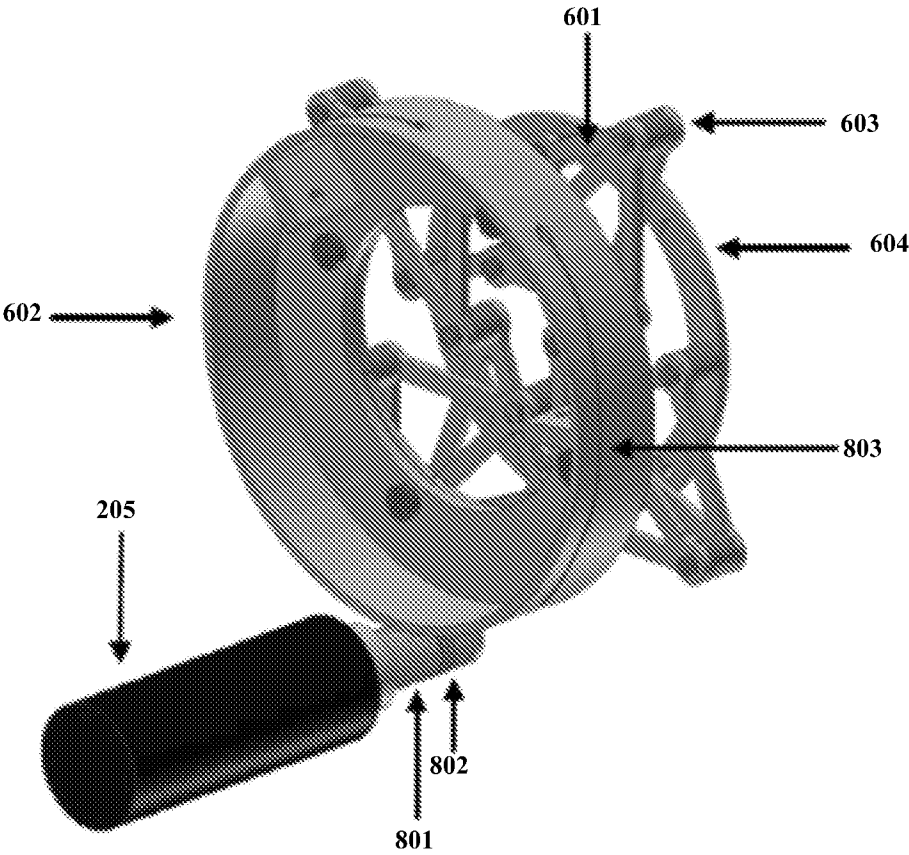


Figure 8

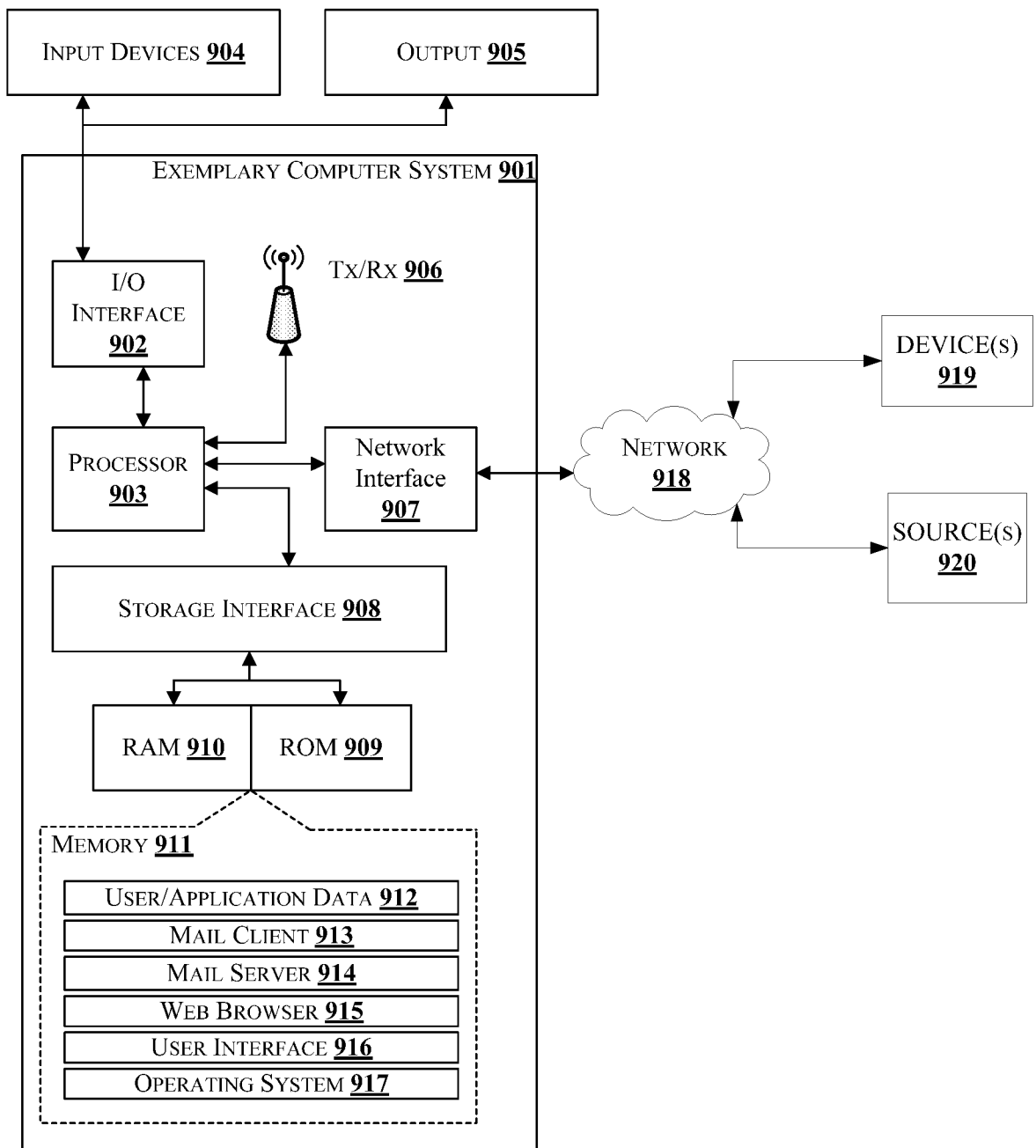


Figure 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/055251

A. CLASSIFICATION OF SUBJECT MATTER
INV. G09B23/28
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G09B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/027329 A2 (ECOLE POLYTECH [CH]; FLACTION LIONEL [CH]; SAMUR EVREN [CH]; MAILLARD) 10 March 2011 (2011-03-10) page 2, line 31 - page 3, line 15 page 5, line 39; figure 1 page 8, lines 10-41 page 2, lines 11-15 page 11, lines 14-24 page 6, lines 16-20	1-30
A	US 2005/064378 A1 (TOLY CHRISTOPHER C [US]) 24 March 2005 (2005-03-24) claim 24; figure 2	1-30
A	US 2001/016804 A1 (CUNNINGHAM RICHARD L [US] ET AL) 23 August 2001 (2001-08-23) claim 1; figure 20b	1-30
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Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

21 October 2015

Date of mailing of the international search report

28/10/2015

Name and mailing address of the ISA/

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Authorized officer

Beauce, Gaetan

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/055251

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2004/048230 A1 (ALEXANDER DAVID [US] ET AL) 11 March 2004 (2004-03-11) claim 1; figures 11a-b -----	1-30

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2015/055251

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2011027329 A2	10-03-2011	CN 102576499 A EP 2473987 A2 US 2012178062 A1 WO 2011027329 A2	11-07-2012 11-07-2012 12-07-2012 10-03-2011
US 2005064378 A1	24-03-2005	US 2005064378 A1 WO 2005037057 A2	24-03-2005 28-04-2005
US 2001016804 A1	23-08-2001	NONE	
US 2004048230 A1	11-03-2004	US 6929481 B1 US 2004045561 A1 US 2004048230 A1 US 2006046235 A1	16-08-2005 11-03-2004 11-03-2004 02-03-2006