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Declarations under Rule 4.17:

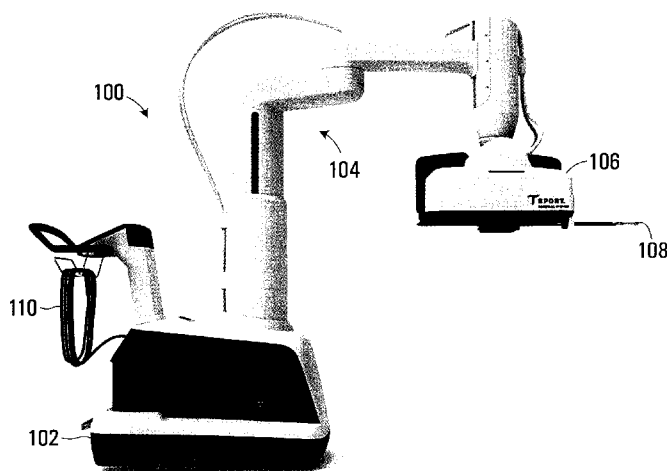
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(54) **Title:** CAMERA POSITIONING METHOD AND APPARATUS FOR CAPTURING IMAGES DURING A MEDICAL PROCEDURE

**FIG. 1**

(57) **Abstract:** A method and apparatus for positioning a camera to capture images inside a body cavity of a patient during a medical procedure is disclosed. The apparatus includes an insertion tube, a plurality of connected linkages extending from a distal end of the insertion tube, each linkage having a threaded actuator received on a threaded end of a drive shaft extending between the threaded actuator and a proximal end of the insertion tube. The apparatus also includes a camera disposed at a distal end of the plurality of connected linkages. Each connected linkage has at least one associated movement actuated by movement of the threaded actuator in response to rotation of the drive shaft, the associated movements of the connected linkages together operable to facilitate positioning of the camera within the body cavity of the patient.



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- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

CAMERA POSITIONING METHOD AND APPARATUS FOR CAPTURING IMAGES DURING A MEDICAL PROCEDURE

BACKGROUND

5 1. Field

This disclosure relates generally to positioning a camera for imaging and more particularly to positioning a camera inside a body cavity of a patient for capturing images during a medical procedure.

10 2. Description of Related Art

Miniaturized cameras are used during investigative medical procedures and surgical procedures such as laparoscopic surgery and computer assisted robotic surgery to produce images of a site of the procedure within a body cavity of the patient. The camera generally includes an illumination source for illuminating the site of the procedure.

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SUMMARY

In accordance with one disclosed aspect there is provided an apparatus for positioning a camera to capture images inside a body cavity of a patient during a medical procedure. The apparatus includes an insertion tube, a plurality of connected linkages extending from a distal end of the insertion tube, each linkage having a threaded actuator received on a threaded end of a drive shaft extending between the threaded actuator and a proximal end of the insertion tube. The apparatus also includes a camera disposed at a distal end of the plurality of connected linkages. Each connected linkage has at least one associated movement actuated by movement of the threaded actuator in response to rotation of the drive shaft, the associated movements of the connected linkages together operable to facilitate positioning of the camera within the body cavity of the patient.

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Each drive shaft may include a drive coupler at the proximal end of the drive shaft, the drive coupler operable to receive a drive torque for causing rotation of the drive shaft.

The drive couplers may be housed within a drive interface operably configured to removably couple to a driver unit, the driver unit being operable to provide the respective drive torques.

- 5 Each drive coupler may include a rotational coupler for transmitting torque to each drive shaft, the rotational coupler being operably configured to receive the proximal end of the drive shaft and to transmit the drive torque to the drive shaft while accommodating linear movement of the proximal end due to resulting movements of the camera.
- 10 The rotational coupler may include a tubular body for receiving the proximal end of drive shaft, the tubular body having a slotted portion that engages a pin extending through the proximal end of the drive shaft for coupling to the tubular body.

- Each rotational coupler may include a moveable detent coupled to the proximal end of the drive shaft and operable to resiliently engage a fixed detent in the drive interface corresponding to a startup position for each of the proximal ends of the respective drive shafts, the startup positions of the drive shafts defining an insertion position of the camera.
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- The interface may be removably received on the drive unit, and wherein when received the moveable and fixed detents may be disengaged to permit movement of the camera away from the insertion position. Prior to removal of the interface, the drive unit is operably configured to place the camera in the insertion position causing the moveable and fixed detents to be aligned. When removed, the moveable and fixed detents are engaged to retain the rotational couplers in the startup position.
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- 25 In the insertion position the camera may be positioned generally in line with a longitudinal axis extending outwardly from the insertion tube.

The plurality of connected linkages may include at least a panning linkage for producing side-to-side motion of the camera, an elevating linkage for moving the camera away from the longitudinal axis, and a tilt linkage for tilting the camera forward and backward with respect to the longitudinal axis.

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The panning linkage may be connected to the distal end of the insertion tube, the elevating linkage is connected to the panning linkage and the tilt linkage is connected to the elevating linkage, and the camera may be attached to the tilt linkage.

10 At least one of the drive shafts may include a compliant portion facilitating bending of the shaft in response to movements of the camera while continuing to permit rotation of the at least one drive shaft.

Each linkage may include a revolute joint constrained to permit motion in a single degree of freedom corresponding to the associated movement of the linkage and the threaded actuator may be coupled to the linkage to cause motion about the revolute joint.

15 In accordance with another disclosed aspect there is provided a method for positioning a camera to capture images inside a body cavity of a patient during a medical procedure, the camera being disposed at a distal end of a plurality of connected linkages extending from a distal end of an insertion tube, each linkage having a threaded actuator received on a threaded end of a drive shaft extending between the threaded actuator and a proximal end of the insertion tube. The method involves selectively causing rotation of the respective drive shafts to cause movement of the respective threaded actuators, the movement of the respective threaded actuators causing associated movements of the connected linkages to positioning of the camera within the body cavity of the patient.

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Selectively causing rotation of the respective drive shafts may involve causing the respective drive shafts to position the camera in an insertion position prior to removal from the body cavity of a patient.

- 5 Causing the respective drive shafts to position the camera in an insertion position may involve causing the camera to be positioned generally in line with a longitudinal axis of the insertion tube.

10 In accordance with another disclosed aspect there is provided an apparatus for positioning a camera to capture images inside a body cavity of a patient during a medical procedure. The apparatus includes an articulated arm includes a plurality of connected moveable linkages, a camera disposed at a distal end of the plurality of connected linkages, the camera including a camera housing enclosing image capture optics, an image sensor, and image capture electronic circuitry operable to produce image data representing images captured by the image sensor, and data transmission electrical circuitry operable to generate and transmit data signals encoding the image data to a host system, the data transmission electrical circuitry being housed within in one of the moveable linkages and coupled to the image capture electronic circuitry via a flexible interconnect.

20 Other aspects and features will become apparent to those ordinarily skilled in the art upon review of the following description of specific disclosed embodiments in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

In drawings which illustrate disclosed embodiments,

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Figure 1 is a perspective view of a robotic surgical apparatus;

Figure 2 is a perspective view of a drive unit and camera of the robotic surgical apparatus shown in Figure 1;

Figure 3 is a perspective view of an insertion tube, linkages, and the camera shown in Figure 2;

Figure 4 is a further enlarged perspective view of the linkages and camera shown in Figure 3;

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Figure 5 is a rear perspective view of the linkages and camera in a deployed state;

Figure 6 is a rear perspective view of a drive interface shown in Figure 3; and

10 Figure 7 is a front perspective view of the linkages and camera in a deployed state.

DETAILED DESCRIPTION

Referring to Figure 1, a robotic surgical apparatus is shown generally at **100**. The surgical apparatus **100** includes a cart **102** that supports an articulated boom **104** that carries a drive unit **106** having a camera **108** mounted on the drive unit. The cart **102** may be wheeled up to a patient (not shown) and the articulated boom **104** deployed to maneuver the drive unit **106** and camera **108** into a location for accessing a body cavity of the patient and positioning a camera to capture images inside the body cavity of a patient during a medical procedure. The surgical apparatus **100** may be controlled by a workstation console (not shown) connected to the surgical apparatus via a cable **110** that carries signals for controlling the drive unit **106** and camera **108**.

Referring to Figure 2, the drive unit **106** and camera **108** are shown in front view. The camera **108** is mounted at a distal end of a plurality of connected linkages **120** extending from a distal end **122** of an insertion tube **124**. The insertion tube **124** extends outwardly from a drive interface **126** that is removably received on the drive unit **106**.

The camera **108**, insertion tube **124**, and drive interface **126** are shown in greater detail in Figure 3. Referring to Figure 3, in the embodiment shown the plurality of connected linkages **120** include a panning linkage **130**, an elevating linkage **132**, and a tilt linkage **134**. The panning linkage **130** is

connected by a revolute joint **136** to the distal end **122** of the insertion tube **124**, which constrains the panning linkage to side-to-side motion in the direction indicated by the arrow **138**. The elevating linkage **132** is connected to the panning linkage **130** by a revolute joint **140**, which constrains the linkage to movement away from a longitudinal axis **142** in the direction indicated by the arrow **144**. The tilt linkage **134** is connected to the elevating linkage **132** by a revolute joint **148**, which constrains the linkage to movement for tilting the camera **108** forward and backward with respect to the longitudinal axis **142** in the direction indicated by the arrow **150**.

In the embodiment shown the panning linkage **130** is thus connected to the distal end **122** of the insertion tube **124**, the elevating linkage **132** is connected to the panning linkage **130** and the tilt linkage **134** is connected to the elevating linkage **132**. The camera **108** is disposed at a distal end of the plurality of connected linkages **120**, in this case connected to the tilt linkage **134**. In other embodiments the plurality of connected linkages **120** may be otherwise arranged and one or more of the linkages may be omitted.

The connected linkages **120** are shown in enlarged detail in Figure **4** with a distal cap **152** (shown in Figure **3**) on the insertion tube **124** removed. Referring to Figure **4**, the panning linkage **130** has a threaded actuator **180** received on a threaded end **182** of a drive shaft **184**. The elevating linkage **132** has a threaded actuator **188** received on a threaded end **190** of a drive shaft **192**. The tilt linkage **134** has a threaded actuator **194** received on a threaded end **196** of a drive shaft **198**. Each of the drive shafts **184**, **192** and **198** extend between the respective threaded actuators **180**, **188**, and **194** and a proximal end **186** (shown in Figure **3**) of the insertion tube **124**. The drive shafts **184**, **192** and **198** are routed through respective bores **170**, **172**, and **174** extending through the insertion tube **124** (only shown in part in Figure **4**). The bores **170**, **172**, and **174** are sized and configured such that each drive shaft **184**, **192** and **198** is freely rotatable within the bores as indicated by the arrows shown in Figure **4**.

Each connected linkage **120** thus has at least one associated movement actuated by movement of the respective threaded actuators **180**, **188**, and **194** in response to rotation of the respective drive

shafts **184**, **192** and **198**. The associated movements of the connected linkages **120** are together operable to facilitate positioning of the camera **108** within the body cavity of the patient. For example, rotation of the shaft **184** causes the threaded actuator **180** to move either forwardly or rearwardly in a direction aligned with the longitudinal axis **142** causing the panning linkage **130** to pan about the revolute joint **136** moving the camera **108** from side to side. In the embodiment shown, each of the linkages **120** thus includes a revolute joint (**136**, **140**, **148**) constrained to permit motion in a single degree of freedom corresponding to the associated movement of the linkage and a threaded actuator (**180**, **188**, and **194**) coupled to the linkage to cause motion about the revolute joint.

Referring to Figure 5, the camera **108** is shown in rear view in a deployed state with the drive shafts **184**, **192** and **198** omitted for clarity. The threaded actuator **180** terminates in a ball and socket joint **200** on the rear of the panning linkage **130** which facilitates pivoting at the joint during movement. Similarly the threaded actuator **188** terminates in a ball and socket joint **202** on a strut **204** of the elevating linkage **132**. A proximal end threaded actuator **188** is received in a hinged block **206** and rotation of the drive shaft **192** causes the elevating linkage **132** to raise or lower with respect to the longitudinal axis **142**. Finally, the threaded actuator **194** is mounted in a first swivel block **208** on the elevating linkage **132** and has a distal end that is clamped to a second swivel block on the tilt linkage **134**. Rotation of the drive shaft **198** causes the camera **108** to tilt up or down about the revolute joint **148**.

When the drive shafts **184**, **192** and **198** are rotated to cause the camera **108** to be deployed, the linkages **120** are displaced from the longitudinal axis **142** causing portions of the drive shafts **192** and **198** running through the panning linkage **130** and elevating linkage **132** to be bent through an angle. The drive shafts **192** and **198** thus have at least a compliant portion within the linkages to facilitating bending of the shaft in response to movements of the camera **108**. The compliant portion permits the drive shaft **192** and **198** to be bent through the necessary angle while continuing to permit rotation of the drive shafts for actuating the respective linkages. In some embodiments the drive shafts may be fabricated entirely from a compliant material, while in other

embodiments the drive shafts may have some rigid portions and some compliant portions. In one embodiment at least a portion of drive shafts may be fabricated from a hollow stainless steel tube.

Referring back to Figure 3, the camera 108 and plurality of connected linkages 120 are generally aligned along the longitudinal axis 142 extending outwardly from the insertion tube, which may define an insertion position for inserting the camera 108, linkages 120 and insertion tube 124 into the body cavity of the patient. Once inserted the drive shafts 184, 192 and 198 may be rotated to deploy the camera 108 as shown in Figure 5. Referring to Figures 3 and 4, in the embodiment shown the insertion tube 124 includes at least one bore 154 for receiving an instrument for performing surgical operations within the body cavity of the patient. The instrument may be a dexterous surgical instrument such as described in commonly owned PCT Patent Application PCT/CA2013/001076 entitled ARTICULATED TOOL POSITIONER AND SYSTEM EMPLOYING SAME and PCT Patent Application PCT/CA2015/000098 entitled ACTUATOR AND DRIVE FOR MANIPULATING A TOOL, both of which are incorporated herein in their entirety.

Referring back to Figure 3, the drive interface 126 includes a housing 158 having a front cover 160 and a rear cover 162. Referring to Figure 6, the drive interface 126 is shown with the front cover 160 omitted and the rear cover 162 removed to reveal the drive components. The drive shafts 184, 192 and 198 are routed back through the respective bores 172, 174, and 176 in the insertion tube 124 and are bent upwardly within the housing 158 and have proximal ends 260, 262, and 264 that terminate in respective drive couplers 266, 268, and 270. The drive couplers 266, 268, and 270 are identical and the drive coupler 270 will be further described herein. The drive coupler 270 includes a bevel gear assembly 272 that receives a drive torque from the drive unit 106 (shown in Figure 2) at a drive hub 274 when the drive interface 126 is engaged on the drive unit. The bevel gear assembly 272 rotates in the direction indicated by the arrow and the rotating motion is coupled through the gears via a shaft 276 to a rotational coupler 278. The rotational coupler 278 is generally operable to receive the proximal end 264 of the drive shaft 198 and to transmit the drive torque to the drive shaft while accommodating linear movement of the proximal end due to resulting movements of the camera 108. When the plurality of connected linkages 120 move, the

drive shafts **184**, **192** and **198** extend or retract with the motion, which must be accommodated. In the embodiment shown, the rotational coupler **278** has a tubular body **280** for receiving the proximal end **264** of drive shaft **198**. The tubular body **280** has a slotted portion **282** that engages a pin **284** extending through the proximal end of the drive shaft for coupling to the tubular body.

5 The pin **284** couples the rotational torque to the proximal end **264** of the drive shaft **198** while permitting the proximal end and pin to slide within the slotted portion **282** of the tubular body **280**, thus accommodating extension or retraction of the drive shaft.

In the embodiment shown the drive coupler **270** also includes a moveable detent mechanism **290**, which is coupled to move with the proximal end **264** of the drive shaft **198**. The moveable detent **290** has a pin **292** operable to resiliently engage a rear side of a fixed detent plate **294** on the rear cover **162**. The fixed detent plate **294** has an opening **296** sized to accommodate a head of the pin **292**, the opening being positioned to define a startup position for the proximal end **264** of the drive shaft **198** that places the camera **108** in the insertion position aligned with the longitudinal axis **142**, as shown in Figure 3. In one embodiment, the drive interface **126** is removably received on the drive unit **106** and when received, the pin **292** on the moveable detent mechanism **290** is disengaged to permit movement of the camera **108** away from the insertion position. Prior to removal of the interface **126** from the drive unit **106**, the drive unit is operably configured to return the camera **108** to the insertion position causing the pin **292** and the opening **296** on the fixed detent plate **294** to be aligned but not yet engaged. When the drive interface **126** is removed from the drive unit **106**, the pin **292** and the opening **296** engage and retain the rotational coupler **278** in the startup position. The drive couplers **266** and **268** have similar moveable and fixed detent mechanisms that operate in the same way. Advantageously, the detent mechanism locks the drive interface **126** in the insertion position when not received on the drive unit **106** preventing movement of the drive hub **274** and other drive hubs which would at least partially deploy the camera **108**. The plurality of connected linkages **120** and camera **108** thus remain in the insertion position while being cleaned and sterilized, and when re-used will be in a known orientation.

The camera **108** shown in the above embodiments will general be miniaturized to improve access to the body cavity of the patient and to reduce the size of incision needed to provide access for the camera in surgical procedures. In some embodiments, the camera may include one or more high definition image sensors (not shown), where a pair of image sensors are capable of producing stereoscopic 3D views within the body cavity. The image sensors include sensor electronic circuitry that generates image data representing the captured images. The captured image data must be transmitted back to the drive unit **106**, which requires additional data transmission circuitry. The image capture electronic circuitry and data transmission electrical circuitry may generate significant heat within the housing of the camera **108**. Referring to Figure **7**, in one embodiment the camera **108** houses the image sensors and image capture electronic circuitry. A data transmission printed circuit board **300** carries the data transmission electrical circuitry and is housed within the elevating linkage **132**. The image capture electronic circuitry and data transmission electrical circuitry may be coupled via a flexible interconnect (not shown) that permits the **108** to be tilted by the tilt linkage **134**. Advantageously, the separation of electrical circuitry places a significant source of heat in the linkage away from the housing of the camera **108**, thus spreading the heat load over a larger area.

In accordance with another disclosed aspect there is provided an apparatus for positioning a camera to capture images inside a body cavity of a patient during a medical procedure. The apparatus includes an articulated arm that includes a plurality of connected moveable linkages, a camera disposed at a distal end of the plurality of connected linkages, the camera including a camera housing enclosing image capture optics, an image sensor, and image capture electronic circuitry operable to produce image data representing images captured by the image sensor, and data transmission electrical circuitry operable to generate and transmit data signals encoding the image data to a host system, the data transmission electrical circuitry being housed within in one of the moveable linkages and coupled to the image capture electronic circuitry via a flexible interconnect.

While specific embodiments have been described and illustrated, such embodiments should be considered illustrative of the invention only and not as limiting the invention as construed in accordance with the accompanying claims.

What is claimed is:

1. An apparatus for positioning a camera to capture images inside a body cavity of a patient during a medical procedure, the apparatus comprising:

an insertion tube;

5 a plurality of connected linkages extending from a distal end of the insertion tube, each linkage having a threaded actuator received on a threaded end of a drive shaft extending between the threaded actuator and a proximal end of the insertion tube;

a camera disposed at a distal end of the plurality of connected linkages; and

10 wherein each connected linkage has at least one associated movement actuated by movement of the threaded actuator in response to rotation of the drive shaft, the associated movements of the connected linkages together operable to facilitate positioning of the camera within the body cavity of the patient.

2. The apparatus of claim 1 wherein each drive shaft includes a drive coupler at the proximal end of the drive shaft, the drive coupler operable to receive a drive torque for causing rotation of the drive shaft.

3. The apparatus of claim 2 wherein the drive couplers are housed within a drive interface operably configured to removably couple to a driver unit, the driver unit being operable to provide the respective drive torques.

4. The apparatus of claim 3 wherein each drive coupler comprises a rotational coupler for transmitting torque to each drive shaft, the rotational coupler being operably configured to receive the proximal end of the drive shaft and to transmit the drive torque to the drive shaft while accommodating linear movement of the proximal end due to resulting movements of the camera.

5. The apparatus of claim 4 wherein the rotational coupler comprises a tubular body for receiving the proximal end of drive shaft, the tubular body having a slotted portion that engages a pin extending through the proximal end of the drive shaft for coupling to the tubular body.
- 5 6. The apparatus of claim 4 wherein each rotational coupler includes a moveable detent coupled to the proximal end of the drive shaft and operable to resiliently engage a fixed detent in the drive interface corresponding to a startup position for each of the proximal ends of the respective drive shafts, the startup positions of the drive shafts defining an insertion position of the camera.
- 10 7. The apparatus of claim 6 wherein the interface is removably received on the drive unit, and wherein:
- when received, the moveable and fixed detents are disengaged to permit movement of the camera away from the insertion position;
- prior to removal of the interface, the drive unit is operably configured to place the camera in the insertion position causing the moveable and fixed detents to be aligned; and
- 15
- when removed, the moveable and fixed detents are engaged to retain the rotational couplers in the startup position.
8. The apparatus of claim 6 wherein in the insertion position the camera is positioned generally in line with a longitudinal axis extending outwardly from the insertion tube.
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9. The apparatus of claim 1 wherein the plurality of connected linkages comprise at least:
- a panning linkage for producing side-to-side motion of the camera;
- an elevating linkage for moving the camera away from the longitudinal axis; and

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a tilt linkage for tilting the camera forward and backward with respect to the longitudinal axis.

10. The apparatus of claim 9 wherein the panning linkage is connected to the distal end of the insertion tube, the elevating linkage is connected to the panning linkage and the tilt linkage is connected to the elevating linkage, and wherein the camera is connected to the tilt linkage.

11. The apparatus of claim 1 wherein at least drive shaft associated with the plurality of connected linkages comprises a compliant portion facilitating bending of the shaft in response to movements of the camera while continuing to permit rotation of the at least one drive shaft.

12. The apparatus of claim 1 wherein each linkage comprises a revolute joint constrained to permit motion in a single degree of freedom corresponding to the associated movement of the linkage and wherein the threaded actuator is coupled to the linkage to cause motion about the revolute joint.

13. A method for positioning a camera to capture images inside a body cavity of a patient during a medical procedure, the camera being disposed at a distal end of a plurality of connected linkages extending from a distal end of an insertion tube, each linkage having a threaded actuator received on a threaded end of a drive shaft extending between the threaded actuator and a proximal end of the insertion tube, the method comprising:

selectively causing rotation of the respective drive shafts to cause movement of the respective threaded actuators, the movement of the respective threaded actuators causing associated movements of the connected linkages to positioning of the camera within the body cavity of the patient.

14. The method of claim 13 wherein selectively causing rotation of the respective drive shafts comprises causing the respective drive shafts to position the camera in an insertion position prior to removal from the body cavity of a patient.

15. The method of claim 14 wherein causing the respective drive shafts to position the camera in an insertion position comprises causing the camera to be positioned generally in line with a longitudinal axis of the insertion tube.

16. An apparatus for positioning a camera to capture images inside a body cavity of a patient during a medical procedure, the apparatus comprising:

an articulated arm comprising a plurality of connected moveable linkages;

a camera disposed at a distal end of the plurality of connected linkages, the camera including a camera housing enclosing image capture optics, an image sensor, and image capture electronic circuitry operable to produce image data representing images captured by the image sensor; and

data transmission electrical circuitry operable to generate and transmit data signals encoding the image data to a host system, the data transmission electrical circuitry being housed within in one of the moveable linkages and coupled to the image capture electronic circuitry via a flexible interconnect.

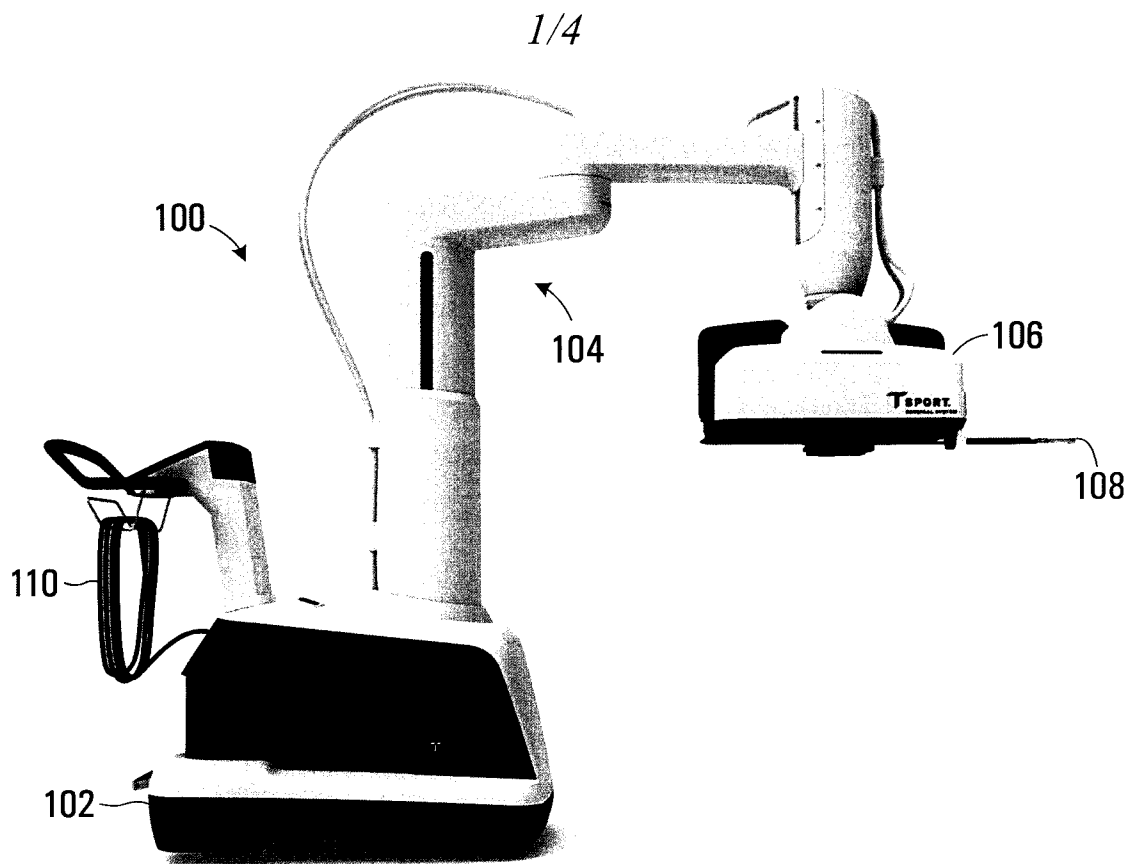


FIG. 1

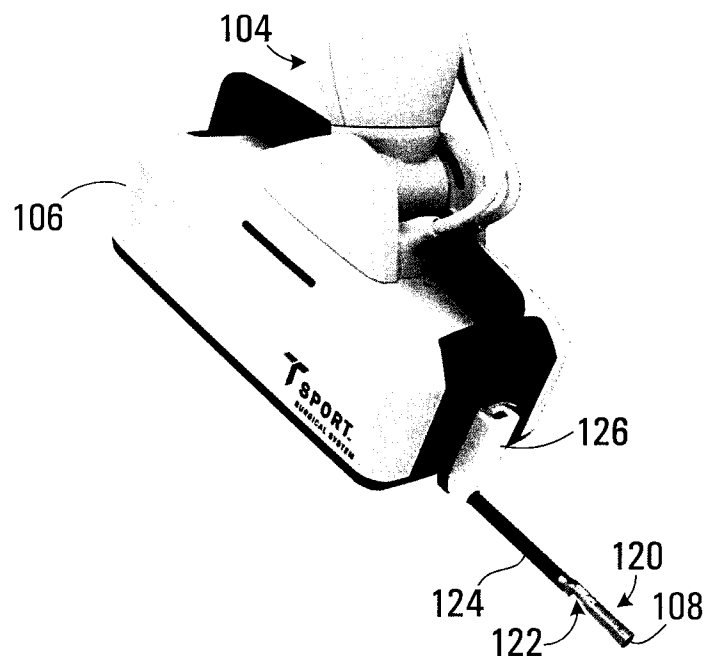


FIG. 2

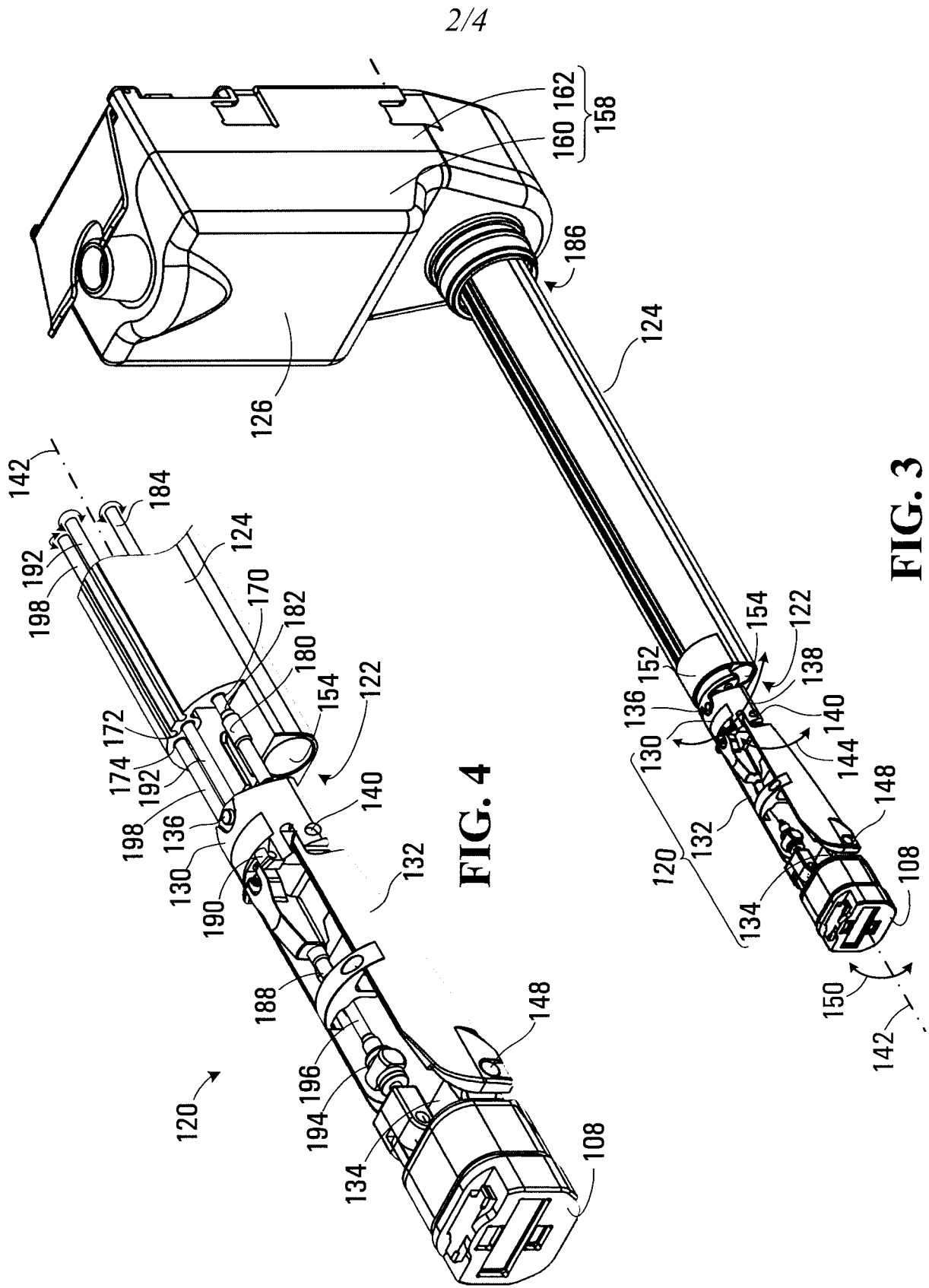
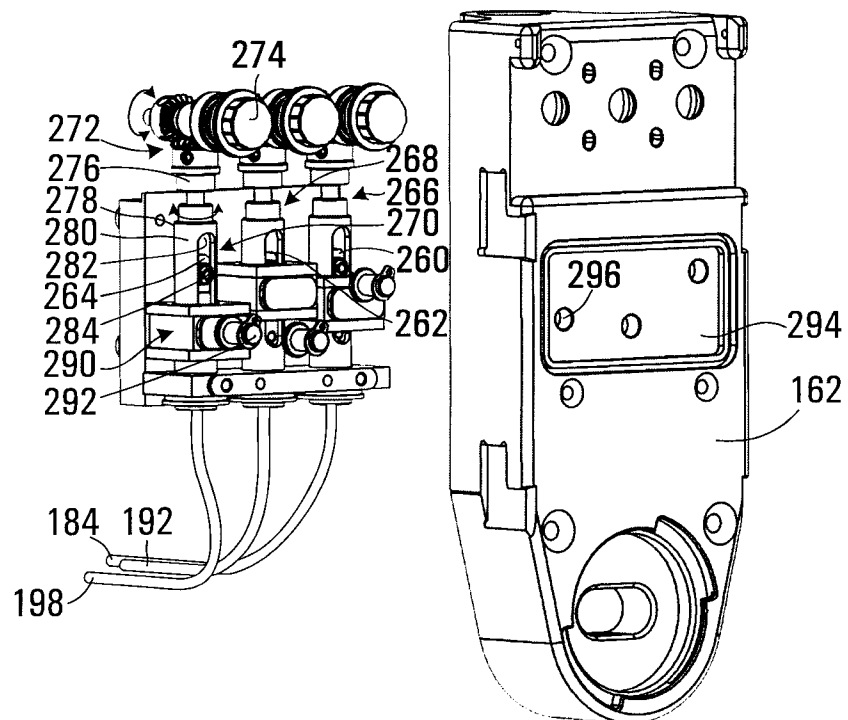
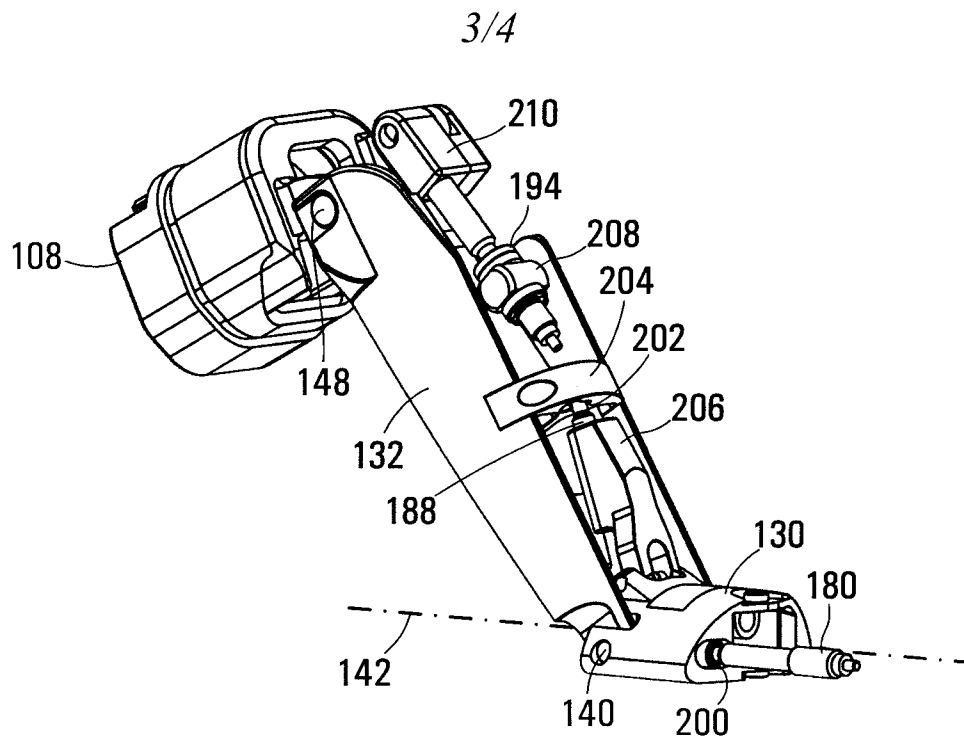


FIG. 3

FIG. 4



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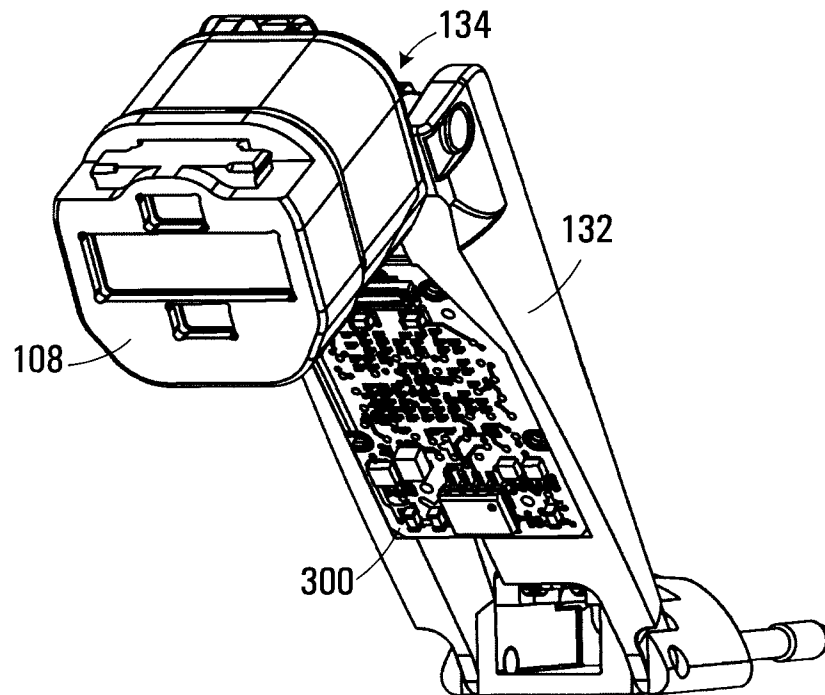


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CA2017/000078

A. CLASSIFICATION OF SUBJECT MATTER

IPC: **A61B 1/01** (2006.01), **A61B 1/008** (2006.01), **A61B 1/05** (2006.01), **A61B 1/06** (2006.01)

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)

A61B* (all subgroups and keywords)

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

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

Google, Canadian Patent Database, Orbit

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US9028478 (Mueller) 12 May 2015 (12-05-2015) Figure references 23, 32, 36, 37; Figure 2, 3, 4; col. 3, line 65- col. 4, line 23; col. 1, lines 29-40	1-5 and 9-16
Y	US6007484 (Thompson) 28 December 1999 (28-12-1999) Figure references 5, 51, 180, 204, 206, 218; col. 3, lines 23-38; col. 3, lines 39-47; col. 3, lines 49-54; col. 4, lines 5-10	1-5 and 9-16

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* "A" "E" "L" "O" "P"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance earlier application or patent but published on or after the international filing date document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) document referring to an oral disclosure, use, exhibition or other means document published prior to the international filing date but later than the priority date claimed	"T" "X" "Y" "&"	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 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 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
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Date of the actual completion of the international search
16 August 2017 (16-08-2017)

Date of mailing of the international search report
17 August 2017 (17-08-2017)

Name and mailing address of the ISA/CA
Canadian Intellectual Property Office
Place du Portage I, C114 - 1st Floor, Box PCT
50 Victoria Street
Gatineau, Quebec K1A 0C9
Facsimile No.: 819-953-2476

Authorized officer

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2017/000078

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of the first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

GROUP A: Claims 1-15 are directed towards an apparatus comprising an insertion tube, a plurality of linkages extending from a distal end of the insertion tube and a proximal end of the insertion tube and a camera.

GROUP B: Claim 16 is directed towards an apparatus comprising an articulated arm comprising a plurality of connected movable linkages, a camera and a data transmission electrical circuitry operable to transmit data signals.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claim Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CA2017/000078

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
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