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(54) Title: SURGICAL INSTRUMENT WITH SHIFTABLE TRANSMISSION

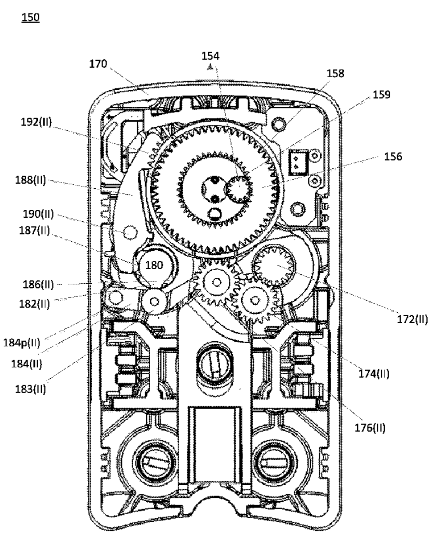

FIG. 7B

(57) Abstract: A surgical tool having an elongated shaft having a proximal end and distal end. A surgical end effector is located about the distal end. The surgical end effector has a plurality of effector mechanisms comprising a plurality of degree of freedoms. An effector body is located at the proximal end. The effector body includes a plurality of motor interfaces for driving the plurality of effector mechanisms. A transmission is coupled to the effector body

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SURGICAL INSTRUMENT WITH SHIFTABLE TRANSMISSION

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 61/973,257, filed March 31, 2014, which is incorporated by reference herein.

BACKGROUND OF THE INVENTION

[0002] Minimally invasive medical techniques are intended to reduce the amount of extraneous tissue that is damaged during diagnostic or surgical procedures, thereby reducing patient recovery time, discomfort, and deleterious side effects. One effect of minimally invasive surgery, for example, is reduced post-operative hospital recovery times. Because the average hospital stay for a standard surgery is typically significantly longer than the average stay for an analogous minimally invasive surgery, increased use of minimally invasive techniques could save millions of dollars in hospital costs each year. While many of the surgeries performed each year in the United States could potentially be performed in a minimally invasive manner, only a portion of the current surgeries use these advantageous techniques due to limitations in minimally invasive surgical instruments and the additional surgical training involved in mastering them.

[0003] Minimally invasive telesurgical systems have been developed to increase a surgeon's dexterity and avoid some of the limitations on traditional minimally invasive techniques. In telesurgery, the surgeon uses some form of remote control (*e.g.*, a servomechanism or the like) to manipulate surgical instrument movements, rather than directly holding and moving the instruments by hand. In telesurgery systems, the surgeon can be provided with an image of the surgical site at a surgical workstation. While viewing a two or three dimensional image of the surgical site on a display, the surgeon performs the surgical procedures on the patient by manipulating master control devices, which in turn control motion of the servo-mechanically operated instruments.

[0004] The servomechanism used for telesurgery will often accept input from two master controllers (one for each of the surgeon's hands) and may include two or more robotic arms on each of which a surgical instrument is mounted. Operative communication between master controllers and associated robotic arm and instrument assemblies is typically achieved through a control system. The control system typically includes at least one processor that relays input commands from the master controllers to the associated robotic arm and instrument assemblies and back from the instrument and arm assemblies to the associated master controllers in the case of, for example, force feedback or the like. One example of a robotic surgical system is the DA VINCI® system available from Intuitive Surgical, Inc. of Sunnyvale, California, USA.

[0005] A variety of structural arrangements can be used to support the surgical instrument at the surgical site during robotic surgery. The driven linkage or "slave" is often called a robotic surgical manipulator, and exemplary linkage arrangements for use as a robotic surgical manipulator during minimally invasive robotic surgery are described in U.S. Pat. Nos. 7,594,912; 6,758,843; 6,246,200; and 5,800,423; which are incorporated herein by reference. These linkages often make use of a parallelogram arrangement to hold an instrument having a shaft. Such a manipulator structure can constrain movement of the instrument so that the instrument pivots about a remote center of manipulation positioned in space along the length of the rigid shaft. By aligning the remote center of manipulation with the incision point to the internal surgical site (for example, with a trocar or cannula at an abdominal wall during laparoscopic surgery), an end effector of the surgical instrument can be positioned safely by moving the proximal end of the shaft using the manipulator linkage without imposing potentially dangerous forces against the abdominal wall. Alternative manipulator structures are described, for example, in U.S. Pat. Nos. 7,763,015; 6,702,805; 6,676,669; 5,855,583; 5,808,665; 5,445,166; and 5,184,601; which are incorporated herein by reference.

[0006] A variety of structural arrangements can also be used to support and position the robotic surgical manipulator and the surgical instrument at the surgical site during robotic surgery. Supporting linkage mechanisms, sometimes referred to as set-up joints, or set-up joint arms, are often used to position and align each manipulator with the respective incision point in a patient's body. The supporting linkage mechanism facilitates the alignment of a surgical manipulator with a desired surgical incision point and targeted anatomy. Exemplary supporting linkage mechanisms are described in U.S. Pat. Nos. 6,246,200 and 6,788,018, which are incorporated herein by reference.

[0007] While the new telesurgical systems and devices have proven highly effective and advantageous, still further improvements are desirable. In general, improved minimally invasive robotic surgery systems are desirable. Often, new surgical instruments are developed for use on existing telesurgical system platforms. Thus, the instrument is required to adapt to the telesurgical system, since development of a new telesurgical system for a particular surgical application is cost prohibitive. However, issues arise when existing telesurgical platforms do not have the required amount of motor outputs for all of the mechanisms of a particular surgical instrument. Thus, there is a need to adapt new surgical devices to existing telesurgical systems without limiting the surgical capabilities and without requiring modification to the existing telesurgical systems.

BRIEF SUMMARY OF THE INVENTION

[0008] Many embodiments are directed to a surgical tool comprising an elongated shaft having a proximal end and distal end. A surgical end effector is located about the distal end. The surgical end effector may include a plurality of effector mechanisms, each effector mechanism having one or a plurality of degree of freedoms (DOFs). An effector body may also be located at the proximal end. The effector body may include a plurality of motor interfaces for driving the plurality of effector mechanisms. For example, the plurality of motor interfaces may include a first motor interface. A transmission may be coupled between the effector body and the surgical end effector. The transmission may be configured to shift coupling of the first motor interface between only a portion of the plurality of effector mechanisms and associated DOFs.

[0009] Many embodiments are directed to a surgical tool comprising an elongated shaft having a proximal end and distal end. A surgical end effector is located at the distal end of the shaft. The surgical end effector has a plurality of end effector components each associated with a unique mechanical degree of freedom. The plurality of end effector components has a first end effector component and a second end effector component. A drive mechanism is located at the proximal end of the shaft. The drive mechanism has a first motor interface and a transmission. The transmission includes a shift mechanism movable between a first state and a second state. In the first state the first motor interface is coupled via the transmission to drive the first end effector component without driving the second end effector component. In the second state the first motor interface being coupled via the transmission to drive the second end effector component without driving the first end effector component.

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