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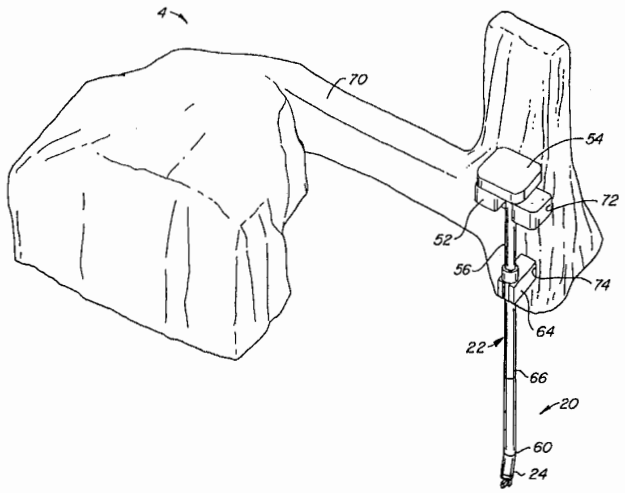


**(57) Abstract**

The present invention provides systems and methods for performing robotics assisted surgical procedures on a patient. In particular, a three component surgical system (2) is provided that includes a non–sterile drive and control component (40), a sterilized end effector or surgical tool (20), and an intermediate connector component (24) that includes mechanical elements for coupling the surgical tool (20) with the drive and control component (40), and for transferring motion and electrical signals therebetween. The drive and control component (40) is shielded from the sterile surgical site, the surgical tool (20) is sterilized and disposable and the intermediate connector (24) is sterilized and reusable. In this manner, the intermediate connector (24) can be sterilized after a surgical procedure without damaging the motors (170) or electrical connections within the drive and control component (40) of the robotics system.

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# MULTI-COMPONENT TELEPRESENCE SYSTEM AND METHOD

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of, and claims the benefit of priority from, U.S. Provisional Patent Application Serial No. 60/033,321, filed December 12, 1996, the full disclosure of which is hereby incorporated by reference.

## BACKGROUND OF THE INVENTION

This invention relates to robotically-assisted surgical manipulators and more particularly to systems and methods for performing telerobotic surgical procedures on a patient while providing the surgeon with the sensation of physical presence at the surgical site.

In robotically-assisted or telerobotic surgery, the surgeon typically operates a master controller to remotely control the motion of surgical instruments at the surgical site from a location that may be remote from the patient (e.g., across the operating room, in a different room or a completely different building from the patient). The master controller usually includes one or more hand input devices, such as joysticks, exoskeletal gloves or the like, which are coupled to the surgical instruments with servo motors for articulating the instruments at the surgical site. The servo motors are typically part of an electromechanical device or surgical manipulator ("the slave") that supports and controls the surgical instruments that have been introduced directly into an open surgical site or through trocar sleeves into a body cavity, such as the patient's abdomen. During the operation, the surgical manipulator provides mechanical

such as tissue graspers, needle drivers, electrosurgical cautery probes, etc., that each perform various functions for the surgeon, e.g., holding or driving a needle, grasping a blood vessel, or dissecting, cauterizing or coagulating tissue.

This new method of performing telerobotic surgery through remote manipulation has, of course, created many new challenges. One such challenge results from the fact that a portion of the electromechanical surgical manipulator will be in direct contact with the surgical instruments, and will also be positioned adjacent the operation site. Accordingly, the surgical manipulator may become contaminated during surgery and is typically disposed of or sterilized between operations. Of course, from a cost perspective, it would be preferable to sterilize the device. However, the servo motors, sensors, encoders and electrical connections that are necessary to robotically control the motors typically cannot be sterilized using conventional methods, e.g., steam, heat and pressure or chemicals, because they would be damaged or destroyed in the sterilization process.

Yet another challenge with telerobotic surgery systems is that a surgeon will typically employ a large number of different surgical instruments during a procedure. Since the number of instrument holders are limited due to space constraints and cost, many of these surgical instruments will be attached and detached from the same instrument holder a number of times during an operation. In laparoscopic procedures, for example, the number of entry ports into the patient's abdomen is generally limited during the operation because of space constraints as well as a desire to avoid unnecessary incisions in the patient. Thus, a number of different surgical instruments will typically be introduced through the same trocar sleeve during the operation. Likewise, in open surgery, there is typically not enough room around the surgical site to position more than one or two surgical manipulators, and so the surgeon's assistant will be compelled to frequently remove instruments from the holder and exchange them with other surgical tools.

What is needed, therefore, are improved telerobotic systems and methods for remotely controlling surgical instruments at a surgical site on a patient. These systems and methods should be configured for easy sterilization so that they can be reused after the components have been contaminated during an operation. In addition, these systems and methods should be designed to minimize instrument exchange time during the surgical procedure.

## SUMMARY OF THE INVENTION

The present invention provides systems and methods for performing remote, robotically-assisted surgical procedures on a patient while providing the surgeon with the sensation of physical presence at the surgical site (i.e., telepresence). In particular, a three-component surgical system is provided that includes a non-sterile drive and control component, a sterilizable end effector or surgical tool and an intermediate connector component that includes mechanical elements for coupling the surgical tool with the drive and control component, and for transferring motion from the drive component to the surgical tool. The drive and control component is shielded from the sterile surgical site, the surgical tool is sterilizable and disposable and the intermediate connector is sterilizable and reusable. In this manner, the intermediate connector can be sterilized after a surgical procedure without damaging the motors or electrical connections within the drive and control component of the robotic system.

The drive and control component of the present invention generally includes the drive actuators, e.g., motors, gears or pulleys, etc., and positioning devices that are necessary to articulate the surgical tool at the surgical site. In addition, the drive and control component will usually include the encoders and electrical connectors required to couple the component to a servomechanism to form a master/slave telerobotic surgical system. In a specific configuration of the invention, this component comprises a

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