Flexible and Steerable Robotic Surgery System for Quick and Safe Deep Access into Mammalian Anatomy

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Summary

This technology uses a novel continuum robot that provides a steerable channel to enable safe surgical access to the anatomy of a patient. This robotic device has a wide range of clinical application and is a significant advance from the rigid tools currently used in minimally invasive surgical (MIS) procedures.

Challenges for Minimally Invasive Surgical Tools

- The rigidity of most instruments used in minimally invasive procedures limits their ability to access certain parts of the body and adapt to the natural movement of various tissue structures that occurs within the body during an operation
- This inflexibility leads to the need for an increased number of surgical access ports (more incisions) and increased risk of damaging healthy tissue during an MIS procedure
- The few surgical platforms that do offer flexible deep surgical access are mechanically complex and have a much larger outer diameter compared to the inner surgical channel, thereby warranting a larger incision and resulting in an unnecessarily bulky surgical device
- Existing access channels do not maintain parallelism of their distal tip despite changes in the shape of the access channel as it navigates the body. This complicates and lengthens surgical deployment time

Technology Description

This robotic system consists of a flexible channel that can be remotely steered deep into an anatomical cavity and then locked into place upon reaching the desired surgical site. The robot maintains orientation of its tip despite change in the shape of its flexible body such that it can be steered using a joystick and vision feedback. Once in place, the channel serves as a stable passageway through which users can deploy and guide other tools. The flexible, steerable channel increases the operating range for surgeons while preventing damage to healthy tissue during the procedure. The design allows for quick deployment while affording the surgeon with control of the orientation of the tip of the channel. During deployment, the channel flexibly adapts to anatomical passages. The design decouples changes in the shape of the flexible channel and changes in the orientation of its tip, thus affording surgeons with simple control of the orientation of the tip. Once deployed, the channel can be locked in a particular shape.

Commercial Applications

Over 57 million minimally invasive procedures are performed every year, and this surgical access robot is applicable to a large percentage of those procedures. Any procedure that seeks access to inner anatomy would be made safer and more efficient by the revolutionary capabilities of this system. The MIS industry grows by over 7% each year, but this robotic system promises to expand that growth even further by increasing the types of procedures that can be performed in a minimally invasive manner. Particular applications include trans-oral surgery of the throat, trans-vaginal, trans-anal, and colorectal surgery.

Advantages

- This steerable channel has a flexible body that gives surgeons freedom to maneuver around vital anatomy without damaging healthy tissue
- Once it reaches the target, the channel can lock into place so that other surgical tools can use the access channel
- The algorithms in place in this system hold the tip stationary as the body flexes, allowing the user to steer the tip simply with a joystick and visual feedback
- Due to its efficient design, the ratio between available bore and outer diameter is much smaller than similar devices, making this system much less invasive
- The design also decouples changes in the shape of the access channel from changes in the orientation of the tip.

Intellectual Property Status

- Issued US Patent: US 9,549,720
- Published Paper: Bajo, A., et al., (2012). IEEE International Conference on Robotics and Automation
- Video example: https://youtu.be/YSz3zZDdBKc?t=62

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