Insertable robot offers new approach to minimally invasive surgery

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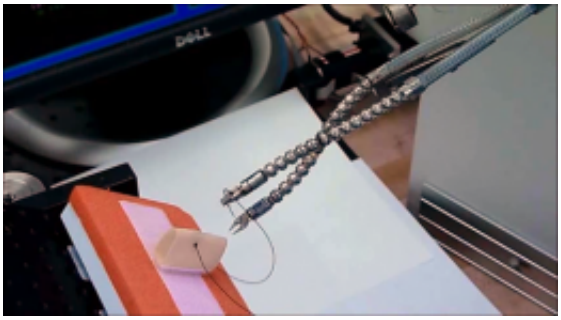

The Insertable Robotic Effector Platform in action

A collaboration between Columbia Professors Peter Allen (Computer Science, Columbia Engineering), Nabil Simaan (formerly Mechanical Engineering at Columbia, now at Vanderbilt) and Dennis Fowler (Surgery, Columbia University Medical Center) has resulted in an innovative new approach to minimally invasive surgery. They have developed a novel robotic platform for minimally invasive single-port surgery—Insertable Robotic Effector Platform (IREP)—that they say is the world's smallest in required diameter (∅15 mm) that can enter the body while enabling dual-arm-dexterous operation, 3-D visualization, and automated instrument tracking. It was recently licensed to Titan Medical, Inc.

Patients prefer minimally invasive surgery because it results in smaller scars, less pain, and a quicker recovery. However, minimally invasive

surgery techniques such as laparoscopy often require multiple incisions and a large team of personnel. As a result of reducing the size and scope of the instruments, the difficulty of minimally invasive procedures has increased significantly, often resulting in increased operation time and cost. The techniques are simply too complex and too costly for all surgeons and all hospitals to be able to provide them.

“Our IREP system represents an exciting new development in robotic surgery,” says Allen. “Instead of multi-million-dollar large robotic systems, this is a low-cost, minimally invasive, compact system that includes state-of-the-art robotic arms and surgical instrumentation with 3-D stereo-vision imaging and a suite of intelligent software for control and visualization to assist the surgeon.”

The IREP consists of a collapsible configuration for insertion into natural orifices or through a small incision, a dual arm configuration with seven degrees of freedom per arm, and a binocular camera for 3-D visualization. The unique 3-D vision system, which includes two controllable miniature cameras inside the body, can be used to automatically track anatomical structures and surgical tools during a procedure, providing real-time in-vivo viewing for the surgeon. Using stereo reconstruction methods, surgeons can also model the patient’s internal anatomy and register it with pre-operative CT, Ultrasound, or MRI scans.

The IREP’S unique mechanical architecture includes snake-like continuum robots with push-pull actuation, parallel linkages, and passively flexible actuation stems. It has also been designed as a platform for multi-modal use including energy and drug delivery and suction. This is achieved through the use of tubular access channels within each surgical arm.

“In contrast to existing systems, which are too large to be mounted on the

surgical bed, this device is so small that it can be easily attached, allowing for quick orientation of the patient during surgery," says Fowler. "We anticipate that robots in the future can greatly improve the care of surgical patients, and we are very excited about the partnership with Titan. By reducing the invasiveness of surgery, we will improve the outcome of surgery for patients, for surgeons, and for hospitals."

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