Building Disposable Surgical Robots

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Minimally invasive, or laparoscopic, surgery has many advantages. By using several small incisions rather than one large cut, it reduces patient trauma and pain while speeding recovery and lowering costs. Yet it remains a niche procedure. Professor Peter Allen, who likens it to pushing long sticks through small holes, sees several reasons why

First, laparoscopic tools move counter-institutively. Surgeons must move left to go right, or up to go down, for example. That means extensive training to learn to make precision cuts or tie sutures. The use of long, rigid sticks also limits the complexity of potential procedures. Finally, laparoscopy demands a high level of teamwork by surgeons inserting tools through several incisions.

Allen's solution is much simpler: small, intuitive robotic tools that provide a single surgeon with everything he or she needs to conduct a procedure through a single incision. He has already taken the first step, licensing a small robotic imaging system co-developed with Columbia physician Dennis Fowler. The device pans, tilts, and zooms to generate 2D or 3D images, and tracks surgical instruments automatically. The system has been tested in-vivo on animals.

Building the device presented many engineering challenges. The package's high-resolution camera, bright lights, powerful motors, and control system had to fit through a single half-inch incision. "We want to create a robotic surgical platform that is so small, it can perform surgeries through natural orifices without an incision. That's the way surgery is moving. We could move it through the esophagus to the stomach, perform the operation, stitch it up, and take it out again."

To control costs, Allen opted for common off-the-shelf parts that he could buy through catalogs. He assembled the device from 5 millimeter watch motors, small surveillance cameras, and LED lights. "The idea was to keep costs down," Allen said. "Ultimately, we want to drive component costs under a few hundred dollars so we can make it disposable."

Automated tracking is one of the device's most innovative features. Physicians manually box an image of whatever they want to track. The software keeps the camera aligned. "It's a challenging environment, with blood spills and occlusions. If the camera loses the target when it moves behind an organ, it does an intelligent search to reestablish its position," Allen said.

"What we have now is a robotic platform inside the body that can move a camera," he continued. "We want to extend that by adding more tools and creating a small, affordable platform for robotic surgery."

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