

EndoView™ :

A fully-insertible, robotically-assisted imaging and effector platform for minimally invasive surgery

The Clinical Challenge and Problem

There are many benefits of minimal access/minimally invasive surgery: reduced trauma from multiple small incisions compared to one large incision results in less pain, better preservation of pulmonary function, quicker return of GI function, and a much smaller stress response leading to better preservation of immune function. This results in a less painful, quicker recovery for the patient.

The benefits of this approach have been demonstrated for not only abdominal surgery, but also for chest and joints. Also, there is recent evidence that fewer incisional hernias and fewer intestinal obstructions occur after laparoscopic surgery (the most common form of minimal access surgery) than after traditional open surgery. The result is a major reduction in morbidity and suffering associated with late complications. Additionally, there is reduced cost of caring for these patients, measured in the billions of dollars each year.

Despite much evidence that minimally invasive surgery is beneficial in many ways, the incidence of laparoscopic surgery for the treatment of many intra-abdominal conditions is disappointingly small. For example, only 7% of all colon resections in the U.S. are performed laparoscopically each year. While laparoscopic techniques for minimally invasive surgery offer considerable advantages over traditional surgical techniques, these advantages come at a cost.

By minimizing the invasiveness of the surgical procedures, surgeons have also minimized their access to the operation site, thereby forcing themselves to adapt to techniques that are counterintuitive and difficult to learn.

Employing such techniques often makes even simple surgical procedures much more difficult, increases the amount of operating time required to complete operations, and significantly increases the effort and time necessary to learn the technique.

The complexities of existing minimally invasive techniques arise from several sources:

1. Use of these tools requires the surgeon to look at a video display rather than his/her hands, thus breaking hand-eye coordination.
2. Conventional scopes provide only a two-dimensional image which severely limits the surgeon's depth perception.
3. Tools used by the surgeon are inserted via a surgical port, which acts as a pivot. Surgeons are required to move their hands opposite to the direction in which they intend to move the end of the instrument.
4. The pivot of the instrument insertion at the surgical port limits the movement of the tip of the instrument to only two directions. This reduces the tip's number of degrees of freedom from six (unconstrained position) to only four.

Technology Description

The EndoView™ platform, developed at Columbia University, is a new technology for surgeons to learn and perform minimal access surgery. By making minimal access surgical intervention safer, easier to learn, less costly, and even less invasive than current techniques, the device will increase the availability of minimal access surgery for most, if not all, intra-abdominal conditions requiring surgery.

Currently, the EndoView™ device exists as a prototype comprised of a fully-insertible pen-sized single-camera platform and a small control box exterior to the body, connected with a 2 meter long cable (Figure 1). The cable is ~ 10mm in diameter and carries power and video to the camera(s), the camera control unit, and the five motor controllers contained in the insertible portion of the system. The cable has three serial connectors, one of which is occupied by a joystick control device.



Figure 1(a) EndoView without camera lens deployed.



Figure 1(b) EndoView with camera lens deployed.

The existing prototype will be refined to create a first-generation platform, the EndoView™ I, a 2-camera device with light source and corporeal attachment mechanism. This will be a significant improvement over the existing laparoscopic surgical setup. A second-generation EndoView™ II device, envisioned, will have integrated effectors, remote/wireless control, and more sophisticated visualization via a head-mounted display. This product has the potential to revolutionize not just improve upon the way surgeons perform minimal access surgery.

Potential Market

The EndoView™ device is a potentially disruptive technology as it may entirely replace or diminish the dominance of laparoscopic methods. The market is currently dominated by several large players. Growth in the market is driven by the increase in the number of minimally invasive surgeries performed, a reflection of both conversion of open to MIS procedures, as well as a growing population.

The steep learning curve associated with laparoscopic surgery is a major barrier to expanded use among surgeons. The inventors believe that the more intuitive design of the EndoView™ platform will drive clinical adoption, replace the current laparoscopic technology, and expand the market due to increased conversions from the open surgery to the MIS paradigm.

In addition to conventional laparoscopy, EndoView™ will compete in the emerging robotic surgical device/equipment market. This market is currently dominated by Intuitive Surgical, Inc. which had 2004 sales of \$138M and 50% growth (over 2003 sales), and markets the only commercially available systems.

Intuitive Surgical systems improve on traditional open surgery by allowing surgeons to reach places not possible using the human hand, and by enabling better precision (reduced tremor). However, these systems retain the following characteristics:

- Enormous physical size and installation requirements;
- High purchase cost (\$800,00 to \$1,000,000);
- High service/maintenance (\$100,000+) and operational (\$200,000+) costs, plus associated disposables;
- Need to change surgical workflow for surgeon and staff;
- Requirement of multiple incisions;
- Use of endoscopes with limited mobility within body cavities; and
- Ultimately, they have not reduced the invasiveness of the procedures.

Inventors:	Dennis L. Fowler, M.D.; Professor of Clinical Surgery Peter K. Allen, Ph.D.; Professor of Computer Science Andrew Miller, Ph.D.; Research Scientist, Computer Science Department.
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Further Information:	Donna See, Associate Director, Science & Technology Ventures, Tel: (212) 305-7214; Email: dk26@columbia.edu

The Center for Advanced Information Management

The Center for Advanced Technology Information Management at Columbia University is a joint effort of the Department of Biomedical Informatics (Columbia University Medical Center), the Computer Science Department (School of Engineering, Columbia University), the Center for Computational Biology and Bioinformatics, and the bio-imaging group in the Biomedical Engineering Department (School of Engineering). The goal of the Centers for Advanced Technology program is to support cutting-edge research at major New York State research institutions, and to make the resulting technology available to industry for commercialization. CATs work with industry partners in several ways to achieve this goal. Inquiries are welcomed.

General Information

Vincent Tomaselli, Ph.D.; Deputy Director; Center for Advanced Information Management
Voice: 212.305.2944; E-mail: tomaselli@cat.columbia.edu

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