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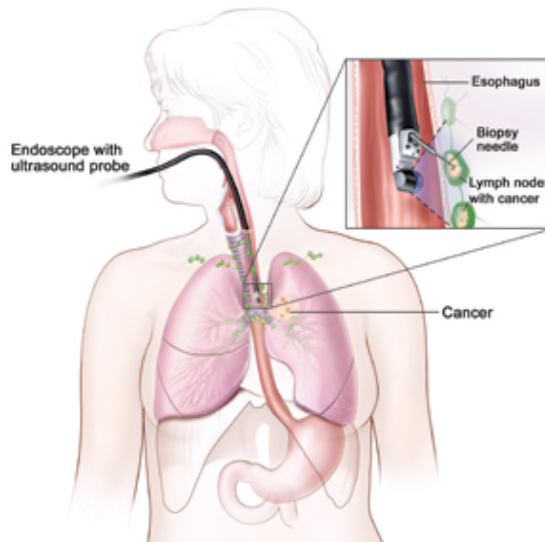
Advances in Endoscopy

Latest trend is throw-away endoscopes that feature a miniaturized sensor and downstream video-processing circuitry

By [Lee J. Nelson](#)
Contributing Editor

During the past decade, I have been subjected to more endoscopic examinations than I care to recall. The process of being poked, prodded, diagnosed and treated—all at once—is not something I would describe as pleasant. Yet, I must marvel at the materials, optics and sensor technologies that are propelling medicine and surgery to increasingly sophisticated, minimally invasive triumphs.

As I presaged in the January 2007 issue of *AI*, those advances are addressing applications and market opportunities for disposable instruments; specifically, a throw-away endoscope that combines a miniaturized sensor and "downstream" video



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An artist's conception of an ultrasound-guided endoscopic biopsy of the esophagus.



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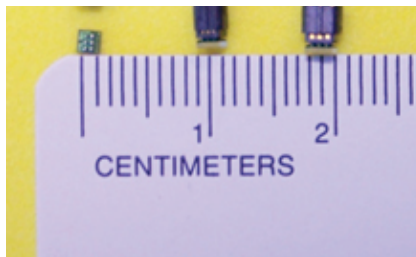
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processing circuitry. Enter Micro-Imaging Solutions' (Englewood, Colo.) minute CMOS pixel array, mounted on the endoscope tip. Most of the **electronics** are housed in a remote, reusable unit and connected by cable. The chip contains only the pixel array and a few essential timing and control circuits, making the package as small and inexpensive as possible with no adverse impact on image resolution.

Micro-Imaging Solutions began building an intellectual property portfolio with its first patent, issued in 2001. Since then, they have received a total of 13 U.S. and five international patents that cover the methodology and format of relocating circuitry away from the image plane. That positions the firm uniquely, versus some other CMOS camera-on-a-chip designers, allowing Micro-Imaging Solutions to populate sensor dies with 40 to 60 percent more pixels than their competitors.

Jeffrey Adair, one of the founders and Micro-Imaging Solutions' Vice President of Research and Development, said, "We have finished development of three different sized CMOS image sensors that are high-resolution with very small form factors." He anticipated working prototypes would be available as we went to press. Next generation sensor architecture occupying the same footprint will support up to four times the resolution of the present products. Packaged dies will range between 1.0 and 4.6 mm2 with pixel density from 352x352 to 2040x2040.

One of Micro-Imaging Solutions' primary targets is the reusable and disposable endoscope segment for cardiology, balloon angioplasty and stenting; laparoscopy to examine, diagnose and treat abdominal symptoms; and arthroscopy of the knee, shoulder and hips. The company's flagship 4-mm diameter disposable arthroscope—the first of its kind with a distally-



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Miniaturized, high-resolution sensors in disposable endoscopes for cardiology, laparoscopy and arthroscopy.



An illustration of the relative size of the newest video endoscopes, which surmount the 5-mm barrier.

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mounted image sensor—is a collaborative effort among stakeholders, Cypress Semiconductor Corp. (San Jose, Calif.), Imaging Solutions Group of N.Y., (Fairport), Lighthouse Imaging Corp. (Portland, Maine) and XinTec, (Tao Yuan, Taiwan). Other intended disciplines include gastrointestinal endoscopy, neuroendoscopy, otolaryngology (sinoscopy), pulmonary endoscopy (bronchoscopy) and urology (cystoscopy). Beyond eventually offering disposable replacements for all rigid and flexible endoscopes, Adair foresees adding vision-assist to hand instruments such as endotracheal tubes, wound staplers and clip-appliers, vein harvesters, tracers and intubation devices.

While progressive size reductions and imaging enhancements are enabling diagnostic and interventional procedures to be less invasive and more efficient, there is a parallel thrust to improve the informational content obtained during endoscopy. Two clinical examples are the ability to observe placental vascular abnormalities and to monitor middle-ear bone (ossicle) vibrations.

Valuable data on blood flow can be acquired with an optical Doppler effect. Streaming erythrocytes scatter light and cause a wavelength shift. Speckle pattern modulation also proves viable to visualize vasculature. As opposed to Laser Doppler Velocimetry and Speckle imaging, which impart transverse views of tissue perfusion, Interstitial Doppler Optical Coherence Tomography—previously demonstrated in the skin, retina and gastrointestinal tract—returns high-resolution, cross-sectional images of microcirculatory flow. Even though those techniques have been implemented with larger endoscopes or through their accessory channels, no ultraminiature probe (<1 mm Ø) presently achieves three-dimensional Doppler at video rates.

Auditory motion often is detected by Laser Doppler Vibrometry, an interferometric method that can help verify movement of the tympanic membrane (eardrum). Historically, exposing the middle-ear was required to quantify vibrations of the middle-ear ossicles or inner-ear structures.

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