# Tunable microlenses shine light on medical imaging

October 13 2008, by Liz Ahlberg

(PhysOrg.com) -- University of Wisconsin-Madison engineers have developed tunable liquid microlenses that can quickly scan images and record video. Integrated onto fiber-optic probes, the lenses further could reduce the invasiveness of such minimally invasive diagnostic medical procedures as endoscopies.

Assistant professor of electrical and computer engineering Hongrui Jiang and his student Xuefeng Zeng developed the lenses. The two published their findings in the cover story of today's (Oct. 13) issue of *Applied Physics Letters.*

Tunable liquid microlenses are Jiang's specialty. He first developed the technology in 2006 in collaboration with David Beebe, a UW-Madison professor of biomedical engineering. They form the lenses from tiny droplets of water and oil, actuated by a thick, jelly-like polymer called a hydrogel. The hydrogel expands or contracts in response to external stimuli, reshaping the droplets and focusing the lens.

Jiang previously has demonstrated lenses that respond to changes in temperature and pH, but both are inconvenient for fiber-optics applications, he says. To create a hydrogel that responds to infrared light, the researchers integrate tiny nanoparticles of gold into the hydrogel. Gold absorbs energy from infrared light, which it then releases as heat, causing the temperature-sensitive hydrogel to shrink. As a result, the lenses can scan a depth range of inches in seconds.

To integrate the lenses onto a fiber endoscope or other fiber-based optical devices, researchers could add infrared-light-delivering fibers to the bundles that already provide light for illumination and transport image data. "Because it's light-driven, it's easier to integrate with fibers," says Jiang.

A major advantage to the tunable lens system is its scanning capability. "In current endoscopes, the lens at the tip is fixed, so the endoscopist has to move the instrument around. If you have a tunable lens, it offers them scanning abilities, so it reduces the manual operation," Jiang says.

In other words, as an alternative to threading an endoscope completely through the bodily area of interest and then manipulating it to gather images point by point, the physician can leave the scope in one place, scan the area, record all the images and rely on post-image processing to reconstruct the area. "Once you scan through it, you have a whole-picture 3-D rendition of the area."

In addition to still images, the infrared-light-actuated lenses are capable of video feed, allowing physicians to observe dynamic conditions within the body.

Jiang is in the process of building a prototype fiber endoscope that includes a tunable liquid lens. He also is investigating the feasibility of applying the infrared technique to arrays of lenses. In addition, he hopes to demonstrate other applications for the technology in such areas as sensing, defense, diagnostics and other optical imaging.

"The main advantage of this technique is that we demonstrate that it is possible to integrate tunable lenses with fiber," he says. "It's my hope that this will contribute to fiber-based optics in a broad sense."

Provided by University of Wisconsin-Madison