Colonoscopies of the future: Adjustable-focus endoscope helps to reduce discomfort

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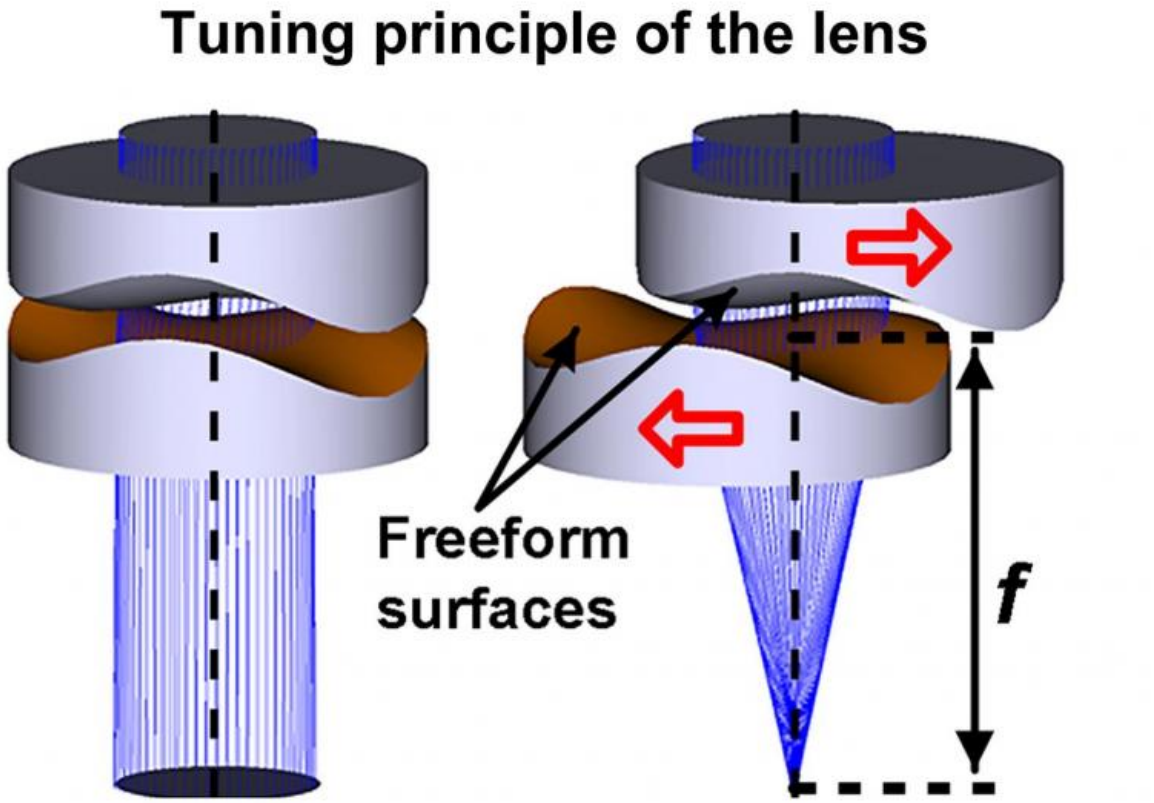

The miniature solid tunable lens technology may enable compact optical zoom endoscope with autofocus capability that could switch conveniently from a wide field-of-view to a clear high-resolution close-up view without moving the endoscope probe. Credit: Zhou Guangya, National University Singapore

Colonoscopy is a safe and effective medical procedure that's proven to saves lives. Used for routine cancer screening, it can help identify colon tumors in their early stages. In addition, it is a key non-surgical imaging technique that allows doctors to spot ulcers, polyps or bleeding inside the large intestines of their patients safely, avoiding complications that an exploratory surgery might induce.

Yet despite its medical relevance, the colonoscopy suffers a bad rap in modern society because of the discomfort it can inflict. Other types of endoscopies examine similarly hard-to-reach places, such as the stomach or gallbladder. Whatever the target, reaching organs far within your body can be challenging, and moving the endoscope around in sensitive tissue can cause discomfort. Existing endoscopes that try to surmount this problem by zooming—thus reducing the need to physically move the camera—tend to be bulky.

Researchers from the National University of Singapore have created an endoscopic probe that delivers adjustable-focus capabilities in a slimmer package. Their findings, published this week in the journal *Optics Express*, published by The Optical Society, could ultimately facilitate more effective and less painful imaging of internal tissues.

The lens system contains two transparent polymer plates, each with one flat surface and one freeform curved surface. The freeform surfaces are inverses of each other. When the transparent plates are perfectly aligned with the freeform surfaces facing each other, they behave as one unit without any focusing power—any wave phase shift induced by one is cancelled out by the other. However, when they are slightly offset in a sideways direction, they refract light like a traditional lens. Two piezoelectric benders drive these minute shifts in lens placement, controlling the focusing power of the endoscope by changing the degree of displacement. The image is then transmitted to an external camera monitored by a technician.

The resulting device is far less bulky than existing high-magnification endoscopes. Although some labs are testing an alternative approach to reducing the size of endoscopes by making them with tunable liquid-crystal lenses, those lenses can be fragile and difficult to handle, according to the research team. Their new design, they said, uses only solid components.

"It is the first time, to our knowledge, that a solid electrically-tunable lens is implemented in an endoscopic system for the purpose of focus tuning," said Guangya Zhou, a researcher at National University Singapore who led the project.

Their device is still in the early stages and has not yet been tested in a clinical setting. The next step will be to incorporate multiple tunable lenses into the system so that it has not just adjustable focus, but full-fledged optical zooming capabilities.

"Once successful, the miniature optical zoom endoscope with autofocus capability may allow doctors to switch conveniently from a wide field-of-view to a clear high-resolution close-up view without moving the endoscope probe," said Zhou. "This may not only reduce the complexity of the endoscopic procedure but also allow potentially high-magnification endoscopy."

In some cases, he said, high-resolution imaging might provide enough information about the tissue to eliminate the need for an invasive biopsy. Such a development would be welcome news for patients and practitioners alike.

More information: Y. Zou, W. Zhang, F. Chau, G. Zhou, "Miniature adjustable-focus endoscope with a solid electrically tunable lens," *Opt. Express* 23, 20582-20592 (2015). www.osapublishing.org/oe/abstr … m?uri=oe-23-16-20582