Early detection of blinding eye disease could be as easy as scanning a barcode

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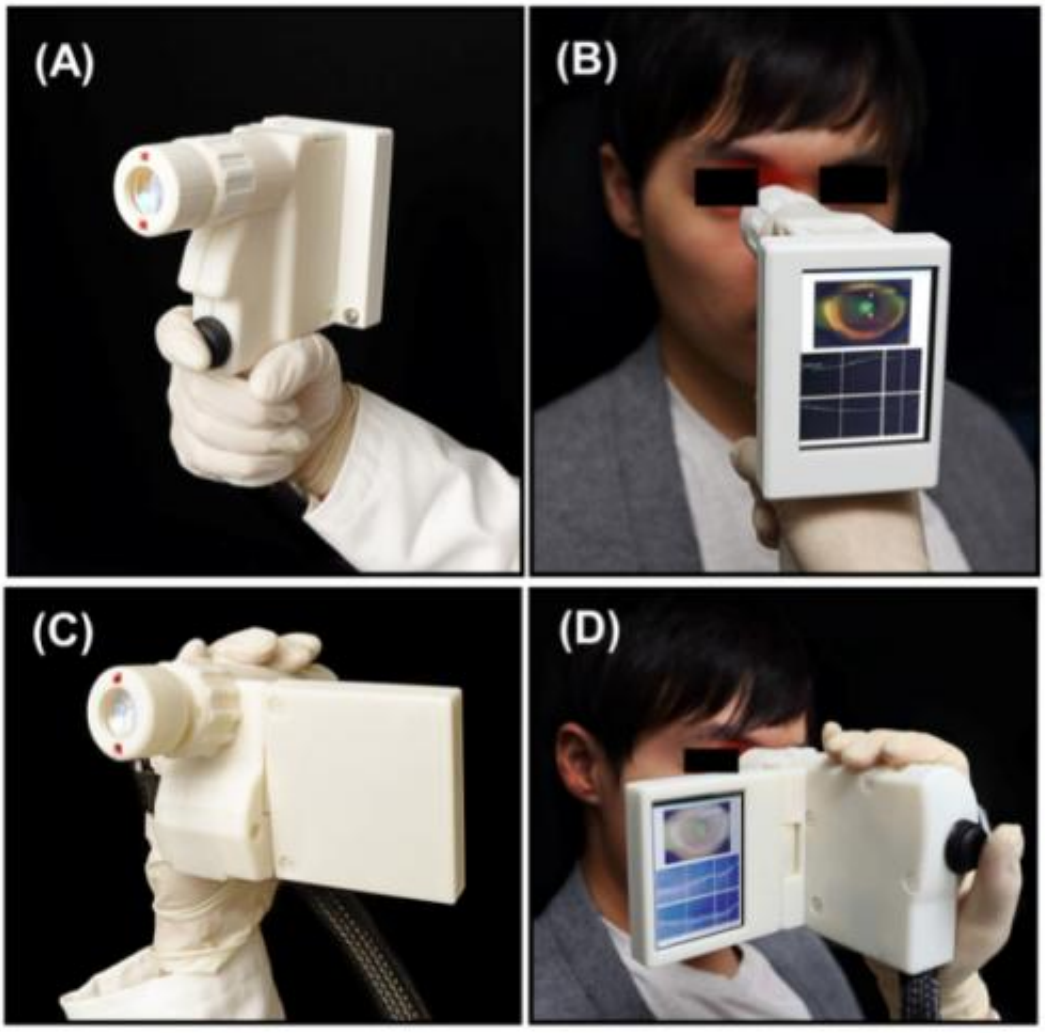

This shows photographs of the power grip style (A-B) and camcorder style designs (C-D) of the prototype OCT scanner. Both devices acquire 3D OCT images of the retina. Credit: *Biomedical Optics Express*

A new optical device puts the power to detect eye disease in the palm of a hand. The tool—about the size of a hand-held video camera—scans a patient's entire retina in seconds and could aid primary care physicians in the early detection of a host of retinal diseases including diabetic retinopathy, glaucoma and macular degeneration. Researchers at the Massachusetts Institute of Technology (MIT) describe their new ophthalmic-screening instrument in a paper published today in the open-access journal *Biomedical Optics Express*, published by The Optical Society (OSA).

Although other research groups and companies have created hand-held devices using similar technology, the new design is the first to combine cutting-edge technologies such as ultrahigh-speed 3-D imaging, a tiny micro-electro-mechanical systems (MEMS) mirror for scanning, and a technique to correct for unintentional movement by the patient. These innovations, the authors say, should allow clinicians to collect comprehensive data with just one measurement.

Normally, to diagnose retinal diseases, an ophthalmologist or optometrist must examine the patient in his or her office, typically with table-top instruments. However, few people visit these specialists regularly. To improve public access to eye care, the MIT group, in collaboration with the University of Erlangen and Praevium/Thorlabs, has developed a portable instrument that can be taken outside a specialist's office.

"Hand-held instruments can enable screening a wider population outside the traditional points of care," said researcher James Fujimoto of MIT, an author on the *Biomedical Optics Express* paper. For instance, they can be used at a primary-care physician's office, a pediatrician's office or even in the developing world.

How it Works

The instrument uses a technique called optical coherence tomography (OCT), which the MIT group and collaborators helped pioneer in the early 1990s. The technology sends beams of infrared light into the eye and onto the retina. Echoes of this light return to the instrument, which uses interferometry to measures changes in the time delay and magnitude of the returning light echoes, revealing the cross sectional tissue structure of the retina—similar to radar or ultrasound imaging. Tabletop OCT imagers have become a standard of care in ophthalmology, and current generation hand-held scanners are used for imaging infants and monitoring retinal surgery.

The researchers were able to shrink what has been typically a large instrument into a portable size by using a MEMS mirror to scan the OCT imaging beam. They tested two designs, one of which is similar to a handheld video camera with a flat-screen display. In their tests, the researchers found that their device can acquire images comparable in quality to conventional table-top OCT instruments used by ophthalmologists.

To deal with the motion instability of a hand-held device, the instrument takes multiple 3-D images at high speeds, scanning a particular volume of the eye many times but with different scanning directions. By using multiple 3-D images of the same part of the retina, it is possible to correct for distortions due to motion of the operator's hand or the subject's own eye. The next step, Fujimoto said, is to evaluate the technology in a clinical setting. But the device is still relatively expensive, he added, and before this technology finds its way into doctors' offices or in the field, manufacturers will have to find a way to support or lower its cost.

Why Early Screening is Important

Many people with eye diseases may not even be aware of them until

irreversible vision loss occurs, Fujimoto said. Screening technology is important because many eye diseases should be detected and treated long before any visual symptoms arise. For example, in a 2003 Canadian study of nearly 25,000 people, almost 15 percent were found to have eye disease—even though they showed no visual symptoms and 66.8 percent of them had a best-corrected eyesight of 20/25 or better. Problems with undetected eye disease are exacerbated with the rise of obesity and undiagnosed diabetes, Fujimoto said. The Center for Disease Control and Prevention estimates that 11.3 percent of the U.S. population over the age of 20 has diabetes, even though many do not know it.

In the future, Fujimoto envisions that hand-held OCT technology can be used in many other medical specialties beyond ophthalmology – for example, in applications ranging from surgical guidance to military medicine.

"The hand-held platform allows the diagnosis or screening to be performed in a much wider range of settings," Fujimoto said. "Developing screening methods that are accessible to the larger population could significantly reduce unnecessary vision loss."

More information: "Handheld Ultrahigh Speed Swept Source Optical Coherence Tomography Instrument using a MEMS Scanning Mirror," Lu, C.D. et al., *Biomedical Optics Express*, Vol. 5, Issue 1, pp. 293-311 (2013). www.opticsinfobase.org/boe/abs … .cfm?uri=boe-5-1-293

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