A compact fundus camera to improve global access to retinal and optic nerve imaging

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Conditions that lead to vision loss can be diagnosed outside the clinic using a portable, pen-sized camera that is simple to align and operate. To reduce rates of blindness and vision loss from treatable eye conditions, improving patient access to early diagnosis is critical. Identification and treatment of eye disease are vital to preserve the function of the retina and optic nerve, as current therapies can delay or avoid the onset of blindness. To conduct eye examinations, clinicians routinely use the widely available direct ophthalmoscope, which illuminates the eye’s interior for examination, but the instrument has limited utility. It has a small field of view, provides a fleeting image, and leaves no examination record. Ophthalmologists and optometrists utilize more advanced and accurate examination techniques, but access to these types of providers is far from universal. Traditional fundus cameras, which photograph the eye’s interior to monitor disease, are a valuable alternative technology, but they are expensive, bulky, and typically used by trained technicians in well-funded eye care centers. As a result, a lack of a quality routine retinal examination puts many people at risk for vision loss.

Several handheld fundus cameras have emerged in the marketplace, including Volk Pictor, Nidek NM-200D, OptoMed Smartscope, and Kowa Genesis. The use of these cameras is hampered by their precise alignment requirements: the task of aiming such a camera into a patient’s pupil at the correct angle is challenging for the technician holding the camera. Furthermore, the camera focusing mechanism needs constant adjustment to match the patient’s changing accommodation, which can confuse the camera’s autofocusing algorithms. These constraints require that the operator continually visualizes the retinal image provided by the camera, leading to a need for larger systems that have fewer practical applications.

Our approach solves these problems and offers opportunities to miniaturize the technology. Steven Feldon and Geunyoung Yoon at the University of Rochester have created a ‘one-button’ process for imaging the fundus that is safe and simple enough for users with various levels of skill. Feldon previously developed the Tono-Pen, an applanation tonometer that measures eye fluid pressure as an indicator of glaucoma and which is similar in operation to our miniature camera.

To use our system, the operator holds the device like a pen and brings the tip into contact with the patient’s cornea. This contact triggers the image recording process, which continuously adjusts the focus of the camera from one extreme position to another, so that it rapidly acquires multiple images. We anesthetize the cornea with an eye drop prior to contact and use a new sterile disposable tip for each patient. Since the device is brought into direct contact with the eye, the camera is easily held steady and properly aligned. In addition, the contact dramatically reduces the back reflections from the cornea, which allows us to keep the

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optics inside the camera simple. By reducing complexity in the design, we are able to build the device on a miniature scale.

The image acquisition process takes less than a second, after which the camera’s electronics analyze the images, select the one with the greatest sharpness, and verify the presence of the main retinal features. Rapid image gathering of all planes of focus, and the system’s secondary automated analysis remove the need for the user to verify the image. A simple audio signal indicates the acquisition of a good quality rendering. A physician can then view and evaluate the image on any display device (tablet, smartphone, or personal computer, for example) by connecting the camera directly or through a wireless system.

Once in widespread use, the camera will allow health practitioners to easily obtain, view, and repeatedly access with their own hands the high-quality fundus images that are required to optimally manage retinal and optic nerve diseases. The device would benefit family practice physicians, internists, and pediatricians, and would be used to examine and help diagnose special populations, including the military, residents of nursing homes, prisoners, and people living in isolated or rural communities. Developing nations, where the lack of access to fundus examination is especially severe, would see significant benefit from eye care that incorporates the use of this camera.

Lumetrics has developed an initial prototype of our system, which captured acceptable fundus images. Our future work aims to develop fully functional commercial prototypes for demonstration to potential investors and customers.

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References