



Credit: Nanyang Technological University, Singapore

Singapore scientists invent new pen camera for faster and cheaper diagnosis of glaucoma

BY: PRIYANKAR BHUNIA

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The device combines a high-resolution camera and LEDs for illumination to take a high-quality image of the human eye. The camera captures images of the eye from four different perspectives, which can be magnified several times for a better diagnosis by an eye doctor. A software is then used to analyse the images, helping doctors and eye specialists with their diagnosis.

Scientists at Nanyang Technological University, Singapore (NTU), with clinicians from the Singapore Eye Research Institute ([SERI](#)), have [invented](#) a new 'pen camera' that makes it easier for doctors to diagnose patients with glaucoma.

Glaucoma is an eye disease, where the high fluid pressure within the eye damages the delicate fibres of the optic nerve, which carry visual impulses from the eye to the brain. It is a leading cause of blindness in the world. It has no early symptoms, but a build-up of pressure inside the eye can be an indicator. In Singapore, around three

per cent of people over the age of 40 years – or over 65,000 people – have glaucoma. This percentage rises with age.

High pressure within the eye is caused by an imbalance between fluid production and its drainage out of the eye, typically due to clogged drainage channels.

An eye specialist determines the type of glaucoma through a gonioscope, a hand-held lens placed in direct contact with the eye. The specialist then peers through a microscope paired with the lens to make a visual diagnosis. Each type of glaucoma requires a different form of treatment. The drawback of this method of peering through a lens is that the doctor cannot review the image of the eye at a later date. Machines are available on the market that can capture images of the angle with or without any direct contact with the eye, but they are very expensive, ranging from US\$25,000 to US\$120,000 (S\$33,000 to S\$158,000).

The new 'pen camera', called the GonioPEN, provides the ability to detect the type of glaucoma in a faster and cheaper manner. It combines a high-resolution camera and LEDs for illumination to take a high-quality image of the human eye. The prototype pen camera, estimated to cost S\$5,000, is connected to a computer via a USB cable. The camera captures images of the eye from four different perspectives and saves it to the computer, which can then be magnified several times for a better diagnosis by an eye doctor. A software is then used to analyse the images, helping doctors and eye specialists with their diagnosis.

The device causes negligible discomfort, unlike the current gonioscopes, which are glass scopes that must be pressed against the eyeball of the patient. In a recent pilot study by Assistant Professor Baskaran Mani from SERI, all 20 patients found the GonioPEN more comfortable than the conventional hand-held lens used with a microscope.

The prototype device is portable and digital, allowing a trained technician to capture images of the eye quickly with minimal training. Its ease of use means it can be used by primary, secondary or private eye care physicians, while its compact size makes it portable for all healthcare set-ups. The cost is also kept low by eliminating the need for a microscope.

Moreover, the current gonioscopy method takes up to 15 minutes to perform and requires a skilled specialist's expertise to diagnose the problem on the spot, and hence, it is not done in clinics as a routine. Consequently, nearly half the patients do not go through the test in clinics, leaving glaucoma undiagnosed. The GonioPEN addresses these problems by capturing high-resolution digital images of the eye from the side of the cornea. in just three minutes. The images, which could be taken by a technician, are reviewed separately by the eye specialist, shortening the time the patient's eye needs to be under the microscope as the specialist makes his diagnosis as in the existing method.

The pen camera was developed over the last two years by a joint research team led by NTU Associate Professor Murukeshan Vadakke Matham, Director of NTU's Centre for Optical and Laser Engineering, in collaboration with Professor Aung Tin,

the Executive Director of SERI. The team also includes NTU researchers Dr Sandeep Menon P, Dr Shinoj VK and Mr Hong Xun Jie, Jesmond.

The research is supported by grants from the National Medical Research Council and the National Research Foundation (NRF) Singapore. Patents have been filed for the GonioPEN by NTU's innovation and enterprise arm, NTUitive.

The press release states that innovative devices such as the GonioPEN, developed on campus, are aligned with NTU's [Smart Campus vision](#) of harnessing the power of digital technology and tech-enabled solutions to support better learning and living experiences, the discovery of new knowledge, and the sustainability of resources.

Asst Prof Mani said, "With GonioPEN, the diagnosis can be generated with an automated software, instead of only relying on a doctor's expertise. This saves time for both doctors and patients involved in eye care, allowing more patients to be examined in clinics. Clinically, patients found the GonioPEN more comfortable than a gonioscope."

Assoc Prof Murukeshan, who is from NTU's School of Mechanical and Aerospace Engineering, said, "With the GonioPEN, a digital camera image of a higher resolution can now be stored for future reference and retrieved easily. A technician could perform the gonioscopy before a specialist reviews the images to give an in-depth diagnosis or a second opinion. Doctors can also better track the changes in their patients' condition over time.

Prof Aung Tin, who is also Deputy Medical Director (Research) at the Singapore National Eye Centre, said that in the digital era of healthcare and future teleophthalmic care possibilities, such a device will enable advancement in the standard of medical care.

"The GonioPEN, with its compactness and integration to our electronic medical records, will achieve such goals for the future eye care model in Singapore," he commented.