Self-learning retinal screening tech cuts time needed to spot signs of diabetic eye disease

Timothy Goh

Imagine a future where the results and analysis of an eye scan can be produced in three minutes instead of an hour, and where even people in remote rural communities can receive access to early screenings to prevent diabetic blindness.

Three options may soon become realities, thanks to a state-of-the-art artificial intelligence (AI) software system, Selena. The deep learning system was jointly developed by a research team from the Singapore National Eye Centre’s (SNEC) Singapore Eye Research Institute (SERI) and the National University of Singapore’s (NUS) School of Computing. Licensed to local start-up Eyvis, the system is trained to analyse retinal photographs for signs of diabetic eye diseases in a fraction of the time it currently takes humans.

Selena, which stands for the Singapore Eye Lesion Analyser Plus, does this by scanning the photographs for signs of three diabetic eye diseases. These are yellow and red lesions in the retina, a sign of diabetic retinopathy; an abnormal cup-to-disc ratio, a sign of glaucoma; and yellow lesions in the macula, a sign of age-related macular degeneration.

Diabetic retinopathy, a major consequence of diabetes, is the leading cause of vision loss in working-age adults worldwide, which can lead to blindness.

Currently, such analysis is done by skilled readers in the SNEC Ocular Reading Centre (SORC) and at another centre in Tan Tock Seng Hospital.

The work is tedious, time-consuming.

SORC’s senior manager Hadilah Hamzah, who is also a founding member of Eyvis, said her centre receives more than 4,000 images a day, and each is processed by just eight to 10 staff who grade eye conditions.

These graders sit in a darkened room staring at retinal images on a screen, which they need to scan for abnormalities. They are typically not allowed to work for more than half a day as the job is too strenuous.

The image is first taken at an angle after it has been sent to SORC. Ms Hadilah said that around half of all images at this level typically turn out to have no abnormalities.

Images with abnormalities, as well as 30 per cent of the “normal” images, are then sent to a group of secondary graders.

If the primary and secondary graders disagree in their analysis of an image, it will be sent to an ophthalmologist. Only about five per cent of such images reach this stage, said Mr Hadilah.

Selena is set to replace the role of the primary graders.

The system will address the need for increased manpower to tackle diabetes, the world’s fastest-growing chronic disease.

Preliminary tests have shown Selena can cut the time that it takes for a report to return to a patient with “normal” results to just three minutes, down from one hour.

Eyvis chief executive Lai Teik Kin said his company hopes to improve Selena so that future patients can receive their results almost instantaneously.

He added that the AI has proven itself “so good as a trained grader, if not better” during trials.

“Humans are inconsistent, but AI is consistent and doesn’t tire,” he said.

As a deep learning system, Selena “learns” and improves itself through experience, which means that the more images it has in its training dictionary to learn from, the more accurate it becomes.

The system was able to benefit from the large number of data sets – more than half a million – made available to it through the Singapore Integrated Diabetic Retinopathy Programme. The programme, which was started in 2005, allows patients to be screened for signs of diabetic eye disease.

Mr Lai, who is also chief executive of healthcare company Novohealth, said Selena is pending regulatory approval from the Health Sciences Authority before being rolled out across Singapore.

And when it does, it will be the first AI product in the world to be used by a national healthcare system for screening.

Mr Hadilah said she hopes that Selena will be used in other Asian countries as well.

During screenings with Selena, a type of digital camera equipped with specialised lenses – known as a Fundus camera – takes images of patients’ eyes. The images will be downloaded on a computer that has Selena installed, after which the AI will make its assessment.

Mr Lai said he is seeking approval for Selena with other regulatory authorities around the world.

He added that the AI – as well as the software responsible for its inner face, Eyviscans – can be adapted for different cultures and languages.

The concept of the Selena program was conceived in the 1990s by Professor Wong Tien Yin, who is currently medical director of SNEC, and two professors at NUS School of Computing: Dr Wyune Hoo, who is now deputy head at the department of computer science, and Dr Loo Meng Li, now a professor of computer science.

The three of them are also founding members of Eyvis.

Due to technological limitations and a lack of clinical screening results at the time, initial software prototypes were unable to reach the required levels of accuracy for regulatory approval.

SERI’s Technology Development and Commercialisation team, headed by Dr Danny Belkin, assisted the researchers with essential commercialisation aspects such as regulatory documentation and finding a multinational company to which it could license the technology.

Mr Belkin also linked Dr Hoo and Dr Lee with Novohealth, which helped to create Eyviscan, the software used to interface with Selena.

The various parties from SNEC, NUS and Novohealth then came together to form Eyvis, to which Selena and Eyviscan were licensed.

Dr Belkin said: “There are huge markets where there are just not enough (trained) graders and the scalability of an AI solution can solve a lot of problems...that’s why this is a very exciting opportunity (and we’re very excited about it).”

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Erased photo: Alan Khan (far left) using a speculation camera, an intern as a Fuukin, at a mock screening session with the Selena AI. The system will address the need for increased manpower to tackle diabetes and related eye diseases. (ST PHOTO: OLIVIA YAY

SERI’s team working on over 100 projects

Selena is just one of more than 100 projects that SERI’s Technology Development and Commercialisation team has been working on since it was formed in 2012.

They include:

- Myopine, a set of eyepieces which can slow childhood myopia.
- An application called Focus that helps parents manage their children’s smart device usage.
- OptoMind, a device which helps children’s parents position and administer eye drops into their eyes.
- Tan Ender, a device which helps children insert a portion of a contact lens into a patient’s eye during surgery.

The team, which includes members with business and science experience, has three main roles:

- assisting researchers with the development of their technologies
- fostering partnerships with companies
- training researchers in aspects of commercialisation such as project management and patents.

It also works with industries to bridge the gap between academia and industry.

There are around seven major projects involved in the commercialisation process, from the checking to see if there are any patents for similar projects and assessing the regulatory hurdles before researchers go through a prototype phase.

The product may also undergo human trials before it is introduced to the public.

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