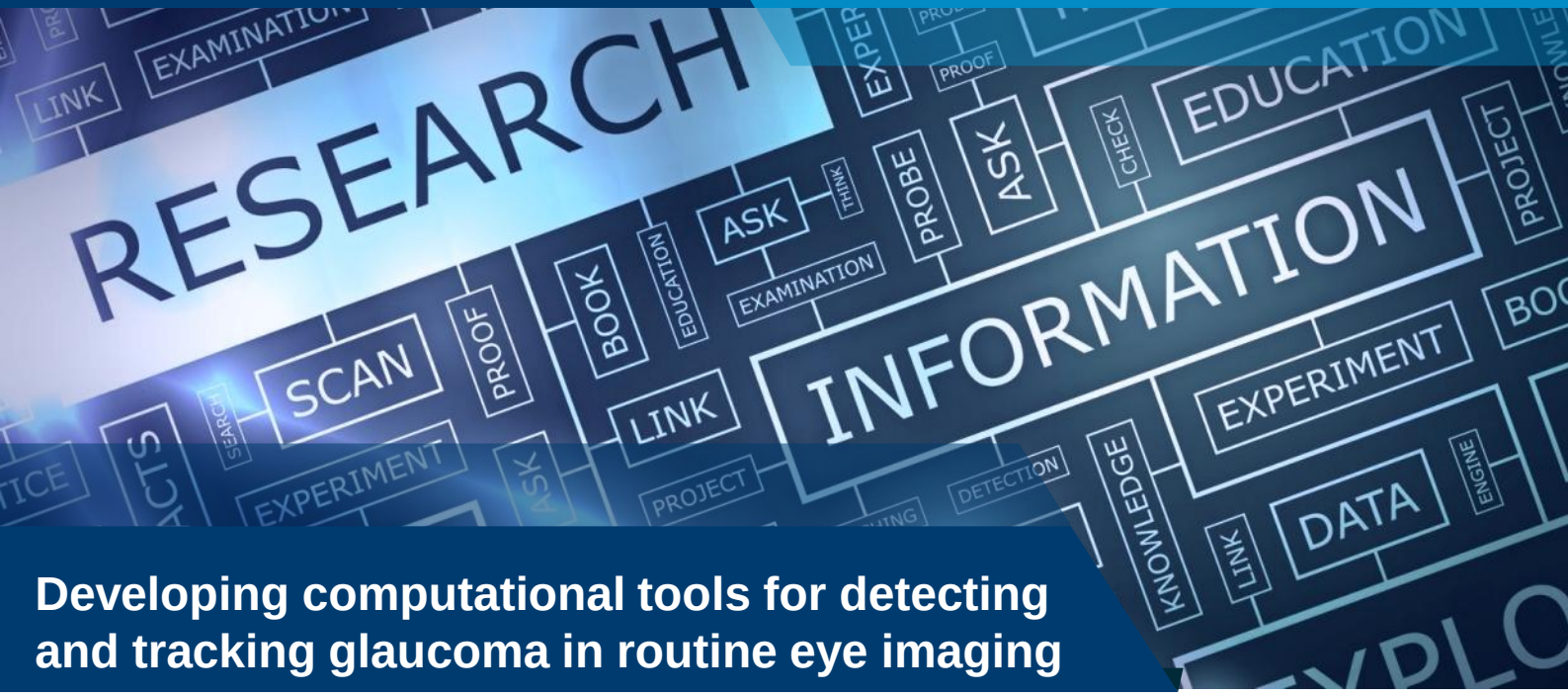
CHIEF SCIENTIST OFFICE

CODE: TCS/22/21

RESEARCH PROJECT BRIEFING



Developing computational tools for detecting and tracking glaucoma in routine eye imaging

AIMS

Glaucoma affects 2 in every 100 people over the age of 40 and can lead to irreversible sight loss and blindness. While some patients lose vision quickly, others experience slower changes in sight. Our goal was to develop computational analysis tools that could enable routinely collected eye images to be used to identify individuals at high risk of visual loss, ensuring they are targeted to receive appropriate specialist treatment quickly. Individuals at lower risk could receive less intensive monitoring via their local optometrist closer to home. With ophthalmology being the busiest outpatient service in the NHS, this would help alleviate pressure on hospital eye services, free up skilled clinicians to focus on patients at high risk of blindness, reduce backlogs and shorten waiting times.

KEY FINDINGS

The development of novel image analysis technologies specifically for fundus photographs that are taken routinely at every eye test:

1. Computational assessment of image quality and with real-time feedback to retinal camera operators to improve future acquisitions and reduce capture of unsuitable images.
2. Registration of longitudinal imaging to help spot the early emergence of signs of disease and to track changes over time.
3. Implementation of measurement algorithms crucial for detecting signs of glaucoma in the retina – i.e., cup-to-disc profiler, a more informative means of detecting changes to the optic nerve head that helps identify the disease early and to track its progression.

WHAT DID THE STUDY INVOLVE?

We accessed several datasets of images of people with glaucoma. This included some publicly available data as well as a dataset accessed through NHS Fife of people attending their hospital eye service who had consented to research. We developed a computer algorithm (using Artificial Intelligence) to detect artefacts in fundus images (e.g., dust particles, shades and light reflection areas) that interfere with images being used clinically. We also looked at reconstructing 3D eye shape using registration of multiple 2D images, which can also be used to track changes over time. Finally, we implemented a cup-to-disc profiler as a method for assessing changes related to glaucoma at the optic nerve and its progression.

WHAT WERE THE RESULTS AND WHAT DO THEY MEAN?

1. The technologies we developed will help in utilising routine retinal imaging for earlier glaucoma detection and monitoring of patients.
2. We show that it is possible to provide real-time feedback of image quality to help improve imaging for clinical assessment.
3. These tools are now ready for use in impending studies looking at personalised risk prediction for glaucoma progression.

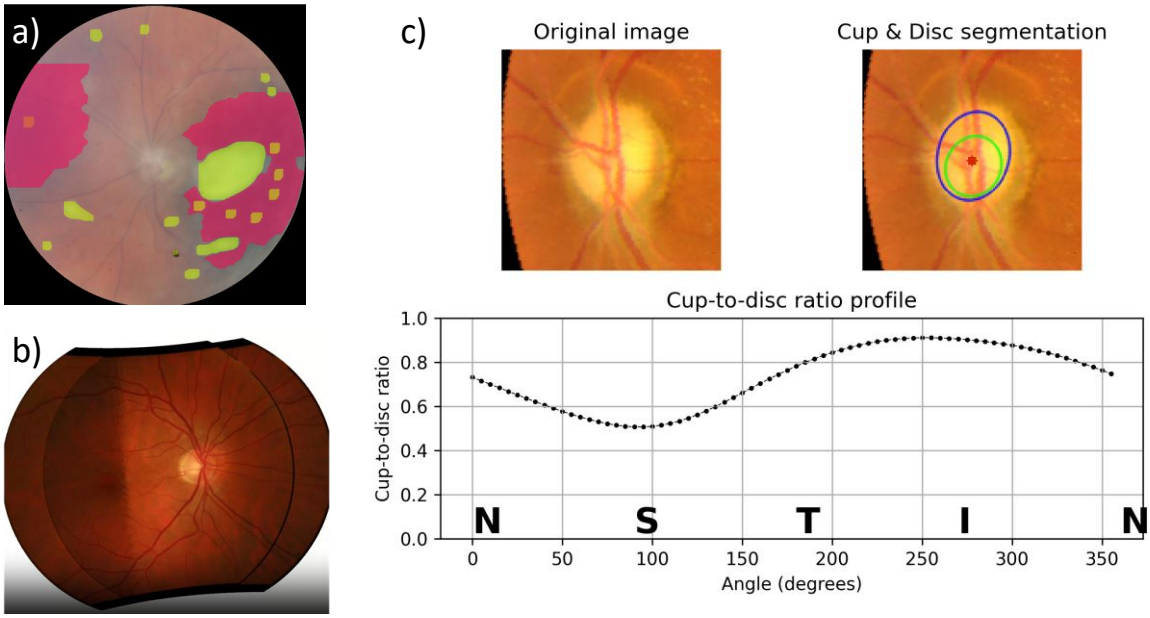


Figure 1: Computational tools for analysing fundus images. a) detecting artefacts and areas of poor image quality for feeding back to the operator. b) Registration to track changes in the retina over time. c) Measuring the cup-to-disc profile of as means of detecting early signs of glaucoma and monitoring progression. The graph shows the profile which is used to assess loss of nerve fibres in the optic disc, which is often associated with glaucoma. Nasal (N) side of retina closest to the nose; Superior (S) upper part of the retina; Temporal (T) side of the retina closest to the temples. Inferior (I) lower part of the retina.

WHAT IMPACT COULD THE FINDINGS HAVE?

- Routinely collected clinical eye data, such as fundus photographs, could be used to detect glaucoma early and to stratify patients into *slow* and *rapid* progressors.
- This would identify individuals at higher risk of visual loss ensuring they are targeted to receive appropriate specialist treatment more quickly.
- The technologies we have developed will now be employed in a project aiming to deliver on these goals - “Early detection of glaucoma in primary care using artificial intelligence aided analysis of retinal images (TCS/24/15)”.

HOW WILL THE OUTCOMES BE DISSEMINATED?

We shared our findings with the Edinburgh Clinical Research Facility Patient Advisory Group, some of whom are glaucoma patients. The feedback from this indicated the importance of empowering patients with a clear understanding of how new technologies might alter care and treatment in the future and how they could impact positively upon their experience. The insights patients provided will have implications for future activities and it was enlightening to hear the experiences of individuals and their views on issues such as the application Artificial Intelligence in healthcare

CONCLUSION

The image analysis technologies we have developed for fundus photographs will empower future clinical studies into early detection of glaucoma and personalised prediction of the risk of disease progression.

RESEARCH TEAM & CONTACT

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Additional Information

Project completed November 2024, £236,417