Vascular Assessment and Measurement Platform for Images of the REtina

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Lay Summary

Cardiovascular disease and diabetes cause changes to the blood vessels in the eye. Additionally, changes in the blood vessels at the back of the eye are thought to mirror changes that can occur in the small vessels in the brain due to diseases such as vascular dementia and stroke. Photographs of the retina clearly showing blood vessels can be acquired easily, safely and accurately using standard digital imaging systems. It is thought that assessment of a retinal photograph may provide insight into an individual's risk of a variety of diseases. However, the changes to retinal blood vessels are often very subtle and may be missed by a human assessor visually inspecting a photograph. We have developed an integrated set of software tools, VAMPIRE, to analyse retinal photographs quickly and objectively.

Background

VAMPIRE is an international collaboration led by two Scottish universities (Edinburgh and Dundee) featuring researchers from the UK, Spain, Croatia, Italy and Singapore.

The aim is the development of novel, semi-automated and validated techniques for the computational analysis of retinal photographs in clinical research. The project brings together and builds on previous work from the **Edinburgh WTCRF** and **Dundee CVIP** groups on automatic landmark detection, vasculature location and quantification, and lesion detection in retinal fundus images and fluorescein angiograms.

Purpose & Methods

The key purpose of the VAMPIRE software platform is to enable an efficient, mostly automatic analysis of large image sets acquired from cognitive, clinical and genetic studies.

Accurate segmentation of the retinal blood vessels and optic disc boundaries is performed while other post-processing algorithms determine the geometry at vessel bifurcations, the tortuosity of major vessels, and the branching complexity (through fractal dimension) of the vasculature. See Figure 1-3. Much of the processing performed by VAMPIRE is hidden from the user, who is expected to provide only a minimal level of intervention.

Discussion

The beta version of VAMPIRE includes validated modules for:
i) vessel detection, ii) branching angle geometry and iii) tortuosity.

Modules being validated include:
i) vessel width estimation, ii) optic disc contouring and iii) fractal analysis.

Automatic estimation of arterio-venous ratio is under development.

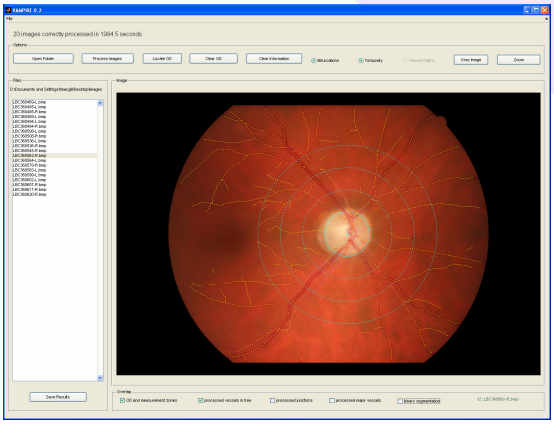

Figure 1: Detecting the optic disc in a retinal photograph. The main arcades (magenta) and bright areas in the image are located and used to find an initial position (green cross). From this initial point boundaries are then determined (red).

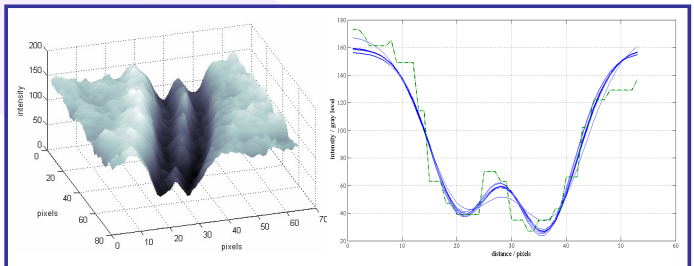

Figure 2: Section of retinal image showing a segment of blood vessel. Plot of vessel cross-sectional intensity profile (green) with computationally fitted profile curve (blue) used to determine vessel width.

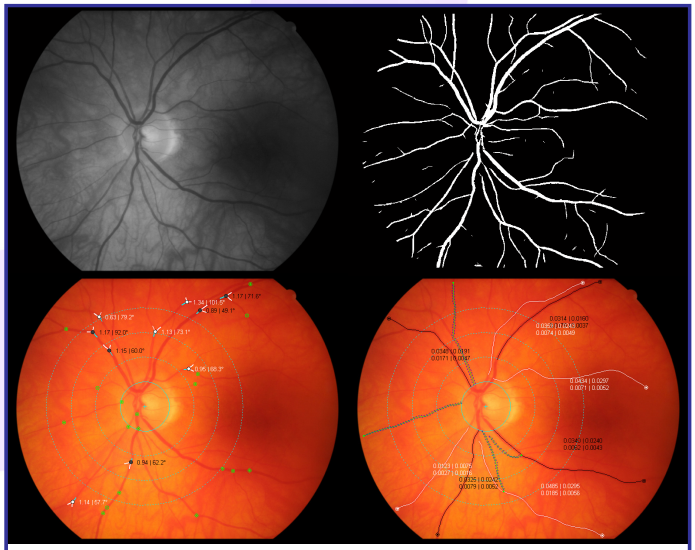

Figure 3: The green channel of the colour retinal photograph is filtered and processed to detect blood vessels and produce a binary map. This mapping is used to asses bifurcation geometry and estimate tortuosity for the major vessel paths. The user selects between arterioles and venules, which are marked as white and black respectively on the original colour image.

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