NHS Forth Valley

Next-Generation Ophthalmic Diagnostics

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Abstract – We are developing a fully automated mobile application (app) to test for contrast sensitivity by measuring the ability of the patient to follow a moving dot on a digital screen. The test results are evaluated automatically using algorithms that measure the gaze direction of the user. Here we present preliminary results of the app development.

Motivation for digital measurement of contrast sensitivity

Contrast sensitivity (CS) testing can be a potential indicator of serious conditions such as glaucoma (1) or optic neuritis (2). CS is normally tested with static targets such as with the Pelli-Robson or the low contrast ETDRS. However, dynamic testing can provide a better representation of daily visual tasks (3). Additionally, using the current standard tests requires investment in that specific test and a clinician to deliver them. Using digital devices such as computers or tablets could bring the testing to the community, since most community stakeholders will have access to such devices. Furthermore, using face/gaze tracking could allow to automate the test, potentially reducing the need for expert clinician intervention.

Automated measurement of preferential looking

Preferential looking can be used to measure visual ability. It can be determined automatically using gaze direction classification. We have developed a library that estimates (i) the head pose and position; and (ii) the position of the iris within the eye. For (i) we match facial landmarks in the video recording to their respective positions on a 3D model (perspective n-point problem). For (ii) we maximize the correlation of an iris template and the image. As shown by the example results in Fig. 1, by combining this data the algorithm classifies the gaze into left or right.

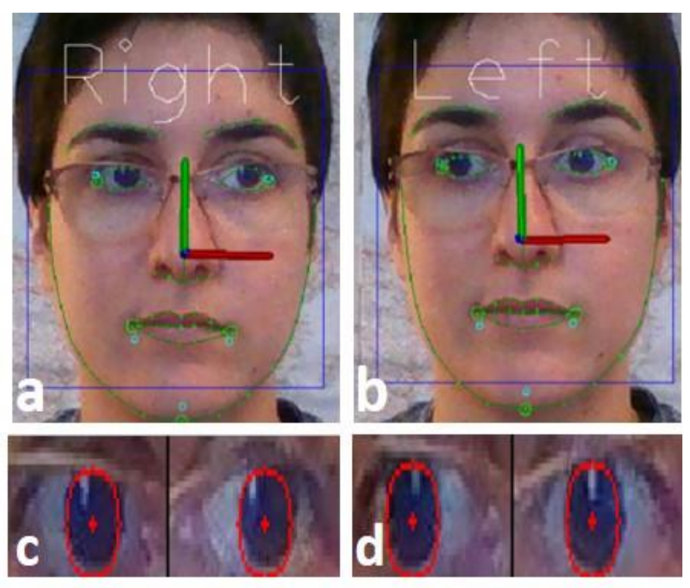

Fig. 1 - Gaze classification examples. Results are printed as text onto the images (a, b), correctly classifying the gaze direction as right and left respectively. Detected features are shown in green (a, b: facial landmarks) and red (c, d: iris).

Measuring CS with a moving dot

We developed a dynamic test for contrast sensitivity consisting in a moving dot that moves to the sides alternatively. The contrast of the dot is manipulated in a similar way to the Pelli-Robson optotypes. The patient is asked to follow the movement of the dot with their eyes. The head movement is not constrained, in view of analysing the data with our preferential looking library.

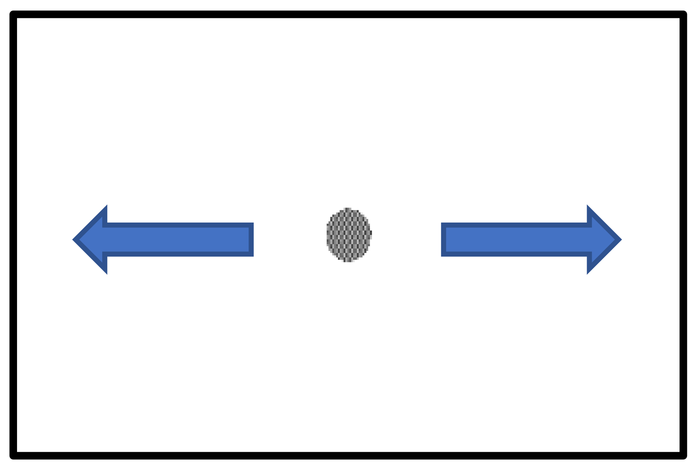

Fig. 2 – Moving dot test.

While screen grayscale does not have sufficient grey levels for the low end of contrast values, the range can be incremented by dithering or bit-stealing.

A pilot study was made at the University of Strathclyde with nine adult healthy volunteers, whose CS was artificially degraded via Bangerter filters. The moving dot was shown on a computer screen, and the volunteers were asked to track it and to advise when tracking was lost. The results responded to the changes in CS, returning lower values with higher filtering.

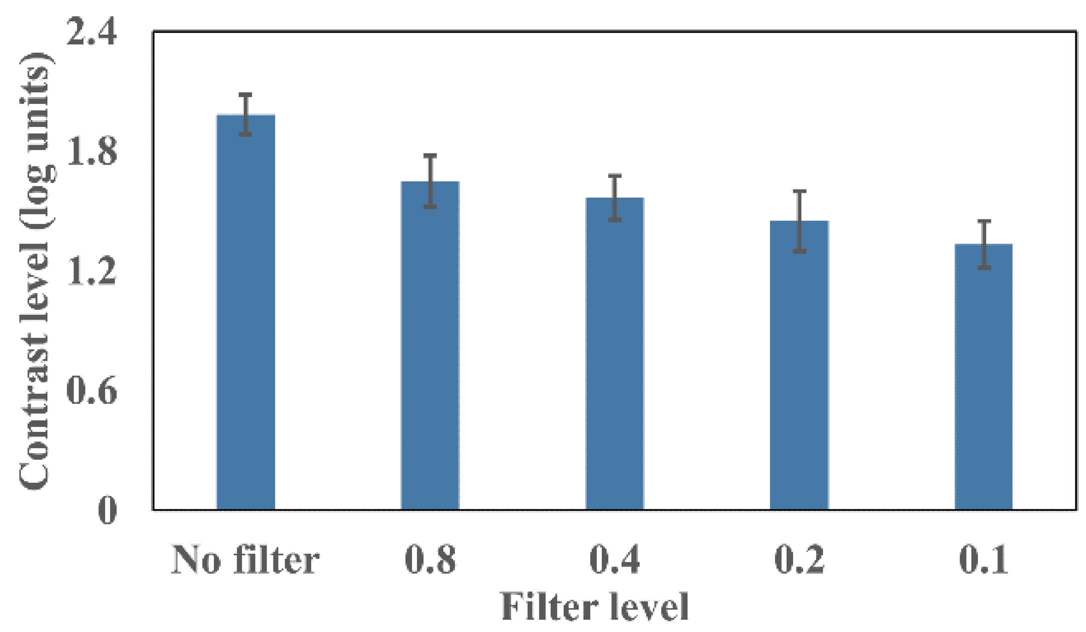

Fig. 3 – Results from the moving dot test for each Bangerter filter. The results are presented in log units of contrast as in the Pelli-Robson test.

Conclusion and next steps

The initial results are promising, as the test appears to correlate well with the artificially degraded CS. We are now in the process of integrating it with it with our face/gaze tracking technologies, aiming towards a full automation of the test.

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