Rapid Assessment of Contrast Sensitivity with Mobile Touch-screens

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Purpose

The need for periodic vision assessment during long-duration space flight has been recognized by NASA and its international partners. The current practice is to perform visual function tests utilizing static stimuli, such as the Ishihara plates, and require that the observer fixate on the stimuli. This poses significant challenges for astronauts, as it may be difficult to maintain fixation with an unaided eye, or with eye glasses. Moreover, the Ishihara plates are not well adapted to space flight conditions, as they are too large to fit on the small personal digital displays used in space habitats. The present project seeks to provide an easy-to-use method for rapid assessment of contrast sensitivity and other parameters of visual function, using readily available low-cost equipment.

Approach

The images shown below depict a “sweep grating,” in which spatial frequency is swept in the horizontal dimension, while contrast is swept in the vertical dimension. An observer’s contrast sensitivity function can be traced out as the “sweep” is performed. The image shown below depicts a “sweep grating,” in which spatial frequency is swept in the horizontal dimension, while contrast is swept in the vertical dimension. The implementation has been developed using an in-house scripting language known as QuIP (QUick Image Processing). QuIP provides an interpreted environment similar to Matlab, includes an extensive image processing library, and supports development and deployment on the Apple software platform.

Software implementation

The implementation has been developed using an in-house scripting language known as QuIP (QUick Image Processing). QuIP provides an interpreted environment similar to Matlab, includes an extensive image processing library, and supports development and deployment on the Apple software platform.

Devices

The initial implementation demonstrated here has been done for Apple Computer’s iPad operating system, which runs on the popular iPod and iDav devices. The tablet shows the display parameters of the model used. Calculations of min. and max. spatial frequencies were performed assuming a viewing distance of 20 inches, a minimum contrast of 4 pixels and a maximum of half the largest dimension of the screen.

Stimulus Rendering

To facilitate field testing of contrast sensitivity and acuity, the QuIP framework provides an interpreted environment similar to Matlab, which includes an extensive image processing library. The implementation has been developed using an in-house scripting language known as QuIP (QUick Image Processing). QuIP provides an interpreted environment similar to Matlab, includes an extensive image processing library, and supports development and deployment on the Apple software platform.

Calibration

The implementation has been developed using an in-house scripting language known as QuIP (QUick Image Processing). QuIP provides an interpreted environment similar to Matlab, includes an extensive image processing library, and supports development and deployment on the Apple software platform.

CSF Estimation

Although the entire CSF may in principle be obtained with a single swipe, we may wish to obtain an estimate of the parameters of the measurement, by analyzing the variability of repeated measurements. Additionally, we hope to devise an easy-to-use method for measuring contrast sensitivity function without requiring the observer to fixate on the stimulus. This can be done in either a swept grating, in which both spatial frequency and contrast are swept in the horizontal dimension, or in a swept grating in which spatial frequency is swept in the horizontal dimension, while contrast is swept in the vertical dimension.

Conclusion

Much work remains to be done to develop a robust system - calibration and interoperator variability. The results presented here demonstrate proof-of-concept of the technique, and that the touch-screen interface can enable more efficient psychophysical methods.

References


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