Novel LCD Shutter Goggles for Eye-Tracking Experiments

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An automated approach for the quantification of squint angles is evaluated and tested. A goggles system consisting of a controllable LCD shutter, including power management and converter circuit, is built. The system is used to alternately cover the eyes, while allowing to record the eye-movements by using an IR camera. Tests to characterize the LCD in the visible and infrared spectrum have been performed. The frame for the goggle is printed using additive manufacturing.

Introduction

With a prevalence of 5%, strabismus is one of the most common eye diseases worldwide. Quantification of squint angles is usually done by alternated covering of an eye while maintaining fixation and studying the resulting eye movements. To enable eye-tracking experiments where one or both eyes are covered, an LCD-shutter system is developed, and its feasibility evaluated. The system shall be integrated into the current test environment in the eye movement laboratory at Inselspital Bern.

Methods

A goggle system is designed with two LCDs. When applying a voltage to the LCD, the glass gets darker until the subject cannot see through anymore. The LCD are driven by a power management and converter circuit which is controlled by a PC over an optical decoupled input. As the LCDs are penetrable by infrared light the eye can still be tracked using a camera system working in the infrared spectrum. To mount the LCD shutter in front of the eyes, a frame is designed, using 3D design software and printed with additive manufacturing methods.

Results

The market has been screened for small LCDs available in low quantities and the transmission spectrum of the LCD has been measured (Fig 2). The LCD is reducing the light transmission to 32% in visible spectrum and 82-92% in the operating range of the eye tracker. When applying a voltage of 5V the transmission in visible spectrum is reduced to 3% while reducing the transmission in IR by less than 25%. The designed frame is simple to assemble and can be adapted to fit different head shapes. (Fig 1) The control mechanism is external, and wires lead away from the goggles to receive signals and to power the LCDs.

Conclusions

As human perception is logarithmic a reduction to 32% is no fundamental problem. Whereas the 3% transmission in the opaque state could lead to problems with the suppression of bright targets.

Outlook

In a next step the feasibility of the LCD shutter system is evaluated in a small experimental series, and the electronic circuit optimized and minimized so it will fit into the goggle frame.

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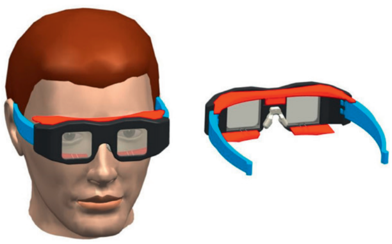

Fig 1) CAD goggle design. Shadow bars (red) on top and bottom together with temples (blue) block off natural light.

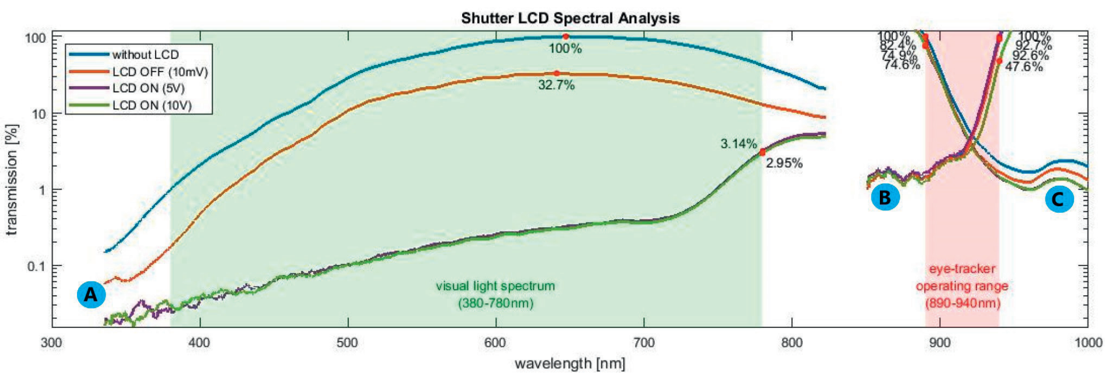

Fig 2) (A) Visual light spectrum of LCD with GMP light source. (B) Exalos 1000nm IR light source to measure upper operating range. (C) Exalos 835nm IR light source to measure lower operating range.