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On Improving Electrooculogram-Based Computer Mouse Systems: The Accelerometer Trigger

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ON IMPROVING ELECTROOCULOGRAM-BASED COMPUTER MOUSE SYSTEMS: THE ACCELEROMETER TRIGGER

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INTRODUCTION

Eye tracking is a well-established method of computer control for profoundly paralysed people (Anson et al., 2002). Cameras are commonly used to track eye movements (Morimoto et al., 2005) but one alternative is the bioelectrical signal known as the electrooculogram (EOG).

There are some EOG mouse control systems that facilitate the use of GUI applications, but certain actions, which are straightforward using a conventional mouse, remain impossible. Unless the eyes are tracking a target, they move in saccades (jumps), making it impossible to voluntarily trace out smooth trajectories with one's gaze, as would be required to draw a smooth curve.

The conventional paradigm for EOG mouse control maps horizontal and vertical angular displacement of the eyes onto the coordinates of the mouse pointer (Gips et al. and Estrany et al., 2008), while the head remains stationary. Reversing this paradigm, if the point of fixation remains unchanged, the EOG can measure head movement. The present system adopts this approach, mapping smooth, saccade-free head movement onto mouse pointer movement, while the gaze remains fixed on a point that is either stationary or moving smoothly (e.g. the mouse pointer). Because the eyes move in pursuit mode rather than in saccades, smooth mouse control is possible.

Voltage drift, which arises due to changing electrode junction voltages, poses a serious problem for EOG-based mouse control. In this paper we show how an accelerometer can be used to mitigate the effect of voltage drift.

MATERIALS AND METHODS

Wet Ag-AgCl electrodes were used to measure horizontal and vertical EOG. An ADXL345 accelerometer was attached to the back or the head. The accelerometer and amplified EOG signals were recorded using a PIC18F4520 microcontroller and relayed to a PC via RS232.

All signals were processed using custom software written in Python. When the magnitude of the acceleration vector measured by the accelerometer was below a pre-defined threshold, it was assumed that the head was stationary and variations in the EOG channels were ignored. Otherwise the EOG was mapped to mouse pointer movements. The accelerometer therefore acts as a trigger, allowing the EOG to control the mouse pointer only when actual head movements are made.

Based on promising tests carried out by the authors, we propose to conduct a more formal set of experiments, involving drawing and text entry tasks. In the text entry task, subjects are presented with an on-screen keyboard and asked to input a series of phrases while the times are recorded.

In the drawing task, subjects are presented with a set of cross-hairs, with markers on either side of the intersection. The aim is to draw a square whose sides intersect the markers followed by a circle inside the square with the circumference also intersecting each marker, as seen in Figure 1. The results will then be compared with the conventional paradigm.

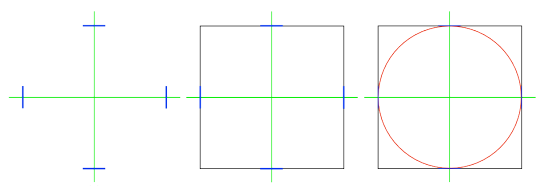

Figure 1 (a) The stimulus presented to the test subject, (b) square drawing task, (c) circle drawing tasks.

RESULTS & DISCUSSION

The authors' preliminary tests suggest that this method improves EOG-based mouse control. The problem of voltage drift is greatly reduced. Aligning the mouse pointer with the point of gaze through continuous adjustment of head position is comfortable and intuitive. Also, the mouse pointer position does not change while the head is stationary. However, user tests are required to rigorously assess the usability of this method in everyday use.

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