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# EOG-BASED GLASSES-TYPE WIRELESS MOUSE FOR THE DISABLED

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*Abstract* A new EOG(Electrooculogram)-based computer input device was developed for the disabled. The device acquires EOG signals generated by eye movements and blinks and produces output for emulating the PC mouse. For the user's convenience, electrodes are positioned on five specific points on the frame of a glasses having good contact with skin and requiring no electrolyte gel. From the acquired signals we estimate the direction and amplitude of eye movement and detect blinks using a microcontroller. The estimated information is sent to a PC through a wireless Radio Frequency (RF) linkage for the device to be used as a wireless mouse. A new virtual lead positioning (VLP) algorithm was also developed to detect vertical eye motion which is relatively difficult to be measured in this specific electrode positioning. Test results shows sufficient performance of the device in using basic Windows functions and even playing TETRIS, a well known computer game.

**Keywords** : EOG, computer input device, virtual lead positioning, wireless mouse

## INTRODUCTION

Recently, there has been much effort to develop EOG-based devices for computer interface and environmental control.[1]. In most of the devices, however, inconvenience and bad appearance due to electrode attachment and connecting wires hinder their practical application.

In this study, we developed a new EOG-based glass type computer input device mainly for the disabled. Focusing on the wearability and appearance improvement, we locates 5 electrodes at the specific points on the frame which have good contact with skin. Since spectacles have no contact in vertical adjacency to the eyes, virtual lead positioning (VLP) algorithm was proposed to solve this problem.

## METHODS

*A. System Description*

Simplified block diagram of the entire system is shown in *Fig 1.* Four unipolar EOG signals are acquired from circled electrodes embedded in the frame of the glasses. Subscript r, l, n and s denote right, left, nose and side, respectively. Based on the computer simulation results, we select three optimal differential leads to determine the direction and magnitude of right and left eye movement. In order to detect amplitude of vertical motion, virtual lead is computationally positioned corresponding to a vertical line through the eye ball. Two banks of band pass filter have center frequencies corresponding to eye movement and blink. A microcontroller (PIC16C76, Microchips, U.S.A.) digitizes each waveforms and estimates the viewing direction and angle, detects eye blinks, and sends the information in serial mouse protocol to a PC by a RF transmitter.

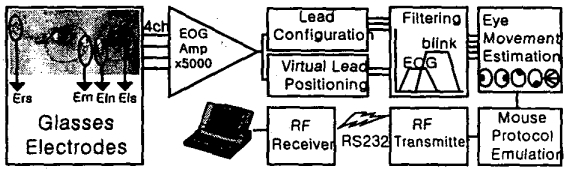


Fig 1. Entire system block diagram

*B. Virtual Lead Positioning (VLP)*

Virtual lead waveform is reconstructed by a weighted sum of the acquired real lead waveforms, where normalized weight vector $\varpi_n$ is optimally determined to minimize the cost function $\xi$ by iterative gradient search method. $\xi$ is designed to maximize the vertical eye motion on the optimal $\varpi_n$. The physical meaning of VLP is to adjust virtual lead to vertical lead.

$$V_{vl} = \omega \bullet V_{rl}, \qquad \xi = \frac{\left|V'_{vl,left}\right|^2 + \left|V'_{vl,right}\right|^2}{\left|V'_{vl,up}\right|^2 + \left|V'_{vl,down}\right|^2}$$

*where Vvl, Vrl represent virtual and real(acquired) lead waveform, $V'_{vl}$ means derivative of virtual lead waveform, respectively.*

## RESULTS

The developed device is very convenient to wear and provides users with free mobility. We evaluated performance of the total system by playing TETRIS, a well-known computer game where right, left, up and down key inputs are required. The examinees were able to move blocks to an intended position at intended velocity after a few minutes of training.

## CONCLUSIONS

EOG-based Glasses-type Wireless Mouse (EGWM) has been developed for people with severe motor disabilities. The device is also expected to be practically used as a new man-computer interface.

## REFERNECES

[1] Tecce JJ, *et al* "Eye movement control of the computer function" *Int Psychophysiology.* Vol 29, pp 319-325, 1998.