

## EOG Based BCI For Disabled People To Access Electrical Appliances

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**Abstract**— In recent year the EOG based brain computer interaction has attracted more for new inventions. The electrical appliances can be accessed using EOG based brain computer interaction by old age and disabled person. The objective is to design a BCI to control electrical appliances directly using EOG signals. The communication takes place using Electro Occulo Gram (EOG) signals generated by the movement of eyes. The RF interface may be used between Electrodes and processing part and application to handle and easy to use by disabled person in homes and hospitals. The left, right movements can be used to activate and deactivate the devices. Further by providing time period the device can be deactivate along with the audio and visual indication. Finally, the results can be observed and analyzed for better solution in the future.

**Keywords**- Brain Computer Interface, electrooculography (EOG), Disposable(EEG) electrodes.

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### I. INTRODUCTION

In an intelligent home system, to accessed electrical and electronic equipment remotely by household persons, EOG based BCI (Brain Computer Interface) has the potential to enable severely disabled people to access any interfaced device directly by bio-electricity rather than on off links. Several persons have an ability to control their eye movements, which may be used to develop new brain computer interface systems to help them to communicate with other persons or control some electrical appliances.

The EOG based HMI was designed and implemented successfully. These signals are then processed into commands at UART interface. These commands are sent to the application part which interprets and moves cursor accordingly and button is clicked using the same output and corresponding relay is toggled hence appliance is controlled [1].

ECG,EMG, and EEG systems measure heart, muscle, and brain activity (respectively) used for measuring electric potentials on the surface of living tissue. Nervous stimuli and muscle contractions can be detected by measuring the ionic current flow in the body. This is accomplished using a biopotential electrode [6].

Man Machine Interface, an interface used by mobility impaired patients, allows to use their eyes for calling doctor, 4 directional impulse tracking (via pattern recognition) [5]

Temperature, Pressure. Heartbeat Sensor, Zigbee based system for Monitoring the Health Status of a Patient [12].

There has been an effort to design alternative interfaces for people with disabilities to replace traditional computer input devices such as keyboard and mouse.

The proposed system is mainly designed to control appliances directly using EOG signals. It will detect the variations in electric signals through voltage level around eye area and generates analog signals in order to control the home appliances.

This module will deal with the controlling of hardware appliances using microcontroller (embedded 'C prog) the electronic Relay Module. Further one Timer is used to set the

timing if the person has forgotten to switch off the device. Actual home appliances are connected to this circuit and the circuit will be then connected to the computer. It works as an interface between actual household appliances and the computer system.

### II. PRINCIPLE OF ELECTROOCULOGRAPHY

In Electro-oculo graphy (EOG) technology a small pulse of an electrical signal is generated, for each left, right, up and down movements if two ECG electrodes are placed around the eye brow of the person. The amplitude of EOG signals varies in the range of 10-300uV, The electrooculogram (EOG) is an electrical signal generated by the potential difference between the retina and the cornea of the eye. The EOG is measured in uVs in human eye and is linearly proportional to eye displacement. The human eye is an electrical dual pole with a negative pole at the retina and a positive pole at the cornea.

### III. GENERATION OF EOG

Due to the higher metabolic rate at the retina compared to the cornea, the eye maintains a voltage of +0.45 to +1.0 millivolts with respect to the retina. This cornea retinal potential, which is roughly aligned with the optic axis and (as a result) rotates with any direction, can be measured by the electrodes placed around the corner of eyes. The actual measured potentials are very small in the range of 15 to 200 microvolts and require amplification before processing [6]. With proper calibration, the orientation of the electric dipole can be used to specify the angular position of the eyeball with minimum accuracy which lies in 2 degrees vertically and 1.5 degrees horizontally [11]

### IV. METHODOLOGY

Human brain mainly works on electric signals transmitting all over the body to send the information in order to operate the entire body structure, even with rotating eye ball, body increases or decreases the resistance near human eye. This change in electric signals can be measured using ECG electrodes.



Figure 1.: Electrode placements

left for switching on and off the device -1  
 Right for switching on and off the device -2  
 3 is for reference

In the designed system using BCI , three electrodes are used to sense EOG signals. The electrode placement 1 and 2 for detecting left and right movement, 3 is for reference as shown in Figure 1. [1]

#### V. BLOCK DIAGRAM OF THE PROPOSED SYSTEM

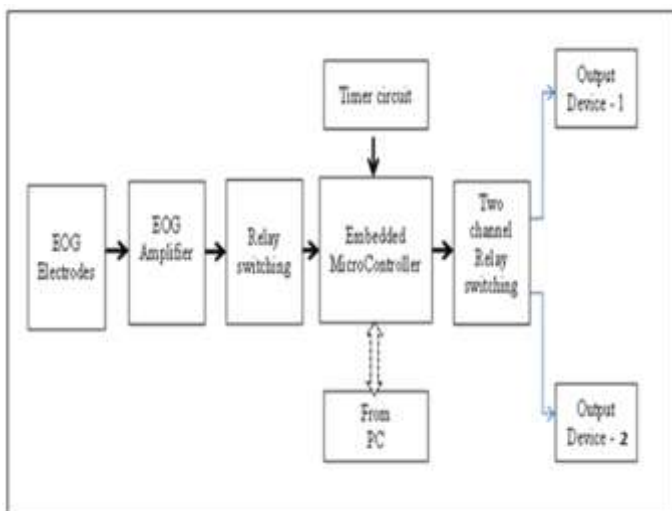


Figure 2. Block Diagram

#### A. Brief Description

- The block diagram is the representation of EOG based system as shown in Figure 2. The eye movements are acquired individually by using DAQ unit or switching circuit.
- Depending upon the direction (L or R) of eye movement, separate control signals are generated. The signals are transmitted using RF transmitter unit and at receiver, the decoder decodes the signal through the RF receiver unit. or it can be directly applied. The microcontroller switch 'ON' and 'OFF' the interfaced devices depending on the arriving data. The function of each block is explained.
- This system may be used for increasing communication and controlling the devices. The

generated analog signals will be amplified using instrumentation amplifier then converted it to digital signal and applied to microcontroller circuit to turn on and off the devices. The EOG signal is obtained by placing two electrodes on the outer side corner of the eyes to detect horizontal movement and another pair above and below the eye to detect vertical movement. A reference electrode is placed between the two eyes or anywhere on the body part. Eye movement will generate voltage up to 15uV and 20uV. The signal is known as the Electrooculogram (EOG).

#### A. Electrodes and input cables

- Low cost disposable pre-gelled Ag/AgCl electrodes are used to acquire EOG signals from the body part. Since the EOG signal amplitude range was in microvolts, they were very much sensitive to various noise effects. To minimize the effects of RF noise and electromagnetic interference, shielded wire is used to connect Ag/AgCl electrodes and data acquisition circuits. Those disposable (ECG) electrodes which are placed around the human eye that capture signals from eye movements including noise signals.

#### B. Amplifier circuits

- The generated signals from electrodes are applied to AD620 precision Instrumentation amplifier. The EOG signal electrical potential level ranges from 50-3000  $\mu$ V and bandwidth varies in the range of 50 to 60 Hz. Further, SL100 transistor is used for proper amplification. The gain of the bio potential amplifier is adjusted to amplify EOG signal. The sensitivity is adjusted using 1.2 K or 1M variable resistance. Once the resistivity gets set device starts operating perfectly. Also, the characteristics of AD620 suggest that as the gain of bio-potential amplifier is increased, there was a subsequent increase in the common-mode rejection ratio (CMRR). By considering the above facts, an amplifier was designed with a gain of 1500-2000. Circuit diagram of EOG signal acquisition system is given in Figure 3. Same circuit can be used to acquire vertical EOG signals.

#### C. Filter Block

- Low pass Active filter is used in the circuit, cutoff frequency for this filter is 40Hz to 100Hz and high pass filter to block DC and frequencies up to 0.6Hz.-0.12Hz These filters and gain blocks are implemented using 741 Opamp or can be applied to switching circuit such as SL 100 transistor and relay circuit.

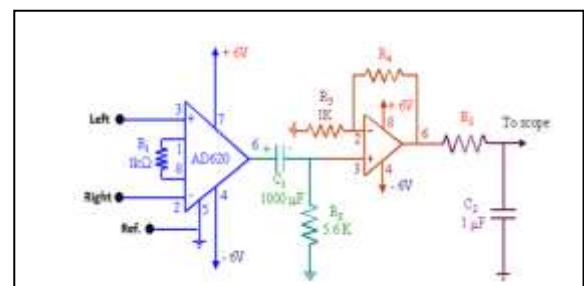


Figure 3. EOG signal amplifying circuit

Whenever any device gets activated and if the disabled person forgot to switched off the device, to avoid such condition, a person can set the time using timer and counter device interfaced with the circuit to make the device automatically switched off after a fixed duration of time, it provides audio and visual indication for disabled person using buzzer and display unit. Once the time is fixed to switch off the device the counter starts counting the after time limit buzzer starts beeping and device gets switched off.

## VI. IMPLEMENTATION

Software: KEIL SOFTWARE, Flash magic and HyperTerminal, .net

PC requirements: Pentium 4 PC or higher,

OS: Win XP or higher, minimum 1GB RAM

The main objective of system is to detect an electric signal near eye area and using electrodes system will try to identify the changes in electric pulse in order to detect the motion of any eye.

Initially, look in the straight direction for stability. The sensitivity is to be adjusted by selecting proper value of sensitive potentiometer, once stabilized it is turned to give high sensitive signal using eye movements. Turn eye towards left to switch ON the first device, repeat the process to switch OFF the device.

Turn the eye towards right direction to switch ON the second device, repeat the process to switched OFF the second device.

### A. Devices Accessed using BCI

Automatic control system can control many tasks, such as lights and electrical appliances. These can be operated by using Human computer interaction or BCI. The person can access any pre-defined device; it makes life easy, particularly the people with disabilities or limited agility.

### B. Lighting

Lights on your front porch or in drawing hall, bedroom can be turned on, by the eye movements, useful for everyone but particularly persons with physical disabilities. ECG electrodes that activate lights can be especially beneficial to people with limited mobility and physical disabilities because they do not have an ability to activate a switch manually.

### C. Television and Home Entertainment

EOG signal will enable to control devices such as the TV, satellite dish and stereo from wherever they are, by simply using a BCI.

## VII. CONCLUSION

After successful implementation of the EOG based BCI system, it is concluded that the system is able to identify the human brain wave to control the electrical appliances in home hospitals with fast reaction. Further, the devices can be

controlled by applying fixed time. The system senses the signal from eye movements of disabled person and follows the fix commands accordingly and corresponding relay is toggled hence user can comfortably operate or handle the home appliances.

Without any interpreting command to moves cursor for clicking button at UART interface, corresponding relay is toggled directly, using switching and sensing device, hence appliance is controlled.

### Scope of Improvement

The drift in the eye movements is the major factors affecting to the system, by implementing even more, shielded cables high end circuitry and embedded system software for more accuracy.

The RF interface can be used for remote accessing or even zig-bee module can be used, to control more than one devices.

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