

# An approach to control appliances using EOG signal for physically challenged persons

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## ABSTRACT

Paralysis is one amongst the major neural disorder that causes loss of motion of one or more muscles of the body, wherein depending on the cause, it may affect a specific muscle group or region of the body or a larger area may be involved. In pursuit of rehabilitation, the eye can be regarded as one of the organs that can help a paralyzed person to communicate suitably. Eye movement can be used by the paralysis patients and armless persons to perform simple tasks. This system describes the acquisition and analysis of EOG signals for activation of home appliances for paralysis patients. The proposed method here uses a minimum number of electrodes for signal acquisition thereby reducing the occurrence of artifacts, further following a simple circuitry for implementation of signal conditioning which is also cost effective from the user point of view. The standing potentials in the eye can be estimated by measuring the voltage induced across a system of electrodes placed around the eyes as the eye-gaze changes, thus obtaining the EOG and this EOG signal can be used as an input for a microcontroller in order to control home appliances and help the paralyzed patients.

**KEYWORDS:** Paralysis, Electrooculography (EOG), Electrodes, Microcontroller.

## INTRODUCTION:

Paralysis has been commonly referred to the complete or partial impairment of the body function due to the loss of mobility of the muscles or nerves of the body. The predominant causes of paralysis range from stroke, cerebral palsy, multiple sclerosis and spinal cord injury that prevails the rest. According to a study, there are 1 in 50 people living with paralysis that approximates to be around 6 million people. It means that we all know someone a brother, sister, friend, neighbor, or colleague, living with paralysis. In order to regain the function and independence following the disease, different mobility aids and medications have been brought into light in hands with the technology. In the past few decades, various classes of bio signals have been used which have contributed a key role in the rehabilitation of the disabled. From these, for the purpose of communication and control, especially for those with eye motor coordination, Electro oculogram is considered to be the most convenient signal over the others due to many factors. EOG signal is based on the dipole within the eye. It is commonly known as the electrical signal produced from the potential difference of the cornea (positively charged) and the retina (negatively charged). There is a steady corneal-retinal potential from the back of the eye to the

front of the eye[1-5]. This steady dipole may be used to measure eye potential by placing surface electrodes around the eyes. When the eyes are looking straight, the electrodes spaced equally from the eyes will be at right angles with the eye's electric field which will result in the output to be zero. Due to movement of the eyes, there is a direct current voltage shift experienced which gives the EOG signal. The most important factor that makes EOG far better than the other modalities is a linear relationship of EOG signal over the eye movements that make it suitable for the application. The other reasons include better face access, good accuracy and resolution, great range of eye displacements, and more importantly economical. This paper outlines on the development and implementation of a low cost eye movement detection device for controlling home appliances for paralyzed patients. The device also incorporates an alarm system that alerts during an emergency[6-10].

### EXISTING SYSTEM MODEL:

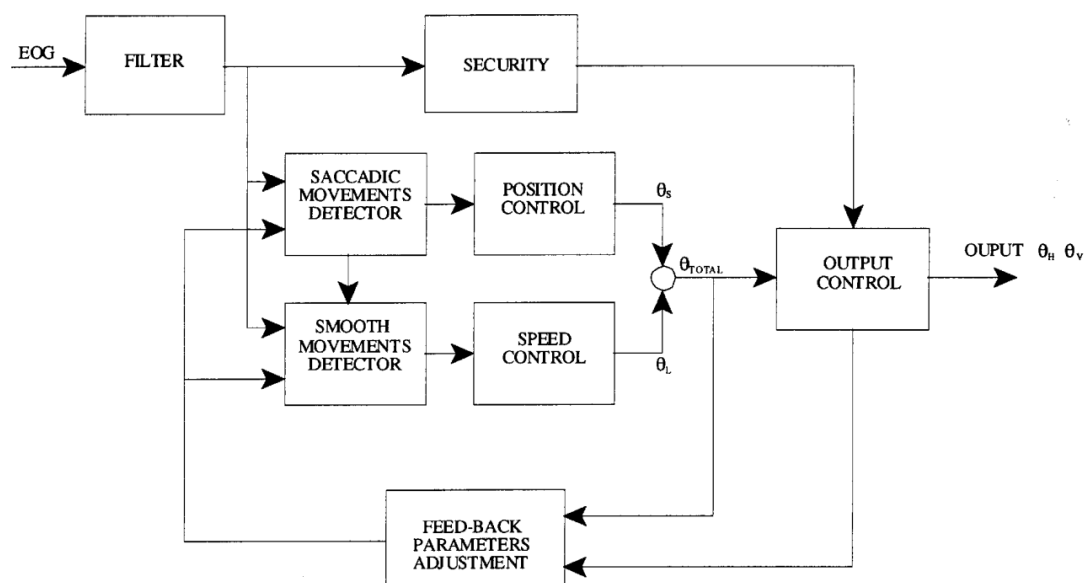


**FIG 1.EYE MODEL BASED ON EOG (BiDiM-EOG)**

This work describes an electrooculography eye model capable of obtaining the gaze direction by detecting the eye movements using electrooculography. The oculometer system is modelled with the eye position within its socket as the output variable, i.e., the eye position with respect to the cranium o- cr, although this angle is usually represented by the deviation angles with respect to the eye's central position. This variable can be obtained by different methods, such as video oculography (VOG) [15], infraredoculography (IOR), shell coil (SC) [16], etc. In a survey of eye movements recording methods can be seen where the main advantages and drawbacks of each one are described. In this paper, however, it is going to be modelled in terms of the electrooculography (EOG) signal because it presents a good face access, good accuracy and resolution, great range of eye displacements, works in real time, and is cheap. In view of the physiology of the oculo motor system, the modelling thereof could be tackled from two main

viewpoints: i) Anatomical modelling of the gaze-fixing system, describing the spatial configuration thereof and the ways the visual information is transmitted and processed; ii) modeling of the eye movements, studying the different types of movements, and the way of making them. On the basis of the physiological and morphological data of the EOG, an EOG-based model of the oculomotor system is proposed (Bi dimensional dipolar model EOG, BiDiM-EOG.) This model allows us to separate saccadic and smooth eye movements and calculate the eye position in its socket with good accuracy (error of less than 2°). The filter eliminates the effects due to other bio potentials, just as the blinks over to the EOG signal. The security block detects when the eyes are closed, where upon the output is disabled. After that, the EOG signal is then classified into saccadic or smooth eye movements by means of two detectors. If a saccadic movement is detected, a position control is used, whereas if a smooth movement is detected, a speed control is used to calculate the eye position. The final position (angle) is calculated as the sum of the saccadic and smooth movements. Besides, the model also has to adapt itself to the possible variations of acquisition conditions (electrode placement, electrode-skin contact, etc). To do so, the model parameters are adjusted in accordance with the angle detected. Several tests prove that the derivative of the electrooculographic signal allows us to determine when a sudden movement is made in the eye gaze and this variation can be easily translated to angles. This technique can be used to help disabled people, since we have obtained an accuracy error of less than 1° and a spatial resolution nearly 1°. Although in this work we are going to comment on the results obtained in the guidance of a wheelchair (mobility aid), other applications have been developed to increase communication facilities shown in fig 1.

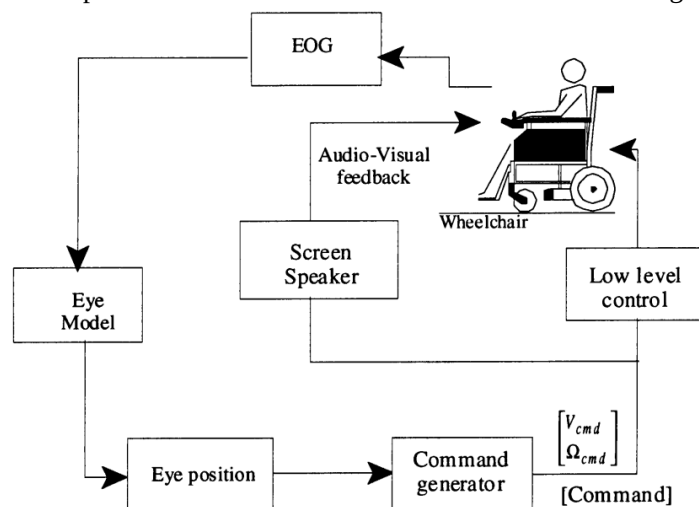


**FIG 2. GUIDANCE OF A WHEELCHAIR USING EOG**

The goal of this control system is to guide an autonomous robotic wheelchair using electrooculographic signal generated by eye movements within the socket. Fig. 2 shows the prototype implemented and a diagram of the control system. The EOG signal is recorded by means of Ag-AgCl electrodes and an acquisition card, and this data is sent to an on-board computer in which they are processed to calculate the eye gaze direction or eye movements using

the BiDiM-EOG model of the eye. This then serves as the basis for drawing up the control strategy for sending the wheelchair control commands.

## PROPOSED SYSTEM:

This system delivers a method to guide and control the appliances for disabled people based on movement of the eye. The signal is measured by the electrodes and depending on the signal frequency the appliances can be controlled. These electrodes are comparatively inexpensive and help in reducing the drift by careful application, also prevents the motion artifact and contact with the eye shown in fig 3. Electrooculography (EOG) is a new technology of placing electrodes on users forehead around the eyes to record eye movements. This technology is based on the principle of recording the polarization potential or corneal-retinal potential, which is the resting potential between the cornea and the retina. This potential is commonly known as electrooculogram. EOG is a very small electric potential that can be detected using electrodes. The EOG ranges from 0.05 to 3.5mV in humans and is linearly proportional to eye displacement. Basically EOG is a bio-electrical skin potential measured around the eyes but first we have to understand eye itself. Many experiment shows that the corneal part is the positive pole and the retinal part has the negative pole in the eyeball. Eye movement will respectively generates voltage upto 16uV and 14uV per 1degree in horizontal and vertical way. When the eyes are stationary or when the eyes are looking straight ahead, there is no considerable change in potential and the amplitude of signal obtained is approximately zero. To measure the eye movement, a pair of electrode are typically placed either above or below the eye and to the left or right of the eye. These electrodes will pick the EOG signal. whereas, the eye movement is monitored by using electrodes. Further, the measured information is given to microcontroller as input. The information is processed in PC using python and data is transferred to load via microcontroller. According to the received data the load will be ON/ OFF condition. Here the EOG signal is acquired with the help of Ag/AgCl electrodes. These electrodes are comparatively inexpensive and help in reducing the drifts by careful application, also prevents the motion artifact and contact with the eye. The number of electrodes used here are three and the reference electrode is placed on the forehead. These electrodes will pick the EOG signal. Then the signal is send to the amplifier circuit to boost the signal which get through the electrodes and send to the microcontroller as an input. The controller performs the operation and gives to the relay circuit. Relays play a key role in switching between two circuits that are completely separate. This property of the relay makes it more convenient for our application. They are applied to interface a low voltage electronic circuit(5v) to an electrical circuit which operates at a very high voltage (230v). In our application a Darlington pair formed from two transistors are used to interface microcontroller with the relay (5 pin), thus driving the appliances conveniently shown in fig 4.

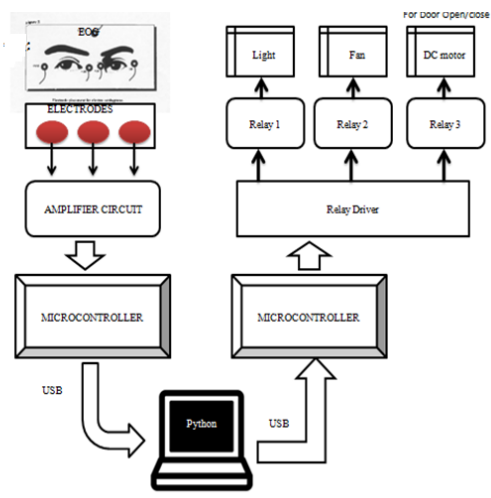


**FIG 3: EOG PLACEMENTS AND ITS WORKING**

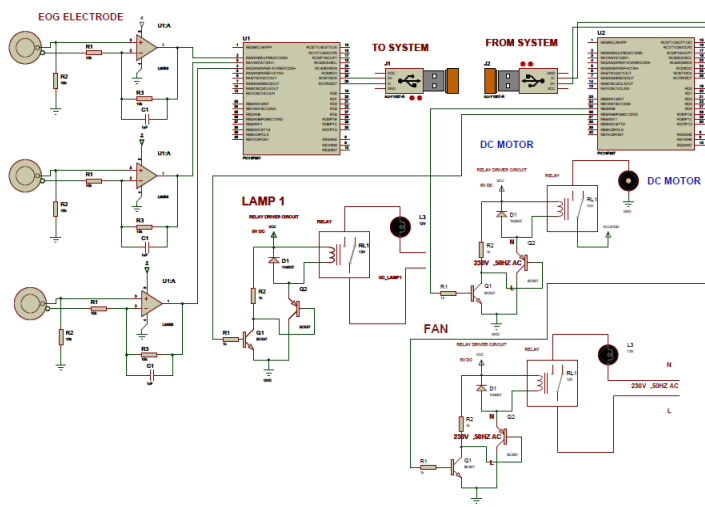


**FIG 4: CIRCUIT DIAGRAM OF PROPOSED SYSTEM**

**PIC MICROCONTROLLER:**

PIC microcontrollers are a family of specialized microcontroller chips produced by Microchip Technology in Chandler, Arizona. The acronym PIC stands for "peripheral interface controller," although that term is rarely used nowadays. A microcontroller is a compact microcomputer designed to govern the operation of embedded systems in motor vehicles, robots, office machines, medical devices, mobile radios, vending machines, home appliances, and various other devices. A typical microcontroller includes a processor, memory, and peripherals shown in fig 5.



**FIG 5: 167887 MICROCONTROLLER**

#### **UART:**

A Universal asynchronous receiver/transmitter, abbreviated UART is a piece of computer hardware that translates data between parallel and serial forms. UARTs are commonly used in conjunction with communication standards. The universal designation indicates that the data format and transmission speeds are configurable. The electric signaling levels and methods (such as differential signaling etc.) are handled by a driver circuit external to the UART shown in fig 6.

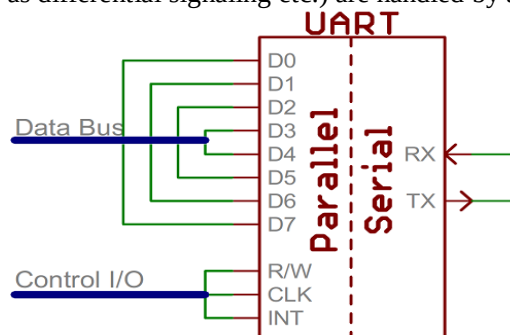


**FIG 6: UART**

#### **EOG ELECTRODE:**

By means of EOG you measure movement of the eye by measuring the potential that exists between the back and the front of the eye. Our special micro-electrodes with their small measurement surface of about 1mm are perfect for measuring EOG. The small measurement

surface makes the skin movement artifacts as well as the crosstalk, much smaller than conventional electrodes shown in fig 7.

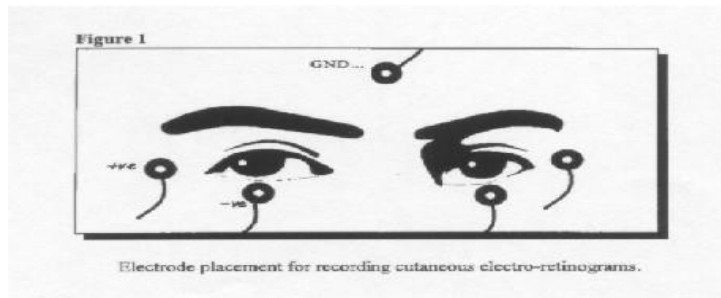


**FIG7 :EOG ELECTRODES PLACEMENT**

## RELAY



**FIG 8:RELAY**

A relay is an electrical switch that uses an electromagnet to move the switch from the off to on position instead of a person moving the switch. It takes a relatively small amount of power to turn on a relay but the relay can control something that draws much more power. Ex: A relay is used to control the air conditioner in your home. The AC unit probably runs off of 220VAC at around 30A. That's 6600 Watts! The coil that controls the relay may only need a few watts to pull the contacts together shown in fig 8.

## RESULT:



**FIG 9: EXPERIMENTAL SETUP**

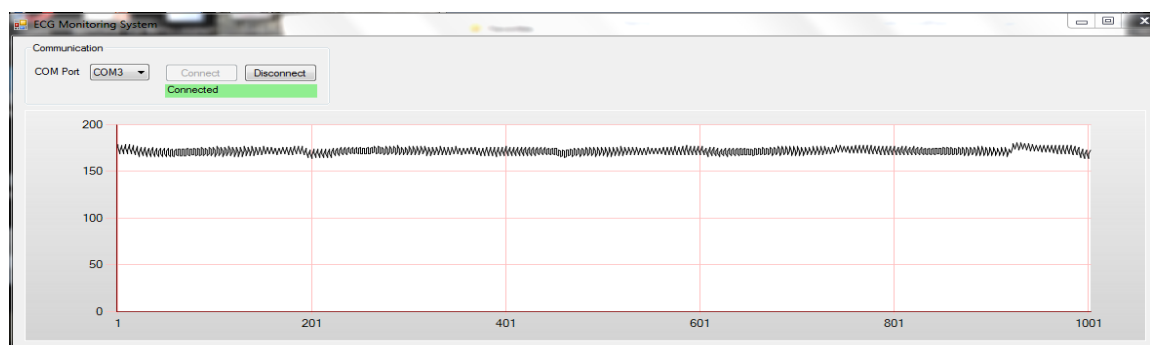


**FIG 10: WAVEFORM WHEN THE PATIENT EYES ARE AT STATIONARY**

When the eyes of the patient are stationary or when the patient is looking ahead there is no considerable change in potential and the amplitude of the signal does not vary. It is a linear zero output. The above waveform shows that the patient is stationary shown in fig 9&10

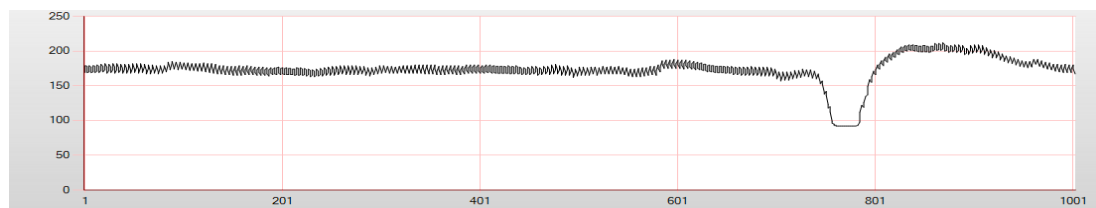


**FIG 11: WAVEFORM WHEN PATIENT ROTATES HIS EYE TO THE RIGHT.**

To switch on the first load (light), the patient rotates his eye to the right. Then the electrodes

gather the signal and the load is switched on. This waveform(fig 11) shows that the first load is switched ON.

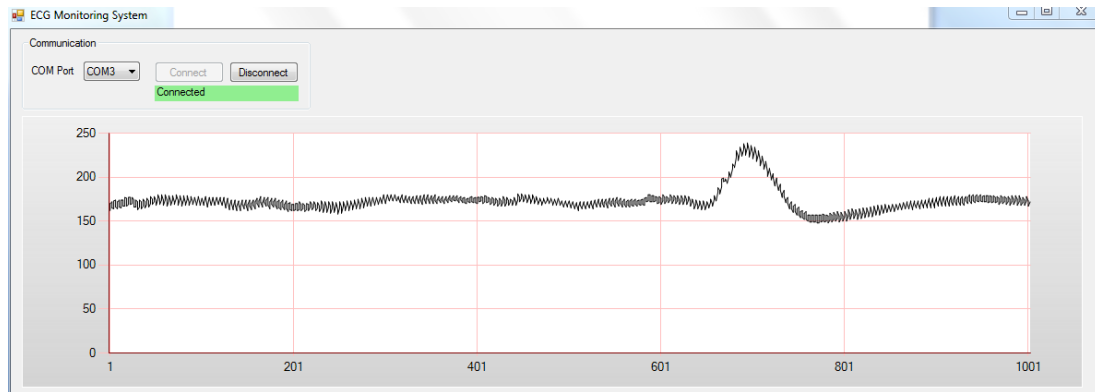


**FIG 12:WAVEFORM WHEN PATIENT ROTATES HIS EYE TO THE LEFT**

To switch on the second load (fan) the patient rotate his eye to the left. Then the electrodes gather the signal and the load is switched on. This waveform shows that the second load is switched ON shown in fig 12.

#### **OUTPUT 4:**

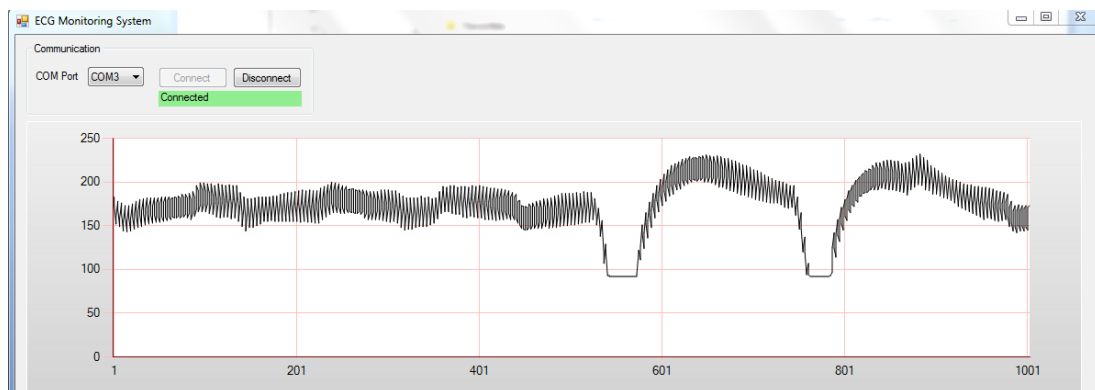


**FIG 13:WAVEFORM WHEN PATIENT MOVE HIS EYES UPWARDS**

To switch on the third load(dc motor) the patient move his eye to upwards. The electrodes will pick the EOG signals and do the process for switch on the third load. This waveform shows that the third load is switched ON shown infig 13

#### **CONCLUSION:**

The eye movement based detection device for controlling home appliances has been proposed in this system. The device is developed mainly for the paralyzed people, for whom mobility is a point of concern. The device is based on the acquisition of EOG signal which is comparatively inexpensive, efficient in terms of linear relationship of the signal over the eye movements that makes it suitable for the application. The device here incorporates activation and deactivation of appliances such as fan, bulb and door control. Towards the future, this method can be extended to control other appliances like operating computers. Thus, using this EOG method the burden for the paralyzed patients can be reduced.

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