Designing of Wheelchair to provide Ability to Move around for Disabled People using Electrooculography

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Abstract

In our daily life robots play a key role in advancing the quality of life for people with disabilities. There is a wide range of systems that allow to manage independent mobile robotics. The main purpose of our control system is to guide an independent mobile robots by using Electrooculography (EOG). The EOG signals can developed using Ag/AgCl electrodes and developed EOG signals are managed by the microcontroller for the calculation of eye gaze. The system has been verified using the test signal which has been provided by potentiometer. The cataloguring of different eye movements permits us to create simple code for monitoring the wheelchair. This work was designed towards developing a functioning and low cost assistive robotic wheelchair system for disabled people speciality with the eye-motor coordination. The movement of the human eye signal is used as a control signal for the wheelchair movement, called Human Machine Interface System. The goal is to design an Electrooculography based system which can be helpful for a physically handicap person.

Keywords - *Electrooculography(EOG), Microcontroller, Electrodes, Motor, Motor Driver, Wheelchair.*

I. INTRODUCTION

Now a day's disable population, In India as per census (2016) and National Sample Survey Organization's wide survey in India out of 121 Cr population, 2.68 Cr are disabled. Between the disabled population 56%(1.5 Cr) are males and 44%(1.18 Cr)are females. There are different types of disability, distinctions due to gender, class, place of residence,(rural, urban) etc. Disable population occupy in rural areas(1.86 Cr disabled person in rural areas and (0.81 Cr in urban areas). According to census and NSS disabilities is increasing rapidly every single year**[1].** Today, a smart system needs to be developed to serve humanity in life. People with physical disabilities need to deal with many dynamic issues and need new tools with the latest technology to help with comfortable mobility. Several types of examination groups at a world level have begun to set up cooperation project, projects to aid communication and mobility of disabled person with the purpose of increasing their quality of life and approving them a more self-sufficient lifestyle and better chances of social integration[2][3].

An ordinary motorized wheelchair helps the mobility of disabled people who can't walk their disability permits them to control the joysticks safely Handicap persons can't use that joystick for mobility. For some cases it is essential to develop more complex human-wheelchair interfaces adapted to the disability of the user, thus allowing them to input movement commands in a safe and simple way. Among all these type of interfaces, the least developed ones at the moment are those based on visual information, due mainly to the vast amount of information that needs to be processed. One form of communication that is of particular interest here is the detection and following of the eye gaze or eye control system. By studying severe disabilities they develop an oculo motor system, so to develop new human machinecommunication systems they uses eye movements**[4].**The main intense behind this work has consequently been the intend of making a contribution towards fulfilling the technological needs of wheelchair users by manipulative an eye-movement control system for severely disabled patients, with an economic and functional possibility that would facilitate them to get better their quality of life.

II. SYSTEM CONFIGURATION

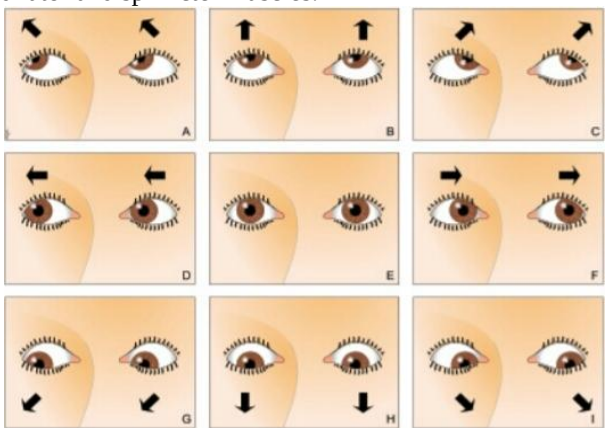
In this proposed system configuration, the flow of Parameter Measurement procedure is as follows:

The proposed system consists of following measurement parameters: Anatomy of eye, an Acquisition of EOG signals with electrodes placement and signal conditioning circuit.

A. Anatomy of Eye

The anatomy of eyeball and its related structures. Generally referred shape to as a globe, the eyeball is not a sphere but an oblate spheroid. The

anterior segment is made up of the cornea, iris and lens. The size of the pupil, which controls the amount of light entering into the eyes & is adjusted by the iris dilator and sphincter muscles.

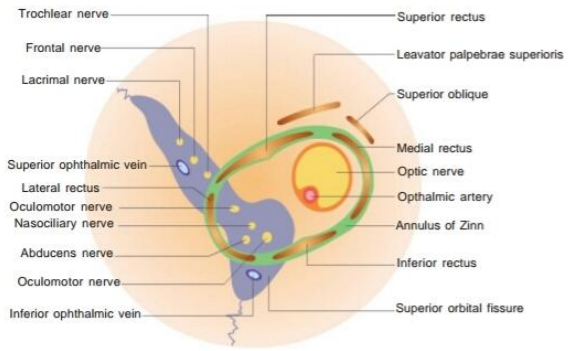


[Fig. Diagnostic position of gaze]

Dimension of an adult eyeball:

Anteroposterior diameter	24mm
Horizontal diameter	23.5mm
Vertical diameter	23mm
Circumference	75mm
Volume	6.5ml
Weight	7gm

In the Fibrous coat is an anterior $1/6^{th}$ of this fibrous coat is transplant and is called cornea and posterior $5/6^{th}$ opaque is called sclera. From anterior to posterior, which are iris, ciliary body and choroid. A set of six extraoccular muscles control the movements of each eye. Rectus muscles are Superior(SR), Inferior rectus(IR), Medial rectus(MR), Lateral rectus(LR). The oblique muscles include Superior oblique(SO) and Inferior oblique(IO). The human visual system embraces a group of responsible for gathering information from the surrounding, whose main structures- the eyes- react to the light, being able of focusing, in a balance between refraction, converting stimuli to signals. This message is transported through neurons and other optical pathways until the forebrain, where it is decoded; accessory structures, as eyebrows, palpebrae, eyelids andlacrimal apparatus, supporting the visual function. Eye has three main layers or tunic, a thinmembrane structure, highly vascularized, includes the ciliary body and iris; and nervous tunic; formed by the retina.



[Fig. Origin by the rectus and the oblique muscles]

B. Electrode placement for acquisition of EOG signal

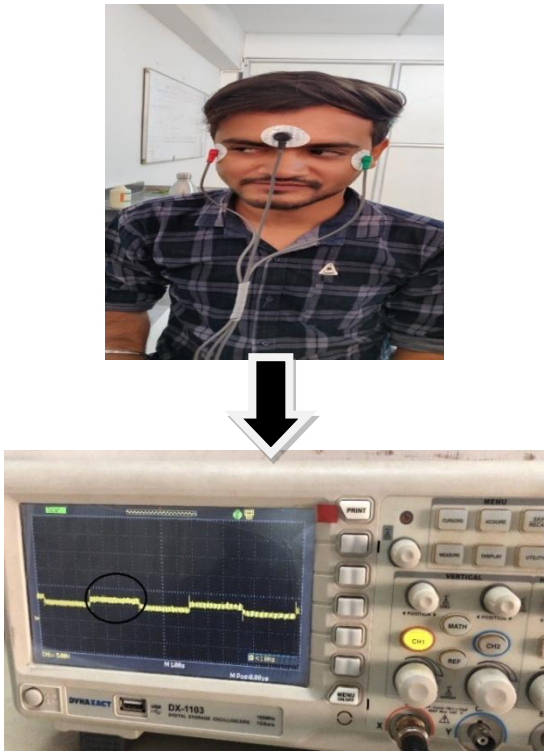
Electrooculography is a technique for measuring Cornea-retinal Potential Technique used for recording of eye movements and eye position provided by the difference in electrical potential between two electrodes placed on skin on either side of eyes. The eyeball may actuallybe regarded as asmall battery, with a positive pole in the cornea and a negative pole in the retina**[5].** Changes in the position of the eyeball cause changes in potential at the skin. The reference electrode is placed on forehead and electrodes are placed on left and right temples for lateral eye movement detection.
The signal gathered from this electrode is collected in the EOG signal acquisition block. If the eye moves from center position toward one of the two electrodes, this electrode "sees" the negative side of the retina. Consequently, a potential is constant, the recorded potential is a measure of the eye's position**[6].**

The eye acts as a dipole in which the frontal pole is positive and the latteral pole is negative. In Left gaze : the cornea approaches the electrode near the exterior canthus of the left eye, which results in a negativetrending change in the recorded voltage difference. In Right gaze: the cornea approaches the electrode near the interior canthus of the left eye, which results in a positivetrending change in the recorded voltage difference. EOG is a technique for measuring the eye movement and it is based on recording the standing corneal&retinal potential arising from hyper-polarizations and de-polarizations present between the cornea and the retina; this is commonly known as an electooculogram. This potential can be considered as a steady electrical dipole with a negative pole at the fundus and a positive pole at the cornea.

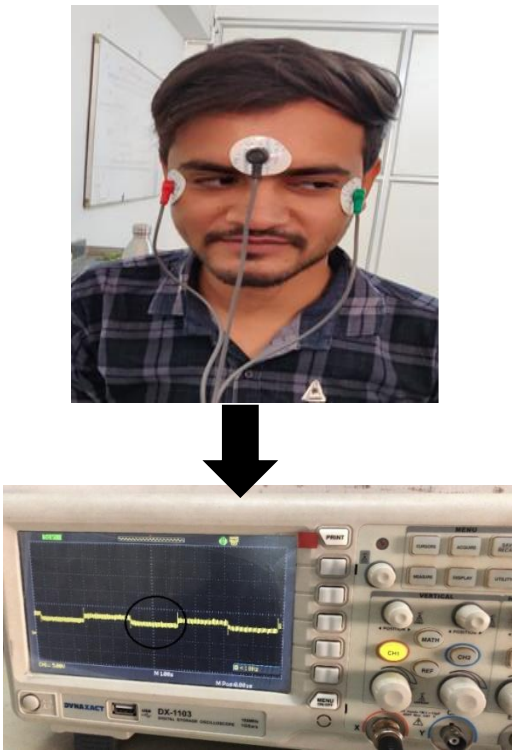
The standing potential in the eye can thus be estimated by measuring the voltage induced cross a system of electrodes placed around the eyes as the eye gaze changes, thus obtaining the EOG. The EOG value

varies from 50 to 3500 V with a frequency range of about dc-100Hz. Its behavior is practically linear for gaze angles. It should be pointed out here that the variables measured in the human body (any bio-potential) are rarely deterministic. Its magnitude varies with time, even when all possible variables are controlled. Most of these bio-potential vary widely among normal patients, even under similar measurement conditions. This means that the variability of the electrooculogram reading depends on many factors that are difficult to determine: perturbations caused by other bio-potential suchas EEG(electroencephalogram),EMG(electromyogram), in turn brought about by the acquisition systems, plus those due to the positioning of the electrodes, skin electrode contacts, lighting conditions, head movement, blinking, etc.

In various studies were made of the accuracy and precision of the EOG in tracking the eye gaze. To eliminate or minimize these defects, therefore a considerable effort had to be made in the signal acquisition stage to make sure it is captured with the minimum possible perturbations and then during the study processing there of to obtain in the best possible results**.**



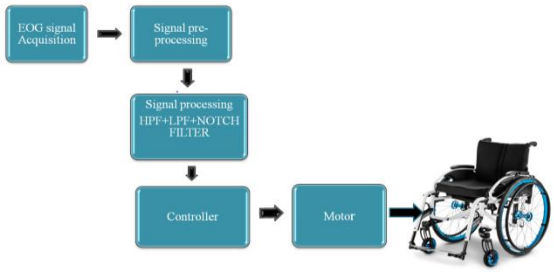
[Fig. Real time acquired EOG signal through Right eye movement]



[Fig. Real time acquired EOG signal through Left eye movement]

C. Signal conditioning circuit

The signal carried out from EOG signal acquisition block is passed through signal pre-processing unit where it is filtered and amplified. The filtered and amplified signal output is obtained. Notch filter is used to remove 60 Hz power line noise. High pass filter is used to filter out the noise generated due to movement of the three pairs of eye muscles such as Superior rectus(SR), Inferior rectus(IR), Medial rectus(MR), Lateral rectus(LR), Superior oblique(SO) and Inferior oblique(IO). Low pass filter is used to remove noise generated due to improper placement of electrodes. The signal which are received,are amplified and filtered and passed through the controller. The controller control the amount of signal and generatesthe out as per the input signal. It is used to control the speed of the wheelchair and to move the wheelchair in the suggested direction.

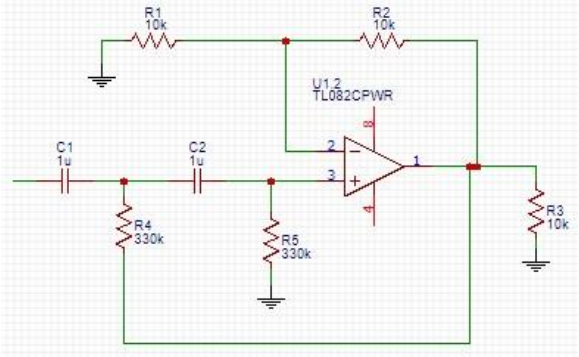


[Fig. Block diagram of proposed system]

III. HARDWARE DESIGN

A. *High pass filter*

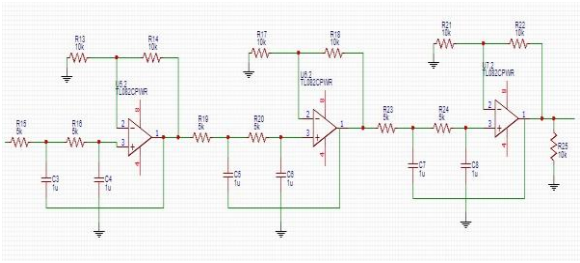
A high pass filter is an electronic filter that passes a signal with a frequency higher than a certain cutoff frequency and attenuates signal with frequencies lower than the cutoff frequency. The EOG signal obtained by the amplifier is affected by different low-frequency EOG noises so to remove this noise we have to use high pass filter.



[Fig. High pass filter]

B. *Low pass filter*

A low pass filter is a filter that passes signals with a frequency lower than a certain cutoff frequency and attenuates signals with frequencies higher than the cutoff frequency. Butterworth 4th order low pass filter is generally used to remove the noise generated through improper placement of electrodes, absence of conducting gel etc.



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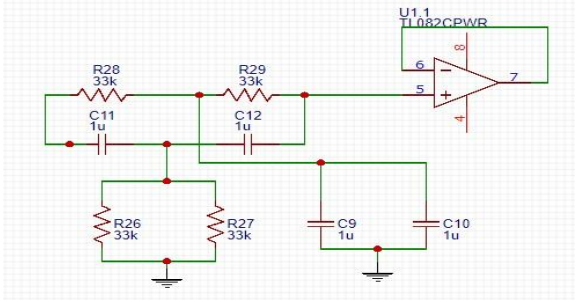
[Fig. Low pass filter]

C. *Notch filter*

A Notch filter is a filter that passes all frequencies except those in a stop band centred on a centre frequency. The amplitude response of a notch filter is flat at all frequencies except for the stop band on either side of the centre frequency. The standard reference points for the rolls-offs on each side of stop band are the points where the amplitude has decreased by 3 db, to 70.7% of its original amplitude.



[Fig. Notch filter]

D. *Interfacing with Arduino*

The Microcontroller is used as an Arduino. Arduino is a singleboard microcontroller, It is planned to make building cooperating objects or environments more accessible. The hardware consists of an open source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM[6]. A digital signal which has only two values: HIGH and LOW. The microcontroller board is a 14 digital Input/Output pins, 6Analog pins and 16MHz crystal oscillator and a reset button. This microcontroller converts the information received from the processing unit into signals and transmits themto the receiving motor driver unit attached to the wheelchair. The Receiving Motor driver unit receives signals from transmitting microcontrollerand accordingly initiates the movement in the essential direction.

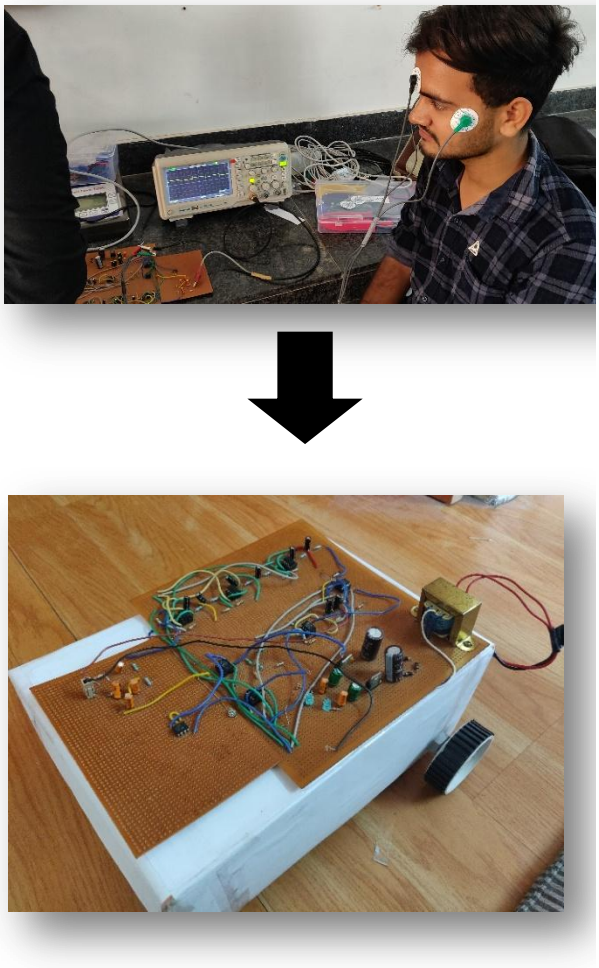
E. *Motor Driver*

Motor driver is required to run the motors since the motors require more current than the microcontroller pin can generate. Motor driver is mostly a current amplifier which takes a lowcurrent signal from the microcontroller and gives out a proportionally higher current signal which can control and drive a motor. In most cases, transistor act as an switch and perform this task which drives the moves single direction.

[Fig. L293D Motor Driver]

IV. RESULT

The wheelchair thus developed will move in the focused direction based on the eye movement. The wheel chair is attached with two motors for the movement of wheelchair for different conditions. When the eye is focused left, one motor rotates the left wheel backward and another motor rotates the right wheel forward, so that the wheelchair moves towards left and vice versa for right movement. When the eye is focused up, both motors running forward and move the both wheels forward so that the wheelchair moves forward similarly when the eye is focused down the wheelchair moves backward as both motors move the wheel backward. While looking straight, the wheelchair will be in stop conditions. The conditions can be altered in the IC program according to the user's choice. One of the main goals for eye movement controlled wheelchair is to enable completely paralyzed patients to make their life more accessible and to provide them opportunity of independent and movement.



[Fig. Complete EOG Acquisition system interface with wheelchair prototype]

V. CONCLUSION

We are introducing smart wheelchair which is multifunctional and can be controlled by various devices according to the comfort of patients. With the help of this multifunctional smart wheelchair patients who are disabled physically and mentally can make use of this smart wheelchair without the requirement of caretaker, so this is a multifunctional smart wheelchair the improvement and self-reliability of many disabled people.

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