Novel Approach of Man-Machine Interaction using Brain Waves Electric Signals

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Abstract.:- Electrooculography is a technique for measuring the resting potential of the retina. The resulting signal is called the electrooculogram The bio-potential signal also is one of the examples of human–machine interface using of nonverbal information such as electrooculography (EOG), electromyography (EMG), and electroencephalography (EEG) signals. The EOG and EMG signals are physiological changes; but here we are focusing the mainly on EOG signals for the human–machine interface. This paper has investigated that different EOG signals obtained from four different places around eye; (right, left, up, and down) have led to different level of distance and rotation of wheelchair. Those four signals are correspond to different levels of right and left steer, forward and backward motion. There are many research that have concentrated in making use of the eye movement signals for tetraplegia. Despite of all the complexity that arises when analyzing the eye movement signals. In this case the constraints are made such that the eye movement is assumes to be very limited to; (straight-to-up, straight-to-down, straight-to-right and straight-to-left). The issue of other eye movement patterns.

Keywords—*Brain computer interface, Electroculogram, Electrodes, Robotic Prototype Model*

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I. INTRODUCTION

In searching for better interfaces between users and their computers, an additional mode of communication between the two parties would be of great use. The problem of human computer interaction can be viewed as two powerful information processors (human and computer)attempting to communicate with each other via a narrow-bandwidth, highly constrained interface. Faster, more natural, more convenient (and, particularly, more parallel, less sequential) means for users and computers to exchange information are needed to increase the useful bandwidth across that interface [1].

A brain–computer interface (BCI) often called a mind-machine interface (MMI), or sometimes called a direct neural interface or a brain–machine interface (BMI) [2], is a straight communication between the human brain and an electronic or electromechanical external devices. Brain computer interface are in many situation directed at boosting, augmenting, or repairing human subjective or sensory-motor functions. .A brain-computer interface (BCI) [6] is a device that enables acutely disabled bodies to acquaint and collaborate with their environments application their academician waves. Utmost analysis investigating BCI in bodies has acclimated scalp-recorded electroencephalography or intracranial electrocorticography. Use of academician signals acquired from stereotactic depth electrodes to ascendancy a BCI has not ahead been explored.

The eye could be a seat of a gentle electric potential field that's quite unrelated to lightweight stimulation. It is also possible that, this field could also be detected with the attention in blackness and or with the eyes closed. It often represented as a stable dipole with positive pole at the cornea layer and negative pole at the retina layer. The magnitude of this corneoretinal potential is within 0.4-1.0 mV. It's not generated by sensitive tissue however, rather, is attributed to the upper rate within the retina. The polarity of this potential within the eyes of invertebrates is opposite to it of vertebrates. This potential and therefore the rotation of the attention area unit the premise for a symbol measured at a combine of per orbital surface electrodes. The signal is understood because the electrooculogram, (EOG). It's helpful within the study of eye movement.

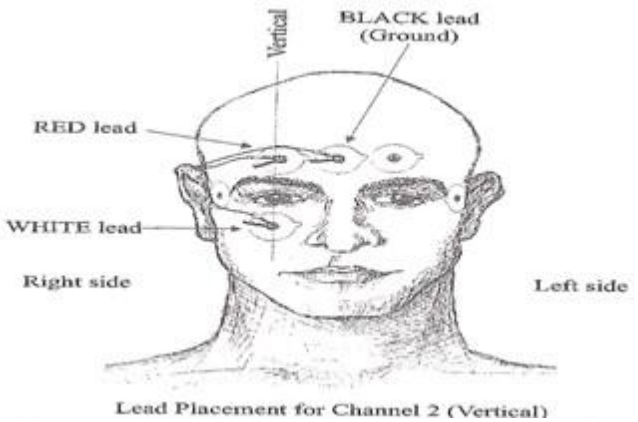

Figure 1: Different electrode placement

As per [1] Michita Imai, Tetsuo Ono, and Hiroshi Ishiguro, they projected a system that a joint attention mechanism to attain such joint attention also as a speech generation system. The joint attention procedure implies eye contact and a spotlight expression functions. All these functions are robot's physical expressions, and these functions permit the joint attention techniques to draw the person's attention to the equivalent sensor data information as that noticed by the robot.

II. RELATED WORK

Arslan Qamar Malik, and Jehanzeb Ahmad (2007) designed and developed an EOG based mouse control device. They used Instrumentation Amplifier INA126P which has a high CMRR (around 94DB) and can handle signals in microvolt range. Total gain of 100000 was achieved by using two amplification stages. A protection system in the form of an RC low pass filter with cutoff at 47 Hz was implemented at the INA126p's inputs to remove high frequency RF interference and Electro-Static Discharge. Common Mode Rejection Ratio (CMRR) was further increased by using Driven-Right Leg circuit. To overcome the problem of 60/50 Hz power line noise, a notch filter with 60Hz cut off frequency was implemented after the first INA126p IA. Another major problem of DC offset was overcome by high pass filter of cut off frequency .14Hz and Roll off of -80DB/Decade. This was implemented by two 2nd order Bessel High Pass Filters in series. One of such 4th order filters was implemented after Notch filter during first phase of amplification[3].

The second one was implemented after second INA126P during second phase of amplification. The high pass filter was followed by a low pass filter of roll of rate -80DB/Decade with cutoff at 30Hz to reduce the power line noise and aliasing effect. Rule used to select cut of frequency is that it should less than a quarter of the sampling frequency. After amplification and filtering the purified EOG signal was digitized using 12 bit ADC ADS7800. ADS7800 was selected since it is fast and can handle wide range of analog data (-10 to 10). Digitized signal was directly interfaced with computer through parallel ports. Two parallel ports were used: one parallel port received digital data of up-down motion from one ADC and another parallel port received digital data of right-left motion from another ADC. Software program was written in visual C++ language.

Manuel Merino, Octavio Rivera, Isabel Gómez, Alberto Molina, Enrique Dorronzoro (2010) developed a system to detect eye movement based on the EOG signal. They used Ag/AgCl sensors and BCI2000 and the amplifier gUSB amp for EOG acquisition. Since EOG signal information is mainly contained in low frequencies, band pass filter with a range between 0.1 and 30Hz and sample rate of 128 was used. Noise was further removed by an averaging filter. Developed algorithm for EOG classification depends on derivative and amplitude level of EOG signal. Derivative of EOG signal was used to detect the edges of the signal. This algorithm found out initial edge, final edge, and area between edges. For an up movement and blink, initial edge is positive and final edge is negative. A timer calculated width of area between edges. A pulse was classified as a blink if the width of this area was smaller than 250ms[5][6].

A. B. Usakli, S. Gurkan, F. Aloise,G. Vecchiato, F. Babiloni (2010) developed and realized a virtual keyboard that allowed the user to write messages and to communicate other needs based on EOG signals.5 Ag/AgCl electrodes are used for EOG acquisition. The data acquisition system was microcontroller based and had electronic noise 0.6Vpp, CMRR 88 dB, and sampling rate was 176 Hz. Differential approach was used to remove the DC level and 50 Hz power line noise. After filtering and amplification EOG signals are digitized and transferred to PC. These signals were then processed by using Nearest Neighborhood algorithm. By using this virtual keyboard user could type with a speed of 5 letters/25 seconds.

Patterson Casmir D'Mello, Sandra D'Souza (2012) developed a LabVIEW based EOG classification system. Ag/AgCl electrodes were used for EOG signal acquisition. To overcome the poor conductivity of skin, they used an electrolytic gel based up on Sodium Chloride. EOG signals were then amplified and filtered by using a high pass filter of 0.5Hz and low pass filter of 30Hz. M Series USB-6221 was used as a data acquisition interface. They used amplitude based EOG classification algorithm. They used the fact that amplitude of blink signal is higher than other eye movement. They compared the peak amplitude with a threshold value and if the amplitude was greater than threshold, then it was considered as a blink.

The EOG measures the electrical difference that exists between the cornea and the retina, known as resting or standard potential of the eye. The cornea is almost 6 m positive with respect to the retina, which changes with clashing retinal illumination. The potential of the eye is generated mainly by the transepithelial potential across the pigmented epithelium of the retina[1].

Electrooculogram change under totally different states of retinal illumination. The EOG is employed to assess the function of the pigment epithelium. In dark adaptation scenario, resting potential drops slightly and reaches a minimum ("dark trough") once many minutes. Once light is switched on, a substantial increase of the resting potential happens ("light peak"), which drops off after many minutes when the retina adapts to the light. The ratio of the voltages is known as the *Arden ratio*. The measurement is similar to eye movement recordings. The patient is asked to modify eye position repeatedly between

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two points. Since these positions are static, a amendment in recorded potential originates from a change within the resting potential. EOGs are most appropriate when diseases that affect the retinal pigment epithelium may be present. Fishman (1990) outlines those dystrophies of the pigment epithelium that may give rise to EOG abnormalities. The only one disease that consistently associated with abnormal EOGs, however, is Best (vitelliform) macular dystrophy. Autosomal-dominant macular degeneration is a best disease that may be congenital or may have an onset of up to 7 years of age.

Recording of eye movements and eye position provided by the difference in electrical potential between two electrodes placed on the skin on either side of the eye. The electrooculogram comprises of two potentials: the standing potential that is elicited by moving the eyes within the dark and originates from the retinal pigment epithelium and therefore the light potential (light rise) which is evoked by moving the eyes in a lighted environment and originates from the photoreceptors. The common magnitude ratio between the light and no light potentials (sometimes conjointly known as the Arden index or Arden ratio) is assessed. If that ratio is less than 1.8 it reflects a malfunction of the structures from which the potential originates.

A method of automated measurement of the EOG amplitude is described. The advantages are as follows:

1. The mean of amplitudes, at a series of time dots within a single EOG deflection recorded with DC-amplification, are automatically measured.
2. Artifacts due to blinks, overshoots or other irregular eye movements are automatically eliminated.
3. A base line drift is automatically compensated.
4. The Lift to Drag ratios acquire in 80 eyes with this method was essentially equal to those obtained by a manual measurement.

III. PROPOSED SYSTEM

This proposed system implements a human-computer interface based on electrooculography (EOG) that permits interaction with a computer using eye movement. The EOG stores the movement of the eye by measuring activity, through electrodes, and therefore the difference of potential between the cornea and the retina. A robotic vehicle is a part of control parameter in proposed system where user can control the vehicle in multiple direction using facial motions near eye area.

The main objective in system is to detection of electric signal near eye area and using electrodes system will try to identify the changes in electric pulse in order to conclude the motion to be taken. Proposed system includes the wireless robotic vehicle which can be controlled in 4 different directions. User can have access to this vehicle using radio frequency enabled circuitry through brain signals generated using eye motion.

Likewise user can control the computer cursor and the applications using electric signals. This will enable disabled patients to have good access over computer system. To implement this there will be a microcontroller to USB interfacing circuitry which will convert microcontroller signals in to computer understandable signals which will then get processed by software program.

IV. PROPOSED METHODOLOGY

Electroencephalography (EEG) is the most studied potential non-invasive interface, due to fine temporal resolution, ease of usability, portability and low set-up cost. But as well as the technology responsibility to noise, another substantial barrier to using EEG as a brain–computer interface is the extensive training required before users can work the technology. For example, in experiments trained severely paralyzed people to self-regulate the slow cortical potentials in their EEG to such an extent that these signals could be used as a binary signal to control a computer cursor.

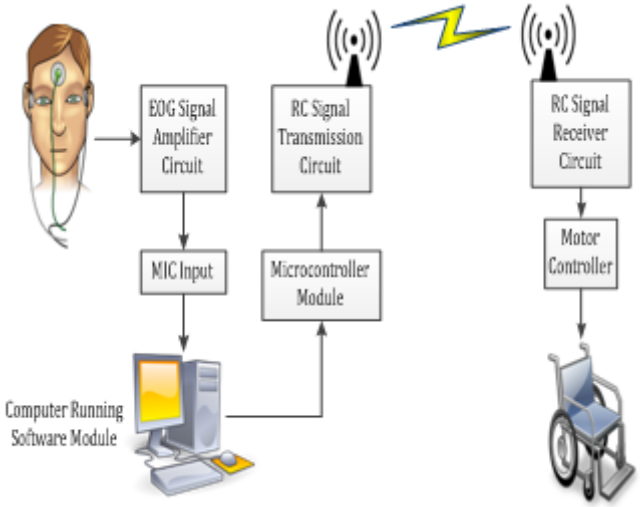

Figure 2: Block diagram of proposed system

An instrumentation amplifier is a type of differential amplifier that has been outfitted with input buffer, which eliminate the need for input impedance matching and thus make the amplifier particularly suitable for use in measurement and test equipment. A high pass filter is an electronic filter that passes high-frequency signals but attenuates signals with frequencies lower than the cutoff frequency. A low pass filter is a filter that passes low frequency signals with frequencies higher than the cutoff frequency. The actual amount of attenuation varies depending on specific filter design.

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The eye can be considered a dipole with the anterior part relatively more positive than the posterior pole. EOG electrodes have become fixed for the outer and inner canthi of the left eye. On the left of the diagram as the eye moves to the left, the outer canthal electrode (being closer to the positive pole of the eye) becomes more positive than the inner canthal electrode. This change in potential can then be recorded on a voltage meter. When the eye moves to the right side direction, the inner canthal electrode then becomes positive and again a change in potential can be recorded but with opposite polarity. .

V. RESULT ANALYSIS

A. Hows API software Works

The sound APIs work on signal acquisition Process provide the media for audio applications to access audio end point devices like headphones and microphones. The sound APIs developed for higher-level audio APIs named as Microsoft DirectSound and the Windows multimedia wavexxx procedures. Many of the applications interact with the higher-level APIs, however some of the applications with genuine requirements need to interact directly with the sound API interface.

B. Signal Acquisition Process

In general, the signal (or data) acquisition process has 3 steps.

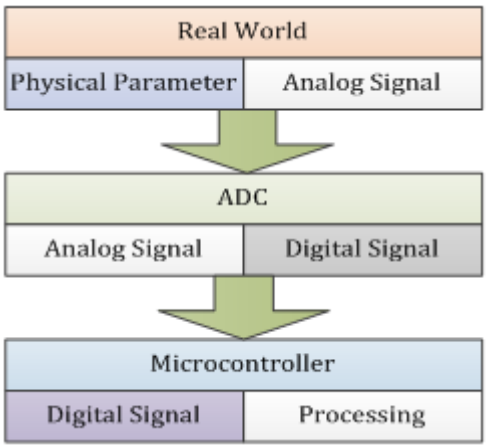

Figure3: Signal Acquisition Process

- In the Real World, a sensor senses any physical parameter and converts into an equivalent analog electrical signal.
- For efficient and ease of signal processing, this analog signal is converted into a digital signal using an Analog to Digital Converter (ADC).

This digital signal is then fed to the Microcontroller (MCU) and is processed accordingly

Figure 4:- AVR board with wireless wheelchair

For a hard and fast eye position, the EOG is way from being constant in magnitude, however may be influenced by a many of external factors. These factors embody

1. The noise generated between the electrodes' contacts and also the skin
2. The metabolic state of the tissues (pO2, pCO2, and temperature)
3. Visual stimulation
4. Shrinkage of facial muscles

To get the amplified signals from eye movement using electrode the application must set the trigger value setting. Because of this the left and right movement of eye should not go beyond the range which is previously set by the trigger slider. As soon as the trigger values are set then the eye detection is ready to start. When the eye detection is started the trigger value which is set for left and right movement will not go beyond the preset value and hence proper movement signal generated successfully and the eye movement is assumes to be very limited to; (straight-to-up, straight-to-down, straight-to-right and straight-to-left). The issue of other eye movement patterns.

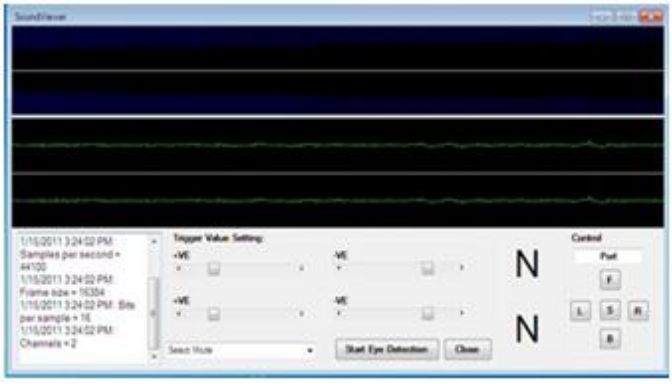

Figure 5 : API software

VI. CONCLUSION

In this paper we propose human machine interaction technique using EOG signal obtain near eye area by using this signal we can control any real time machine like computer system , robot , vehicle , wheelchair etc.

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References

[1] Massaro D, Savazzi F, Di Dio C, Freedberg D, Gallese V, et al. (2012) When art moves the eyes: A behavioral and eye-tracking study. PLoS ONE 7: e37285.

[2] Michita Imai, Tetsuo Ono, and Hiroshi Ishiguro "PhysicalRelation and Expressio: Joint Attention for Human-Robot Interaction", August 2011.

[3] Iáñez E, Úbeda A, Azorín JM, Perez-Vidal C (2012) Assistive robot application based on an rfid control architecture and a wireless eog interface. Robotics and Autonomous Systems 60: 1069–1077.

[4] Postelnicu CC, Girbacia F, Talaba D (2012) Eog-based visual navigation interface development. Expert Systems with Applications 39: 10857–10866

[5] Úbeda A, Iáñez E, Azorín J (2011) Wireless and portable eog-based interface for assisting disabled people. Mechatronics, IEEE/ASME Transactions on 16: 870–873.

[6] Iáñez E, Azorín JM, Úbeda A, Ferrández JM, Fernández E (2010) Mental tasks-based brain-robot interface. Robotics and Autonomous Systems 58: 1238–1245.

[7] Andreas Bulling, Jamie A. Ward Hans Gellersen "Eye movement analysis for activity recognition using electrooculography" 2010 IEEE

[8] Nintendo Instruments,"eyMario- Controling Video Games with Eye Movemet", Aug 2010.

[9] Perez-Vidal C, Carpintero E, Garcia-Aracil N, Sabater-Navarro J, Azorin J, et al. (2012) Steps in the development of a robotic scrub nurse. Robotics and Autonomous Systems 60: 901–911.

[10] Úbeda A, Iáñez E, Azorín J (2011) Wireless and portable eog-based interface for assisting disabled people. Mechatronics, IEEE/ASME Transactions on 16: 870–873.

[11] Popescu F, Fazli S, Badower Y, Blankertz B, Müller KR (2007) Single trial classification of motor imagination using 6 dry eeg electrodes. PLoS ONE 2: e637.

[12] W.B. Heinzelman, A.P. Chandrakasan, H.Balakrishnan , "Application specific protocol architecture for wireless microsensornetworks", IEEE Transactions on Wireless Networking (2002), 2002.

[13] Barea R, Boquete L, Mazo M, López E (2002) Wheelchair guidance strategies using eog. Journal of Intelligent and Robotic Systems 34: 279–299.

[14] The McGill physiogy Lab "Biological signal acquisation:.

[15] Core audio APIs "New for core windows sound APIs".