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EOG Signals-Based a Robot Implementation

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Abstract: ***This paper presents a novel hands-free control system for a mobile robot as a ground vehicle, which is based on EOG (ElectroOculoGram) signals. Horizontal human eye movements result in electrical signals at ocular muscles, which are sensed and amplified to produce the EOG signal. This EOG signal is translated to produce the DC motor's control signal, which can drive a ground vehicle movement totally in the analogue domain. The results show that this EOG signal can possibly control the rotation direction of a DC motor and it is expected that this study pertaining to man-machine interaction will help to further develop control methodologies used in assistive devices for disabled people.***

Keywords: electrooculogram signal, electrodes, FPAA, ground vehicle

1. Introduction

Electrooculogram (EOG) is an electrical signal generated when muscles move the eyeball, these muscles are located between the retina and the cornea, the EOG signal ranges between a few microvolts to a few millivolts within a frequency domain of 0-38Hz [1] [2] [3].

In 2008, Talla Vamsi and Suhas Mishra [4] focused on the EOG signal acquired through a two-channel acquisition process and common artefacts and inter-channel interferences have been suppressed. It was suitably processed and applied to demonstrate an efficient and cheap text communication system.

In 2010, Fkirin et al [5] described a novel motorized wheelchair control method, which senses EOG signals produced by saccadic human eye movement. Using that EOG signal in conjunction with a graphic user interface and computer controls could enable wheelchair motion in the desired direction. That method used numerical integration according to the direction of the eye gaze in order to condition and assure signal quality.

In 2013, Geethanjali et al [3] constructed and presented a design of a low-cost signal conditioning system that would sense ElectroMyoGram (EMG) and ElectroOculoGram (EOG) signals and would also condition those signals for assistive device applications. That system comprised of two units: a signal detection unit and a signal-conditioning unit. The electronic circuit they developed recorded signals and interfaced with a PC for data acquisition and analysis using the LABVIEW software package.

The aim of this work is to develop a motor control system utilizing a man-machine interface, which senses eye movement using three or more electrodes attached to the skin around the eye. This system can be used to actuate devices in assistive technologies to empower disabled people [5], most noteworthy being the development of intelligent robotic devices [6].

2. EOG Signal Acquisition and Its Conditioning Process

Pairs of electrodes are placed on the skin surrounding the eye, usually in the following locations, either above or below the eye or to the left and right of the eye. If an eyeball rotates from dead center position towards an electrode a charge potential difference is detected between electrodes and this potential difference is recorded and is proportionate to the eyeball's rotational displacement [4]. The main aim of the signal acquisition system is to acquire a signal in the range of 0-38 Hz at appropriate voltage levels and suppress interference from electrical noise sources.

The acquisition of EOG signal from the electrodes represents the first stage of the bio signal acquisition system. figure 1 shows the placement of the aforementioned electrodes.

Figure 1: Placement of electrodes for EOG signal acquisition

The second stage of EOG bio signal acquisition is the pre-amplifier which would provide the initial amplification with appropriate voltage level, the electrodes and the pre-amplifier are parts of the kit "KL-75003 EOG MODULE". Since the EOG ranges between DC and 38 Hz a band pass filter, with cut off frequencies below 0.1Hz and above 38Hz, is used for signal preconditioning to reduce unwanted noise [3] [4].

The output of the pass band filter is fed to an amplifier with two output terminals. Both the filter and the amplifier are part of Field Programmable Analogue Array (FPAA) technology, type AN221E04 card [7], which produces signals for controlling the DC motors through H-bridge to move the robot in forward and reverse directions. The function of the H-bridge circuit can be explained as follows. The H bridge motor drive circuit consists of typically four MOSFET transistors, wired to switch in pairs to change electrical polarity at the motor's terminals, which in turn, changes the direction of rotation from forward to reverse and vice versa. These transistors enable a higher supply current to flow through the transistor pairs from drain to source (I_{ds}) to drive the motor whilst only sensing a small amount of current at the gates (I_g) [8]. figure 2 shows the block diagram of the practical devices.

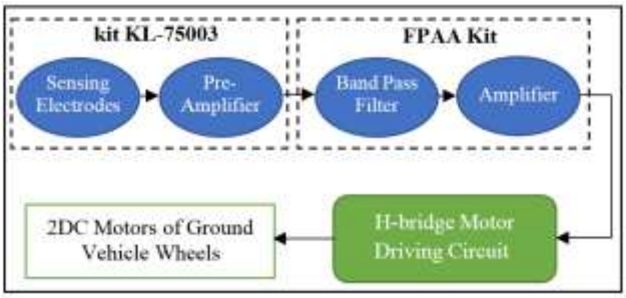

Figure 2: EOG signal-based robot system block diagram.

3. EOG Signal-Based Robot Implementation

The implemented ground vehicle robot uses three wheels the single front wheel is free to rotate, whilst two motors independently drive the rear wheels of the robot to vary direction. Each of this two driver wheels is moved by a DC motor as depicted in figure 3. The controlling goal of the DC motor rotation direction of the Ground Vehicle has been carried out using the practical set up of figure 2 depending on EOG signal, through FPAA port via H-bridge circuit.

Figure 3: The internal structure view of the implemented robot

4. Practical Results

EOG signals are acquired for straight right direction and straight left direction of the eyes gazing and the results are shown in figure 4 using an oscilloscope and photography camera. The signal goes negative peak for left movement of the eyes, while the signal goes positive peak for right movement of the eyes. When the eyeball is centered, looking straight ahead, the potential difference between electrodes is approximately zero the amplitude of the obtained signal is zeroing too.

Figure 4: Practical EOG signals at the amplifier output (the signal goes negative peak for left movement of the eyes, while the signal goes positive peak for right movement of the eyes).

In the case that the person looks to the right side, the EOG signal becomes positive, and through the H-bridge, it spins the DC motors (and hence drives the ground vehicle) in the forward direction. When the person looks to the other side, the EOG signal becomes negative, and through the H-bridge, it spins the DC motors (and hence drives the ground vehicle) in the reverse direction.

5. Conclusion

The system enables hands-free control for a disabled person to drive a ground-based robot. The robot senses EOG signals using analogue electronic circuits giving the system a fine real-time control without the issues of signal quantization and additional signal processing delays. The FPAA interprets real human analogue EOG signals, which emanate from ocular muscles and are filtered. The FPAA amplifies this signal to actuate motors. This happens totally within the analogue electronics domain and hence is not subject to the signal processing delays and complexities of digital signal processing techniques, giving this system, a superior level of real-time control compared to digital systems. This actuation method has the potential to be an enabling technology for the disabled and improve quality of life. It can be applied to electric wheelchair design artificial organs it could also be used in other Remote Operated Vehicle (ROV) applications too.

References

[1] Qiyun Huang, and et al, "An EOG-Based Human-Machine Interface for Wheelchair Control," IEEE

Engineering in Medicine and Biology Society, pp.1-11, Vol. PP, Issue: 99, 27 July 2017.

[2] Rajesh Kannan Megalingam nad, and et al, "Orthotic arm control using EOG signals and GUI," International Conference on Robotics and Automation for Humanitarian Applications (RAHA), pp.1-5, 18-20 Dec. 2016, Kollam, India.

[3] P. Geethanjali, Y. Krishna Mohan and P. Bhaskar, "*A Low-cost EMG-EOG Signal Conditioning System for Brain Computer Interface Applications"*, International Journal of Engineering and Technology (IJET), pp. 2268-2271, Vol. 5 No. 3, 2013.

[4] Talla Vamsi and Suhas Mishra, "*EOG Based Text Communication System forthe physically handicapped and Speech impaired*", Design Lab Project Final Report, Department of Electronics & Communication Engineering, Indian Institute of Technology, Guwahati, 23rd April 2008.

[5] M.A.Fkirin, S.Badawy and A.S.El-Sherbeny, "*Driving a DC Motor by Numerically Manipulated Eye Signal Captured by EOG*", The Online Journal on Electronics and Electrical Engineering (OJEEE), Vol. (2) – No. (1) pp. 170-173, 2010.

[6] M.Malini and K.SubbaRao, "Analys*is of EOG Signal using Haar Wavelet*", International Symposium on Devices MEMS, Intelligent Systems & Communication (ISDMISC), pp.28-31, 2011.

[7] Thomas L. Floyd, *"Electronic devices"* 7th edition, Prentice Hall, pp.910-929, 2005.

[8] DC Motor-Driver H-Bridge Circuit, datasheet of the H-bridge293D. http://www.datasheet4u.com/share_search.php?sWord=L293D, 2013.