جامعة الطائف
TAIF UNIVERSITY

Electrooculography (EOG)

Students name:

Mohammed Abdullaziz albadrani **44105884**

Maan Abdulrahman Al-Fatah **44109284**

Ahmed Abdulrahman Al-Rashidi **44151822**

Dr. Chokri BEN AMAR

1. definition and goal of the project

Electrooculography (EOG) is a technique to measure electrical activity resulting from eye movement. They are used to record eye movement and gaze direction, and form them by measuring potential differences between specific points on the skin around the eye.

Electrooculography (EOG) is an important and useful technique in studying and understanding eye movement, and has many applications in both medical and engineering fields

Electroretinography is used to diagnose and monitor many conditions and diseases, such as retinitis, night blindness, color vision disorders, optic genetics, and many other disorders that affect retinal function

the main goal of EEG is to provide important information about retinal health and function in a non-invasive and painless manner, which helps doctors diagnose various eye and vision-related conditions

2. some solutions from the literature

- Independent Component Analysis (ICA):

ICA has been widely used in EOG signal processing to separate the - EOG signals from other artifacts or physiological signals, allowing for better isolation and analysis of EOG activity

- Wavelet Transform:

Wavelet transforms have been employed for EOG signal denoising, feature extraction, and event-related potential analysis. This has proven to be effective due to its ability to capture both time and frequency information in the signal

- Machine Learning and Pattern Recognition:

Various machine learning algorithms, such as support vector - machines neural networks, and hidden Markov models, have been utilized for EOG signal classification, eye movement detection, and even for brain-computer interface applications

- Adaptive Filtering Techniques:

Adaptive filtering methods, like recursive least squares (RLS) and - least mean squares (LMS), have been applied to remove noise and artifacts from EOG signals, improving the reliability of the recorded data

- Deep Learning Approaches:

Recently, deep learning techniques, such as convolutional neural - networks (CNNs) and recurrent neural networks (RNNs), have shown promise in EOG signal processing, particularly in tasks like gaze estimation and eye movement recognition

These methods, among others, aim to extract meaningful information from EOG signals while mitigating the impact of noise and artifacts, enabling a wide range of applications from clinical research to human-computer interaction. It's such a vast and evolving field

3. detail one of the different technics available to solve your problem

Electrooculography (EOG) is a fascinating technique for measuring the resting potential of the retina. One of the different techniques available to solve problems with EOG is called the corneal-retinal potential method.

- Corneal-Retinal Potential Method

In this technique, the electrodes are placed on the surface of the cornea and around the eye. The corneal-retinal potential is the electrical potential generated by the cornea and the retina, which results from the constant polarization of the cornea and the retinal pigment epithelium with respect to the posterior pole of the eye

The corneal-retinal potential method is useful for recording changes in the electrical potential of the eye during eye movement. EOG using this method can be used in various applications such as assessing eye movements, detecting eye diseases, and even creating human-computer interfaces.

This method is non-invasive and is relatively easy to use, making it suitable for a wide range of applications. By analyzing the signal obtained through this technique, researchers and clinicians can gain insights into eye movement patterns and diagnose certain eye-related conditions

*How It Works

When the eye moves, the eye muscles cause a shift in the electric potential of the eye. By measuring the electrical potential around the eye, the movements of the eyeball can be detected, allowing for the analysis of various eye movement patterns

**Use Cases

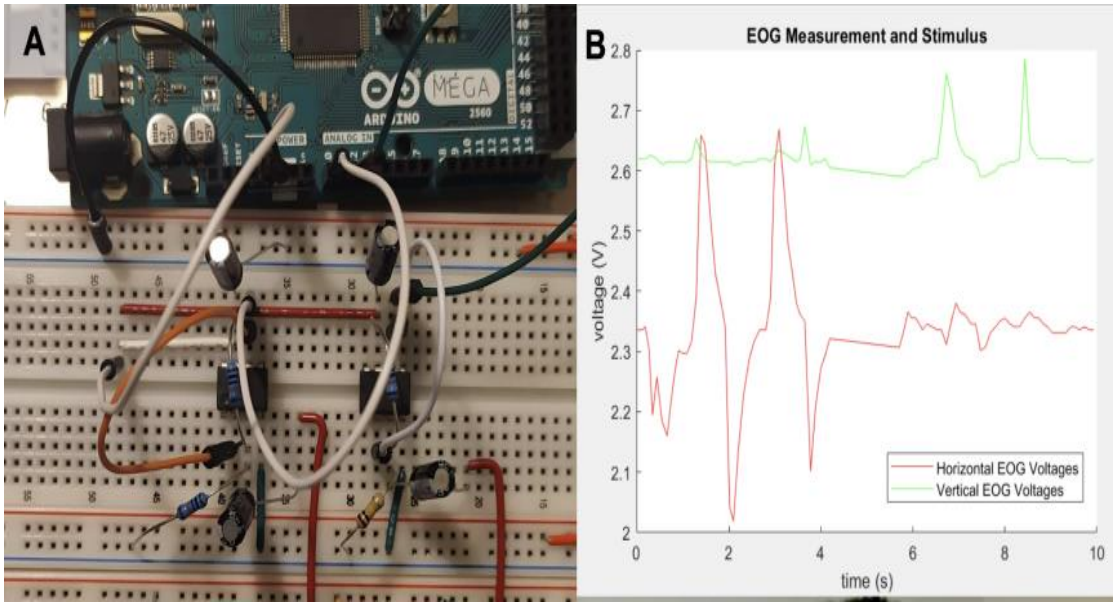
This method is often used in fields such as ophthalmology, neurology, and human-computer interaction. It can help in diagnosing conditions such as nystagmus, deconjugate eye movements, and other eye movement disorders. Moreover, the corneal-retinal potential method is also helpful in developing assistive technologies like eye-controlled computer interfaces

The corneal-retinal potential method is just one of the fascinating techniques used in EOG. It's amazing how technology allows us to gain insights into the electrical activities of the eye

4. EXPERIMENTAL METHODS

- Building the EOG circuitry

The experimental EOG setup, modified to use different circuit components, consists of two separate commercial AD622 IAs powered by +/- 12 V sources with gains of approximately 506 V/V (external resistor of 100 Ω). The signals are then filtered by separate but identical passive BPFs designed with unity gain for 1-55 Hz. Signals from the BPFs are then sent separately into level-set circuits that add a DC offset of 2.5 V such that the signals fall approximately between 0-5 V and are therefore readable by the Arduino. These signals are then sent into separate input pins of an Arduino Mega 2560 (A0 and A2) and imported into MATLAB for processing. No DRL was implemented due to the modified design of this circuit. A recorded trial using this experimental setup is shown in the picture below.

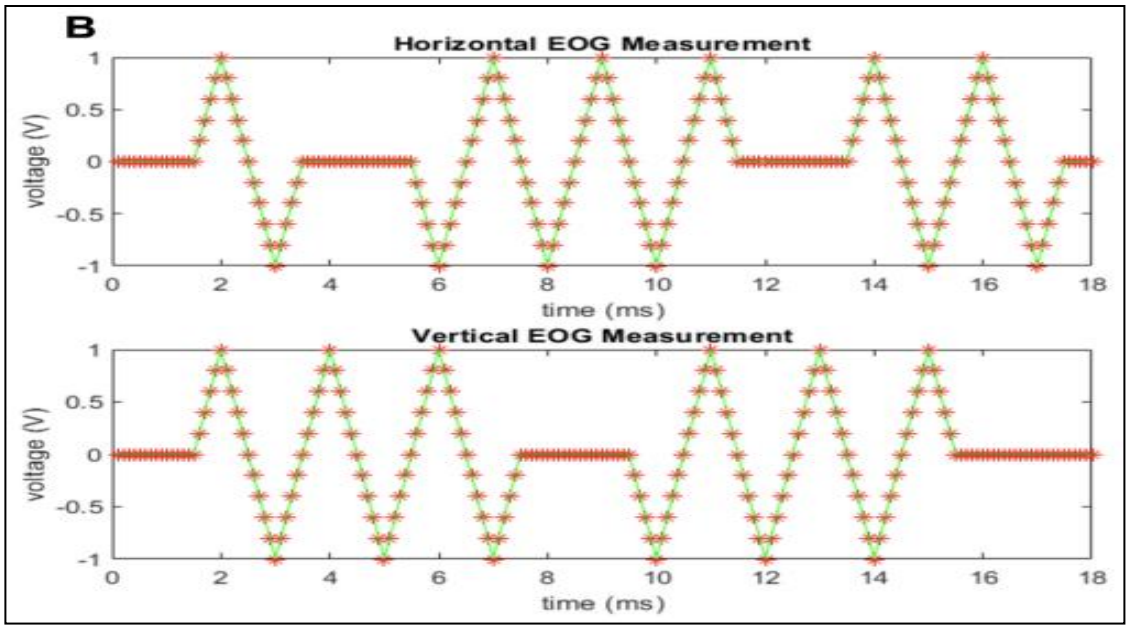


Experimental set-up of the modified EOG circuit.

(A) The circuitry for the modified EOG, level-set circuits, and connection to the Arduino.

(B) Graphed recorded EOG signals on MATLAB using standard pediatric-grade Ag/AgCl electrodes. We are able to see some leakage of azimuth and elevation movement, as the subject is not moving their eyes precisely along these axes and the electrode placement is also not precise.

- Signal Processing



Output eye movements are visualized using a 3x3 grid.

(A) A 3x3 grid is used to visualize where the eyes are focused by turning a square red to indicate the area which is being focused on.

(B) The corresponding signal to A is graphed to show the horizontal and vertical eye movements.

REFERENCES

[1] N. Barbara, T. A. Camilleri, K. P. Camilleri. “EOG-based eye movement detection and gaze estimation for an asynchronous virtual keyboard.” Biomedical Signal Processing and Control. Science Direct. (2018) https://doi.org/10.1016/j.bspc.2018.07.005

[2] S. K. Chen, M. O’Leary. “Eye Gaze 101: What Speech-Language Pathologists Should Know About Selecting Eye Gaze Augmentative and Alternative Communication Systems.” Perspectives of the ASHA Special Interest Groups. (2018). https://doi.org/10.1044/persp3.SIG12.24

[3] K. Sakurai, M. Yan, K. Tanno, H. Tamura. Gaze Estimation Method Using Analysis of Electrooculogram Signals and Kinect Sensor. Hindawi Computational Intelligence and Neuroscience. (2017). https://doi.org/10.1155/2017/20747524

[4] A. Lopez, F. Ferrero, J. R. Villar, O. Postolache. “High-Performance Analog Front-End (AFE) for EOG Systems.” MDPI Electronics. (2020) doi:10.3390/electronics9060960

[5] D. J. Mack, P. Schonle, S. Fateh, T. Burger, Q. Huang, U. Schwarz. “An EOG-Based, Head-Mounted Eye Tracker With 1kHz Sampling Rate.” IEEE. (2015)

[6] T. Yagi, “Eye-gaze Interfaces using Electro-oculography (EOG).” Tokyo Institute of Technology. (2010)

[7] A. A. Abusharha,“Changes in blink rate and ocular symptoms during different reading tasks.” Dovepress Clinical Optometry. (2017). doi: 10.2147/OPTO.S142718

[8] G. Cauwenberghs. “Lectures 8, 9, 10, 11, 12.” BENG 186B: “Introduction to Bioinstrumentation Design” (Winter 2021)

[9] Hofflich B.F. “Electrooculography-EOG-Eye-Gaze-Communication-Devi ce”. GitHub. (2021). https://github.com/benhofflich/Electrooculography-EOG-Ey e-Gaze-Communication-Device