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ELECTROOCULOGRAPHY

Dr Veena S[1], Rekha B A[2].

[1] Associate Professor, Department of Electronics and Communication engineering, S J C Institute of Technology Chickballapur, India, veenasdl@gmail.com

[2] UG Student, Department of Electronics and Communication engineering S J C Institute of Technology Chickballapur, India, rekhaba688@gmail.com

ABSTRACT :

Electrooculography-based Human-Computer Interaction (EOG-HCI) is a rapidly developing area of study. The primary objective of research in this field is to analyze eye movement patterns by measuring the potential difference between the cornea and retina. This process allows for the translation of eye movements into commands, thereby enhancing human-computer interaction through the use of eye movements. The goal is to offer a thorough examination of the latest advancements and obstacles within this domain. This involves a meticulous and organized review of the arrangement of electrodes for EOG signal detection, the design of hardware for EOG signal acquisition, commonly utilized features, and algorithms. Noteworthy studies in each category are presented to aid readers in quickly understanding the typical technologies employed in this field. Moreover, the article underscores the examination of interaction design in the EOG-HCI realm, classifying various types of interaction tasks and modalities to provide valuable insights into prevalent interaction research. By analyzing commonly used evaluation metrics, the current focus of research in this area is elucidated. Finally, a user-centric EOG-HCI research model is suggested to visually depict the current research landscape in the EOG-HCI field from a user's perspective. Additionally, we shed light on the challenges and prospects in electrooculography.

INTRODUCTION:

The electrooculogram (EOG) is a method used to measure the cornea-positive standing potential in relation to the back of the eye. Skin electrodes are attached near the lateral and medial canthus outside the eye to measure the potential while the patient moves their eyes horizontally a specific distance. The voltage decreases in darkness, reaching its lowest point after 8-12 minutes, known as the dark trough. When the lights are turned on, the potential increases, peaking around 10 minutes. A normal ratio of light peak to dark trough should be close to 2:1, with a ratio below 1.7 considered abnormal. The electrooculographic potentials originate from the pigment epithelium of the retina interacting with the mid retina. A normal pigment epithelium and mid retinal function are required for the light peak of the potential. The electrooculogram is commonly used to confirm Best disease, which is characterized by an egg-yellow fundus and can be confirmed by recording both an electroretinogram (ERG) and electrooculogram (EOG). The ERG will show normal results, while the EOG will be abnormal. Additionally, the EOG is utilized to track eye movements. Human-computer interaction (HCI) research focuses on studying the interaction process between humans and machines, forming a continuous loop. Through successive interaction loops, users achieve their goal of using interactive systems. The integration of biomedical engineering technology, such as biosensing and biofeedback, into HCI research enables a more adaptable and context-specific selection of triggers and feedback in interaction design. The eye, being a crucial sensory organ, acts as both a sensor and a trigger.

LITERATURE SURVEY

Shruti Bharadwaj and Bandna Kumari

Research focus: Tracking Human Eye Movements via Electro-Oculography (EOG) Published in: 2023 Description: The primary aim of this study is to present the current state of Electrooculography in Human-Computer Interface (HCI) to aid researchers interested in the field. The interest in developing Human-Computer Interfaces (HCI) has surged in recent decades to facilitate hands-free interaction with computer devices in various fields such as augmented reality applications, gaming, surgery, and assisting disabled individuals, such as those with advanced amyotrophic lateral sclerosis.

B. EstranyP and Fuster-Parra

A Research focus: Electrooculography: Examination of device manipulation through signal processing Published in: 2022 Description: This article delves into a novel technology involving the placement of electrodes on the forehead around the eyes to record eye movements, known as Electrooculography (EOG). It primarily concentrates on capturing the polarization potential, also referred to as corneal-retinal potential (CRP), which represents the resting potential between the retina and cornea. This potential is termed electrooculogram and is a minute electrical potential detectable using electrodes relative to eye displacement. Electrooculography serves as a control method to empower individuals with disabilities, particularly those with eye-motor coordination issues, enabling them to lead independent lives. It is a valuable assistive system for economically disadvantaged disabled individuals. The comprehensive command control EOG allows users to operate it with a high level of comfort. Human-Computer Interaction

(HCI) systems, particularly eye-tracking-based ones, are gaining popularity by the day. Electrooculogram (EOG) serves as a fundamental input source for such systems. The fundamental process of analyzing electrooculogram is termed Electrooculography.

METHODOLOGY

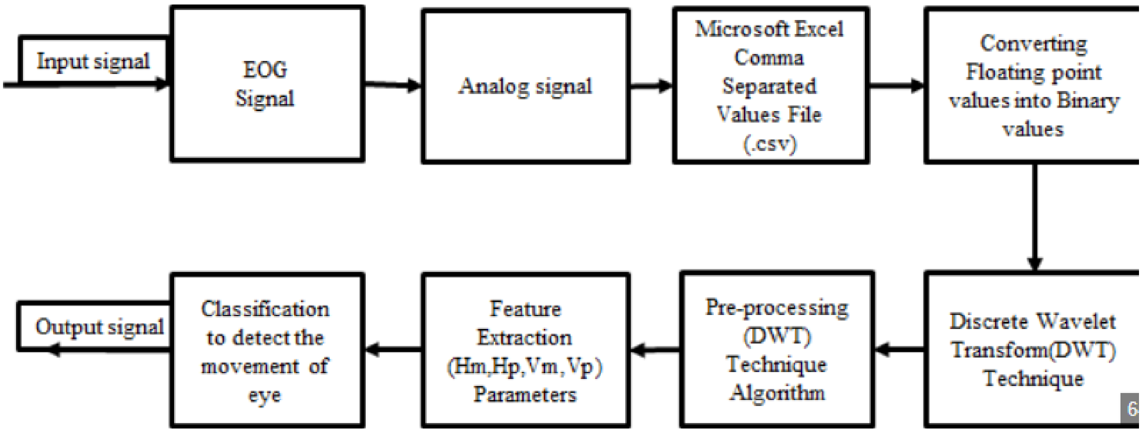

Fig 1: Block Diagram

The proposed Human PC interface based on EOG signals aims to record the movement of a single channel EOG using a remote device to capture the psychological parameters of the individual. These parameters include the horizontal and vertical movement of the injured eye and signs of squinting, which are detected through single flickers and double squints. This interface allows physically disabled individuals to independently operate their own tasks by monitoring the television and keyboard separately.

There are three distinct algorithms used in the proposed procedures to measure the electrooculography signal:

1. The first algorithm involves a pre-processing system that utilizes Discrete Wavelet Transform (DWT), Linear Predictive Coding, and auto backward coding. This system predicts future samples based on present and past samples, enhancing the accuracy of the measurements.
2. The second algorithm focuses on feature extraction, which involves storing the pre-processed samples and removing any raw data noise related to horizontal and vertical movements from the EOG signal.
3. The third algorithm employs a classification method to determine the direction of eye movement based on different eye movements. This method utilizes the continuous Electrooculography signal obtained from a Microsoft comma-separated file in .csv format. The data is collected through the National Institute of General Medical Sciences and the National Institute of Biomedical Imaging and Bioengineering under physionet.

CONCLUSION

The EOG utilized is a cost-effective and reliable human-computer interface that detects eye movements. By placing electrodes around five positions of the eyes, the EOG captures signals which are then amplified using an instrumentation amplifier to ensure accurate measurements for the study. To enhance the analysis, a filter is employed to eliminate high frequency components and power line noise. The resulting EOG signals are stored in a digital oscilloscope, allowing for differentiation of eye movement directions based on time and amplitude. This analysis of EOG signals offers individuals who are unable to manipulate objects with their hands a wider range of options for controlling various appliances. This demonstrates that control systems can be implemented at a non-industrial level, enabling automation and facilitating ease of use. While the focus of this method is on assisting disabled individuals with commuting, it is evident that there are numerous other applications for such a system. For instance, a fork-lift operator at a harbor or pilots navigating in clear conditions can benefit from this technique, making their tasks easier. In conclusion, this paper establishes that control engineering and neural processing can greatly simplify both industrial and non-industrial tasks. There is potential for further improvement in the placement of electrodes around the eyes.

FUTURE SCOPE

Electrooculography (EOG) shows great potential in a range of sectors, especially in healthcare, human-computer interaction, and neurotechnology. Some potential future applications include Healthcare Monitoring, Prosthetics and Assistive Devices, Human-Computer Interaction, and Biometric Authentication.

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