COMMUNICATING WITH PARALYZED PATIENTS USING EYE BLINK DETECTION

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ABSTRACT

Paralyzed individuals face significant challenges in controlling their environment and communicating with others. Existing assistive technology systems is limited in their functionality, making it difficult for these individuals to maintain independence and engage with the world around them. This work seeks to address these challenges by developing an eye blink detection system that can provide paralyzed individuals with a means of communication and control. A review of the existing literature on eye blink detection systems and their applications has been conducted. Several studies have been identified that demonstrate the potential of eye blink detection as a means of controlling various devices and inter- acting with computers. However, few of these systems are specifically designed for use by paralyzed individuals, and many require complex hardware and software con- figurations. The proposed eye blink detection system offers several advantages over existing assistive technology systems. It is low cost, easy to use, and highly accurate. It +is also highly customizable, allowing users to configure it to their specific needs and preferences. The system will be developed using open-source software and hardware, making it accessible to a wide range of users. This work aims to develop an eye blink detection system to assist paralyzed individuals in controlling their environment and communicating with others. The system will use an InfraRed Sensor to detect eye blinks, which will be interpreted as commands to control the system.

I. INTRODUCTION

Paralysis can result from various conditions such as spinal cord injury, stroke, or degenerative diseases, limiting the ability to move, speak or interact with others. It is the reason behind weakness of muscles with respect to hand, feet or voice. Because of this, the patient cannot perform his voluntary actions and it is very difficult for patients to express their needs.

Existing assistive technology systems have provided some solutions to these challenges, but they are costly and have limited functionality. The Eye Blink Detection and Assisting System for paralyzed individuals is an innovative IoT work aimed at addressing the communication and mobilitychallenges fed by individuals with paralysis.

The proposed system is used to control and communicate with other people through eye blinks. By tracking the movements and patterns of the user's eyes, the system can accurately identify intentional blinks and translate them into specific commands oractions. In the recent years due to the rapid advancement in the technology there has been a great demand of human-computer or human- mobile interaction. Eye blink is a quick action of closing and opening of the eyelids. Blink detection is an important enabling component for paralyzed individuals. The proposed system detects the voluntary blinks of the patient and accordingly sends the message about the requirement to the caretaker and also alerts him that the patient is actively using the system through an application.

Overall, the aim behind this work is to develop an innovative and practical solution that can significantly improve the lives of paralyzed individuals byproviding greater independence.

II. LITERATURE SURVEY

Meghana S, Monika R "et al." presents a real-time method for eye blink detection methods and their applications in assisting paralyzed individuals. It discusses the challenges faced by individuals with motor neuron diseases (MND) or paralysis, who often lose the ability to communicate verbally or in writing. Various methods for detecting eye blinks are reviewed, including the use of Haar Cascade Classifier for face and eye detection, and tracking eye movements based on facial axis information. The importance of eye tracking in human-

computer interaction is highlighted, emphasizing its role in measuring user interest and attention. The review also covers existing communication systems for paralyzed individuals, such as those based on brain wave control or eye movement tracking, which are often expensive and not always convenient for users. The work emphasizes the need for cost-effective solutions for paralyzed individuals, advocating for the development of affordable systems that can be used by a wide range of people. Additionally, the challenges of real-time eye blink detection, including variations in lighting conditions and eye movement, are discussed. The proposed method in the work achieves an 8% improvement in accuracy for eye detection and blinking, showcasing its potential for real-time applications and offering a level of independence to paralyzed individuals in communicating with others.[1]

Namratha Ks, Jeevitha Bs "et al." provides an overview highlighting existing techniques for communication used by MND patients, such as brain wave detection, electro- oculography, and swift key techniques. These methods, while effective, can be painful or cumbersome for patients due to the use of electrodes or complex interfaces.

The proposed system aims to overcome these limitations by providing a simpler and less intrusive communication method. It uses a combination of image processing techniques, including Haar-Cascade Classifier algorithm for face and eye detection, to capture and interpret eye blinks as meaningful communication signals. The system is designed to be affordable and easy to use, making it accessible to a wider range of patients.

In terms of methodology, the system relies on an eye blink sensor interfaced with a Raspberry Pi to detect blinks. The input from the sensor is then used to activate a relay circuit, which triggers the execution of corresponding applications. This allows patients to control various devices, such as lights or fans, using just their eye blinks.

Overall, the work presents a novel approach to communication for paralyzed patients, leveraging the advancements in image processing and sensor technology to improve their quality of life.[2]

Ananda Babu J, Keerthi K S "et al." focuses on the challenges faced by individuals with Motor Neurone Disease (MND) in communicating effectively and the existing assistive technologies. MND is a condition that affects the brain and nerves, making it difficult for patients to communicate their thoughts and needs. Traditional communication aids, such as

keyboards and touch screens, are often not suitable for MND patients who may only have control over their eye movements.

Various existing systems and technologies have been developed to assist individuals with disabilities in communication. These include electro-encephalogram (EEG) systems, which record brain waves to detect intent, and electro-oculography (EOG) systems, which track eye movements. However, these systems can be expensive, require training, and may not always be comfortable for the user.

The proposed system in this work aims to overcome these limitations by using a simple and non-intrusive method based on eye blinks. By analyzing the pattern of eye blinks, the system can convert these blinks into speech, allowing MND patients to communicate effectively. The system uses Haar Cascade Classifiers for real-time face and eye detection, making it cost-effective and accessible.

The Eye Aspect Ratio (EAR) formula used in the work is defined as:

$$EAR = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2 \cdot \|p_1 - p_4\|}$$

Here p1,p2,p3,p4,p5 and p6 are 2D facial landmark locations. The numerator represents the distance between the vertical eye landmarks, while the denominator represents the distance between the horizontal eye landmarks. The EAR is used to determine if a blink is detected, with a blink registered when the EAR is below a certain threshold and rises suddenly above the threshold.

Overall, the literature review highlights the need for affordable and user-friendly communication aids for individuals with disabilities, particularly those with conditions like MND. The proposed system in this work aims to address these needs by providing a simple, effective, and accessible solution for communication.[3]

Shiva Kumar, Shilpa "et al."[4] "Eye Blink Detection – A Survey" by Shiva Kumar Patil et al. explores the use of blink detection methods to assist paralyzed individuals, particularly those with Motor Neuron Disease (MND) and other conditions affecting muscle control. The review discusses various technologies and approaches, including Electrooculography (EOG) signal detection using electrodes, Arduino-based systems with eye blink sensors, and microcontroller-based systems for IoT applications. These methods aim to capture intentional

eye blinks and convert them into command signals for communication and control, such as controlling a wheelchair or selecting letters on a screen for communication purposes.

One key aspect highlighted in the review is the user- friendliness and wireless nature of these systems, enabling communication and control from a distance. However, challenges such as discomfort due to wearing electrodes, errors in eye blink detection, and the need for caregiver assistance are also discussed. Overall, the review underscores the potential of eye blink detection systems in enhancing the quality of life for paralyzed individuals by providing them with a means of communication and interaction with the outside world.[4]

Bishar R Ibrahim, Farhad M Khalifa "et al." introduces an embedded system that employs machine learning to detect eye blinks. The primary objective is to accurately identify eye blinks, which can be beneficial for applications such as driver drowsiness detection and human-computer interaction. The authors present the system's design and implementation, which incorporates machine learning algorithms specifically designed for blink detection. The work includes experimental results to evaluate the system's performance and effectiveness.[5]

Lamiya Rahman, Jannatul Adan "et al." presents a system that enables paralyzed individuals to control home automation using an eye blink sensor. The authors propose a solution that utilizes an eye blink sensor to detect and interpret blink patterns, allowing paralyzed people to interact with and control various aspects of their homes. The system focuses on enhancing the independence and convenience of paralyzed individuals by providing them with an alternative means of controlling lights, appliances, and security systems. The work explores the implementation of the eye blink sensor-based system, addressing the technical aspects and considerations specific to paralyzed users. By leveraging eye blink movements, the system offers a non- invasive and intuitive approach to home automation, tailored to the needs of paralyzed users. The study contributes to the field of assistive technology by providing a practical and accessible solution for home automation, empowering paralyzed individuals to have greater control over their living environment.[6]

III. METHODOLOGY

The system works by detecting the presence of the user's eye using the IR sensor within a certain range. The flex sensor measures the bending of the user's eyelid to detect eye blinks. When an eye blink is detected, the system sends a signal to the Node MCU, which then processes the blink and compares it to predefined blink patterns. Each predefined blink

pattern corresponds to a specific message or action. For example, a single blink might indicate a desire to turn on a light, while two rapid blinks might indicate a request for assistance.

Once the blink pattern is recognized, the Node MCU activates the corresponding action. This could involve sending a message through IoT devices to control a specific device or sending an alert message to a caretaker through Telegram. The relay module connected to the Node MCU is used to switch on or off the connected device based on the blink pattern detected.

Overall, this system provides a simple yet effective way for paralyzed individuals to communicate and control their environment using only their eye blinks.
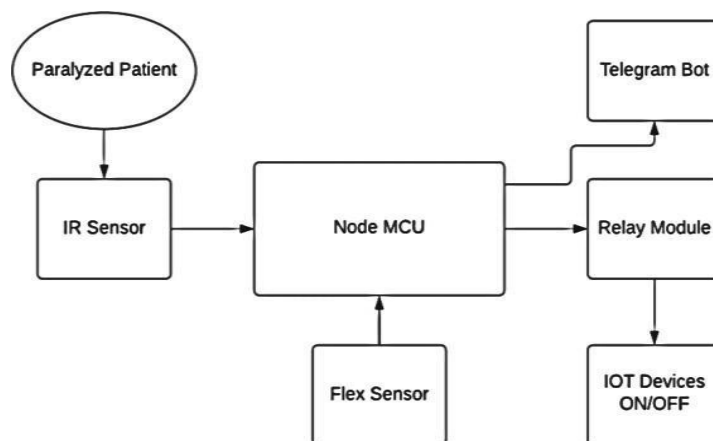

Fig. 3.1: System Design.

Here's a detailed process of how your system works

Blink Detection: The system uses an IR sensor module to detect the presence of the user's eye within a certain range. A flex sensor measures the bending of the user's eyelid to detect eye blinks.

Node MCU: The Node MCU, an ESP8266-based development board, serves as the main control unit of the system. It receives input from the IR sensor and flex sensor to detect eye blinks.

Predefined Messages: For each specific type of blink, the system has predefined messages. These messages could indicate different needs or actions that the user wants to communicate, such as requesting assistance, turning on a device, or indicating a basic need.

Message Transmission: When the system detects a blink that corresponds to a predefined

message, it triggers the transmission of an alert message. The message is sent to a caretaker through the Telegram messaging app, informing them of the user's need or action.

Relay Module: In addition to sending alert messages, the system can also control connected devices. For example, when a specific blink is detected, the system can send a signal to a relay module, which then activates or deactivates a connected device, such as a light or a TV.

Alert Confirmation: The caretaker receives the alert message on their Telegram app, confirming the user's request or action. This allows the caretaker to respond promptly to the user's needs, providing assistance or fulfilling the user's request.

IV. WORKING

The eye blink detection system for paralyzed individuals is designed to provide a communication and control mechanism using eye blinks. The system starts with the initialization of the hardware components, including the Node MCU microcontroller, IR sensor, flex sensor, and relay module, as well as the software setup using Arduino libraries and the Telegram Bot API. The flex sensor continuously detects muscle movements associated with eye blinks and provides analog readings to the Node MCU, while the IR sensor confirms the blink by detecting an object in front of it during the blink.

When an eye blink is detected and confirmed, the system sends a message via the Telegram Bot API to notify the user or caretaker. The system also monitors the frequency and pattern of blinks to differentiate between single and multiple blinks. Based on the blink pattern, the system may toggle the relay states to control external devices, such as lights or appliances, providing the user with a means to interact with their environment. The relay module serves as a switch to control the power supply to these devices, ensuring safety and isolation between the low-voltage signals from the Node MCU and the high- voltage devices.

The system continuously loops through the process of reading sensor data, detecting blinks, controlling devices, and sending messages, ensuring real-time responsiveness. The feedback provided through the Telegram Bot API messages allows the user or caretaker to monitor the system's actions and status, providing a means of communication and control despite the user's paralysis. Overall, the eye blink detection system enhances the user's independence and quality of life by enabling them to communicate and control their environment using just their eye blinks.

V. RESULT

An eye blink detection system is designed to detect and monitor the blinking of a paralyzed person's eyes. The specific results of an eye blink detection system can vary depending on its implementation and intended application. The system can accurately detect and identify instances of eye blinks in real-time. Our work successfully combines eye blink of a person and the flex from the sensor which allows the person to interact with their IOT devices and send massages for their care taker through a telegram bot. It provides real-time tracking of the eye blink and flex sensor which are used to perform different task. The tasks are assigned to the number of eye blink of a person by which he/she can decide which task to perform and the flex sensor is used to select and execute the task. It can analyze the input data and determine when a person's eyes are closed or open, indicating a blink. The system can keep track of the number of blinks that occur within a specific time. The system can trigger an alert or notification when certain blink patterns or conditions are detected. Overall, our work provides a user-friendly and seamless integration with external services and also provide the paralyzed person to communicate with the external world.

The hardware components in the eye blink detection system are connected as follows: The Node MCU (ESP8266) is the main controller, connected to the Wi-Fi network. The flex sensor is connected to the Node MCU's analog pin A0 and ground (GND), detecting eye blinks. The IR sensor, connected to digital pin D0, confirms blinks by detecting objects during blinks (not fully implemented). The relay module connects to digital pins D1 and D2, controlling external devices. All components share a common ground connection for proper functioning. Optional components like LEDs or buzzers can be added for feedback.
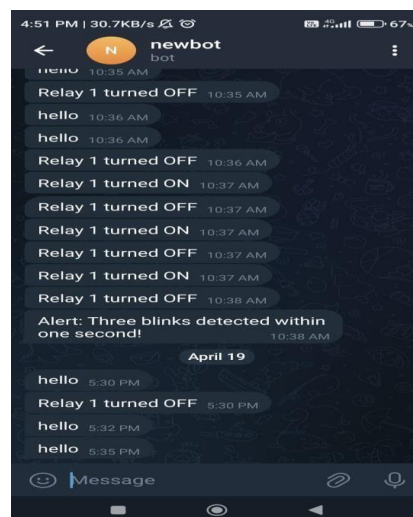

Fig. 4.1: Telegram Bot.

The Telegram Bot in the eye blink detection system also allows the paralyzed individual to send specific messages to the caretaker, indicating their needs or requests. For instance, if the individual needs water, they can blink in a specific pattern or sequence that the system recognizes as a request for water. The system then sends a message to the caretaker via the Telegram app, such as "Alert: User requests water," informing them of the individual's need. Similarly, if the individual requires medication, they can use another predefined blink pattern to convey this message. These messages enable the paralyzed individual to communicate their needs effectively to the caretaker, enhancing their ability to receive timely assistance and support.

VI. FUTURE ENHANCEMENT

Future enhancement involves the integration of IoT technology. By configuring IoT devices, patients could control lighting and fan settings through simple gestures, such as blinking. This approach not only alleviates the caretaker's workload but also fosters a sense of independence for the patient.

A notification alarm could be established to signal instances where the caretaker overlooks incoming calls or messages. This alarm would promptly notify the caretaker, allowing for immediate response and assistance.

VII. CONCLUSION

The Eye Blink Detection and Assisting System offers significant benefits, including improved communication abilities, enhanced independence, and increased social inclusion for paralyzed individuals. It empowers them to regain control over their lives, express their needs and desires, and reduce their reliance on caregivers. The user interface was designed with a focus on accessibility and adaptability, allowing paralyzed individuals to interact effortlessly with the system. Integration with various IoT devices commonly found in households was established, enabling individuals to control their environment, access entertainment, and perform daily tasks using eye blink commands. In targeting it with existing technologies, it can revolutionize the way people interact with digital devices and services. In conclusion, the Eye Blink Detection and Assisting System holds great potential to revolutionize the lives of paralyzed individuals. By harnessing the power of eye blinks for communication and control, this innovative IoT work paves the way for increased independence, improved social interaction, and a higher quality of life for individuals living with paralysis.

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