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AUTOMATIC HOME CONTROLING SYSTEM FOR PARALYZED PATIENTS USING EYE MOVEMENT

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ABSTRACT: Disabled individuals represent a valuable human resource for society, and their effective participation is essential. In this context, we have developed a prototype system that enables the control of home appliances through eye movement for cursor control. The system utilizes a camera to capture images of eye movements and detects the position of the pupil's center. Based on the detected signals, the prototype can control various appliances, providing an innovative solution to enhance the quality of life for disabled individuals. In the realm of assistive technology, this project introduces a pioneering system tailored for individuals with mobility impairments, aiming to provide them with an innovative means of controlling home appliances through the precise tracking of ocular movements. The system leverages a dedicated camera for real-time image acquisition, with a focus on capturing the dynamic movements of the human eye. A central facet of the system entails the intricate analysis of these acquired eye movement images to discern the precise position of the pupil and ascertain its directional shifts. These analyze signals serve as the foundation for issuing control commands to a variety of home appliances.

Index Terms:
Eye Tracking, Home Automation, Machine Learning, Assistive Technology, Paralyzed Patient Centre, Home Control.

I. INTRODUCTION

The thesis explores the realization of smart spaces through IoT, inspired by Mark Weiser's vision. With an estimated 50 billion connected devices by 2020, there are evident benefits like energy efficiency and enhanced safety through automated systems, such as smart lighting and alarms. However, managing interactions with numerous devices can be overwhelming. Context-aware systems, which recognize and respond to environmental situations without explicit user input, could be a solution. Despite challenges in context-recognition due to the complexity of processing data from multiple sensors, these systems are crucial for the IoT's adoption and the vision of smart spaces.

Activity recognition has been achieved through sensors in smartphones and wearables but is limited to physical activities. While computer vision techniques improve accuracy, they raise privacy concerns. Eye tracking presents potential for detecting non-physical activities and states like cognitive load, reading, and emotions. Though current eye trackers have limitations, advancements hint at future unobtrusive integration in smart glasses, as seen in Google Glass and Tobii eye trackers. Eye tracking technology has evolved significantly, finding applications beyond research, such as driver assistance and input modalities for disabled individual

II. RELATED WORK

Here are some related works for an Automatic Home Controlling System for paralyzed patients using eye movements The Article [1] IoT-Based Smart Home for Paralyzed Patients: Newly designed high-tech devices are implanted in the patient's body to help him or her resume daily activities. This system uses an eye blink sensor that is small in size and easy to use to power home electricity appliances. The Research Paper [2] Home Automation Using Eye Blink Sensor for Paralyzed People: This automation technology can be controlled easily using their eyes, which is the only control they have. This system aims to develop a home automation system for patients which could be used with least or minimal effort to control the home appliances. The Paper [3] Home Automation System: By Eye Blinking for Paralyzed and Disabled People: This system uses a blinking sensor to disassemble their retrieval. The blink sensing element is an electronic device that can hear the glow of the eye and, when attention is closed, provides the corresponding output power. The Research Article [4] Paralysis Patient Health Care Monitoring System Using Machine Learning: This system uses an eye blink sensor that detects eye blinks and produces a voltage output when the eye is closed.

III. PROPOSED WORK

Existing systems for automatic home control using eye movement primarily integrate advanced eye tracking technology with popular smart home platforms, such as Amazon Alexa, Google Assistant, or Apple HomeKit. These systems enable paralyzed individuals to control a variety of household appliances and functionalities solely through eye movements, offering a new level of independence and autonomy. Designed with intuitive and user-friendly interfaces, they facilitate easy calibration, customization of settings, and seamless interaction with connected devices. Additionally, these systems incorporate essential safety and security features, including emergency stop functions and secure authentication methods, to safeguard user well-being and prevent unauthorized access or misuse. However, despite the promising advancements and benefits, several challenges and limitations persist. Additionally, addressing the need for personalized and customizable interfaces to accommodate individual user needs, preferences, and abilities is crucial. Furthermore, ensuring reliable and robust performance of the system under various environmental and lighting conditions, as well as addressing the cost implications and accessibility barriers associated with acquiring and maintaining eye tracking technology and smart home devices, remain significant areas of concern. Therefore, further research and development are required to overcome these challenges and enhance the reliability, accuracy, and user-friendliness of existing systems, ultimately empowering paralyzed individuals to effectively and independently control and interact with their smart home environments through eye movements.

Accuracy Concerns: Existing systems may struggle with consistent and accurate eye movement tracking, particularly for individuals with severe motor impairments or fluctuating eye conditions. Limited Adaptability: The lack of personalized and customizable interfaces restricts the system's ability to accommodate individual user needs, preferences, and abilities effectively.

Reliability Issues: The system's performance may vary under different environmental and lighting conditions, potentially affecting its overall reliability and robustness. Cost Implications: The high cost associated with acquiring and maintaining advanced eye tracking technology and compatible smart home devices can be a significant barrier for widespread adoption and accessibility. Complex Calibration: The calibration process required to set up and optimize the system for individual users may be complex and time-consuming, potentially discouraging users from utilizing the system. Security Risks: Despite incorporating safety and security features, existing systems may still be vulnerable to unauthorized access, potential misuse, and security breaches, compromising user privacy and safety.

3.1 PROPOSED SOLUTION

Enhanced Accuracy: The proposed system aims to improve eye movement tracking accuracy through advanced algorithms and calibration techniques, catering to individuals with varying motor impairments and eye conditions.

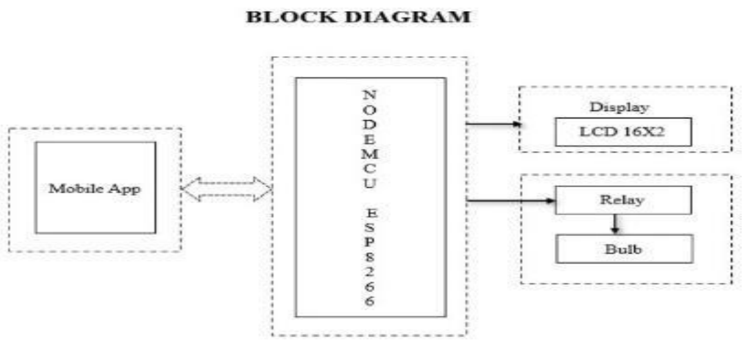
Personalized Interfaces: The system will feature customizable and adaptive user interfaces, allowing personalized settings and configurations to accommodate individual user preferences, needs, and abilities effectively.

Robust Performance: The system will be designed to deliver consistent and reliable performance across diverse environmental and lighting conditions, ensuring robust and uninterrupted operation.

Cost-effectiveSolutions: Implementing cost-effective eye tracking technology and leveraging open-source smart home platforms to reduce overall system costs and enhance accessibility for a broader user base Implementing cost-effective eye tracking.

Simplified Calibration: Introducing simplified and user-friendly calibration processes to streamline the initial setup and optimization of the system, making it more accessible and user-friendly.

Enhanced Security Features: Incorporating advanced security protocols, encryption methods, and multi-factor authentication to enhance user privacy, safeguard against unauthorized access, and mitigate potential security risks and breaches.



Expanded Functionality: Offering expanded functionality and control options, enabling paralyzed individuals

Figure 1 : Block Diagram

3.1.1 MERITS

Improved Independence: Enables paralyzed individuals to independently control and manage their smart home environment without assistance, enhancing their overall autonomy and quality of life.

User-friendly Interface: Intuitive and customizable interfaces make it easier for users to calibrate, operate, and customize the system according to their preferences, needs, and abilities.

Enhanced Accessibility: Utilizing advanced eye tracking technology and open-source smart home platforms ensures broader accessibility and affordability, making the system accessible to a wider range of users.

Increased Reliability: Advanced algorithms and robust performance across various environmental and lighting conditions ensure consistent and reliable operation, minimizing system downtime and interruptions.

Personalized Experience: Tailored settings, configurations, and control options allow users to create a personalized smart home environment that meets their unique needs, preferences, and lifestyle.

Improved Security: Advanced security features, encryption methods, and multi-factor authentication protocols enhance user privacy, protect against unauthorized access, and reduce potential security risks and breaches

3.2 WORKING PRINCIPLE

The circuit diagram for the home controlling system integrates a buck converter, relay module, NodeMCU (ESP8266), and I2C LCD module.

Figure 2 : Hardware Kit

Fig 2: Hardware kit “The buck converter steps down the input voltage to power the system. Relay modules connect to the NodeMCU's GPIO pins, controlling household devices. The NodeMCU processes eye movement data and communicates with the I2C LCD module via the I2C protocol for user feedback. Power and ground connections from the buck converter output provide power to all components. This setup enables the automatic control of home appliances based on eye movements, enhancing accessibility and independence for paralyzed individuals”.

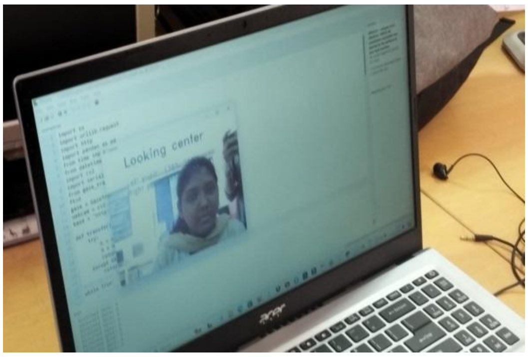


Figure 3: Looking center

Fig 3: Looking center "Incorporating advanced eye-tracking technology, our home control system grants individuals with paralysis unparalleled independence. With a central gaze, lights gently fade into darkness, fostering a serene environment conducive to relaxation or rest. This seamless integration of technology and accessibility ensures a comfortable and personalized living space for all users."

Fig 4: Looking left "Using eye-tracking technology, we've developed an innovative home control system tailored for individuals with paralysis. By simply looking left, the fan activates, providing a refreshing breeze. This intuitive setup offers independence and convenience, empowering users to effortlessly manage their environment with a glance."

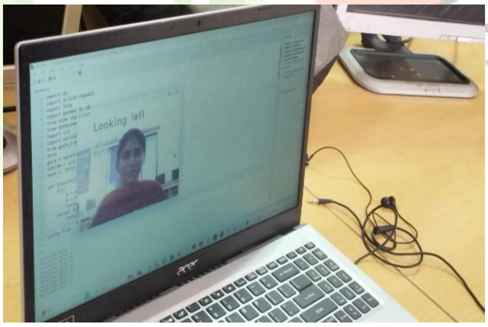


Figure :4 Looking left

Fig 5: Looking right "Continuing our user-friendly home control system, a simple glance to the right ensures comfort and energy efficiency as the fan gracefully powers off. This intuitive design caters to the unique needs of paralyzed individuals, offering seamless control and enhancing their quality of life."

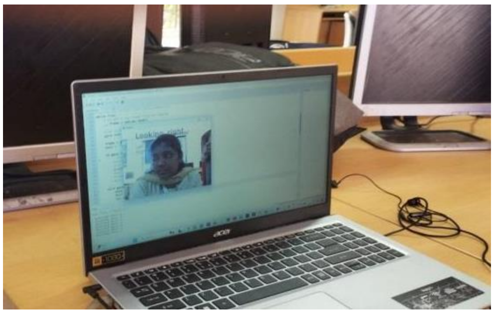


Figure : 5 Looking right

IV. CONCLUSION AND FUTURE WORK:

We have explored the possibility of recognizing daily everyday activities using eye movement data. There is a clear gap in the previous research regarding this topic, few re-searchers have examined 3D environments when detecting activities with eye movement data. Using a home-built eye tracker, we conducted an experiment where ten participants performed everyday activities in a kitchen environment in order to generate data. This data was then annotated and preprocessed and fed to classifiers in order to classify attributes extracted from eye features to certain activities. With our results, we managed to answer our research questions and hypotheses on what level of accuracy can be achieved and what activities were easier to detect. Our results showed that a medium accuracy rate between 30-40% can be achieved for fine-grained tasks but that more general tasks tend to be difficult to detect. In conclusion, our findings suggest that there is a possibility of detecting activities in A 3D environment but that further research, mainly including more data, is needed in order to make any generalization from our results. Our findings indicate that activity recognition in 3D environments still remain difficult and complex. Many variables need to be further examined in detail in order to isolate which can improve the results and which cannot.

For future work on this subject, there is a number of topics that can be further explored. Firstly, having more different varied tasks, environments, participants and more repetitions of each task would probably have yielded quite different results compared to ours. We suggest using real environments, perhaps letting participants use their own kitchen that they use daily would have made less artificial results. Also outdoor environments is an interesting area to explore as it is even more noisy than indoors.

Secondly, we suggest using higher performance eye trackers, both head-mounted and remote in order to compare the differences between them. Our hardware platform was obtrusive and not very reliable for data collection, using better hardware would mitigate these problems.

Thirdly, the importance of the steps in machine learning should not be understated. These attributes could also have been preprocessed differently to reduce noise more efficiently. We also found it difficult to choose which classifiers to use. There are numerous different classifiers with different settings that can be tuned for the specific problem at hand. A study of which classifier works best for which type of eye movement data set would be a valuable contribution for this field of research Fourthly, combining eye tracking in 3D environments together with object recognition or other approaches is an area of high interest. Previous research using a fusion of sensors but in 2D have shown to yield good results. Therefore, using a fusion of sensors in 3D environments would be an interesting area of research.

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