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Eye Ball Motion Controlled Automatic Wheelchair For Paralyzed People

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ABSTRACT :

By utilizing the capabilities of the Raspberry Pi microprocessor, this proposed model aims to provide a new method of controlling a wheelchair by eye ball movement. By employing image processing techniques to identify and track the user's eye movements, this proposed model offers a novel way to control a wheelchair using eye ball movement. The device employs image processing techniques to determine the user's eye movement and direction after taking pictures of their eyes with a camera. The wheelchair is then controlled by commands derived from the identified eye movements. The suggested approach may offer those with mobility disabilities a more straightforward and easy-to-use method of controlling their wheelchair. The masking technique is being applied here. The wheelchair moves to the left when the eye is pointed that way. The wheelchair goes in the right way when the eye is pointed in that direction. The wheelchair was operated by a wiper motor. It is challenging to use an automatic wheelchair or crutches, and the previously developed automatic wheelchairs that are now on the market are not accessible to physically disabled people. The goal of this research project is to suggest an automated wheelchair system that makes life easier for users. The entire body has been incorporated into the design and construction of the suggested wheelchair.

Keywords: Raspberry Pi, Camera, Relay Module, Wiper Motor.

INTRODUCTION

An automatic wheelchair or an electric-powered wheelchair is a device that is powered by an electric motor instead of muscle strength. For people who cannot push a manual wheelchair or who might need to use one for long distances or over uneven terrain that would be taxing in a manual wheelchair, automatic wheelchairs are helpful. They can also be used by those with cardiovascular and fatigue-related disorders in addition to those with traditional mobility problems. Approximately 600 million people are 60 years of age or older worldwide, while one billion people are thought to have disabilities. In India, an estimated 26 million individuals live with a disability, although the situation is far worse [26]. Given that elderly people often have unmovable issues, shaking, and partial paralysis, this is really alarming news.

In recent years, there has been a sharp rise in the population of physically disabled people. According to recent figures, 700 million people, or 15% of the global population, are physically and intellectually disadvantaged. Of them, 100 million are physically disabled. In India, the true situation is far more severe, although one research claims that only 20.28% of the population is physically challenged [26]. In nations like India, the vast majority of people with physical disabilities rely on manual wheelchairs or crutches for mobility. Many wheelchair users are unable to adequately operate their wheelchairs with their hands due to physical limitations. Furthermore, automatic wheelchairs are expensive compared to the average person's financial situation and are not always available in developing nations.

Fig. 1. Hindrance of Wheelchair users during work

Users of conventional automatic wheelchairs require assistance from others and are unable to modify the wheelchair seat to suit their needs (Fig.1). Additionally, users who are physically weak often have trouble gripping the joystick that controls the motorized wheelchairs. The goal of this project is to improve the facilities for users by designing an automated wheelchair with a seat that can be moved vertically.

LITERATURE REVIEW

The automotive industry, medical science, fatigue simulation, car simulators, cognitive testing, computer vision, personality verification, and other fields are among those that apply eye-tracking principles widely. The significance of eye monitoring and identification in industrial applications increased over time. Due to the significance of eye-tracking applications, many modern devices must have more robust and efficient designs. An extensive review of the literature relating to the eye-tracking system has been carried out in healthcare applications.

One method uses machine learning to extract the iris by segmentation algorithm. The MATLAB software was used for all testing, and the algorithm's accuracy of 86% is unsatisfactory. The authors also noted that the speed of detection increased, although they did not specify how much [1].

The imaging processing module, wheelchair-controlled module, SMS management module, and appliance-controlled module are the three primary components of this chair. A camera with glasses attached makes up the imaging processing module. The captured image is transferred to the Raspberry Pi microcontroller will be processed using OpenCV to derive the direction of the two-dimensional eyeball. For controlling movement, the eye movement will be wirelessly relayed to a wheelchair-controlled unit. However, there is no calculation for the calibration time. Their suggested chair lacks components and is somewhat expensive. A microcontroller called Raspberry Pi were used which may cost up to 70$, But our proposed system used the Arduino Uno, which doesn't exceed 10 $ and it reaches the same result [2].

A wheelchair is also designed that moves by eye-tracking, first the camera capture the user image and detect the eye position by edge detection technique (Laplacian), The wheelchair DC motor is then controlled with the aid of a PID controller once the pupil orientation is determined using the segmentation technique (Haar cascade algorithm). The detection accuracy was 90%. However, the Laplacian approach is very sensitive to noise, and calibration time is not computed. Since the Haar cascade approach relies on edge or line detection, it works well for detecting faces and eyes but not for detecting eye movement [3].

The Wheelchair can be controlled by the eyeball movement with the aid of a webcam, which further undergoes multiple image processing techniques. To determine the location of the eye pupil, a continuous image is taken. The usual image processing techniques are then used in conjunction with the Haar cascade algorithm. Wheelchair mobility is facilitated by the DC motor installed on the wheels. The wheelchair is equipped with an ultrasonic sensor that detects obstructions in its path and stops it from moving in response to sensor commands. The chair's 91% accuracy rate needs to be raised. Additionally, as previously stated in this application, Haar cascade consists of numerous weak classifiers, and the wheelchair moves in four directions rather than 360 degrees, unlike our suggested wheelchair, which moves in 360 degrees in the direction of the eyes [4].

Eye-tracking system can be functioned, by recording a video of user's face using an infrared camera. The six stages of the suggested algorithm—eye area extraction, iris border identification, keyframe detection, pupil localisation, deviation estimation, and strabismus evaluation—are then applied to the video. Cover test results from both strabismus and normal people were compiled into a database. The experiments' outcomes demonstrate the accuracy with which our suggested approach may assess strabismus deviation. The accuracy was more than 86% in the vertical direction and more than 91% in the horizontal direction. The sole disadvantage is that measurement precision can be enhanced [5].

In addition to Ambient Space Engineering, the system comes with a wheelchair, eye-tracking glasses, a depth camera, a portable computer with flexible stand for optimal comfort, and a safety off button to turn the device off when needed. The author captures the eye and determines its direction using the CNN method. Their study's calibration time was 36 seconds, and its accuracy was 92%. The suggested solution is built on the deep learning foundation, which offers an easy way to extract eyes and more accuracy in detecting all facial features. utilising his Face Landmark points and the dlib [6].

There are many people who are not able to move wheelchair on their own and according to survey many suffer from disease like quadriplegia.Many people previously worked on this so by taking analysis for previous works. Studying various surveys and analyzing the information from the reviews the wheelchair can be controlled with eye movement. The computer input devices such as keyboard, mouse, and the other input devices have been used to interact with digital instruments. The handicap person cannot handle these devices. The commands are given by detecting the motion of human eyes so computer input is human eyes it is only is proposed for handicap person. This can be divided into five categories.

A. Bio-potential based control[15]

In this method by recognizing the bio-potential signals the interface recognizes the person gestures like forehead movement, closing the jaw using special instrument. Instrument such as Electrooculography(EOG)[11] Electromyography (EMG), and Electroencephalograph (EEG)[12], Search coil can be used for measuring biopotential.EOG [13] method take into consideration voltage differences between the image before and after.

B. Voice based control

In this technique person voice is use as input source which use user's voice as source input. Wheelchair control is obtained using voice commands. Voice analysis is used to analyze user's voice and convert it into digital data. The disadvantage of this system is it is vulnerable against noise. Other voices coming from surrounding atmosphere have effect on this technique.

C. Motion based control

In this technique user’s various moving organs are used to control the computer input. Moving organs include hand, head, foot etc.

D. Image Analysis method

In this technique user utilize camera to capture image of the desired object and after which it is converted into digital data .Several image processing methods are used to analyze user's desire. The user's desire itself can be fulfilled by gaze-based [16] analysis, which uses the user's sight. A variety of algorithms are available to process images.

E. Search coil method [8]

This technique uses induced voltage with coil including in contact lenses attached to user's eyes. Studying and analyzing various aspects of each method image based method is taken into consideration for full-filling the objective of wheelchair control. Numerous individuals have worked on this issue using techniques such as the Viola-Jones Algorithm, Daughman's Algorithm, and the Coherence Algorithm [10]. Many algorithms provide results, but the type of algorithm applied defines how accurate the results are.

METHODOLOGY

The "Eye Ball Motion Controlled Automatic Using advanced eye-tracking technology, this device reads the user's gaze or eye movements and translates them into orders for operating the wheelchair.

The methodology's main goal is to guarantee the smooth integration of control systems, software, and hardware in order to provide a wheelchair that is responsive, dependable, and easy to use. The methodology seeks to provide a solution that improves mobility and independence while preserving comfort and usability by addressing crucial elements such signal acquisition, real-time processing, motion control, and safety.

Problem identification, hardware-software integration, prototyping, testing, and optimization are some of the steps in this methodical process. Every stage is meticulously designed to guarantee the system's precision, dependability, and flexibility to meet the unique requirements of users. The ultimate objective is to create a wheelchair that is incredibly intuitive and effective, enabling users to travel through their surroundings with ease using only their eye motions.

The approach guarantees that the "Eye Ball Motion Controlled Automatic Wheelchair" is created to satisfy the functional and security requirements of those who have trouble moving about. Through the integration of cutting-edge eye-tracking technology with an intelligent control system, this wheelchair provides a dependable, effective, and user-friendly solution to improve users' independence and quality of life. The iterative design, testing, and optimization process ensures a reliable system that is customized to meet user needs.

SYSTEM DESIGN

Block Diagram

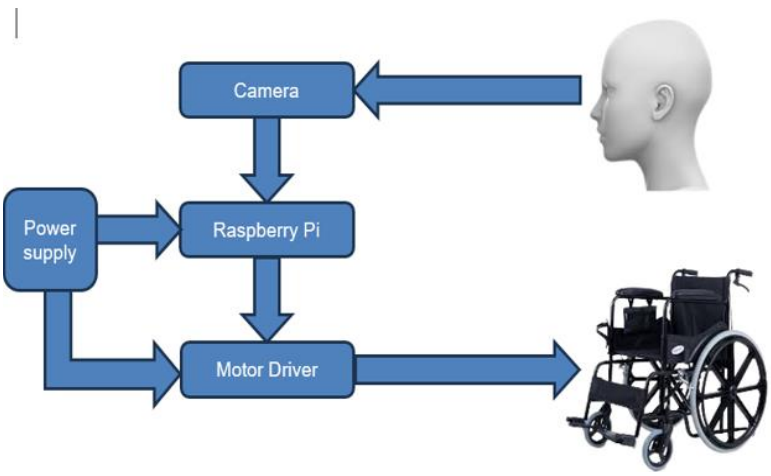

Fig. 2. Block Diagram

Component Description

1. **Camera**: Used for capturing eyeball moment in a form of video feed to the Raspberry Pi.
2. **Raspberry Pi**: Acts as the central control unit, processing data from the camera, giving the output to relays and controlling the motors.
3. **Relay**: Works as a switch to control the wheelchair's motor based on commands from the Raspberry Pi.
4. **Wiper Motor**: Operates based on signals from the relay.
5. **Battery**: Provides power to the Raspberry Pi and motor system.

Working

The Pi Camera is employed to capture a real-time video feed focused on the user's eye. This continuous stream of visual data is transmitted to the Raspberry Pi, which serves as the central processing unit of the system. Upon receiving the input, the Raspberry Pi initiates a series of image processing operations, primarily utilizing a masking algorithm to isolate specific features within the frame.

The core principle of the masking algorithm is to filter out all colors except black. This selective masking effectively highlights the user's pupil, as it typically appears as the darkest region in the captured image. Once the non-black regions are masked, the algorithm proceeds to calculate the centroid of the remaining black area—essentially determining the geometric center of the user's pupil. A virtual marker is then placed at this centroid to serve as a reference point for tracking eye movement.

To interpret the direction of the user's gaze, the live video frame is conceptually divided into a 3×3 matrix, resulting in nine distinct zones. The position of the marker within this grid indicates where the user is looking. For instance, if the marker falls within any of the top three cells, the system interprets the gaze as "looking up." A marker located in the central cell corresponds to a "looking center" command. If the marker is detected in the left or right cells of the middle row, the system interprets these as "looking left" and "looking right," respectively.

Based on the detected gaze direction, the Raspberry Pi sends signals to a set of relays, which act as motor drivers controlling the movement of the wheelchair. If the gaze direction is identified as "looking up," the Raspberry Pi activates both relays simultaneously, engaging both motors and propelling the wheelchair forward. Conversely, if the gaze is directed to the left, only the right motor is activated, causing the wheelchair to pivot left. The same logic is applied for a rightward gaze, where the left motor is activated to turn the wheelchair to the right. In the case of a central gaze, both motors remain deactivated, resulting in the wheelchair coming to a halt.

RESULTS AND DISCUSSIONS

The proposed system was designed and implemented to control the motion of a wheelchair based on the real-time tracking of the user's eye movements. The Raspberry Pi, integrated with a Pi Camera, successfully captured and processed the live video feed of the user's eye. The masking algorithm applied to the feed effectively isolated the pupil by filtering out all non-black regions, thereby allowing accurate centroid detection.

Movement Accuracy

The wheelchair's movement based on gaze direction was tested across various scenarios:

- **Looking Up:** Activated both motors; the wheelchair moved forward.
- **Looking Left/Right:** The system successfully engaged the opposite motor, resulting in a turning radius suitable for indoor navigation.
- **Looking Center:** Both motors were disabled, bringing the wheelchair to a complete stop with minimal delay.

Environmental Factors

Initially, the performance of the system was found to be significantly influenced by ambient lighting. In poorly illuminated environments, the masking algorithm struggled to accurately isolate the pupil, resulting in occasional misinterpretation of gaze direction. To address this challenge, an LED light source was strategically placed near the user's eyeball to enhance local illumination.

REFERENCES

1. Rupanagudi, S. R., Bhat, V. G., Gurikar, S. K., Koundinya, S. P., M. S., S. K., R., S., Satyananda, " A Video Processing Based Eye Gaze Recognition Algorithm for Wheelchair Control". 10th International Conference on Dependable Systems, Services and Technologies.2019.
2. Ragini Singh1 , Harsha Rani2 , Junaid Hasan Khan3 ,Kumari Komal, „„Eyeball Controlled Wheelchair, Journal of Science and Technology "",2020.
3. Hadish Habte Tesfamikael, Adam Fray, Israel Mengsteab , Adonay Semere „„„Simulation of Eye Tracking Control based Electric Wheelchair Construction by Image Segmentation Algorithm""", Journal of Innovative Image Processing ,2021.
4. Nutthanan Wanluk, Aniwat Juhong, Sarinporn Visitsattapongse, C. Pintavirooj, " Smart wheelchair based on eye tracking",The 2020 Biomedical Engineering International Conference,2020.
5. Zheng, Y., Fu, H., Li, R., Lo, W.-L., Chi, Z., Feng, D., Wen, D. "Intelligent Evaluation of Strabismus in Videos Based on an Automated Cover Test". Applied Sciences, 2019.
6. MOHAMAD A. EID1 , NIKOLAS GIAKOUMIDIS, " A Novel EyeGaze-Controlled Wheelchair System for Navigating Unknown Environments: Case Study With a Person With ALS ",IEEE,,2016.
7. W. W. M. Khairosfaizal, A.J Nor'aini. 2009. Eyes detection in facial images using circular hough transform. Signal Processing & Its Applications 2009. CSPA 2009. 5th International Colloquium on. pp. 238-242.
8. Gunda Gautam, Gunda Sumanth, Karthikeyan K C, Shyam Sundar, D.Venkataraman," Eye Movement Based Electronic Wheel Chair For Physically Challenged Persons", International Journal Of Scientific & Technology Research Volume 3, Issue 2, February 2014

9. Michael F. Land "Eye movements and the control of actions in everyday life" 5. S. Tameemsultana and N. Kali Saranya, "Implementation of Head and Finger Movement Based Automatic Wheel Chair", Bonfring International Journal of Power Systems and Integrated Circuits, vol. 1, Special Issue, pp 48-51, December 2011
10. Poonam S. Gajwani,Sharda A. Chhabria, "EYE MOTION TRACKING FORWHEELCHAIR CONTROL". International Journal of Information Technology and Knowledge Management July-December 2010, Volume 2, No. 2, pp. 185-187
11. K. T. V. Grattan, A. W. Palmer, and S. R. Sorrell, _Communication by Eye Closure-A MicrocomputerBased System for the Disabled', IEEE Transactions on Biomedical Engineering, Vol. BME-33, No. 10, October 1986.
12. Q.X. Nguyen and S. Jo, _Electric wheelchair control using head pose free eye-gaze tracker', Electronics Letters, Vol. 48 No. 13, 21st June 2012
13. Q.X. Nguyen and S. Jo, _Electric wheelchair control using head pose free eye-gaze tracker', Electronics Letters, Vol. 48 No. 13, 21st June 2012
14. Djoko Purwanto, Ronny Mardiyanto, Kohei Arai, _Electric wheelchair control with gaze direction and eye blinking', Artif Life Robotics, 14:397–400, May 18, 2009.
15. S. Mitra, T. Acharya: ―Gesture Recognition: A Survey, IEEE Transactions on Systems, Man, and Cybernetics‖, Part C: Applications and Reviews, Vol. 37, No. 3, May 2007, pp. 311 – 324. [16]
16. L.R. Rabiner: ―A Tutorial on Hidden Markov Models and Selected Applications in Speech Recognition‖, Proceedings of the IEEE, Vol. 77, No. 2, Feb. 1989, pp. 257 – 286.
17. Viola Jones Algorithmhttp://en.wikipedia.org/wiki/Viola%E2%80%93Jones_obj ect_detection_framework
18. Motor Controller circuitry from ECE 4760 web page for lab 4 – http://people.ece.cornell.edu/land/courses/ece4760/labs/f2 013/lab4.html
19. Cascade Object Detector – http://www.mathworks.com/help/vision/ref/vision.cascade object detector-class.
20. V. Kazemi J. Sullivan, "One millisecond face alignment with an ensemble of regression trees", IEEE Conference on Computer Vision and Pattern Recognition,2014.
21. X. Cao,Y.Wei, F.Wen, J. Sun, "Face alignment by explicit shape regression",2013.
22. Zhou, W., Gao, S., Zhang, L., Lou, X, "Histogram of Oriented Gradients Feature Extraction from Raw Bayer Pattern Images", IEEE Transactions on Circuits and Systems ,2020.
23. https://www.instructables.com/Using-Motors-With-L293D-IC/.
24. Yi-Hong Lin, Hsiau Wen Lin, "Face Detection Based on the Use of Eyes Tracking", IEEE International Computer Symposium (ICS), 2017, Electronic ISBN: 978-1-5090-3438-3.
25. Youming Zhang, Martti Juhola, "On Biometrics with Eye Movements", IEEE Journal of Biomedical and Health Informatics, 2017, Volume: 21, Issue: 5, ISSN: 2168-2208.
26. Ariz, Dilshad. (2018). DISABLED POPULATION IN INDIA: A REGIONAL ANALYSIS. Annals of Valahia University of Targoviste Geographical Series. 136-143. 10.2478/avutgs-2018-0015.