Eye Gaze Controlled Wheelchair With Health Monitoring System Using Raspberry Pi

CHANDINI [1], DEEPAK N[2], LALATENDU TRIPATHY[3], LIKHITH C[4]

[1234] *UG students, Department of Electronics and Communication Engineering, AMC Engineering College, Karnataka, India*

ABSTRACT

This paper proposes a system designed to help those with disabilities. To assist those with disabilities, an electric wheelchair that is operated by eye movement has been designed. People with disabilities can move around with ease and not require assistance from others thanks to this method. Through the use of a gaze estimation algorithm and image processing, the system analyzes the eye image to detect the gaze direction. With its high level of accuracy, the gaze estimation algorithm combines the functions of two different algorithms—Canny Edge detection and Hough Transform—to achieve a single goal. A raspberry pi processor was used for image processing to track the location of the pupils in both eyes after a webcam was set up in front of the subject to record their live movements. Here, OpenCV is being utilized for the image processing method known as gaze tracking.

Keyword: *Health Monitoring Sensor's, Eye Gaze Tracking, Python, OpenCV, Raspberry Pi.*

---

1. Introduction

Elderly individuals and those with physical limitations depend heavily on wheelchairs for mobility aid. The purpose of the eye-controlled wheelchair system is to employ camera-based image processing to read the user's eye motions and pupil location in real time. The wheelchair with motorization is then propelled by the orders that are translated from those movements. Wheelchairs with voice or joystick controls are commercially available, although they can be difficult for individuals who are completely paralyzed to operate on their own. For those who don't require as much outside assistance or physical exertion, the eye-controlled device increases their level of independence and ease of living. The user's gaze direction and blinking patterns are used to regulate the wheelchair's movement. Using OpenCV and eye gaze recognition, the pupil's location is precisely determined. Based on predetermined thresholds, the pupil's shifting location throughout a series of webcam photos is categorized as left, right, forward, halt, etc. To facilitate movement, a motor driver receives those commands and communicates with the wheelchair motors. The hardware consists of a camera that is attached to a laptop or base station computer that is using OpenCV to run Python image processing algorithms. In conclusion, the eye-controlled wheelchair aims to minimize the amount of external effort needed while enabling independent, hands-free mobility for individuals who are unable to use their hands. The technology based on computer vision tracks the user's eye movements and blinks in order to steer the motorized wheelchair.

2. Literature survey:

A survey of literature has been carried out in order to identify the research problem, formulate the objectives, and determine the methodology to evaluate the proposed solution for this project.

[1]. In 2020, a team developed a “Information Fusion Based Wheelchair Control for Paralyzed Patient” which was authored by Poornima G and Mohana kumar S from M.S. Ramaiah Institute of Technology, Bangalore, India. It proposes a new technique to control a wheelchair using eye-tracking and voice commands, aimed at assisting physically disabled people. The system uses computer vision algorithms like HAAR cascade and Hough circle transform for eye tracking, and an Arduino-based voice module for voice commands. It also incorporates ultrasonic sensors for obstacle detection and a messaging module for emergency alerts. [2] The paper titled "Eye And Voice Controlled Wheel Chair" is authored by Dr. HemaMalini B H, Vandana R, Supritha R C, Yadav R, and Venkatesh Prasad N K. It proposes a smart wheelchair controlled by eye-tracking and voice assistant modules. The eye-tracking module utilizes a camera and OpenCV to detect pupil movement and control the wheelchair's direction. The voice assistant module allows users to control the wheelchair using voice commands. The system aims to provide independence and ease of movement for people with disabilities. [3] The paper titled "Eye Pupil Controlled Transport Riding Wheelchair" is authored by Jannatul Mawa Akanto, Md. Kamrul Islam, Ajijul Hakim, Md. Azizul Hoque Sojun, and Kawshik Shikder. It proposes an eye-controlled wheelchair system for physically disabled individuals. The advantage is that it allows fully paralyzed people to control the wheelchair using only their eye movements, promoting independence. However, the disadvantage is that the accuracy of detecting backward movements is relatively low due to the difficulty in tracking the exact pupil location during blinking. [4] This paper proposes an intelligent camera-based eye-controlled wheelchair system that uses image processing techniques, specifically the Haar Cascade algorithm for face and eye detection and the Gaze Estimation algorithm for tracking eye movements, to control the wheelchair's movements. The system captures live eye movements using a camera and moves the wheelchair accordingly, providing independence for people with disabilities. The advantage is that it offers a hands-free and effortless way for disabled individuals to control a wheelchair. However, the system's accuracy and performance may be affected by lighting conditions and individual variations in eye features.

3. Design and implementation:

The system architecture, represented in a block diagram, is based on the complex interaction between hardware and software. The Raspberry Pi, which functions as both the literal and central processing unit, is in the center. Its main responsibility is to process the camera's live video stream, which is a necessary input for the system's overall operation. The key component of the system is its sophisticated image processing methods, which allow it to recognize and follow eye movements. The Haar Cascade Algorithm first identifies faces and separates the eye regions as areas of interest. Subsequently, the gaze tracking algorithm uses the camera feed to precisely record and interpret eye movements in real time. The system converts the data into directional commands to control the chair's movement with precise eye tracking. A driver module that communicates with the chair's motors and actuators makes this possible and enables the chair to react to commands like left, right, or center. In addition to system capabilities, safety is critical. An ultrasonic sensor constantly searches ahead for impediments to avoid crashes. If an object is detected, the system will stop moving if it is within a predetermined distance.

Furthermore, blink detection acts as a safeguard. If a blink is detected, chair movement pauses until the eyes reopen, preventing unintended motion during eye closure. The system is controlled by left, right, and center instructions after eyes are tracked using the previously outlined algorithms. The system is programmed to halt whenever blinking is detected and to restart when the eyes open again. Obstacles in the path are identified and measured using an ultrasonic sensor, which stops the device when the distance to an obstacle drops below a threshold.

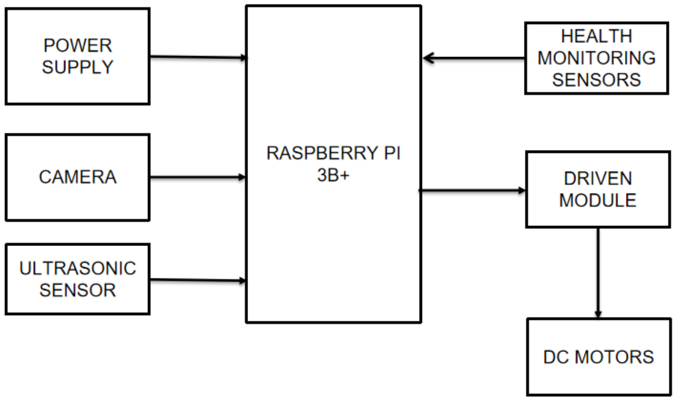

Fig -1: Block diagram

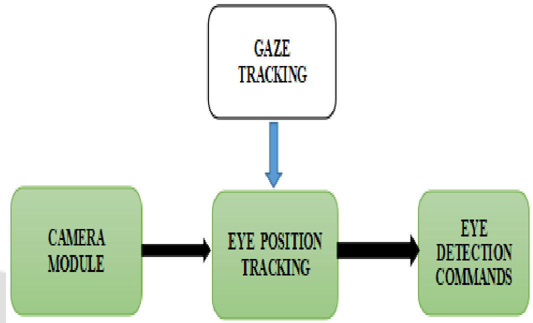

Fig-2: Eye Gaze Estimation Flowchart

The core ideas of the system are the tracking of pupil detection. These are accomplished using a variety of image processing methods. The way this system actually operates is as follows: the eyes and human face are detected using the Haar Cascade Algorithm, which treats the eyes as a zone of interest. The tracking of the eyes is then obtained from the camera's live feed using the Gaze Tracking algorithm. The driver module tracks the eye movement and uses that information to tell the chair how to move. An ultrasonic sensor is added as a safety precaution to help avoid impediments on the path by identifying them ahead of time. The real operation of the algorithms stated is depicted in fig-2.

4. Results:

The powerful algorithm gaze tracking effectively tracks the eye tracking. The way it moves indicates and determines the direction of the person gazing. The wheelchair is driven in the appropriate direction by the motor driver, who receives this tracking information continuously. Even in environments with low ambient light, this method is more accurate and efficient. Fig 3 shows the prototype model of proposed system which is operated with raspberry pi processor with power supply given. This model for the wheelchair system which is trained and tested with the live feed from web camera. This can be adapted and developed into a complete functional system.

Fig-3: Prototype model of the porposed system

4.1 Right movement: Fig 4 shows the right movement of the eyes that are parallelly shown on the screen which drives the motor towards right direction with help of motor driver.

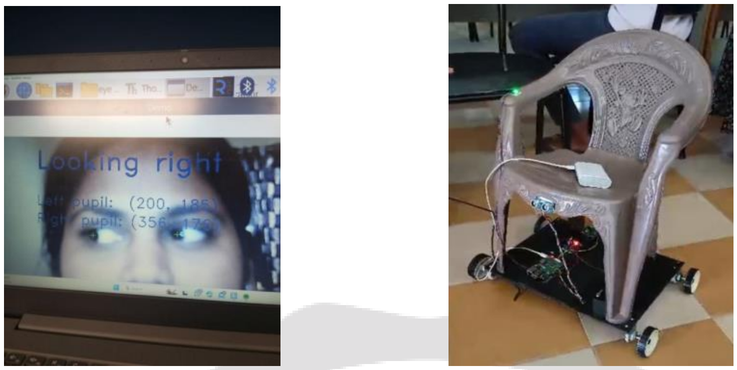

Fig-4: Right movement

4.2 Left movement: Fig 5 shows the left movement of the eyes that are parallelly shown on the screen which drives the motor towards left direction with help of motor driver.

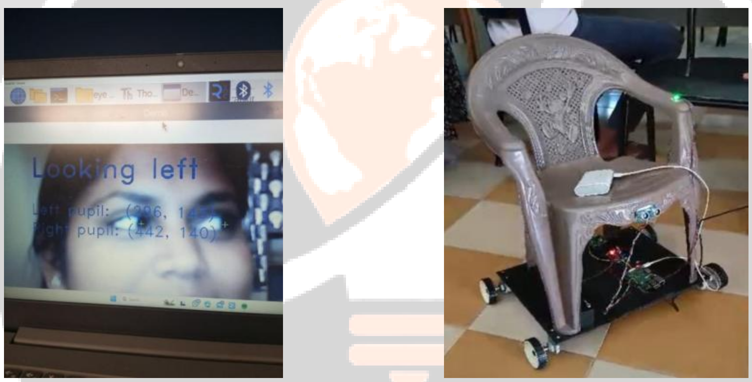

Fig-5: Left movement

4.3 Center movement: Fig 6 shows forward movement that parallelly shown on the screen the center position of eyes drives the motors forward direction with help of motor driver.

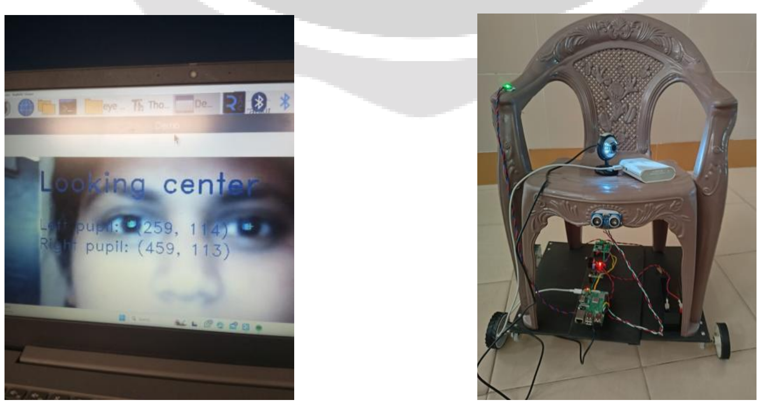

Fig-6: Forward movement

4.4 Blinking: Fig 7 shows the blinking detection whether the eyes of person is open or not. If the blink is detected the system is instructed to stop until the eye is opened again. The blinking action is also displayed on the output terminal with stop and distance measurement of obstacle in the path.

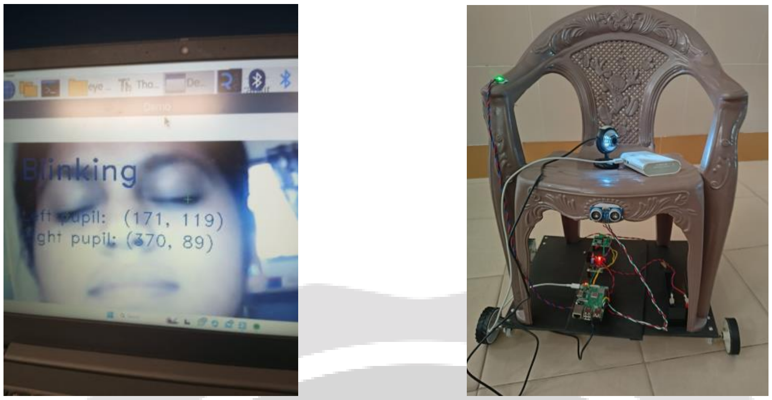

Fig-7: Blinking detection

5. Conclusion

The Raspberry Pi-powered eye gaze-controlled wheelchair with a health monitoring system is a ground-breaking demonstration of assistive technology and healthcare innovation combined. It provides previously unheard-of independence by allowing people with limited movement to travel with their eyes. It also has a health monitoring system that helps users with chronic diseases by tracking vital indicators in real-time. The Raspberry Pi acts as the hub of the system, facilitating communication between various parts and offering an intuitive user interface. This innovative approach prioritizes user health and well-being while improving mobility.

6. References

[1]. V. Viswanatha, A. C. Ramachandra, G. L. Reddy, A. V. S. T. Reddy, B. P. K. Reddy and G. B. Kiran, "An Intelligent Camera Based Eye Controlled Wheelchair System: Haar Cascade and Gaze Estimation Algorithms," 2023 International Conference on Applied Intelligence and Sustainable Computing (ICAISC), Dharwad, India, 2023, pp. 1-5, doi: 10.1109/ICAISC58445.2023.10201118.

[2]. J. M. Akanto, M. K. Islam, A. Hakim, M. A. H. Sojun and K. Shikder, "Eye Pupil Controlled Transport Riding Wheelchair," 2021 2nd International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST), DHAKA, Bangladesh, 2021, pp. 413-417, doi: 10.1109/ICREST51555.2021.9331133.

[3]. G. Poornima and M. Kumar S., "Information Fusion Based Wheelchair Control for Paralyzed Patient," 2020 Fourth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), Palladam, India, 2020, pp. 921-927, doi: 10.1109/I- SMAC49090.2020.9243401.

[4]. I. A. E. Zaeni, A. I. Wijanarko, A. Walad, A. Qi-Sheng and A. N. Handayani, "Applying Neural Network on Wheelchair Control System using Eye Blink and Movement Command," 2020 3rd International Conference on Information and Communications Technology (ICOIACT), Yogyakarta, Indonesia, 2020, pp. 416- 10.1109/ICOIACT50329.2020.9332136.

[5]. M. Tharwat, G. Shalabi, L. Saleh, N. Badawoud and R. Alfalati, "EyeControlled Wheelchair," 2022 5th International Conference on Computing and Informatics (ICCI), 2022, pp. 097-101, doi: 10.1109/ICCI54321.2022.9756116.