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Eyeball And Head Movement Controlled Wheelchair

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ABSTRACT

An eyeball and head movement controlled wheelchair is a system that enables individuals with disabilities to operate a wheelchair using only their eyes and head movements. It is designed to improve the quality of life for those with limited mobility by providing them with greater independence and mobility. A study published in the Journal of Rehabilitation Research and Development found that individuals with spinal cord injuries who used a head-controlled wheelchair had significantly better driving performance than those using traditional joystick-controlled wheelchairs. Research conducted at the University of Toronto found that eye-tracking technology could be used to accurately control a powered wheelchair, with users achieving an average accuracy rate of 92%. The proposed system consists of a web camera that tracks the movement of the user's eyes and head and translates these movements into commands that control the wheelchair's direction and speed. It is non-invasive, easy to use, and has the potential to significantly improve the lives of individuals with disabilities.

Keywords – Body motion, Eye tracking, Image processing, Machine learning, Wheelchair

1. INTRODUCTION

Quadriplegia is the term used to describe the paralysis of all four limbs caused by trauma poses a serious problem to the medical community [1]. Quadriplegia that manifests in the first few days after giving birth is extremely uncommon, especially in the absence of known predisposing factors like pre-existing coagulopathies, anticoagulant therapies, vascular malformations, arteritis, eclampsia, or iatrogenic causes like spinal and epidural injections for labor analgesia or Cesarean section [2]. Since quadriplegic patients cannot walk or move their limbs, after much research, an electric wheelchair has been developed to promote the movement of the patient. With the help of an electric wheelchair, patients can live without the help of others.

A large variety of electric-powered wheelchairs that use different human machine interfaces such as head motion, chin control, voice recognition, and EEG signals, are available. The force-sensing joystick shaft used in chin control technology reduces the need for precise head movements [3]. By making specific shoulder movements, some researchers have employed electromyography signals to operate wheelchairs. Han detected three shoulder motions (both shoulders up, right shoulder up, and left shoulder up) using four EMG electrodes on the Sternocleidomastoid muscle, with an average success rate of 91.2%, to detect shoulder movements and steer the wheelchair. Alternative methods are necessary since, regrettably, some disabled people may not be able to lift their shoulders and bodies [4]. When a section of the spinal cord inside the neck is hurt, it might result in quadriplegia or tetraplegia. Loss of feeling and motion in the arms, legs, and trunk results from this injury. Damaged nerve fibers flow through the wounded location, and this can impact the corresponding muscles and nerves below the injury site partially or completely. The most common spinal injury sites are in the lower back (thoracic and lumbar) and neck (cervical). A lumbar or thoracic injury may impact physiologic processes. As well as affecting upper and lower limb motions, a cervical injury may impair respiration. It is essential to use the patient's head movement to increase mobility in severe quadriplegics because it is the sole remaining joint that can move the wheelchair [5]. One can also freely move his or her eyes. As a result, wheelchair control systems based on ocular movement have been created [6]. EOG (electrooculography) technology detects the electric potential difference between the cornea and the pupil in comparison to a reference electrode positioned on the eye. The forehead measures eyeball rotation, 5 additional electrodes are positioned close to the eye. Each degree of eye movement results in a shift of 20 microvolts being recorded [7]. The head-tongue controller (HTC) is a multimodal alternative controller designed for people with quadriplegia to access complex control capabilities by combining tongue and head tracking to offer both discrete and proportional controls in a single controller[8].

The proposed wheelchair can also work with eyeball and head movements. The system will allow the user to navigate their wheelchair using their eye movements and body moment, which will be detected through image processing technology. The system will use a camera module to capture images of the user's eyes and body movements, which will be processed using advanced image processing algorithms to detect the user's movements. The data will be sent to an Arduino board, which will process it and send a signal to a motor driver to control the movement of the wheelchair.

2. METHODLOGY

The Wheelchair Control System using Eyeball Tracking and Navigation through Body Moment using Image Processing, Arduino, Motor Driver, and Wheelchair Model is a project that aims to provide people with physical disabilities the ability to control their wheelchairs through eyeball tracking and body movement.

The system is composed of a camera that tracks the user's eye movements and an arduino board that processes the data from the camera to control the wheelchair's movement. The camera captures images of the user's eyes and sends the data to the arduino board. The arduino board then uses image processing techniques to determine the direction in which the user is looking and sends commands to the motor driver to move the wheelchair in the desired direction.

In addition to eye tracking, the system also utilizes eyeball and head movement as input. The user can turn their head in the desired direction, and the system will detect this movement and move the wheelchair accordingly.

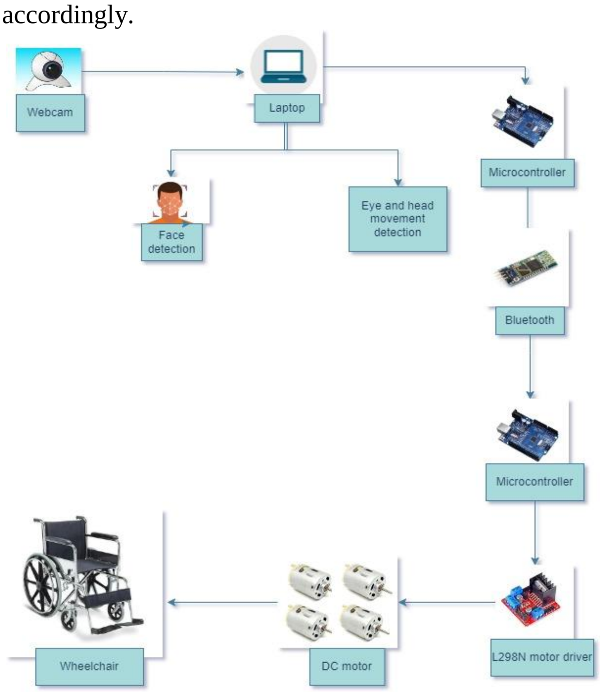

Fig 1: Block diagram of wheelchair

The system is built using a wheelchair model that is equipped with the necessary motors and motor drivers to move in different directions. The arduino board is programmed using a custom code that processes the data from the camera and the head movements to control the movements of the wheelchair.

Via a USB cable, the transmitter circuit is linked to the laptop. The laptop has a machine learning application written in Python that detects faces using the haar cascades idea and records the subject's head and eye movements. The Bluetooth module will take commands from the programme and send them to a prototype bluetooth module to enable the dc motor to move wirelessly. The bluetooth-enabled receiver circuit gets the command from the wireless transmitter circuit and uses an L298N motor driver to control the motors in various directions.

S.NO	MOVEMENT	MEAN RESPONSE TIME(sec)
1.	Forward	8
2.	Left	3
3.	Right	3
4.	Stop	5

Fig 2: Response time of the wheelchair

The mean response time of an eye and head controlled wheelchair refers to the average time it takes for the wheelchair to move in response to the user's input through the eye and head trackers. The response time can be influenced by several factors, including the speed and accuracy of the eye and head tracking, the processing speed of the microcontroller, and the efficiency of the motor control and power management system. Ideally, the response time should be as short as possible to ensure a smooth and responsive user experience. However, it is important to balance the need for speed with safety considerations, such as the ability to stop quickly and avoid obstacles.

3. PROPOSED WORKFLOW

The initial cropping of the eye's region of interest involves presenting every feasible circle on the targeted area for detection. After successfully detecting the eyeball, it moves on to detecting the corner whose center point is the average distance between the center point of the eye circle and the center point.

When there is no movement of the eye, the distance is in the middle; when the movement of the eye is to the left, the left motor that is mounted to the wheels of the wheelchair runs; and vice versa. The minimum distance represents the movement of the eye pupil to the left position, and the maximum distance represents the movement of the eye pupil to the right direction. When the eye is closed for around five seconds, the wheelchair comes to a stop. The arduino processes the continuous image that is captured using a webcam which allows the wheelchair to move in the desired direction.

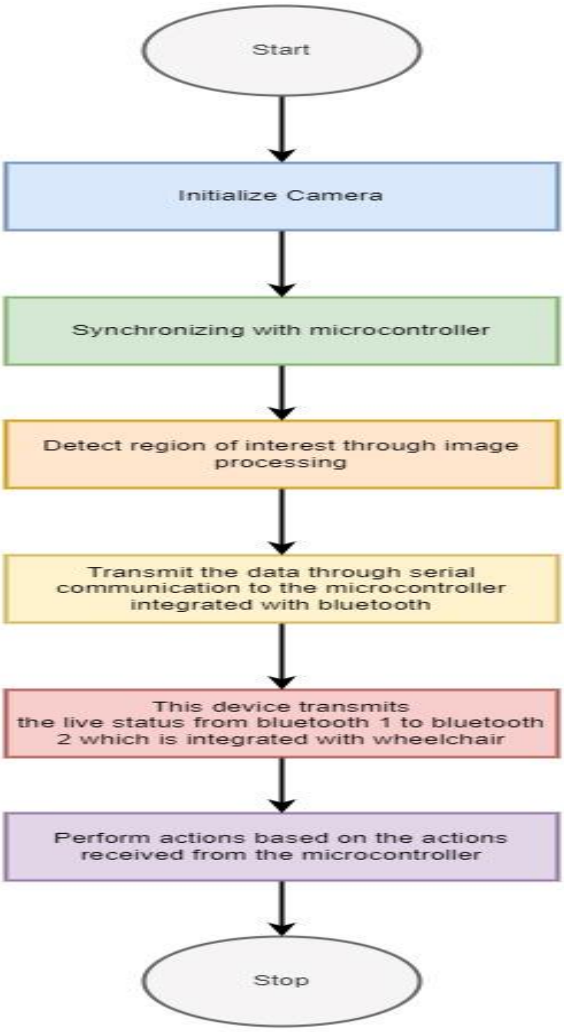

Fig 3: Workflow

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4. RESULT AND DISCUSSION

A real-time strategy for directing a wheelchair based on eye movements that are computationally efficient and reliable is presented. This will be of great benefit to those who require ongoing wheelchair control support. To test the system the experimental setup is done where the prototype is attached to the wheel which is connected to move in different directions. Webcam images were taken, and a machine learning system was used to identify the direction of eye and head movement. The system acquires the resulting image processing data and based on the center eye pupil value signal is sent to the motor driving circuit for chair movement. The performance of a prototype was evaluated. This is simple to incorporate into a wheelchair in real life.

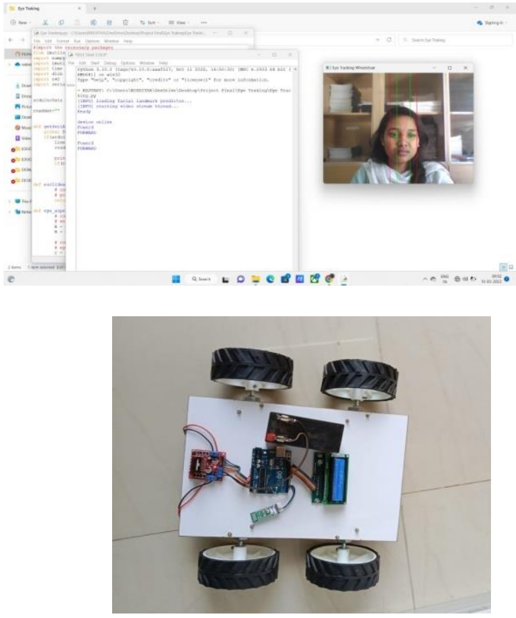


Fig 4: Forward movement

After the face and eye detection, if the center threshold value is placed in the center, the forward movement of the wheelchair is initiated and starts to move. For forward movement, the motors on both sides of the wheelchair are activated, causing the wheels to turn in the same direction and move the wheelchair forward.

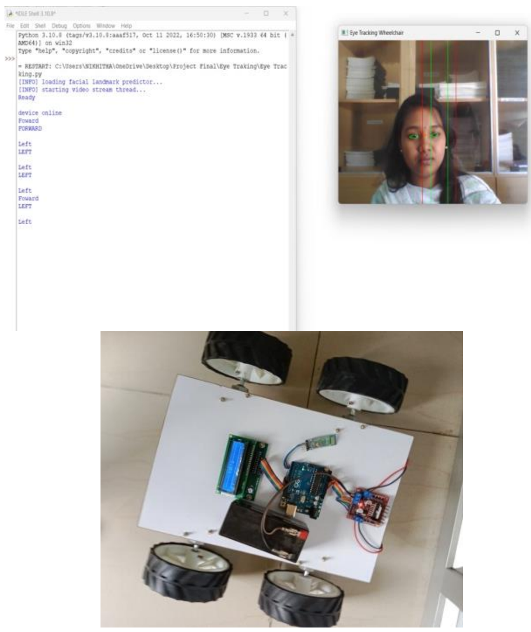


Fig 5: Left movement

When the center value is greater than the left maximum, the wheelchair moves in the left direction. i.e., when the head is tilted slightly towards the left, the wheelchair starts to move in the left direction.

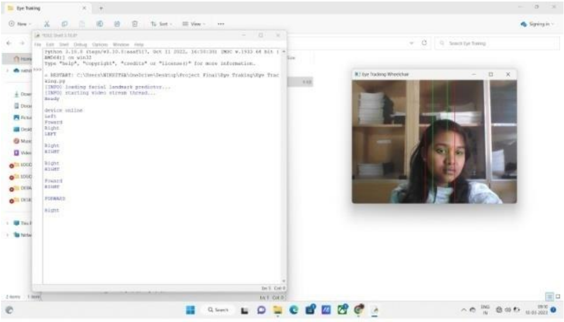
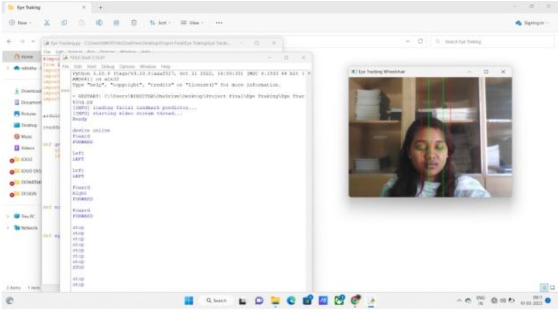


Fig 6: Right movement

When the center value is greater than the right maximum, the wheelchair moves in the right direction. i.e., when the head is slightly tilted right side



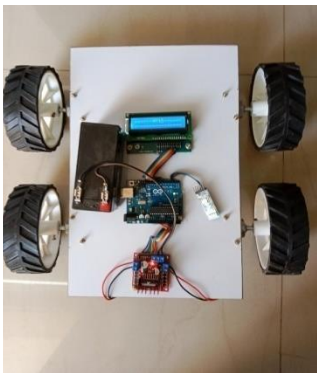


Fig 7: Stop

When the eye is closed for 5 sec, the wheelchair will be stopped. The eye aspect ratio is a constant value when the eyes are open, but quickly drops when the eyes are closed. Human eyes are clean. The program can determine if a person's eyes are closed when the aspect ratio of the eye falls below a certain threshold.

5. CONCLUSION

The combination of eye tracking and head movement input provides a more natural and intuitive
a way for users to control their wheelchairs, enhancing their quality of life. The use of image processing algorithms, Arduino board, and motor driver provides a reliable and efficient control system that can accurately interpret the user's inputs and move the wheelchair in the desired direction. While the project has some limitations and challenges, such as accuracy and responsiveness, it has great potential for future development and integration with other technologies. Overall, this project is a significant step forward in the field of assistive technology, providing people with physical disabilities the ability to live more independent and fulfilling lives.

The potential for head- and eye-controlled wheelchairs is very high. Especially for those with severe spinal cord injuries or neuromuscular diseases, this technology has the potential to dramatically improve the quality of life for people with movement disabilities. The following are some of the improvements that can be done:

- Integration with smart home systems: The system can be integrated with smart home systems to provide users with greater control over their environment. For example, the system can be used to control the lights, TV, or other smart devices in the home.
- Use of machine learning algorithms: The system can be further improved by integrating machine learning algorithms that can learn the user's eye and body movements over time, improving the accuracy and responsiveness of the system.
- Mobile app integration: A mobile app can be developed that allows users to control their wheelchairs remotely, view their eye and body movement data, and adjust the system's settings.
- Integration with other mobility devices: The system can be integrated with other mobility devices such as prosthetic limbs or exoskeletons, providing users with greater mobility and independence.
- Integration with virtual reality systems: The system can be integrated with virtual reality systems to provide users with immersive experiences, enabling them to navigate virtual environments using their eye and body movements.

REFERENCE

[1] Pawaskar Sonali, Padia Isha, Jain Manish, Dubey Ravi, Mrs. Namrata Lade, 2017, Advance Eye Controlled Wheelchair for Disabled Person, In *International Journal Of Engineering Research & Technology* (IJERT) ICIATE – 2017 (Volume 5 – Issue 01)

[2]Bose, S., Ali, Z., Rath, G.P. and Prabhakar, H., 2007. Spontaneous spinal epidural hematoma: a rare cause of quadriplegia in the post-partum period. *British Journal of anaesthesia*, *99*(6), pp.855-857.

[3] Shivappriya, S.N. and Maheswari, K., 2021, October. Intelligent Eyeball Movement Controlled Wheelchair. In *2021 International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA)* (pp. 1-6). IEEE.

[4] Rechy-Ramirez, E.J., Hu, H. and McDonald-Maier, K., 2012, December. Head movements based control of an intelligent wheelchair in an indoor environment. In *2012 IEEE International Conference on Robotics and Biomimetics (ROBIO)* (pp. 1464-1469). IEEE.

[5] Manogna, S., Vaishnavi, S. and Geethanjali, B., 2010, June. Head movement based assist system for physically challenged. In *2010 4th International Conference on Bioinformatics and Biomedical Engineering* (pp. 1-4). IEEE.

[6] Tara Preeth M, Lokesh Arijilli, Siddhartha Reddy and Shanmugasundaram M, Control of Wheelchair by Eye Movement Using Image Processing, *International Journal of Electrical Engineering and Technology*, 11(3), 2020, pp. 231-237.

[7] Dr. Monika Jain, Mr. Shikhar Puri, and Ms. Shivali Unishree,Eyeball- Motion -Controlled -Wheelchair -Using-IR-Sensors.In *International Journal of Computer and Information Engineering* Vol:9, No:4, 2015

[8] Sebkhi, N., Bhavsar, A., Sahadat, N., Baldwin, J., Walling, E., Biniker, A., Hoefnagel, M., Tonuzi, G., Osborne, R., Anderson, D.V. and Inan, O.T., 2021. Evaluation of a Head-Tongue Controller for Power Wheelchair Driving by People With Quadriplegia. *IEEE Transactions on Biomedical Engineering*, *69*(4), pp.1302-1309.