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Eye Controlled and Demand Conveying Automated Wheel Chair

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Abstract

The eye-controlled and demand conveying automated wheelchair is a novel assistive technology that allows individuals with physical difficulties to control their wheelchair using eye movements and communicate their destination to the device through eye recognition. This technology is designed to improve mobility and independence of individuals with limited mobility, enabling them to navigate their environment more easily and communicate their needs more effectively. This project is mainly made to assist the patients affected by paralysis, paraplegia and stroke. The patient can move the wheelchair left or right just by looking in the appropriate direction. It does not require the guidance of third person. The affected person can indicate their needs by pressing the buttons attached with the wheelchair. The combination of these features provides a user- friendly and efficient solution for individuals with physical disabilities to enhance their mobility and independence.

Keywords: Wheelchair, Eye-gesture, Ultrasonic sensor, Accelerometer, Python, Button panel, Alarm.

1. Introduction

Individuals with physical difficulties face various challenges in their daily lives, particularly when it comes to mobility and independence. Traditional manual wheelchairs provide some degree of assistance, but they require significant physical effort and can be challenging to maneuver, particularly for individuals with limited upper body strength or coordination. In recent years, technology has been developed to address these challenges and provide more accessible and user-friendly mobility solutions for individuals with physical disabilities. One such technology is the eye-controlled and demand conveying automated wheelchair, which allows users to control the wheelchair using eye movements and convey their needs to the environment through buttons interfaced with the wheelchair. In this paper, we will discuss the design and implementation of an eye-controlled and demand conveying automated wheelchair, including the technologies utilized and the benefits it provides for users. We will also discuss the challenges and limitations of this technology and opportunities for future development and improvement. Overall, this technology has the potential to significantly enhance the status of life for persons with physical disabilities, enabling them to navigate their environment more easily and communicate their needs more easily and more effectively. An eye-controlled wheelchair is a mobility-aided device for those patients affected by severe difficulties in locomotion. It is particularly intended for the person who cannot move, who cannot use their limbs and who cannot convey their basic needs. The eye movement is captured through head mounted camera which sends data serially to the controller. The controller segments the pupil of the eye thereby generating the commands to the python software. Then the control signals are generated for the movement of wheelchair. Then the buttons like food, water and emergency keys are placed on the wheelchair to convey their needs.

2. Existing System

In this system, eye ball sensing device is used to capture the eye movement of affected person. The human decisions based on their eye gesture. An eye movement is captured through web camera that transfers data to MATLAB. The signals are sent to motor driver which controls the motor. Then the image processing technique generates the control signal by calculating the centroid of the eye. The processed images will be sent to the laptop. Then the output signals are sent to motor driver which controls the motor. The wheelchair can be moved with eye tracking system interfaced with USB micro-controller. It has some of the limitations. The camera will not work well in the night. The eye ball sensor does not senses the eye correctly all the time.

3. Proposed System

The proposed system for an eye-controlled and demand-conveying automated wheelchair consists of several components, including an eye recognition module, head mounted camera, ultrasonic sensor, and a motorized wheelchair. In our proposed system, we design a vision-based wheelchair using head mounted camera to acquire user images. The main reason for our

project is to help the patient affected by disorders like paralysis, paraplegia and stroke. People who have no use of their limbs, who has less ability to move, who cannot convey their needs are restricted in terms of mobility. So, we are implementing automated wheelchair which can itself detects the eye movement without the help of eyeball sensor. The head mounted camera detects the eye movement which is typically mounted on the headband and sends the input data to the controller which is connected with the device. This module utilizes machine learning algorithm to interpret the user's eye movement and convert it into a destination command that can be sent to the wheelchair. The wheelchair can move left when the pupil moves left side and vice versa. The motorized wheelchair is equipped with motors and controllers that allow it to travel in different trajectory and at varying speeds. The micro-controller receives commands from the eye-tracking device and sends corresponding commands to the wheelchair's motors and controllers to move the wheelchair in the desired direction. Along with this button or keys are placed on both the sides of arm raster which is used to convey the need of the patient. The button are like fundamental needs of the patient like water, food, emergency. When the person presses the key the microphone alert the neighbor with a sound so the neighbors can help patient to satisfy their needs.

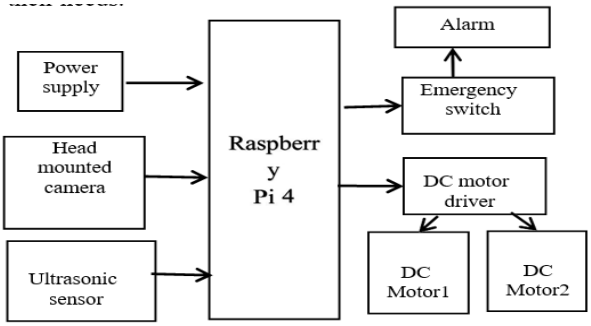

FIGURE 1. Block diagram of proposed system

4. Design Overview

Raspberry pi 4: It is a credit card sized computer and a miniature device. The Raspberry pi has CPU, RAM and GPU in one

component called system on chip (SOC). The pi is engineered to work t 5 volts. It uses an ARM processor and harvard architecture which is single core and is integrated with broad-com 2711,64-bit quad-core cortex=A72 processor and 2GB RAM. They have 40 pins in which 26 are GPIO pins and other are power or ground pins.

FIGURE 2. Raspberry pi 4 module

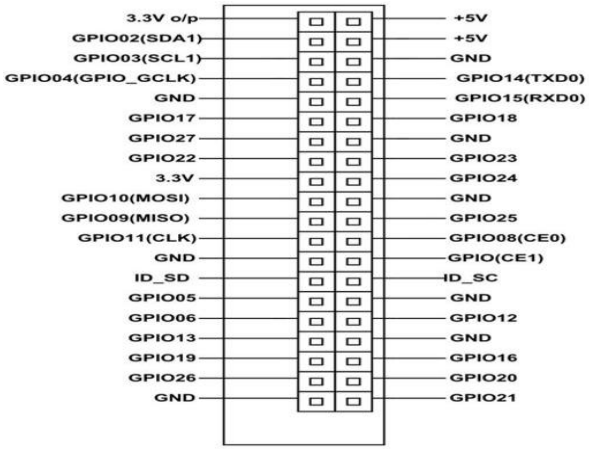

FIGURE 3. Pin layout of Raspberry pi 4

DC Motor Driver: It is a 16-pin driver which guides a pair of DC motors at the same time in any direction.It is designed to provide bidirectional drive currents of upto 600 mA at voltages from 4.5 V to 36 V.They are amplifiers or power modules that are interfaced between a controller and a DC motor.

FIGURE 4. DC motor driver

DC Motor: It is a class of electrical motors that convert direct current electrical energy into mechanical energy. Wheelchairs utilize two permanent magnet DC motors with two 12 V batteries providing a 24 V supply.PM motor have a linear torque speed profile making and easy to control.

FIGURE 5. DC motor

5. Ultrasonic sensor

It measures distance by using ultrasonic waves. It detects obstacles and it measures the distance between a wheelchair and an obstacle. If the obstacle is extremely near to the wheelchair, the motor stops the wheelchair. The ultrasonic sensor measures hair using triangulation.

FIGURE 6. Ultrasonic sensor

Wheelchair: It is used when stepping is challenging or unimaginable due to illness, injury, problems related to disability. The wheelchair is the one of the most commonly used assistive devices to promote mobility and enhances the quality of life for people who have difficulties in walking. It consist of wheels (30 to 66 cm in dia), leg rester, arm rester, back rester, seat cushion, casters (two small front wheels),axles, breaks, hand rims, and cross bars.

FIGURE 7. Wheelchair

Head mounted camera: The camera tracks eye movements to operate wheel chair. This system will allow disabled people to control electric wheelchairs by simply moving their eyes. It weighs about 1.6g.It has image resolution of 640x480 Pixels at frame rates up to 90Hz.

FIGURE 8. Head mounted camera

Accelerometer: It senses the change in direction of eye and accordingly the signal is given to the micro- controller. Depending on the direction of the acceleration, micro-controller controls the wheel chair directions like left, rights, front and back with the aid of DC motors.

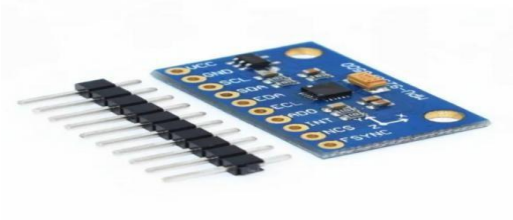

FIGURE 9. Accelerometer

Button panel: Three buttons are placed in the panel on the arm rester to convey the needs of the patients. When the patients presses the switch it alerts the neighbour with an alarm sound.

FIGURE 10. Button panel

ALARM: An alarm can refer to a sound or other sensory signal that alerts the caregivers that the wheelchair is about to encounter an obstacle or reach a pre- determined destination. The alarm may also convey the needs of the patient. When the patient presses a key/buttons ,alarm alerts the neighbors with a sound. Overall, the purpose of the alarm is to provide important feedback that enhance the safety and usability of the eye-controlled wheelchair.

FIGURE 11. Alarm

Software Description: The software used in our eye controlled electric wheelchair prototype is python. Python is a versatile and powerful programming language that is well suited for developing software for an eye controlled wheelchair using Raspberry pi. Python software used in an eye-controlled wheelchair is a set of programs that enable individuals with limited mobility to control the movement of wheelchair using their eyes. Open CV libraries can be used for building an eye controlled wheelchair .Open CV is a popular computer vision library used for detecting eye movements and tracking the gaze of the user. It can be used in combination with a head mounted camera or a Raspberry Pi camera module.

Python software used in eye-controlled wheelchairs typically involves the use of a camera or other sensors to track the user's eye movements, and then translating those movements into commands to control the wheelchair's movement. Here are some of the key components of python software used in eye controlled wheelchair.

Eye-tracking system: The eye-tracking system is typically composed of a camera that captures images of the user's eyes and software that analyzes those images to track the user's gaze. Python software is used to develop this system, which typically involves computer vision and machine learning techniques to accurately track the user's gaze. This software is responsible for tracking the user's eye movements and recording the data.

Data processing software: This software takes the data from the eye tracker and processes it, converting it into signals that the wheelchair can understand.

Control Algorithms: Python software is used to develop control algorithms that translate the user's gaze into commands to control the wheelchair's movement. These algorithms must take into account factors such as the speed and direction of the user's gaze, as well as the layout of the environment to ensure safe and accurate control of the wheelchair. This software is responsible for translating the signals from the eye tracker into wheelchair movement commands, such as turning left or right, stopping or starting.

User Interface: Python software is also used to develop the user interface for the eye-controlled wheelchair. This typically involves developing a graphical user interface that permits the patients to input commands and view information about the wheelchair's status. The user interface is a critical component of the software allowing the user to control the wheelchair and providing feedback on its status. The interface should be designed to be intuitive and easy to use with clear visual feedback.

Communication Protocol*:* Finally, Python software is used to develop the communication protocol between the eye -tracking system and the wheelchair's control system. This protocol must be reliable and efficient to ensure real-time control of the wheelchair's movement. Overall, Python software is an excellent choice for developing software for eye-controlled wheelchairs and plays a critical role in the development of eye- controlled wheelchairs from the eye-tracking system to the control algorithms and user interface. It is simple to understand, has a vast community of developers and offers many libraries and configuration that helps to evolve vigorous and authentic software.

6. Flow Chart

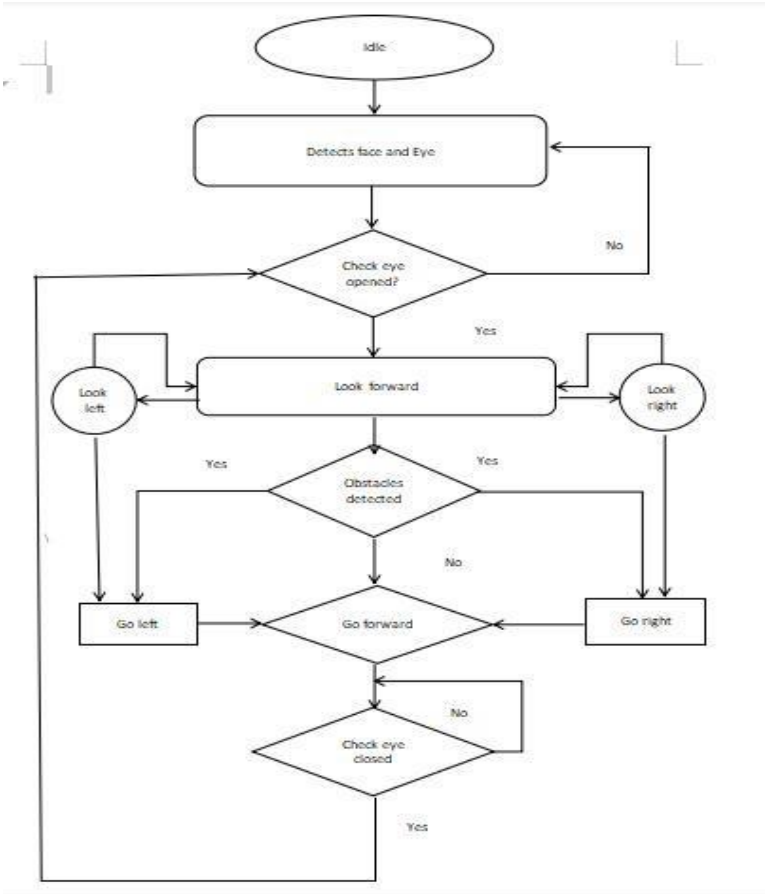

FIGURE 12. Eye tracking algorithm flow

7. Methodology

It consists of multiple modules, each of which has a specific function in the overall system. Here are some of the most important modules that make up the python software used in an eye-controlled wheelchair.

Eye-tracking module: The first step in initializing an eye-tracking system is to calibrate the system to the user's eyes. This module uses an eye-tracking camera to detect the user's gaze direction and pupil position and then calculates the corresponding movement commands for the wheelchair. This involves asking the user to focus on a series of targets on the camera while the system tracks their eye movements. This process helps the system learn the user's eye movements and allows it to accurately track their gaze.

Set the threshold for movement detection: Once the eye tracker is calibrated, it is required to set the threshold for movement detection. This determines how much movement is required before the system registers that the user wants to move the wheelchair in a particular direction.

Set the sensitivity of the system: The sensitivity of the eye-tracking system determines how much movement is required before the system registers the user's gaze. It is important to set the sensitivity at a level that is comfortable for the user while also ensuring that the system is responsive enough to accurately track their movements.

Test the system: Once the system is calibrated and the threshold and sensitivity settings are configured, it is important to test the system to ensure that it is working correctly. This involves asking the user to perform a series of eye movements and verifying that the wheelchair responds appropriately.

Signal processing module: This module takes the raw data from the eye- tracking module and converts it into meaningful gestures that can be used to govern the wheelchair

Processing of eye movements: The eye-tracking technology processes the user's eye movements and translates them into commands for the wheelchair. This is done through software that uses algorithms to interpret the user's gaze direction, speed, and duration.

Movement commands: The commands generated by the eye-tracking technology are sent to the wheelchair's control system, which translates them into movement commands for the motors that control the wheelchair's movement. For example, if the user looks to the left, the wheelchair will move in that direction.

Motor control module: The module receives the movement commands from the signal processing module and controls the motors on the wheelchair to make it move in the desired direction.

Safety features: Eye-controlled wheelchairs also have safety features to prevent accidents. For example, they may have obstacle detection sensors which is ultrasonic sensor that detect obstacles in the path of the wheelchairs and stop it before a collision occurs.

Calibration module: This module enables the user to calibrate the eye- tracking camera to ensure accurate detection of their gaze and pupil position. Eye-controlled wheelchairs can be customized to meet the needs of the user. For example, the sensitivity technology can be adjusted to account for individual variations in eye movements.

Button module: The three buttons are placed on the arm rester of the wheelchair: Water, Food and Emergency. These buttons can be removable which can be fixed on both sides depending on the patient's deficiency. For example, if the person impaired on the right hand, the buttons are placed on the left side of the patient. After the patient presses the key the alarm alerts the neighbor with a sound. So the patient needs are satisfied.

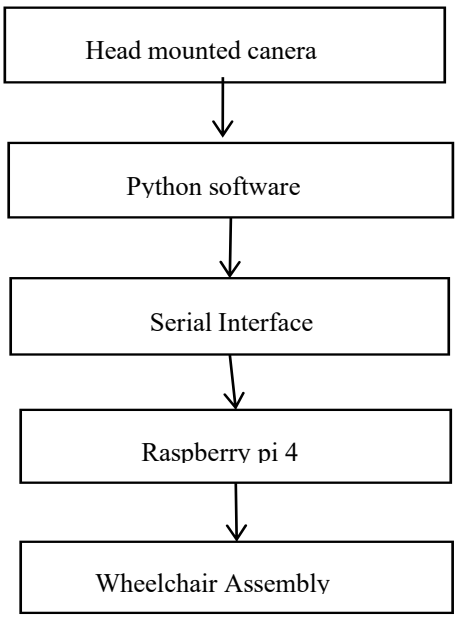

FIGURE 13. Proposed Methodology

8. Result And Discussion

The following diagram exhibits the output of the python software. The area of the pupil inside the circle is considered in determining the motion of the eye. The wheelchair moves in three directions such as left, right and forward. The stopping is done when the person closes their eyes.

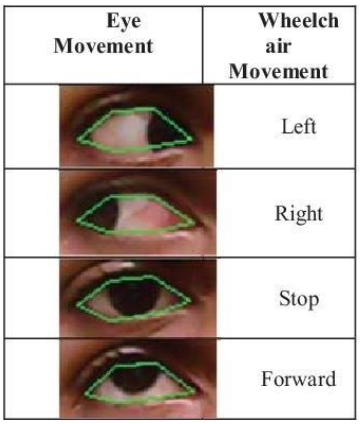

FIGURE 14. Pupil location for wheelchair movement

In the first table, we can see that the position of pupil is left. The signal corresponding to the left side movement will be send to the micro controller. Accordingly, the wheelchair moves toward left. In the second table, the position of pupil is right which results in the motion of wheelchair towards right. In the third table, the eye is about to close. So the controller sends the command to motor to stop the movement of wheelchair. In the last table, the pupil is at center. The position of pupil will be highlighted with the help of the circle shown. As the pupil is at center, the wheelchair moves in forward direction. The position of pupil is detected and are produced using Machine learning algorithm. They are processed using python software and the decision will be taken by Raspberry pi 4. The proposed model had achieved an 99% accuracy and it is easy for the paralyzed patient to carry the camera mounted on the head.

9. Conclusion

This proposed system has guided us to terminate that people suffering from severe difficulties does not require any training to use this wheelchair. In conclusion, eye-controlled and demand conveying automated wheelchair have the potential to greatly improve the mobility and independence of people with severe mobility impairments.

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