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Smart Wheelchair Control Via Voice Commands and Obstacle Avoidance Using Embedded System

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ABSTRACT:

Persons suffering from physical disabilities often experience difficulties in moving around independently in their daily activities. In order to address this issue, a smart wheelchair system based on an embedded system using voice command control, obstacle detection, GPS tracking, and solar charging has been proposed in this project. The system will be controlled using voice commands such as forward, backward, left, and right, which will be detected by a voice recognition system. The detected voice commands will be processed by an embedded system. In order to prevent accidents, ultrasonic sensors will be used to detect obstacles in the path of the wheelchair. The wheelchair will be stopped or changed direction according to the detected obstacles. In addition, a GPS tracker will be used in order to obtain the real-time position of the wheelchair. This will be very helpful in tracking the position of the disabled person. A solar panel will be used in order to charge the battery of the system. This will reduce the need for external power supply and will be environmentally friendly.

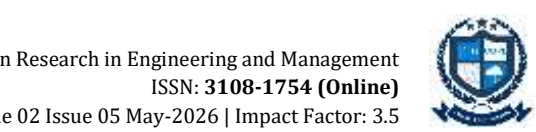
KEYWORDS:
Smart Wheelchair, Voice Command Control, Embedded System, Obstacle Detection, GPS Tracking, Solar Charging, Ultrasonic Sensor.

I. INTRODUCTION:

Mobility assistance systems play a significant role in enhancing the quality of living for physically disabled and elderly people. There are many people who use manual wheelchairs or have to relay on people to move around, which affects their independence to a great extent. In order to overcome this problem, a smart wheelchair system can be proposed using modern embedded technologies. In this project, a smart wheelchair is proposed using voice command control, obstacle detection, GPS tracking, and solar charging. In this system, voice commands are accepted by the embedded controller, which in turn controls the movement of the wheelchair using motors. An ultrasonic sensor is also provided to detect obstacles to prevent accidents during movement. In addition, a GPS module is provided to track the location for safety purposes. A solar panel is also provided to charge the battery using solar.

II. EXISTING WORK:

Different researchers have proposed different types of wheelchairs to provide mobility for people with physical disabilities. The conventional electric wheelchairs use a joystick for control, which needs hand movement. But using a joystick might not be convenient for people with less hand movement.



To overcome these difficulties, researchers have proposed different types of smart wheelchairs using voice control, gesture control, and smart phone apps for better control. Although these technologies enhance the functionality of wheelchairs, existing smart wheelchairs provide only a single or double facility.

Some wheelchairs use ultrasonic sensors for detecting obstacles, while others use GPS for tracking the location. Moreover, solar power is used for charging the batteries of some wheelchairs. But these technologies are implemented individually instead of integrating all the technologies into a single system. Thus, there is a need for an integrated smart wheelchair with voice control, obstacle detection, GPS tracking, and solar.

III. PROPOSED METHODOLOGY:

The proposed method is a smart wheelchair that provides mobility, safety, and convenience for the physically disabled. The proposed system is a combination of different modules that work together as a single entity with the help of an embedded Arduino microcontroller. The proposed system includes a voice recognition module that recognizes voice commands from the user to move the wheelchair forward, backward, left, right, or stop.

The microcontroller processes these commands and provides output to the motor driver module to drive the motor for the movement of the wheelchair. For safety purposes, an ultrasonic sensor is used to detect any object in the path of the wheelchair. If any object is detected within a specified range, the proposed system stops the wheelchair to avoid any accidents.

The proposed system has other advanced features for the support of the disabled. A GPS module is used for location tracking with the help of a global positioning system. A solar panel is used for charging the battery of the proposed system to avoid any other external sources for charging the battery. Moreover, an Alexa module is used for playing music or watching videos with the help of voice commands

Fig1.SmartWheelchair

IV. COMPONENTS:

HARDWARE COMPONENTS:

Arduino UNO (Embedded Controller) – A microcontroller board that controls and manages all functions of the wheelchair system.

Voice Recognition Module – A device that detects and converts spoken commands into signals for the system.

Motor Driver (L298N) – A circuit that helps control the direction and speed of the wheelchair motors.

DC Motors – Electric motors that rotate the wheels and move the wheelchair.

Ultrasonic Sensor – A sensor that identifies nearby obstacles by measuring distance using sound waves.

GPS Module – A module that provides the real-time location of the wheelchair using satellite signals.

Solar Panel – A device that converts sunlight into electrical energy for charging the system battery.

Battery (12V) – A power source that stores energy and supplies electricity to the wheelchair components.

SOFTWARE COMPONENT:

Arduino IDE – Software used to write, compile, and upload programs to the Arduino board.

Embedded C – A programming language used to develop control programs for embedded systems.

GPS Interface Program – Software code that reads and processes location data from the GPS module.

Voice Command Processing Program – A program that interprets voice commands and controls the wheelchair movement.

V. BLOCK DIAGRAM:

The block diagram of the smart wheelchair system describes the connection and interaction of various components in the system. The wheelchair system is controlled by an embedded controller, which is Arduino Uno. The embedded controller is considered the main component of the wheelchair system. A voice recognition module is connected to the embedded controller to recognize voice commands from the user, such as forward, backward, left, right, and stop. These voice commands are processed by the embedded controller, which sends signals to the motor driver to move the wheelchair in the required direction using DC motors.

For safety and support, various important components are connected to the wheelchair system. An ultrasonic sensor is connected to detect obstacles in front of the wheelchair and send distance information to the embedded controller. If obstacles are found in front of the wheelchair within a specific distance, the wheelchair is stopped to prevent accidents. A GPS module is connected to track the location of the wheelchair for monitoring purposes. In addition, a solar panel is connected to charge the battery using sunlight, which is one source of renewable energy.

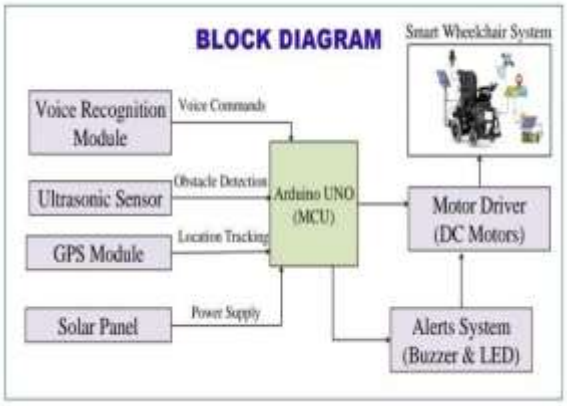


Fig2. Block Diagram

A. EMBEDDED SYSTEM:

The role of the embedded controller, which is Arduino UNO, is to act as a control unit for the smart wheelchair system. The controller receives input signals from different modules, such as the voice recognition module, ultrasonic sensor, and GPS module. The input signals are then processed by the controller with the help of a program, and output signals are sent to control the movement of the wheelchair.

Fig3. ArduinoUno

B. Voice Control System:

The voice control system enables the user to control the wheelchair using voice commands. The voice control system consists of a voice recognition module that recognizes voice commands such as forward, backward, left, right, and stop. The voice commands are received by the embedded controller for further processing. The embedded controller then sends the commands to the motor driver for moving the wheelchair in the desired direction. The user can control the wheelchair without using his or her hands.

Fig4.VoiceRecognitionModule

C. Obstacle Detection System:

The obstacle detection system enhances safety by ensuring that the wheelchair does not collide with obstacles. In this system, an ultrasonic sensor is used to measure the distance between the wheelchair and obstacles. The ultrasonic sensor sends this information to the controller. If there is an obstacle within a certain distance, the wheelchair stops. This ensures that the user moves safely, especially in areas with high congestion.

Fig5.Ultrasonic Sensor

D. GPS Tracking System:

The GPS tracking system is utilized to determine the actual location of the wheelchair. The GPS module receives the signal from the satellite and displays the location. The controller embedded in the system processes the received information. The system can display the location if required. This system is helpful for the caretaker to trace the location of the wheelchair.

Fig6. GPS Module

E. Solar Charging System:

The solar charging system assists in the charging of the battery with the help of solar power. A solar panel is a device that transforms solar power into electric power. This electric power is stored in the battery with the help of a charging circuit. This stored power may be utilized for the electronic devices of the wheelchair, and the life of the battery may be prolonged with the help of solar power.

Fig7.SolarPanel

F. Motor Driver:

The motor driver (L298N) is used to control the speed and direction of the DC motors connected to the wheels of the wheelchair. Since it is not possible to connect the controller directly to the DC motors, the motor driver acts as a bridge between them. The motor driver receives signals from the controller and moves the wheelchair in forward, backward, left, or right directions.

Fig8.MotorDriver

VI. ALGORITHM:

STEP 1:

Start the system and power ON all modules.

STEP 2:

Initialize Arduino, voice module, ultrasonic sensor, GPS, GSM, buzzer, and motor driver.

STEP 3:

Wait for the user's voice command input.

STEP 4:

Capture and convert the voice command into a digital signal.

STEP 5:

Check for obstacles using the ultrasonic sensor.

STEP 6:

If an obstacle is detected, stop the wheelchair and activate the buzzer/LED alert.

STEP 7:

If no obstacle is detected, send control signals to the motor driver.

STEP 8:

Drive the DC motors to move forward, backward, left, right, or stop as commanded.

STEP 9:

Read GPS location and send details via GSM when required; charge the battery through the solar panel in parallel.

STEP 10:

Repeat the process until the system is turned OFF.

VII. RESULTS:

The smart wheelchair system was tested under different conditions to check its performance and reliability. The voice control module was able to recognize the commands of the user, such as forward, backward, left, right, and stop. This enabled the smooth movement of the wheelchair with very little delay. The ultrasonic sensor was able to detect the objects placed in front of the smart wheelchair. This helped the smart wheelchair come to a complete halt and avoid any collision.

The GPS module was also successful in providing information regarding the location of the smart wheelchair. This information can be used when required. The solar charging module helped the smart wheelchair by providing power through solar cells. This indicates that the overall performance of the smart wheelchair can be improved by using a single

VIII. CONCLUSION:

This project develops a smart wheelchair to help physically disabled people move independently. It uses voice commands to control movement, an ultrasonic sensor to detect obstacles and stop the chair for safety, and an embedded controller to manage all parts of the system easily.

The system also includes GPS tracking to know the wheelchair's location and a solar panel to help charge the battery using sunlight. This makes the wheelchair safer, eco-friendly, and easy to use, with future improvements possible like mobile app control and better battery performance.

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