

Prototype Implementation of Hand Gesture Controlled Wheelchair Using Arduino

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ABSTRACT

Mobility is a major challenge for individuals with physical disabilities, particularly for users who find conventional manually operated or joystick-controlled wheelchairs difficult to use. This paper presents the prototype implementation of a hand gesture-controlled wheelchair using Arduino to provide a simple, wireless, and user-friendly mobility solution. An accelerometer is employed to detect the orientation and movement of the user's hand and convert the gestures into directional commands. The processed commands are transmitted wirelessly through an RF communication module to the wheelchair receiver section. An Arduino-based controller interprets the received commands and operates DC motors through an L293D motor driver to achieve forward, backward, left, and right movement. An ultrasonic sensor is incorporated for obstacle detection and collision avoidance. The developed prototype successfully demonstrates gesture recognition, wireless communication, obstacle detection, and motor control. The system provides an economical approach for improving independent mobility and can serve as a foundation for further development of intelligent assistive wheelchairs.

Keywords— Arduino Uno, Hand Gesture, Wheelchair, Accelerometer, Ultrasonic Sensor, RF Module, L293D Motor Driver, Assistive Technology.

INTRODUCTION

People with physical disabilities frequently encounter difficulties in performing everyday mobility activities independently. Conventional wheelchairs may require assistance from another person, while powered wheelchairs generally employ joysticks or other mechanical interfaces that can be difficult for users with restricted hand movement. The project report therefore focuses on developing an assistive mobility system capable of interpreting simple hand movements as wheelchair control commands.

The proposed hand gesture-controlled wheelchair employs an accelerometer to recognize hand movement and an Arduino microcontroller to process the sensor information. The gesture information is transmitted wirelessly from the user-side controller to a receiver mounted on the wheelchair. According to the report, the proposed arrangement is intended to replace conventional joystick control with a hand-based interface and thereby improve the user's independence and maneuverability.

The system also incorporates an ultrasonic sensor for obstacle detection. The combination of gesture recognition, wireless RF communication, Arduino-based processing, and motor control provides a compact and cost-effective approach to assistive wheelchair automation.

LITERATURE SURVEY

Khyati Meena, Vijay Khare, and Shubham Gupta [5] presented a voice-controlled wheelchair that employs speech recognition technology for assisting physically disabled users. Their system integrates Arduino, an HM2007 voice-recognition module, motors, and an optional joystick to provide alternative wheelchair control. Trinayan Saharia *et al.* [1] developed a joystick-controlled wheelchair based on an ATmega328P controller. The system provides powered mobility through manual joystick commands and was proposed as a convenient solution for wheelchair users in environments such as hospitals and public places.

Anjaneyulu *et al.* [2] proposed an intelligent wheelchair controlled through a keyboard and an accelerometer. The ADXL335 MEMS accelerometer detects hand inclination and generates corresponding control information, providing a low-cost alternative to conventional joystick-based operation. Rajesh Kannan Megalingam *et al.* [3] investigated wireless gesture-based wheelchair control, while Arpit Tiple *et al.* [4] developed a touch-controlled wheelchair incorporating obstacle detection and collision avoidance. These studies demonstrate the potential of alternative human-machine interfaces for improving independent mobility. The present work combines accelerometer-based gesture control, RF communication, Arduino processing, ultrasonic obstacle detection, and motor-drive control in a single prototype.

PROBLEM STATEMENT

Traditional and electrically powered wheelchairs often rely on manual assistance or joystick manipulation. Such interfaces can be inconvenient or impractical for individuals with restricted physical movement. Therefore, there is a need for a cost-effective wheelchair that can be operated using simple hand gestures while providing obstacle detection for safer navigation.

OBJECTIVES

1. To design and implement an Arduino-based wheelchair that recognizes hand gestures using an accelerometer and wirelessly converts them into forward, backward, left, right, and stop commands.
2. To improve wheelchair safety and independent mobility by incorporating ultrasonic obstacle detection and automatic motor-control functions.

PROPOSED SYSTEM

The proposed system consists of two primary sections: a transmitter unit and a receiver unit. In the transmitter section, an accelerometer detects hand inclination and movement. The sensor output is processed by an ATmega328-based Arduino controller to identify directional gestures. The resulting control information is transmitted wirelessly through a 433-MHz RF transmitter to the receiver mounted on the wheelchair.

At the receiver section, the RF receiver provides the transmitted information to another Arduino controller. Based on the received gesture, the controller generates appropriate signals for the L293D motor driver, which operates the DC motors to move the wheelchair. An HC-SR04 ultrasonic sensor continuously observes the path in front of the wheelchair. When an obstacle is detected within the predefined range, the controller can stop or modify the wheelchair movement to reduce the possibility of collision. The report identifies Arduino, the RF transmitter/receiver, accelerometer, ultrasonic sensor, L293D driver, DC motors, and power supply as the principal system components.

BLOCK DIAGRAM

The Fig. 1 shows the integrated block diagram of the hand gesture-controlled wheelchair, where the accelerometer detects the user's hand movement and the Arduino transmits the corresponding command through the 433 MHz RF module. The receiver-side Arduino processes the command, controls the DC motors through the L293D motor driver, and uses the ultrasonic sensor for obstacle detection and safe navigation.

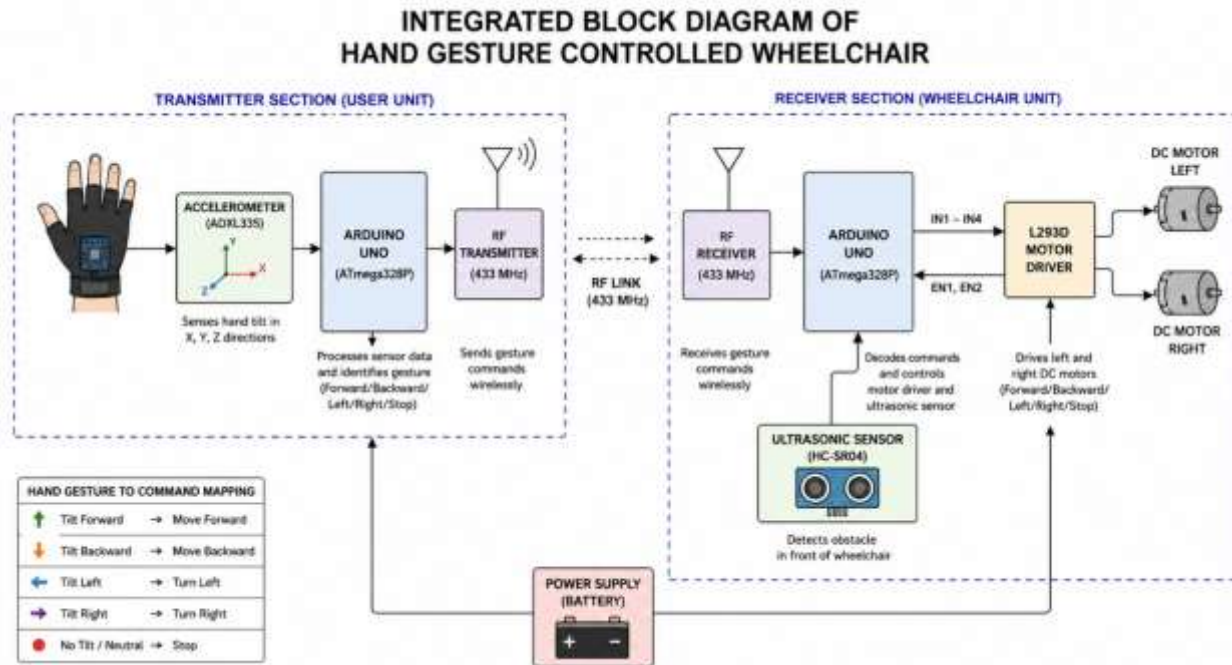


Fig 1 block diagram

CIRCUIT DIAGRAM

The Fig. 2 shows the integrated circuit diagram of the hand gesture-controlled wheelchair, where the ADXL335 accelerometer and Arduino Uno generate gesture commands and transmit them wirelessly through the 433 MHz RF module. At the receiver, the Arduino processes these commands and controls the DC motors through the L293D motor driver, while the HC-SR04 ultrasonic sensor provides obstacle detection for safe wheelchair movement.

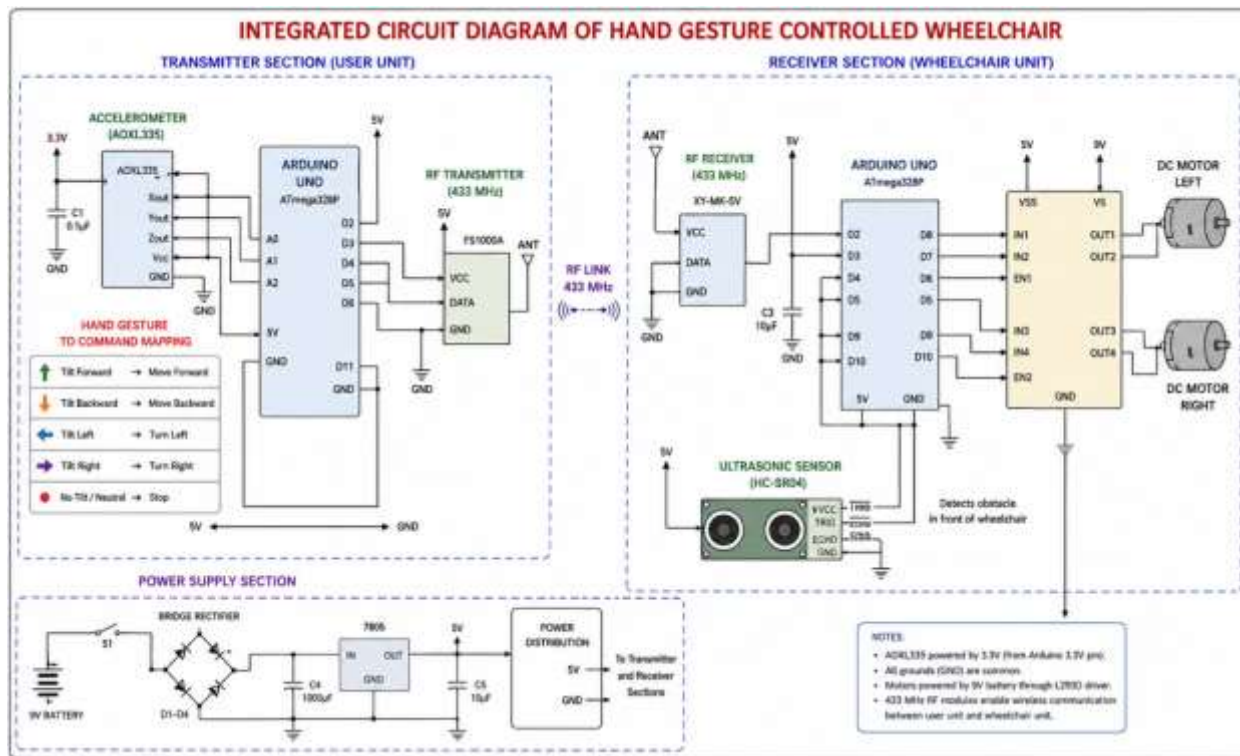


Fig 2 circuit diagram

METHODOLOGY

The operation begins with acquisition of the user's hand movement through the accelerometer. Different hand tilts are associated with different wheelchair movements: forward tilt commands forward movement, backward tilt produces backward movement, and left and right tilts produce the corresponding turning operations. The Arduino processes these sensor signals and transfers the identified gesture through the RF transmitter. At the wheelchair, the RF receiver obtains the transmitted information and forwards it to the receiver-side Arduino for interpretation.

The receiver controller simultaneously processes gesture commands and information obtained from the ultrasonic sensor. According to the required direction, the Arduino activates the L293D motor driver, which provides suitable driving signals to the DC motors. Differential operation of the motors enables forward, reverse, left, and right movement. Meanwhile, the ultrasonic sensor continuously measures the distance to objects in front of the wheelchair. When an obstacle is detected, the Arduino can stop or redirect the wheelchair, giving priority to collision avoidance and user safety.

RESULTS AND DISCUSSION

As shown in **Fig. 3**, the developed prototype successfully demonstrates the implementation of a hand gesture-controlled wheelchair. The accelerometer detects directional hand gestures and converts them into forward, backward, left, and right movement commands, while the RF module provides wireless communication between the transmitter and receiver sections. The L293D motor driver controls the DC motors according to the received commands, enabling smooth and accurate wheelchair movement.

The ultrasonic sensor was also able to detect obstacles in the wheelchair's path and initiate appropriate collision-avoidance responses. According to the project report, the system demonstrated high gesture-recognition accuracy with minimal false detections, practical obstacle detection, and quick response to user commands and obstacle conditions. These results indicate that the integration of accelerometer sensing, RF communication, Arduino processing, and ultrasonic obstacle detection provides an effective prototype for gesture-controlled assistive mobility.



Fig 3 Hardware setup

CONCLUSION

The prototype implementation of the hand gesture-controlled wheelchair using Arduino demonstrates an effective approach for assisting individuals with limited mobility. The developed system successfully enables forward, backward, left, right, and stationary wheelchair operations using accelerometer-based hand gestures. Wireless RF communication transfers commands from the user interface to the wheelchair, while the Arduino and L293D motor driver provide appropriate motor control. The ultrasonic sensor improves operational safety by detecting obstacles in the wheelchair's path.

The experimental prototype demonstrates that embedded hardware and gesture-recognition techniques can provide a convenient alternative to traditional wheelchair controls. The report concludes that the proposed system is effective in terms of performance, accuracy, and efficiency and provides a foundation for further development of intelligent and autonomous assistive mobility systems.

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