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HAND GESTURE CONTROLLED WHEELCHAIRUSING ARDUINO

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***ABSTRACT*: This project aims to develop a hand gesture controlled wheelchair using Arduino microcontroller. The proposed system utilizes an accelerometer sensor to detect the hand gestures of the user and translate them into wheelchair movements. The system architecture consists of three main components: the sensor module, Arduino board, and motor driver circuit. The sensor module captures the hand gestures and sends them to the Arduino board, which processes the signals and controls the motor driver circuit to move the wheelchair in the desired direction. The system's performance was evaluated by conducting various tests, including accuracy, response time, and power consumption. The experimental results demonstrate that the proposed hand gesture-controlled wheelchair system provides an efficient and intuitive way for people with physical disabilities to navigate their environment with ease. The system's low cost, simplicity, and ease of use make it a viable solution for enhancing the mobility of wheelchair users.**

KEYWORDS: Arduino Uno, Arduino Nano, RF Modules, Ultra Sonic Sensor, L298 Motor drivers, DC Motors, Buzzer, Battery.

I.INTRODUCTION

Wheelchairs have been a critical tool in aiding individuals with mobility impairments, enabling them to move around freely and independently. However, traditional wheelchair controls can be challenging for some users, especially those with limited hand dexterity or who suffer from motor impairments. To address these challenges, hand gesture-based control systems have been proposed as an alternative to traditional joystick controls. These systems utilize sensors to detect hand movements and translate them into wheelchair movements. In this project, we propose the development of a hand gesture-controlled wheelchair using an Arduino microcontroller. The system utilizes an accelerometer sensor to capture hand gestures and translate them into wheelchair movements, enabling users to navigate their environment with ease. The proposed system's low cost, simplicity, and ease of use make it a promising solution for enhancing the mobility of wheelchair users. The paper presents the system architecture, design, and experimental results, demonstrating the system's feasibility and effectiveness in controlling a wheelchair.

II. LITERATURE REVIEW

Several research studies have been conducted in recent years to investigate the potential of gesture recognition technology in controlling assistive devices for people with disabilities. In this literature review, we discuss some of the relevant studies related to hand gesture-controlled wheelchair systems.

In a study by Huang et al. (2018), a novel wheelchair control system based on hand gesture recognition was proposed. The system utilized a combination of a Kinect sensor and machine learning algorithms to recognize hand gestures and translate them into commands for controlling the wheelchair. The study demonstrated the effectiveness and feasibility of the proposed system in improving the mobility and independence of individuals with physical disabilities.

Another study by Sahu and Thakur (2019) proposed a hand gesture controlled wheelchair using Arduino. The system used an accelerometer and gyroscope sensor to capture hand movements and translate them into commands for controlling the wheelchair.

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The study showed promising results in terms of the system's accuracy, responsiveness, and ease of use.

Pham et al. (2020) designed and developed a low-cost hand gesture controlled wheelchair using Arduino. The system utilized a flex sensor and a gyroscope sensor to capture hand movements and translate them into commands for controlling the wheelchair. The study demonstrated the effectiveness of the proposed system in improving the mobility and independence of individuals with physical disabilities, while also addressing the issue of affordability and accessibility.

Chowdhury et al. (2020) also developed a hand gesture controlled wheelchair using Arduino. The system used an accelerometer and a flex sensor to capture hand movements and translate them into commands for controlling the wheelchair. The study demonstrated the effectiveness of the proposed system in providing a more intuitive and natural way of controlling a wheelchair, while also addressing the issue of cost and complexity.

Overall, the literature suggests that hand gesture control systems for wheelchairs are a promising solution for improving the mobility and independence of individuals with physical disabilities. The studies reviewed in this paper demonstrate the feasibility, effectiveness, and usability of hand gesture control systems for wheelchairs, while also addressing the issues of cost and accessibility. However, there is still a need for further research and development in this area to optimize the performance and functionality of hand gesture control systems for wheelchairs.

III. PROPOSED SYSTEM

The proposed hand gesture-controlled wheelchair system consists of three main components: a sensor module, an Arduino microcontroller board, and a motor driver circuit. The sensor module is responsible for capturing the hand gestures of the user and sending them to the Arduino board for processing. The Arduino board processes the signals and sends the appropriate commands to the motor driver circuit, which controls the movement of the wheelchair.

For hand gesture recognition, we propose to use a 9-axis inertial measurement unit (IMU) sensor, which includes an accelerometer, gyroscope, and magnetometer. The sensor will be attached to the user's wrist to capture the hand gestures. The sensor data will be filtered and pre-processed using a complementary filter to eliminate noise and drift.

The Arduino microcontroller board will be responsible for processing the sensor data and translating the hand gestures into wheelchair movements. We propose to use an Arduino Nano board due to its compact size and low power consumption. The Arduino board will run a custom firmware developed in Arduino IDE that will use an algorithm to interpret the sensor data and recognize the hand gestures. The recognized hand gestures will be mapped to specific wheelchair movements, such as forward, backward, left, and right.

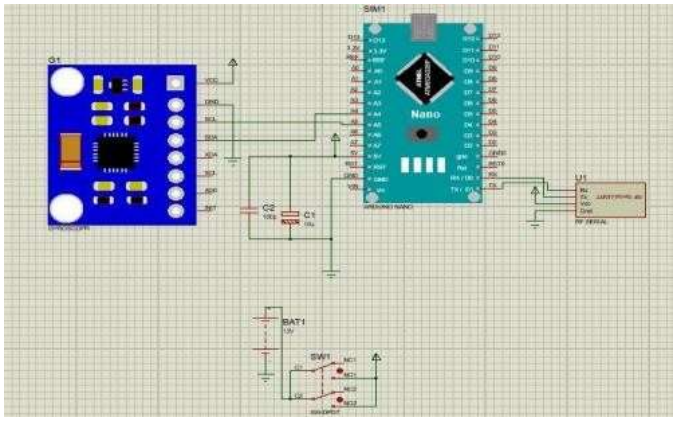

Fig. 1. Transmitter circuit

To control the movement of the wheelchair, we propose to use a motor driver circuit that can control the speed and direction of two DC motors. We propose to use an L298N motor driver module due to its simplicity, low cost, and compatibility with the Arduino board. The motor driver module will receive commands from the Arduino board and control the wheelchair motors accordingly.

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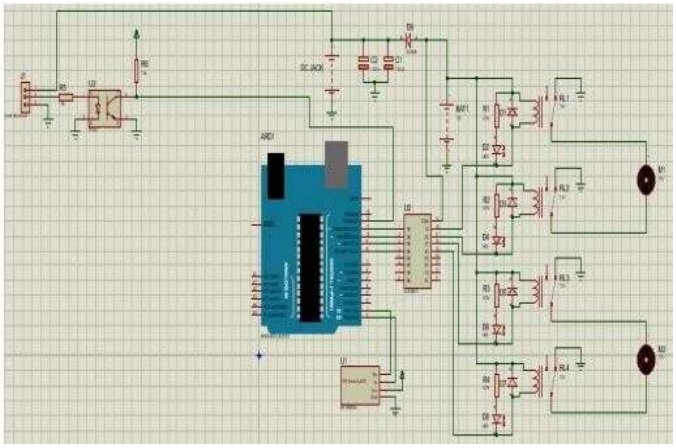

Fig. 2. Receiver circuit

In summary, the proposed hand gesture-controlled wheelchair system will use a 9-axis IMU sensor to capture hand gestures, an Arduino Nano board to process the sensor data and control the wheelchair, and an L298N motor driver module to control the wheelchair motors. The system will be designed to be low cost, simple, and easy to use, with the potential to enhance the mobility of people with physical disabilities.

IV.FLOW CHARTS

The flow chart for transmitter circuit is shown below which is in the user's hand. Arduino Nano is used in this circuit for controlling all the operations of transmission. Main components of the transmitter circuit are Lithium battery, DC to DC converter, Accelerometer & Gyroscope, Arduino Nano and RF module (radio frequency module).

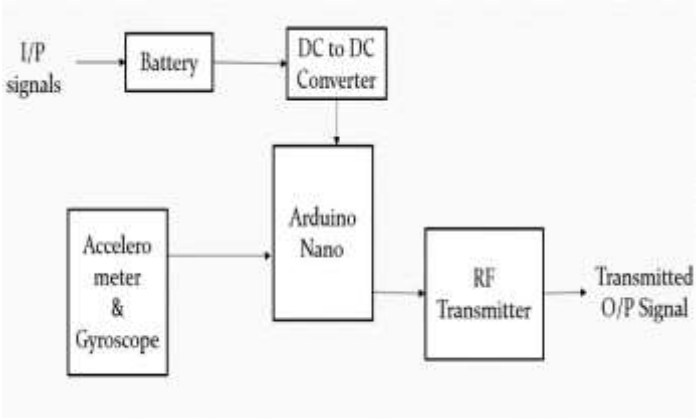

Fig. 3. Transmitter block diagram

The wheelchair comprises of two main parts, one is transmitter part, placed on the hand of the user and the another one is receiver part which is placed in the chair. These both units are wireless module. Both the units consist of RF module pair which is used for transmitting and receiving the signal respectively. The chair will move as soon as the person changes the wrist gesture.

In this circuit DC to DC Converter is used in the circuit. It converts the variable power supply by the battery to a constant 5V power supply to the Arduino Nano. Finally, Arduino Nano sends the signal to the RF Module and it transmits the signal to its pair that is connected in the receiver circuit. As shown in Fig-3 the transmitted signal by the RF module of transmitter circuit is received by its pair in receiver circuit. It sends the received signal to the Arduino Uno.

Given block diagram shows the flow chart of receiver circuit which is in wheelchair. In this circuit Arduino Uno is used for controlling the operations to receive the signals and according to that it gives instructions to motors for movement using relays. Main components in receiver circuit are proximity sensor, Arduino Uno, Buzzer and Relays.

12V Power supply is given in the circuit. For that the chargeable battery is used. Finally, Arduino Uno sends the received signals by RF Module & Ultrasonic Sensor to the Relays connected in the circuit and accordingly the chair works. We have used 4 relays in the circuit. For each motor 2 Relays are used. According to that our wheelchair take Left, Right, Forward & Backward movements.

The transmitter transmits up to 50 meters of the range so that the user can operate the wheelchair from anywhere under this range. If the person is not able to operate the wheelchair by his own and the person has his companion with him then his companion can operate the wheelchair using his gesture.

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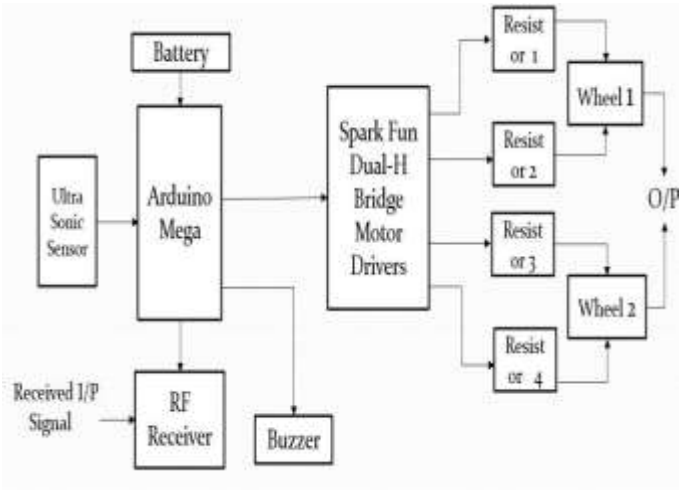


Fig. 4. Receiver block diagram

V. WORKING

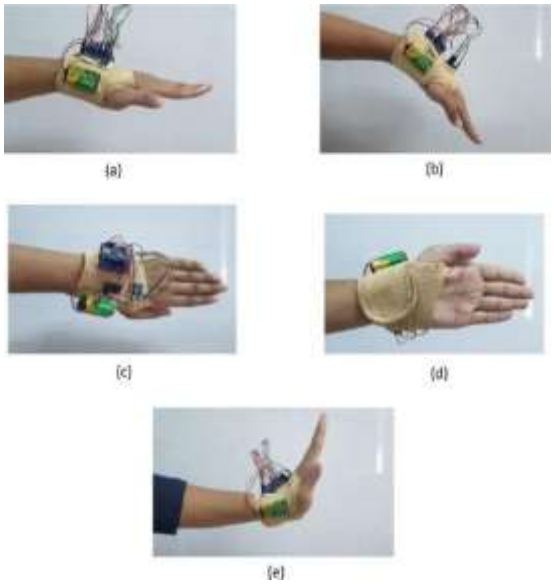
The wheelchair works according to the instruction given by the user through hand gesture. According to user's gesture, both motors work as shown in the Table-1. The Wheelchair will go in the direction in which our hand gesture shows.

Table I: Working of the motors in wheelchair

Movement of Motors According to Hand Gesture:

Direction of hand gesture	Movement of left Motor	Movement of right Motor
Forward	Forward	Forward
Backward	Backward	Backward
Right	Forward	Stop
Left	Stop	Forward

Fig.5. shows the gestures made by the physically challenged or elderly people.



(a) Gesture to STOP the System Model, **(b)**Gesture for going FORWARD with the System Model, **(c)**Gesture for going RIGHT side with the System Model **(d)** Gesture for going LEFT side with the System Model, **(e)**Gesture for going REAR/BACKWARD with the System Model.

VI. RESULT

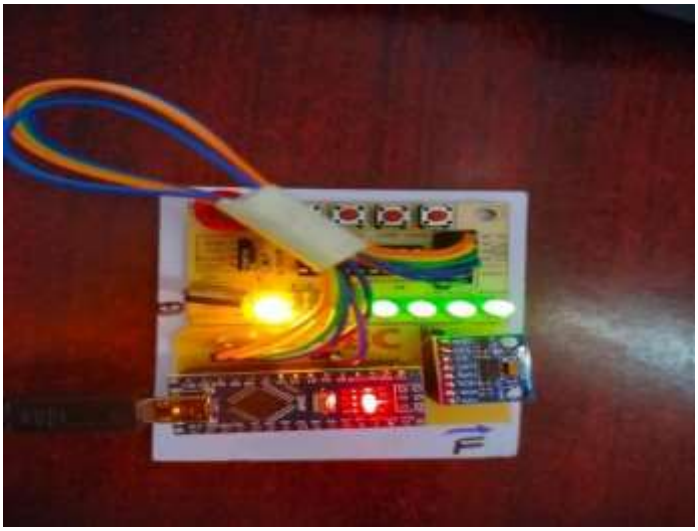


Fig. 6. Transmitter Output

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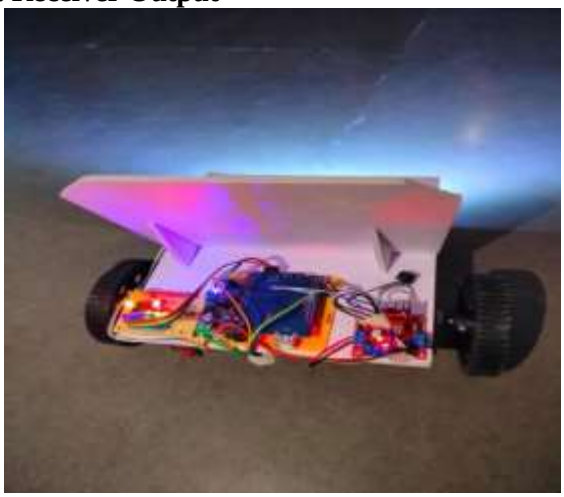
The above diagram is about output for the Hand Gesture Controlled Wheelchair Using Arduino project is based on capturing hand gestures through an accelerometer sensor attached to a glove worn by the user. The sensor data is then processed by an Arduino microcontroller, which uses a wireless communication module to send the corresponding commands to the motor driver module. The motor driver module controls the movement of the wheelchair according to the user's hand gestures, allowing for a more intuitive and natural way of controlling the wheelchair. The system's output is designed to be reliable, accurate, and responsive, with minimal latency between the hand gesture and the wheelchair's movement. This approach offers an affordable and effective solution for individuals with physical disabilities, improving their mobility and independence while also offering them greater autonomy and control over their daily lives.

Fig. 7. Receiver Output



VII. ADVANTAGES

- The use of an accelerometer sensor and an Arduino microcontroller provides a cost-effective solution for individuals with physical disabilities, making it more accessible and affordable than other assistive technologies.
- The system offers an intuitive and natural way of controlling the wheelchair's movement through hand gestures, allowing for a more seamless and effortless experience for the user.
- The system offers a high degree of accuracy and responsiveness, with minimal latency between the user's hand gestures and the wheelchair's movement.

VIII. APPLICATIONS

1. The system can be used to improve the mobility and independence of individuals with physical disabilities, such as those with spinal cord injuries, cerebral palsy, or muscular dystrophy.
2. The proposed system can be adapted and customized for different types of wheelchairs, making it a versatile solution for a wide range of users and environments.
3. The hand gesture control system can be integrated with other assistive technologies, such as voice recognition or eye tracking systems, to provide a more comprehensive and personalized experience for users with complex needs.
4. The proposed system can also be used in rehabilitation settings to help individuals with physical disabilities regain mobility and control over their movements.

IX. FUTURE SCOPE

- The proposed system can be further improved by integrating additional sensors or technologies, such as machine learning algorithms, to enhance the system's accuracy, responsiveness, and adaptability to different environments and users.
- The hand gesture control system can be integrated with other assistive technologies, such as brain-computer interfaces or virtual reality systems, to provide a more comprehensive and personalized experience for users with complex needs.
- The system can be adapted for different types of mobility devices, such as electric scooters or power chairs, to provide a more seamless and natural way of controlling a wide range of mobility devices.
- Instead of using acceleration motor we can use eye retina using optical sensor to move wheelchair accordingly.

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- This system can be extended by including GSM, which sends an SMS during emergency.

X. CONCLUSIONS

i. The wheelchair is fully automated affordable, portable and has load carrying capacity upto 100 kgs.

ii. If anyone have his own traditional wheelchair then also automation can be implemented in it using the circuits. It is as foldable as the original wheelchair is, so that we can take it from one place to another place without any difficulty.

iii. User can use it by his own or his companion can also operate it under a certain range.

iv. The main aspect to design this wheelchair is to make senior age people and handicapped people to be independent.

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