

Solar Powered Gesture Controlled Robot

Ishwarya Dharavath¹, Nithish Chelimela², Abhishek Goud Jinukunta³

Department of Electrical and Electronics Engineering¹⁻³

ACE Engineering College, Hyderabad, India

Abstract: *This paper presents the design and implementation of a Solar Powered Gesture Controlled Robot and integrating MEMS-based gesture control, RF wireless communication, PIR human detection, ultrasonic obstacle avoidance, and solar energy management. The gesture control unit employs a MEMS accelerometer to detect hand movements, which are processed by a PIC microcontroller and encoded using an RF transmitter module. The robot section receives and decodes these signals to control motion through a motor driver, enabling precise navigation. For enhanced security, a Passive Infrared (PIR) sensor detects human presence in restricted areas, while an ultrasonic (SR04) sensor ensures real-time obstacle detection and avoidance. A mode selection mechanism allows switching between gesture-controlled and autonomous operation. The system is powered by a rechargeable battery supported by a solar charging unit, ensuring extended deployment in remote environments. LED indicators provide operational status feedback. The proposed system offers a low-cost, energy-efficient, and hazardous area monitoring. By reducing direct human involvement, the robot enhances operational safety, improves monitoring efficiency, and supports sustainable energy utilization*

Keywords: MEMS Accelerometer, RF Communication, PIR Sensor, Ultrasonic Sensor, Solar Power, PIC Microcontroller, Gesture Control

I. INTRODUCTION

The rapid development of robotics and wireless communication technologies has enabled the creation of intelligent systems that can perform tasks in dangerous and inaccessible environments. In many applications such as military surveillance, disaster monitoring, and hazardous area inspection, sending human personnel can be risky and inefficient. To address these challenges, a Solar Powered Gesture Controlled Robot is designed to perform remote monitoring and movement using simple hand gestures. The system uses a MEMS accelerometer sensor to detect the motion of the user's hand. These gestures are converted into control commands and transmitted wirelessly through an RF communication module to the robot. The robot receives the commands using an RF receiver and processes them using a microcontroller. Based on the received signal, the robot moves in different directions such as forward, backward, left, and right. In addition, the robot is equipped with PIR sensors for human detection and ultrasonic sensors for obstacle avoidance, enabling it to operate safely in dynamic environments. The robot is powered using solar energy, which charges a rechargeable battery and provides sustainable power for long-duration operation. This reduces dependency on external power sources and makes the system suitable for remote areas. Overall, the proposed system provides a low-cost, energy-efficient, and reliable robotic solution for surveillance and monitoring applications.

II. SYSTEM ARCHITECTURE

The solar powered gesture controlled robot consists of two main sections: the gesture control transmitter unit and the robot receiver unit. In the transmitter section, a MEMS accelerometer sensor is used to detect the movement and orientation of the user's hand. These gesture signals are processed by an Arduino Nano microcontroller, which converts the detected motion into corresponding control commands such as forward, backward, left, and right. The commands are then transmitted wirelessly using a 433 MHz RF transmitter module. In the receiver section, the RF receiver module receives these signals and sends them to the microcontroller mounted on the robot. The microcontroller interprets the commands and controls the DC motors through a motor driver to move the robot in the desired direction. Additionally,



the robot is equipped with an ultrasonic sensor for obstacle detection and a PIR sensor for human detection to improve safety and monitoring capability. The entire robot is powered by a rechargeable battery charged through a solar panel, enabling continuous and energy-efficient operation in remote or outdoor environments.

III. BLOCK DIAGRAM

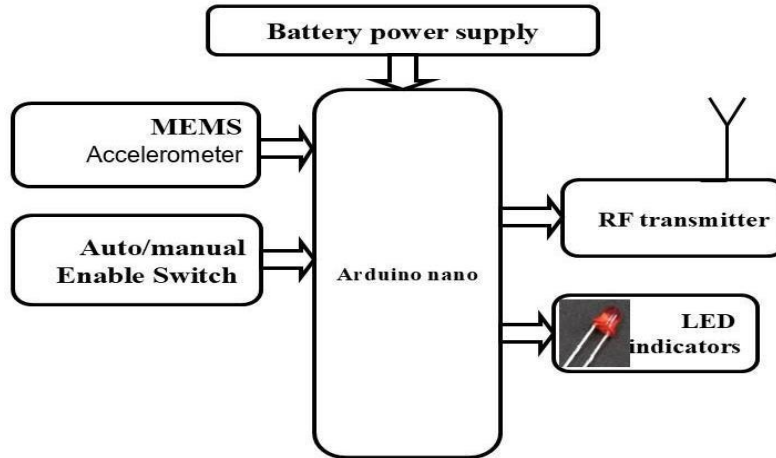


Fig. 1 Block Diagram of Gesture Control

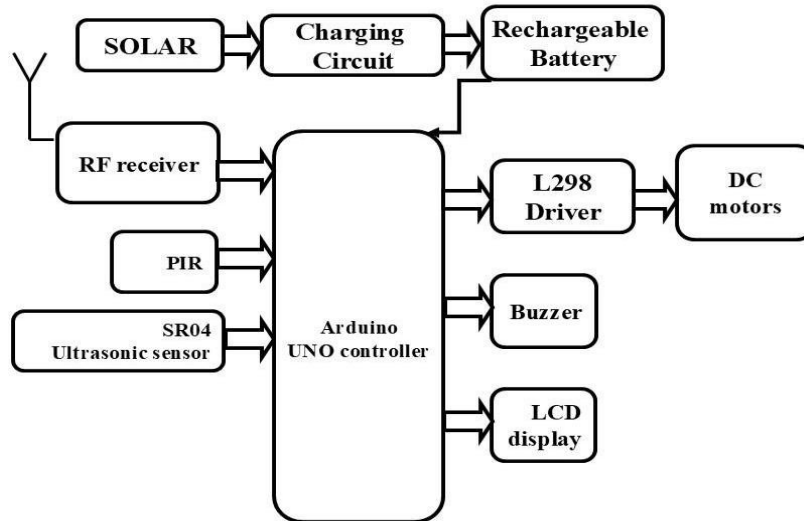


Fig. 2 Block Diagram of Robot Section



IV. CIRCUIT LAYOUT

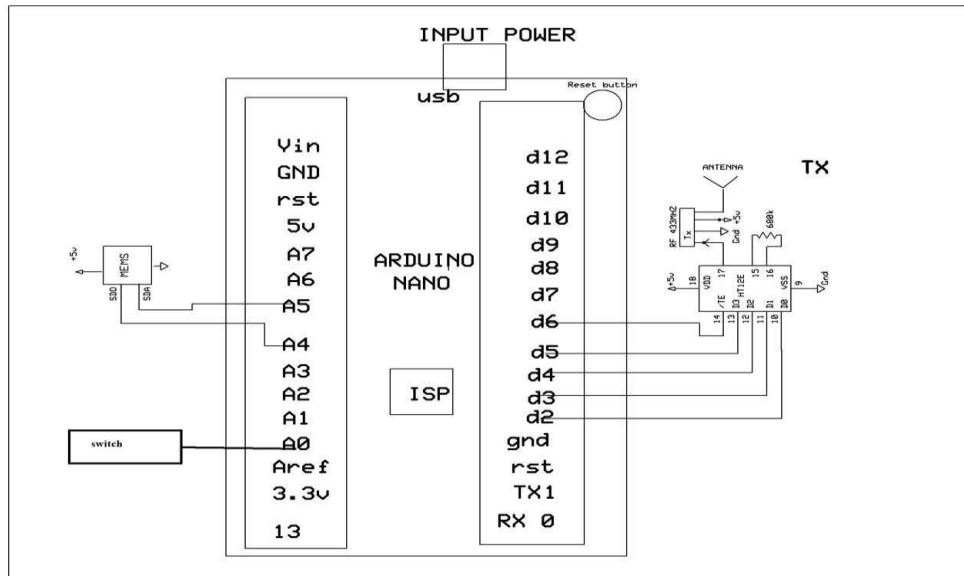


Fig. 3 Circuit Layout of Gesture Control

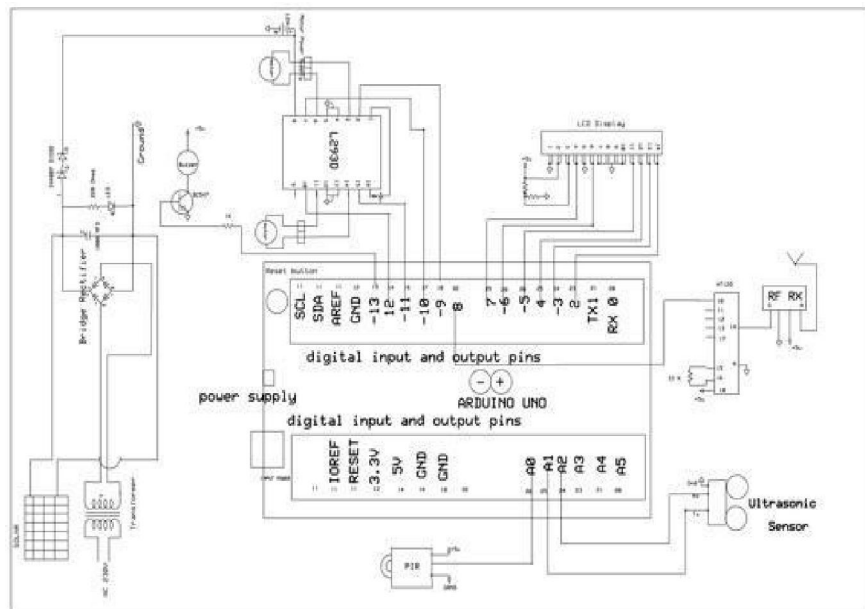


Fig. 4 Circuit Layout of Robot Section



V. PROPOSED SYSTEM

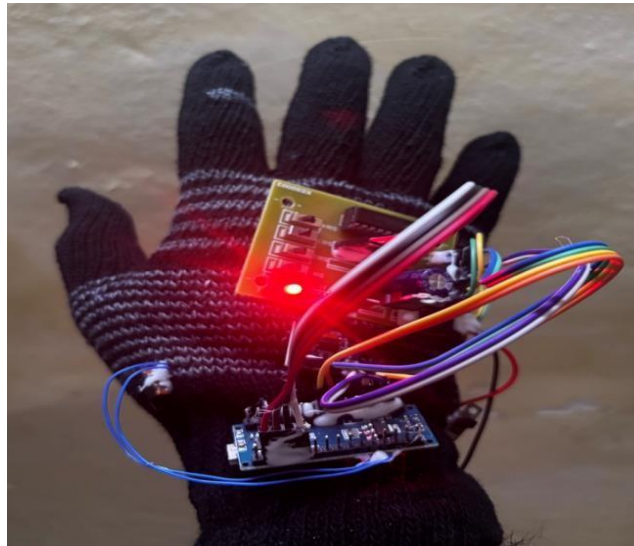


Fig. 5.1 Gesture Control in Study Mode

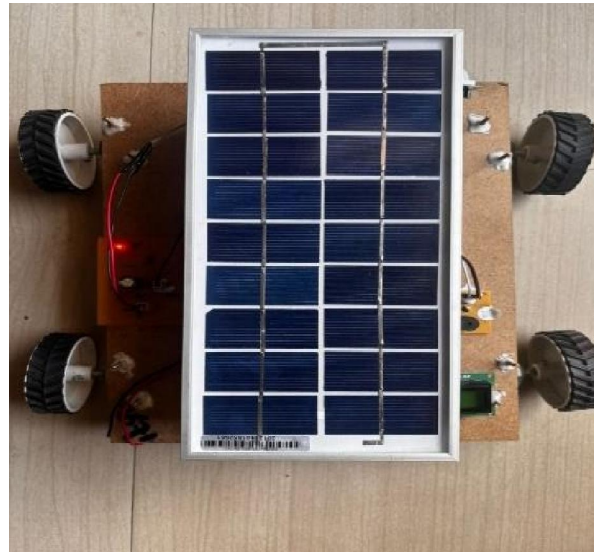


Fig. 5.2 Prototype Robot in Study mode



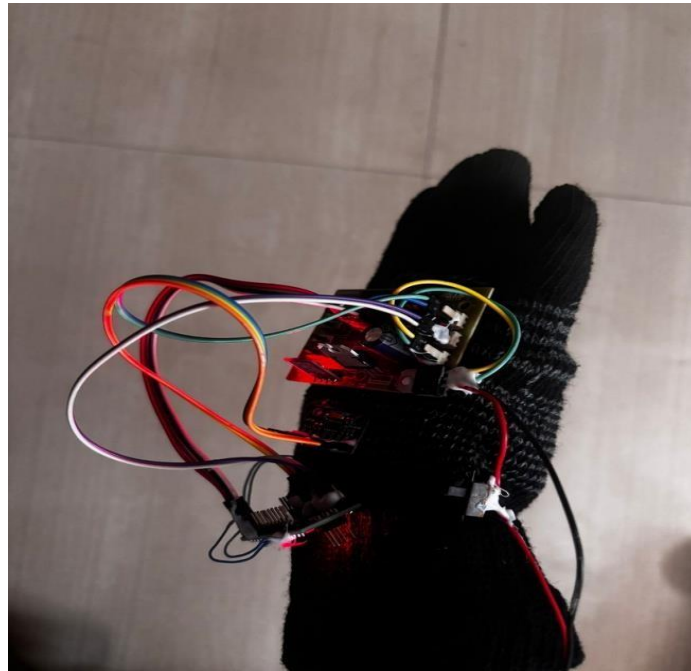


Fig. 5.3 Left Gesture Control

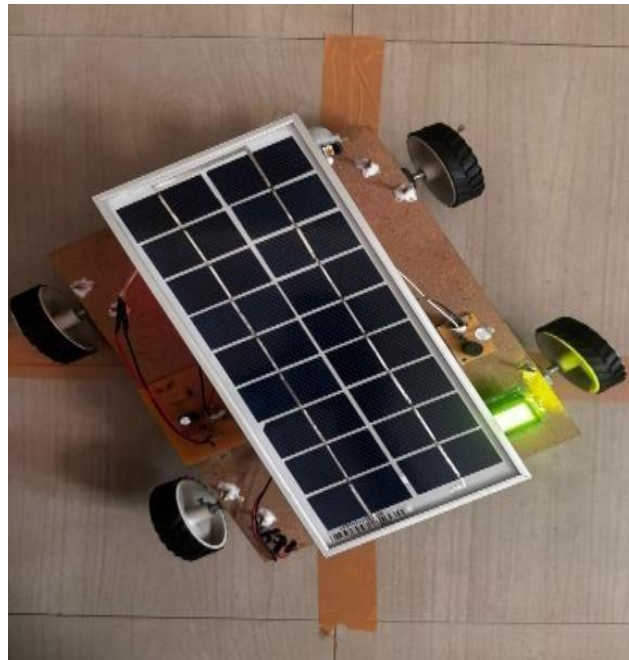


Fig. 5.4 Left Rotation of robot



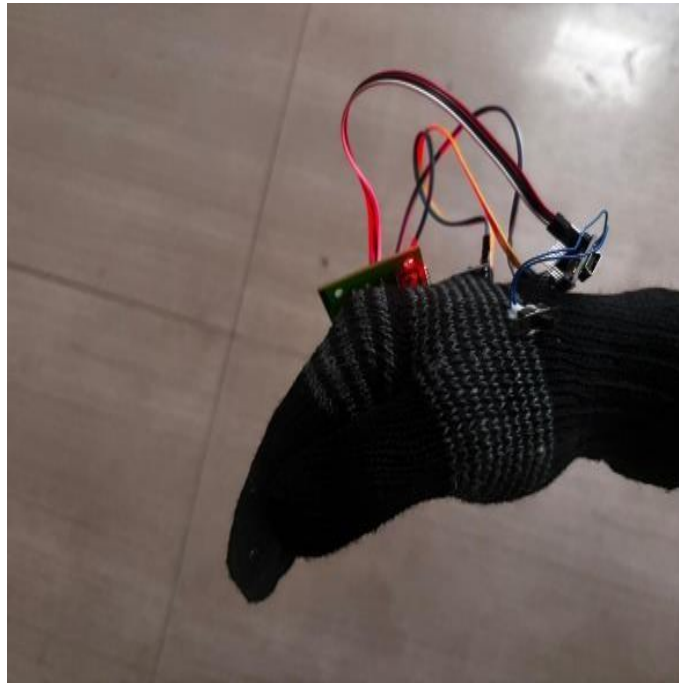


Fig.5 Forward Gesture

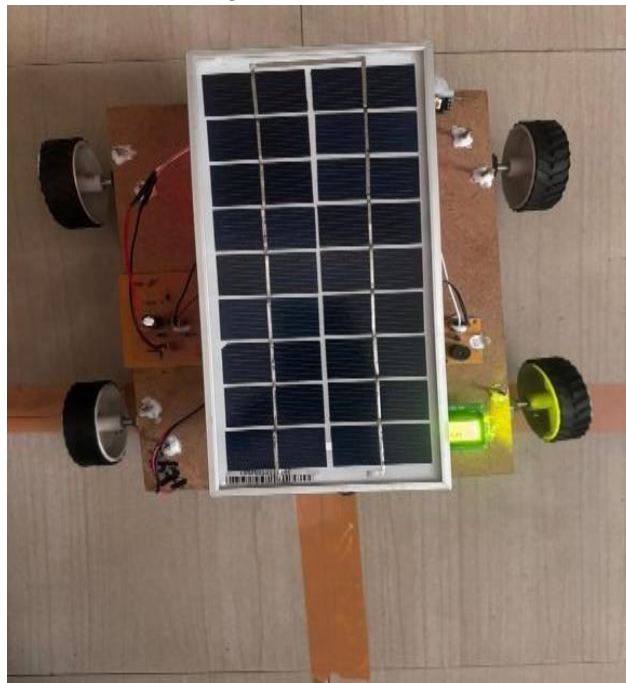


Fig.5.1 Forward Motion of Robot



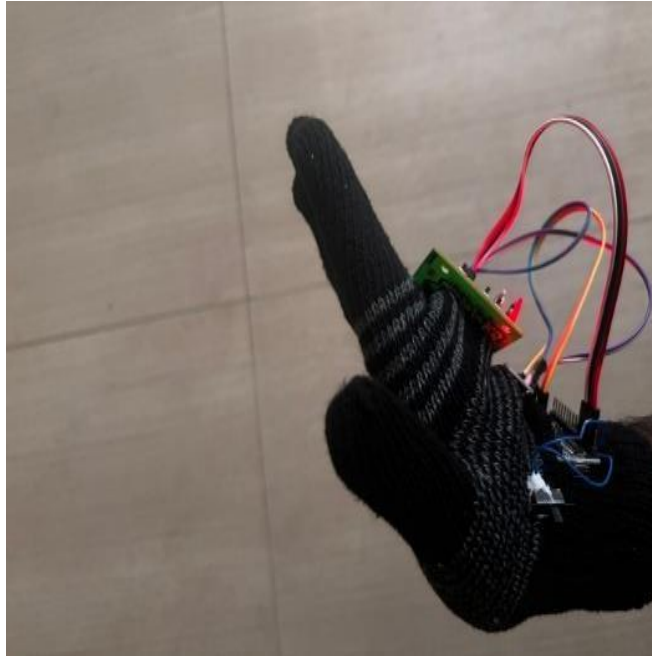


Fig.6. Backward Gesture

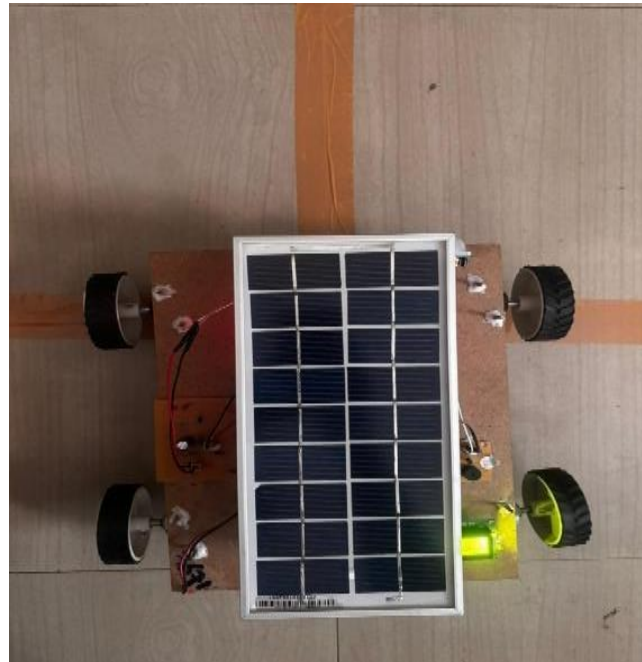


Fig.6.1 Backward Motion of Robot



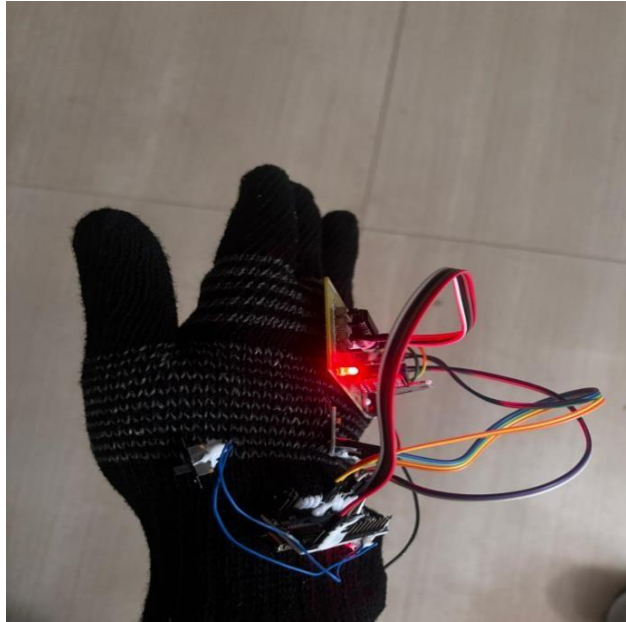


Fig.7 Right Gesture

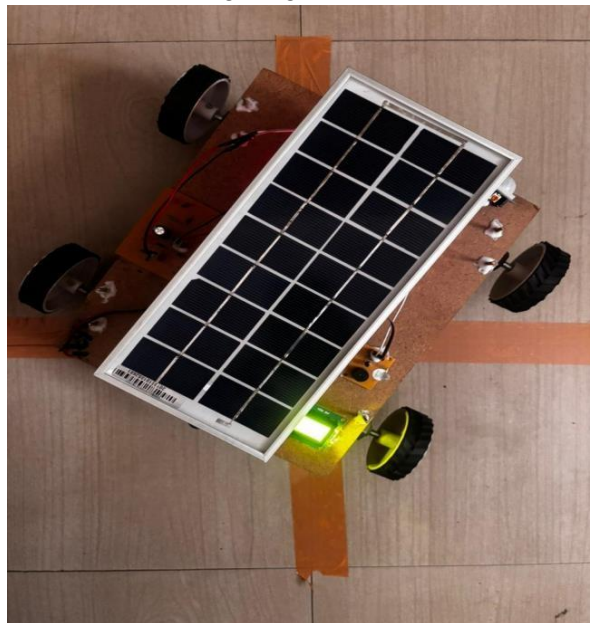


Fig.7.1 Right Rotation of Robot

VI. RESULTS AND DISCUSSION

The prototype of the Solar Powered Gesture Controlled Robot was successfully tested with different hand gestures. The MEMS accelerometer accurately detected the hand movements and transmitted commands through the RF module. Based on these commands, the robot moved in different directions such as forward, backward, left, and right. The ultrasonic sensor effectively detected obstacles, and the PIR sensor successfully identified human presence. The solar



panel provided continuous power by charging the battery, ensuring stable operation. Overall, the system demonstrated reliable gesture recognition, wireless communication, and efficient performance.

VII. FUTURE SCOPE

In the future, the Solar Powered Gesture Controlled Robot can be enhanced by integrating advanced technologies to improve its performance and capabilities. Features such as GPS tracking can be added for real-time location monitoring, and IoT connectivity can enable remote monitoring through the internet. The system can also be upgraded with artificial intelligence for better human recognition and autonomous navigation. Additionally, night vision cameras or infrared sensors can be included to improve operation in low-light conditions, making the robot more efficient for surveillance and security applications.

VIII. CONCLUSION

The Solar Powered Gesture Controlled Robot was successfully designed and implemented to demonstrate gesture-based wireless control. The system effectively detects hand movements using a MEMS accelerometer and controls the robot through RF communication. The integration of ultrasonic and PIR sensors improves safety and monitoring capability, while the solar panel provides an energy-efficient power source. Overall, the project proves to be a reliable and cost-effective solution for surveillance and monitoring applications, especially in hazardous or remote areas.

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