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Gesture Control Robot Using Arduino

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Abstract: *A robot that can be operated with basic human gestures is called a "gesture-controlled car." All the user has to do is wear a gesture device with a sensor built in. The robot will move in the appropriate directions when the sensor records a hand movement in a particular direction. Radio waves are used to establish a wireless connection between the robot and the Gesture instrument. Thanks to wireless connection, users can engage with the robot more amicably. Using accelerometer sensors attached to a hand glove, we can operate the vehicle. The remote control that is typically used to operate the vehicle is supposed to be replaced by the sensors. In addition to controlling the car's throttle with the same accelerometer sensor, it will enable the user to control the vehicle's forward, backward, left, and right movements.*

Keywords: *Robot, Sensor, Gesture, Accelerometer, Arduino.*

1. INTRODUCTION

Numerous businesses, including manufacturing, assembly, services, and construction, use robots. The main advantage of hand gestures is that they provide a more schematic way to direct robots. Wireless communication makes it easier to connect with a robot in a more friendly way because hand movements are natural to humans. When a gesture-controlled robot obeys human commands, it is considered semi-autonomous. These can be controlled by gestures, a phone, a remote, etc. Gesture-controlled robot that is fully controlled by an Arduino that gets commands from another Arduino Within the current setup, the robot detects and imitates the actions of human hands using sensors. The accelerometer moves in tandem with the person's hand movements and sensor displacements, detecting parameters based on the hand's position. With the help of this system, a robotic car that is gesture-driven is created, meaning that the user's gestures determine how the vehicle moves and handles. The potential for applications in a variety of industries, including healthcare, entertainment, and industrial automation, has made human-robot interaction a prominent research area. Hand gesture control has drawn a lot of attention among the various interaction techniques since it is intuitive and natural. In this study, we show the Arduino-based Hand Gesture Controller Robot Car design and implementation, which allows users to manipulate a robot car's motion with hand gestures. This system uses an accelerometer to record gestures, which are then processed by microcontroller software. The parameters are then transmitted to the encoder circuit and microcontroller. This system uses an accelerometer to record gestures, which are then processed by microcontroller software. The parameters are then transmitted to the encoder circuit and microcontroller

2. HYPOTHESIS

The project's hypothesis is that an ADXL335 analog accelerometer and an NRF24L01 wireless transceiver can be used to successfully develop a gesture-controlled robot system. Based on tilt in the X and Y axes, the Arduino Nano-based transmitter will be able to identify and classify human hand movements and wirelessly communicate the appropriate directional orders to a receiver module. Using the L298N motor driver, the receiver—which is also based on an Arduino Nano—will decipher these signals and regulate the movement of a four-wheel robotic vehicle.

2.1 Scientific and Technical Justification

Gesture Recognition Using Accelerometers (ADXL335):

To provide real-time analog voltage output, the ADXL335 employs hand tilt along three axes (X, Y, and Z). By defining voltage threshold ranges, certain movements (such forward, backward, left, and right) can be accurately mapped. Signals may be processed easily without complex calculations due to their analog nature.

Wireless Data Transmission (NRF24L01):
Operating at 2.4 GHz, NRF24L01 facilitates bi-directional wireless communication. It uses little power and can send small packets (gesture data) across a good distance (around 10 to 30 meters indoors). It allows for low latency (less than 100ms) real-time control, which is essential for a responsive gesture-based system. Using an Arduino Nano for Processing and Control: The Arduino Nano can read analog signals from the accelerometer, process them, and turn them into commands because it has enough I/O ports and processing power. Use the SPI interface to send and receive data to and from the NRF24L01. Create motor control signals in response to gesture commands that are received.

Mobility via L298N Motor Driver:
L298N allows two DC motors (or four if paired) to be controlled in terms of direction and speed. It produces enough electricity to run a small four-wheeled robot. Integration with Arduino makes it easy to assign gesture-based motion controls.

3. PROBLEM STATEMENT

Robots operated by conventional wired buttons grow exceedingly bulky and have a limited range. The wearable hand glove that will be used to control the wireless hand-controlled robot will allow the hand's movements to be used as input. Our project's main goal is to create a robot that can identify human interaction and use that information to do specific jobs. As part of our project, we will create a wearable glove using sensors that will record hand movements and transform mechanical data into electrical form.

4. OBJECTIVE

The project's goal is to create a human-machine interface for controlling a robot arm. Our goal is to simplify and lower the cost of this technology so that it can be manufactured and utilized for a variety of applications. The goal of this project is to construct a remotely gesture-controlled automobile. By donning a controller glove and using preset gestures, the user can also control the car's movements in this project. Additionally, there are other possible uses for this, like wireless controller racing cars, etc.

5. LITERATURE REVIEW

To improve the interactivity of industrial robot control systems, this paper has designed a control system based on hand gestures. The system is divided into four parts: the IMU is used in the acquisition of human hand gestures, the signal processing of the IMU is analysed, the relationship between gestures and robot movements in linear motion mode and joint motion mode is analysed, the ABB IRB 120 robot is used as a test object and its program is designed, and finally, the effectiveness of the method proposed in this paper is validated. Currently, the primary programming methods for industrial robots are off-line programming and instructional programming, both of which are time-consuming and require skilled robotics technicians. (1)

Human-robot interaction, which translates human body movements into digital signals through somatosensory devices for teleoperation control, has been the subject of much research on data-driven remote control. It is a clever and practical way to manage the robot and complete the agricultural activity in a complicated setting. This research presents the design of a three-dimensional convolutional neural network based real-time dynamic recognition system for agricultural robots. Following the presentation of the inverted residual structure and deep separable convolution, the gesture classification network architecture is covered. (2)

The ability to operate industrial robots via natural interfaces, including hand gestures, is becoming more and more popular as a way to increase their flexibility and usefulness as these machines play a bigger role in manufacturing and assembly processes. Compared to more conventional techniques like programming, using hand gestures to operate robots has a number of advantages. It reduces the need for intensive training and streamlines the programming process because it is a natural and straightforward way to connect with the robot. The development of hand gesture recognition systems that can precisely decipher human gestures and convert them into orders for robots has advanced significantly in recent years. Usually, these systems record hand movements using cameras or other sensors, then utilize machine learning algorithms to identify and categorize the gesture. (3)

6. RESOURCES REQUIRED

- Arduino Nano
- Trans-receiver module NRF24LO1
- Accelerometer ADXL335
- 4 Motors for Wheels

- Motor driver L298N
- Battery

SOFTWARE REQUIRED: Arduino IDE

7. BLOCK DIAGRAM

Transmitter Circuit:

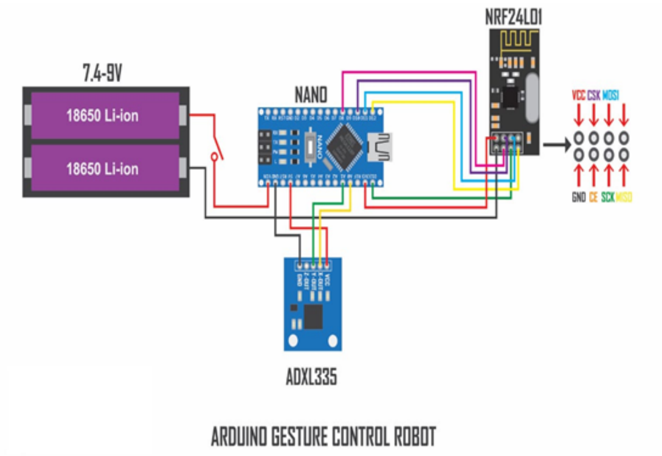

FIGURE 1. Transmitter Circuit

Receiver Circuit:

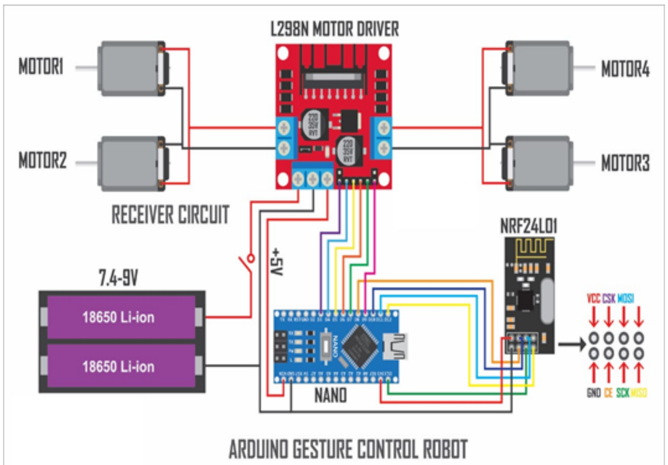

FIGURE 2. Receiver Circuit

8. WORKING

In this architecture, there are two circuits: the transmitter and the receiver, respectively. The transmitter, which doubles as a remote control, will be used to operate the robot. Electrical signals are produced from hand gestures using the accelerometer sensor. These signals are processed by the Arduino Nano before being sent via the RF transmitter. These signals are picked up by the RF receiver on the receiving end, which then sends them to the Arduino Uno for decoding. The Arduino Uno uses the motor driver to activate the motors after receiving the signals, causing the robot to move in one of four directions: "FORWARD," "BACKWARD," "LEFT," or "RIGHT."

9. METHODOLOGY

Hardware Setup Transmitter (Hand/Glove Unit):

- The Arduino Nano receives gesture data from the ADXL335 accelerometer.
- The NRF24L01 module wirelessly processes and sends gesture data.

Robot Car Unit Receiver:

- The NRF24L01 transmits the data to an additional Arduino Nano.
- The incoming gesture data is interpreted to generate motor control signals.
- The L298N Motor Driver controls four DC motors in a four-wheel drive system.
- Software: Both Arduino boards can be programmed using the Arduino IDE.
- For accelerometer measurements, use signal filtering and mapping.
- Set gesture thresholds based on movement instructions (for instance, tilt forward = move ahead).
- In order to interact with the NRF24L01, utilize the RF24 Arduino package.

Testing and Calibration:

- Modify the accelerometer to accommodate different hand gestures.
- Assess the robot's signal range and reaction.

9.1 Arduino nano

Projects involving robotics, embedded systems, automation, the Internet of Things (IoT), and electronics frequently use Arduino boards. Originally intended for non-technical users and students, these boards are now referred to as Arduino boards. utilized extensively in industrial projects. The Arduino Nano is a small, open-source electrical development board that is built around an 8-bit AVR microprocessor. The ATmega328p is the basis for one of these boards, and the ATmega168 is the basis for the other. Although the Arduino Nano is smaller and better suited for projects requiring fewer GPIO pins to connect to and less memory space, it can perform some activities that are comparable to those of other boards available on the market.

FIGURE 3. Arduino nano

9.2 Accelerometer ADXL335

An accelerometer is a device that gauges a structure's acceleration, motion, or vibration. These days, accelerometers in smartphones and cameras use axis-based motion sensors. It is an electromechanical instrument that can measure dynamic or static acceleration. As is well known, acceleration is the measurement of the in velocity upon a specific time. The compass app on your phone makes use of accelerometers. The motion detectors in Accelerometers are also capable of detecting earthquakes. As an additional illustration, when the accelerometers To ascertain the angle at which the instrument is being titled, measure the gravitational pull.

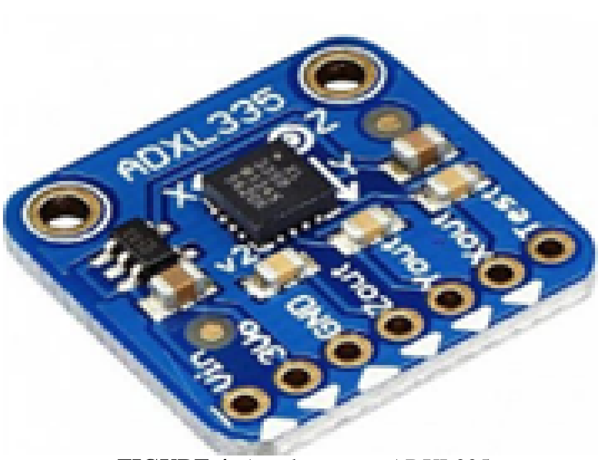

FIGURE 4. Accelerometer ADXL335

9.3 Motor driver L298N

Stepper motors and DC motors can be driven by this high-power L298N motor driver module. This module is made up of a 78M05 5V regulator and an L298 motor driver IC. The L298N Module command can control two DC motors with direction and speed control or up to four DC motors.

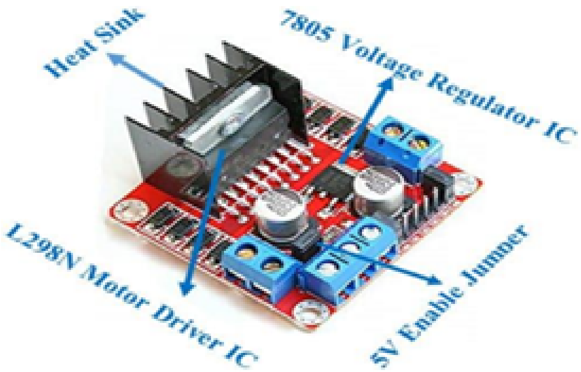

FIGURE 5. Motor driver L298N

9.4 Transceiver module NRF24L01

Based on packet communication, the enhanced shock burst integrated baseband protocol engine enables a range of modes, from manual operation to sophisticated autonomous protocol operation.

Features:

- GFSK modulation and maximum operational rates of 2 Mbps effectiveness, the capacity to prevent interference.
- Especially appropriate for situations involving industrial control.
- 125 channels, frequency hopping, and multi-point connection to fulfill the requirements for communication.
- Integrated hardware multipoint communication and CRC error detection control the address.
- Low power consumption (1.9–3.6V, 1uA in power-down mode) Integrated 2.4Ghz antenna
- A range of microcontrollers can be directly connected to software that can set the address to only receive the local address when output data is received (providing interrupt instruction). Programming software is quite easy.

FIGURE 6. Transceiver module NRF24L01

10. APPLICATION

Assistive Devices for Disabled Individuals: People with mobility problems can be assisted in navigating their surroundings and carrying out daily tasks such as snacking and opening doors by using robotic arms or gesture-controlled wheelchairs.

Smart Home Automation: Gestures can be used to operate home appliances like fans, lighting, and entertainment systems, providing a more natural and intuitive user experience.

Industrial Robots: Workers in the manufacturing industry can increase productivity while lowering physical strain by using gestures to operate robots for activities like lifting heavy objects or assembling pieces.

Interactive Learning Tools: Gesture-controlled robots can be used as interactive learning tools in classrooms to assist students gain a deeper understanding of electronics, programming, and robotics.

11. FUTURE SCOPE

Healthcare and Rehabilitation: Gesture-controlled robots can help patients with limited mobility or those with disabilities by allowing hands-free operation of robotic arms, exoskeletons, and other equipment.

Human-Computer Interaction: Through gestures, these robots can improve experiences in virtual reality (VR) and augmented reality (AR) and provide more intuitive control.

Home Automation: Smart home solutions that allow users to operate appliances or other systems with simple hand gestures can be made simpler using gesture control.

Industrial Automation: Incorporating gesture-controlled robots into industrial environments can provide more accurate and versatile control over tools and machines, minimizing human contact and improving security.

12. RESULT

- Using the ADXL335 accelerometer, the gesture-controlled robot was able to react to hand motions.
- With a low latency (100 ms), real-time wireless control was accomplished with the NRF24L01.
- With over 95% accuracy, the robot obeyed commands like forward, backward, left, right, and stop.
- Within a 10–15 m indoor range, the system operated dependably; Motor control via the L298N driver was responsive and smooth.
- When used continuously, the battery backup lasted roughly 45 minutes.
- Using Arduino and simple sensors, the project was found to be inexpensive, efficient, and simple to duplicate.

13. CONCLUSION

Emerging technology like gesture control has many uses across many industries. Only a little portion of it will be completed by us. The primary goal of the project is to give the robot a more schematic method of control. Because hand gestures are natural to humans, interacting with a robot in a friendlier manner is made easier with the aid of wireless communication.

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