Journal of **N**onlinear **A**nalysis and **O**ptimization
Vol. 15, Issue. 1 : 2024
ISSN : **1906-9685**

HAND GESTURE CONTROL WIRELES ROBOTICS

Bandlamudi. Saritha, Department of Electronics and Communication Engineering, DVR & Dr.HS MIC College of Technology, Kanchikacherla , Andhra Pradesh.
[1] sarithabandlamudi1004@gmail.com
M.Anil Kumar, Associate Professor, Department of Electronics and Communication Engineering, DVR & Dr.HS MIC College of Technology, Kanchikacherla , Andhra Pradesh.
[2] anilmtcr@gmail.com
Bellamkonda kavya, Jaddu Sai krishna and Konakala Rajya Lakshmi
Department of Electronics and Communication Engineering, DVR & Dr.HS MIC College of Technology, Kanchikacherla , Andhra Pradesh.
[3] kavyabellamkonda2002@gmail.com, [4] jaddusaikrishna2410@gmail.com ,
[5] konakalarajyalakshmi294@gmail.com

ABSTRACT
A wireless hand gesture-based robotic control system with the use of Arduino boards, accelerometers and ESP-01 RF transmitters and receivers is being developed. The control system lets users manipulate a robot by means of hand gestures that are picked up by an accelerometer-equipped wristband. The arm movements are taken and forwarded wirelessly to the mechanism by means of ESP-01 RF modules. The receiver side of the robot decodes these inputs into appropriate commands which move the robot. An Arduino board, an ESP-01 RF receiver and a motor driver for controlling DC motors for motion are integrated into the robot. This project provides an interactive way of operating robots which can be controlled through simple hand gestures without any physical contact or complex mechanical controls.
Keywords: Hand Gesture Control Wireless , Robotics, RF modules.

INTRODUCTION
Robots are becoming more and more important in many areas like construction, the military, healthcare, and manufacturing. We've already made some basic robots, like ones that follow lines or are controlled by computers. Now, we've created a new robot that you can control with hand movements using an accelerometer and an Arduino Uno.
There's been a lot of interest lately in finding better ways for people to interact with computers. Gestures, like waving your hand or pointing, are a natural way for us to communicate. So, instead of using buttons or joysticks, we're using hand movements to control our robot.
In our setup, a special device you hold in your hand contains both a radio transmitter and an accelerometer. When you move your hand, this device sends signals to the robot, telling it what to do—whether it's moving forward, turning, or stopping—just by using gestures.
The accelerometer is really important in this setup. It's a device that can measure how fast something is speeding up or slowing down in three different directions. It works by using a special structure made of polysilicon on a silicon wafer. This structure has tiny springs that resist acceleration forces. When the device moves, it changes the capacitance of a circuit, which then tells us how fast the device is moving.

LITERATURE SURVEY

Hand gestures are movements or positions of the hand and arm that convey meaning or help in communication. Because our hands can make many different shapes and movements, hand gestures are the most common type of gestures we use.

There are different kinds of hand gestures depending on how we use them. Conversational gestures, for example, are movements we make while talking to add extra meaning. Communicative gestures, like sign language, help people who are deaf communicate with others or with computers. Controlling gestures are used for things like remote controls for electronics or robots. And manipulative gestures are how we interact with things like virtual objects, such as when we use virtual reality or control robots from a distance.

METHODOLOGY

Our robot that responds to gestures works like this: First, there's an accelerometer that tracks hand movements. This data goes to a comparator, which figures out the right voltage levels for these movements. Then, it's sent to an encoder, which prepares it to be sent wirelessly.

On the other end, the data is received wirelessly and decoded. It's then sent to a small computer called a microcontroller. The microcontroller makes decisions based on this data. Finally, these decisions are sent to a motor driver, which controls how the motors move the robot**.**

3.1 STEPS FOR DEVELOPMENT

The RF modules work on the frequency of 433 MHz. You can check this post to learn how RF Module Works- How 433 MHz RF Module Works & Interfacing with Arduino. It means that the carrier frequency of the RF module is 433 MHz. The RF module enables the user to control the robot wirelessly and with ease. The schematic of transmitting end can be seen below:

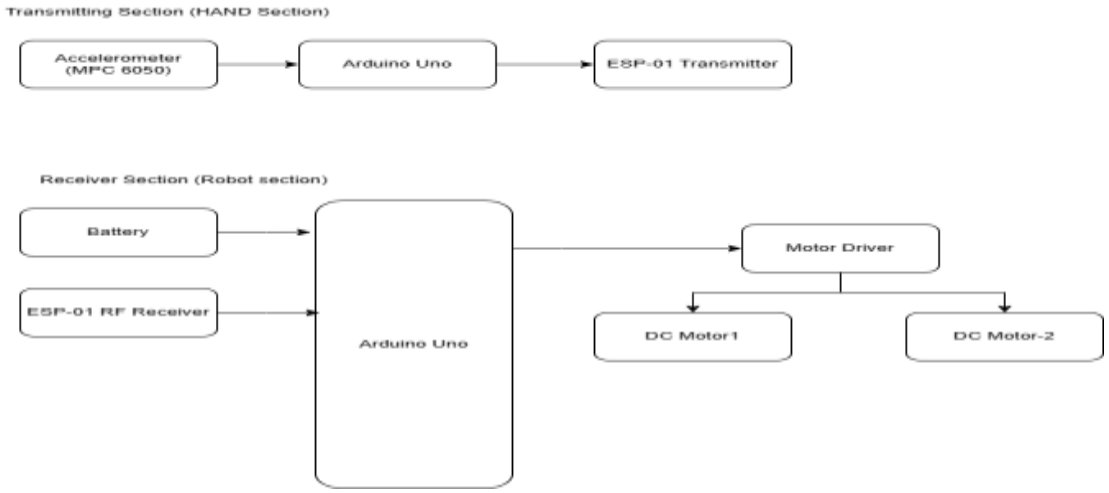

Fig 3.1 Setup

The signal sent by the RF transmitter is received by the RF receiver, where it's transformed back to its original form through a process called demodulation. This transformed signal is then sent to the decoder IC, which translates the coded waveform back into its original data bits. The decoder IC also has a pin known as the Valid Transmission (VT) pin, which can be connected to an LED. When a transmission is successful, this LED will blink, indicating that the signal has been received correctly. The decoded data, now in parallel form, is sent to port 1 of the microcontroller. This data consists of individual bits. The microcontroller reads these bits and makes decisions based on their values. It compares these bits to pre-set coded bits stored in its memory, and then generates outputs accordingly. Port 2 of the microcontroller serves as the output port. The bits sent from this port are then directed to the motor driver IC, which controls the motors based on the detected hand movements.

COMPONENTS

4.1 Hand Device with Accelerometer:

The hand device has a special sensor called an accelerometer to detect how you move your hand.

This accelerometer measures the force of your hand's movements in three directions (up-down, left-right, forward-backward) and turns it into digital signals.
A tiny computer inside the hand device (like Arduino) looks at these signals and figures out what hand gestures you're making based on certain rules.

4.2 ESP-01 RF Transmitter:

This part sends the hand gesture data wirelessly from your hand device to the robot.
It talks to the computer in your hand device through a special wire, then changes the hand gesture data into signals that can travel through the air.
These signals are like invisible waves that carry the information to the robot's receiver.

4.3 Arduino Board (Robot Side):

This is like the brain of the robot. It's a small computer that gets the hand gesture signals from the ESP-01 RF receiver.
The Arduino board reads these signals and figures out what you want the robot to do based on the hand gestures you made.
It then sends commands to other parts of the robot to make it move in the right way.

ESP-01 RF Receiver:

This part of the robot catches the signals sent by the hand device's transmitter.
It takes those signals and turns them back into digital data that the Arduino board can understand.
Then, it sends that data to the Arduino so the robot knows what hand gestures you made.

Motor Driver and DC Motors:

These are what make the robot move. The motor driver is like a conductor that tells the DC motors when to start, stop, or change speed.
The Arduino board sends instructions to the motor driver based on the hand gestures it understood.
The motor driver then sends power to the DC motors, making the robot move accordingly.

SOFTWARE TOOLS

Arduino IDE:

The Arduino IDE is a software tool designed for programming Arduino boards.
It's easy to use and works on different operating systems.
With the Arduino IDE, we can write, compile, and upload code to Arduino microcontrollers.
It comes with a built-in text editor that helps us write and edit code, with features like highlighting, indentation, and code completion.
The IDE also includes useful tools like a library manager, serial monitor, and help documentation, which make the development process simpler for both beginners and experienced users.

Arduino C++ Programming Language:

Arduino C++ is a variant of the C++ programming language tailored for programming Arduino microcontrollers.
It is based on standard C++ with additional libraries and functions specific to the Arduino platform.
Arduino C++ simplifies hardware interaction by providing high-level abstractions for common tasks such as digital and analog I/O, serial communication, and sensor interfacing. The language allows users to write code that is easy to understand.

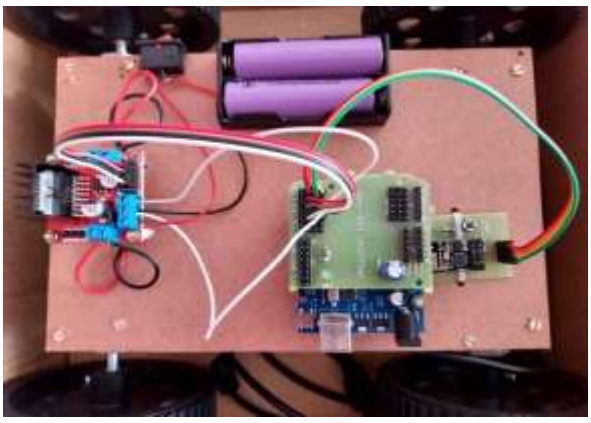


Fig 4.1 Final Prototype

TESTING

Hand gesture control for a wireless robot involves using sensors to detect hand movements, recognizing gestures through algorithms, transmitting commands wirelessly to the robot, and executing actions based on the received commands. It enables intuitive control of the robot without physical touch, finding applications in various fields such as home automation, surveillance, entertainment, and industrial automation.

The Arduino board should receive the commands via Bluetooth and control the motors based on the hand gestures detected by the flex sensors.

Use a hand gesture or a gesture control app on your mobile device to send commands to the robot.

Power up the robot using the appropriate power source.

Pair your Bluetooth-enabled device (such as a smartphone) with the Bluetooth module on the robot.

This robot offers several distinct advantages. Firstly, it doesn't require manual operation or smartphone control; instead, it can be controlled through the movement of a human hand, offering a more intuitive and interactive experience. Secondly, it boasts a good range, allowing it to operate efficiently within various environments. Moreover, it's customizable with the ability to add extra control modes such as Bluetooth control, voice control, and obstacle avoidance.

This versatility allows users to navigate the robot in multiple ways, including forward, backward, leftward, and rightward movements, all while using the same accelerometer sensor to manage the car's throttle. In terms of assembly, the robot's simple circuit connection makes it accessible to a wide range of users while minimizing complexity. Lastly, this robot enhances accessibility, optimizes space utilization, and offers customization options, making it adaptable to different needs and scenarios.

However, there are some downsides to consider. One of the drawbacks is the cost involved in creating this robot, primarily due to the use of two microcontrollers. This cost factor may limit its accessibility to some users. Additionally, the robot consumes a significant amount of power, which can be a concern for battery life or energy efficiency in certain applications. Another disadvantage is its relatively lower stability compared to other robotic systems, potentially impacting its performance, especially in challenging terrain or dynamic environments. Lastly, the robot has a limited gesture vocabulary, which means that its range of responsive movements may not be as extensive as some other robotic systems, potentially limiting its adaptability in certain scenarios.

CONCLUSION

We achieved our objective without any hurdles i.e., the control of a robot using gestures. The robot is showing proper responses whenever we move our hand.

For controlling the robot remotely, Holteks' encoder-decoder pair (HT12E and HT12D) together with a 433MHz transmitter-receiver pair is used.

HT12E and HT12D are CMOS ICs with working voltage ranging from 2.4V to 12V. Encoder HT12E has eight address and another four address/data lines. The data set on these twelve lines (address and address/data lines) is serially transmitted when transmit-enable pin TE is taken low. The data output appears serially on DOUT pin.

The data is transmitted four times in succession. It consists of differing lengths of positive-going pulses for '1' and '0,' the pulse- width for '0' being twice the pulse-width for '1.' The frequency of these pulses may lie between 1.5 and 7 kHz depending on the resistor value between OSC1 and OSC2 PINS.

REFERENCES

[1] "Gesture Controlled Robot PPT"<http://seminarprojects.com/s/hand-gesture-controlled-robot-ppt>

[2] "Gesture Controlled Tank Toy User Guide"<http://www.slideshare.net/neeraj18290/wireless-gesture-controlled-tank-toy- transmitter

[3] "Embedded Systems Guide (2002)"<http://www.webstatschecker.com/stats/keyword/a_hand_gesture_based_control _interface_for_a_car_robot>

[4] "Robotic Gesture Recognition (1997)" by Jochen Triesch and Christoph Von Der Malsburg

<http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.37.5427>[7:40 am, 26/03/2024] Kavya:
[5] "Real-Time Robotic Hand Control Using Hand Gestures" by Jagdish Lal Raheja, Radhey Shyam, G. Arun Rajsekhar and
P. Bhanu Prasad
[6] "Hand Gesture Controlled Robot" by Bhosale Prasad S., Bunage Yogesh B. and Shinde Swapnil V.
[7] <http://www.robotplatform.com/howto/1293 ignotor_driver_1.him>
[8] http://en.wikipedia.org/wiki/Gesture_interface