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ABSTRACT

In this paper, we introduce a hand-gesture based control interface for navigating a car-robot. A 3-axis accelerometer is used to record a user's hand gestures. The data is transmitted wirelessly via an RF module to a microcontroller. The received signals are then classified to one of six control commands for navigating a car-robot. The microcontroller then classifies the hand trajectories. Simulation results show that the classifier could achieve a 92.2% success rate. Now-a-days, as a result of the advancements in technology, human-machine interaction is widely increasing that reduces the gap between machines and humans for easy standard of living. Gestures have played a vital role in diminishing this gap. Robots are playing a crucial role in automation across all the sectors like construction, military, medical, manufacturing, etc. This paper describes regarding how the conventional hand gestures can control a robot and perform our desired tasks. The transmitter will transmit the signal in line with the position of accelerometer and your hand gesture and therefore the receiver will receive the signal and make the robot move in respective direction

HAND GESTURE CONTROL ROBOT

INTRODUCTION

A gesture-controlled robot is controlled by using the hand in place of any other method like buttons or joystick.

In the physical world, humans interact by the means of five basic senses. However, gestures are a vital

means of communication in the physical world from earlier period, even before the invention of any language. In this era of digital technology taking control of each complex tasks, interactions with machines have become more vital than ever. The rising trend currently in the field of science is artificial intelligence. Lately a number of wireless robots are being developed and put to varied applications and uses. In order to reinforce the contribution of robot in our daily lives we need to find an efficient approach of communication with robots. There are many various types of robots available, each created for different tasks and behavior, and works on completely different platforms. Robots may be built for recreation, knowledge, competitions, domestic help, industrial uses, surveillance etc. each of these robots may be classified as autonomous, controlled or semi-autonomous based on the way they're controlled. For this purpose, there are certain developments in area of human-machine interaction. One common sort of communication is Gestures that are not solely restricted to face, body and fingers but also hand gestures. So as to extend the utilization of robot in places where conditions are not certain like rescue operations, robots can be made to follow the instructions of human operator and perform the task consequently. This proposes an integrated approach of tracking and recognition of hands that is intended to be used as humanrobot interaction interface.

In this work, robot controlled by hand gestures is assembled with ADXL355 and it uses 3- axis Accelerometer and the controller part is Arduino uno. Instead of using joystick or physical controller with buttons, hand gestures are used to control the robotic motions. Wireless communication is the main area of work of this work, here receiver receives the data over Radio Frequency link from the hand gestures. Transmitter and receiver sections are the two parts of the project. The RF transmitter and the accelerometer are combined into a transmitting device and is placed on the hand. This transmitting device will transmit commands to robot so that it can move onward, backwards, turning right, turning left and pause. Simply hand gesture will control all these tasks.

Human gestures constituting many body motions expressed by the body include facial expressions and hand movements. As compared to all the gestures, hand gesture can be said as most expressive and commonly used and proves better for the physically disabled people. In order to have a more natural and simple communication with virtual reality systems, it has been a trusted and excellent means for the users not related to technical fields as well. A Gesture Controlled robot is a robot which can be controlled by your hand gestures. You just need to have a small transmitting device in your hand, which included an acceleration meter to transmit an appropriate command to the robot so that it can do whatever we want. The transmitting device included an ADC for analogue to digital conversion and an encoder IC(HT12E) which is used to encode the fourbit data and then it will transmit by an RF Transmitter module. At the receiving end, an RF Receiver receives the encoded data and decoder IC decodes it. A microcontroller processes this data, and the motor driver is used to control the motors. As the user moves his hand, it senses, and it sends the signal for decision. The output from the accelerometer is gathered for the process by a microcontroller. According to the sensor output, the controller is made to work, and it sends the respective signal to the motors. It uses two DC motors to move, to drive them, one motor driver is IC used which provides sufficient current to motors. All this material is mounted on metal chassis. As we move our hand to the right robot will move to the right side.

Around the world almost every day, many peoples are becoming disabled of freely moving in their surroundings. The reasons can be road accidents, constructional injuries, athletic injuries, major nervous system issues and cognitive inability. For these kind of people the only way remains is to sit in a wheelchair and use the help of others, sometimes with great difficulty by themselves to steer the platform in order to interact with their surroundings for their daily needs. From the very early times, the medical industry relied with the general wheelchair and crutches to help these people. First world countries have developed automated wheelchairs with in-build joysticks which are very expensive solution and also sometimes have a steep learning curve for people of various ages or backgrounds & also to people who are not even strong enough to push the controls here and there.\

The research intends to solve these problems for these individuals worldwide to ease their lives by introducing a gesture-controlled robot modified into a moving platform to sit on and solving their issues without anyone's help. Robots has become a part of our exponential technological growth in the world. They are being used in industries in many major sectors such as assembly lines and raw physical works mainly. However, in recent days not only in large industries for cumbersome works but also it is getting a part of our daily lives in the household sector also. Personalized robotics has become a large market around the globe in the developed countries and all the concerns are pushing their boundaries of imagination to implement applications based on this sector.

As this research suggests, it is a potential place for applying this gesture controlled robotic solution to be implemented into suitable platforms comfortable for maneuvering of disabled persons. Though the research is highlighted based on disabled people the application to normal consumers are also limitless for such solution in the available market of tourism, short distance travels and in some cases military applications. However, this paper focuses on the disabled people use cases particularly. Also such problems are happening very rapidly in the developing countries due to the lack of security for social environment and also for the lack of well-built infrastructures. The Arduino controller used to control the robot. Transmitter and receiver are used for transmission of signals. The servomotor is used to drive the motors that are fitted inside of the arm. A flex sensor is used to acquire the hand motion and it is converted into resistance variances, the resistance value is being sent through the transmitter.

PROBLEM STATEMENT

The traditional wired buttons controlled robot becomes very bulgy and it also limits the distance the robot goes. The Wireless Hand controlled Robot will function by a wearable hand glove from which the movements of the hand can be used as the input for the movement of the robot. The basic idea of our project is to develop a system (Robot) which can recognize the Human Interaction with it to accomplish the certain tasks assigned to it. In our project we will design a wearable Hand Glove which will contain the sensors mounted on it to capture the movement of the hand and convert the raw mechanical data into electrical form. This data will be processed by the Microcontroller, and the Microcontroller will deduce the commands and accordingly it will actuate the motor drivers to control the Motors for various tasks on the robot.

OBJECTIVES

To develop a gesture controlled system to perform a specific task using cheap and efficient wireless transmission

MOTIVATION

Increase in the demand for assistant robots led to the fabrication of feeding robots which can be used to feed the elderly and physically or mentally challenged people. The gestures can be recorded using the human hand tracking system which is performed by an image processing technique.The tracking system records the different coloursobtained as the result of the hand movements which is interfaced with the robotic arm.

LITERATURE SURVEY

PAPER 1: HAND GESTURE CONTROL ROBOT

Source:- ieeexplore.org

This paper proposes the constructive design of a hand gesture controlled robot using an Arduino lillypad controller. The lillypadis a compact controller with fewer pins and it can be sewn onto any fabric. It is a low power controller that runs at 8Mhz clock frequency. The basic principle of the project is that the accelerometer senses the acceleration and provides input to the controller that gives output. The controller outputs are encoded and transmitted to the receiver circuit by the RF433 transceiver. Decoding occurs and the signals act as input to the motor driver and the motors rotate leading to movement of the robot.

The working of our project is the same as above, but instead of Arduino lillypad, we'll be using an Arduino Uno board, which can process more data at a higher speed(16MHz). A holder will be sewn onto the glove and the Arduino will be placed in it.

PAPER 2- DESIGN AND FABRICATION OF 6-AXIS GESTURE CONTROLLED ROBOT

Source:- sci-hub.hkvisa.net

In this paper, they have utilised Arduino Atmega combined with a Bluetooth module for connectivity with the android device. They have used the inbuilt sensor present in the smartphone. The smartphone transmits this data via Bluetooth. The data is received by the Arduino and gives the signal to motor driver and hence the motors make the robot move in the determined direction.

But in our project we use an accelerometer sensor to measure the acceleration forces . Motor driver L293D acts as an interface between the motors and the control circuits.

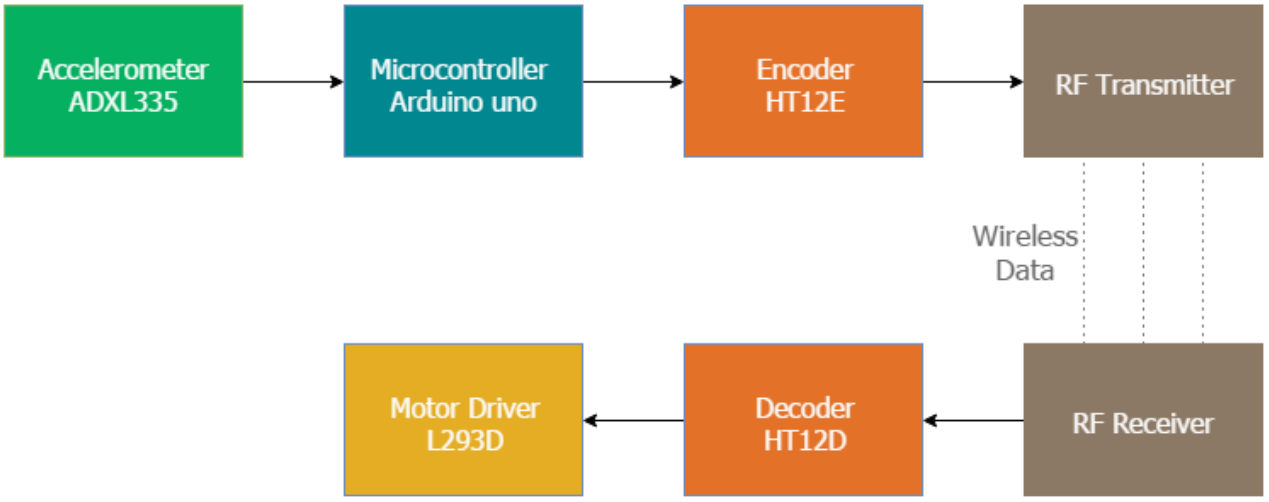
PAPER 3- DESIGNING AND IMPLEMENTATION OF A WIRELESS GESTURE CONTROLLED ROBOT FOR DISABLED AND ELDERLY PEOPLE

Source:- ieeexplore.org

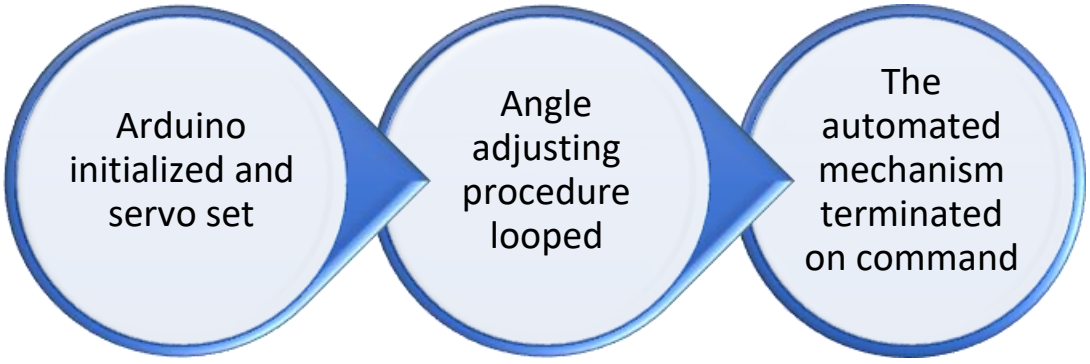
This project is mainly for the easy life of physically challenged people, mainly for those who are handicapped of paralyzed so that they can perform tasks just by using hand gestures. They have utilized Arduino Nano V3. In this project, the design and fabrication of a 6-axis robotic arm is developed by a simple mechanism. Today, technology is developing in the same direction in the line with increasing human needs.

Block diagram: -

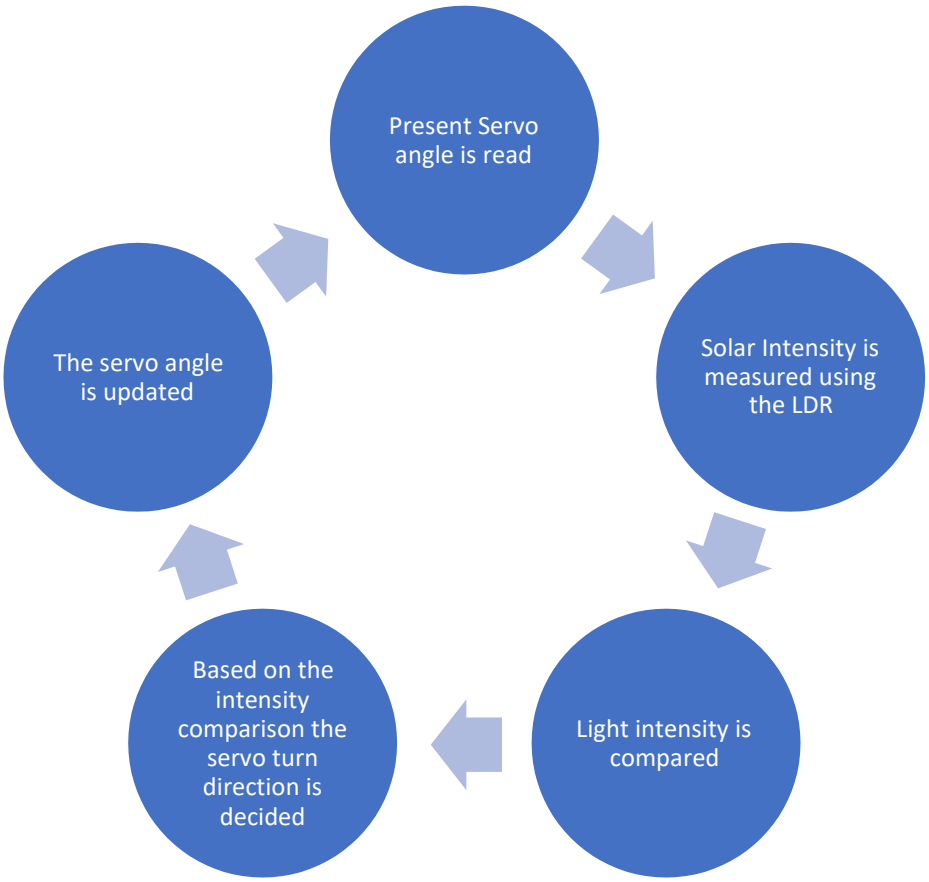
Basic process



Arduino working

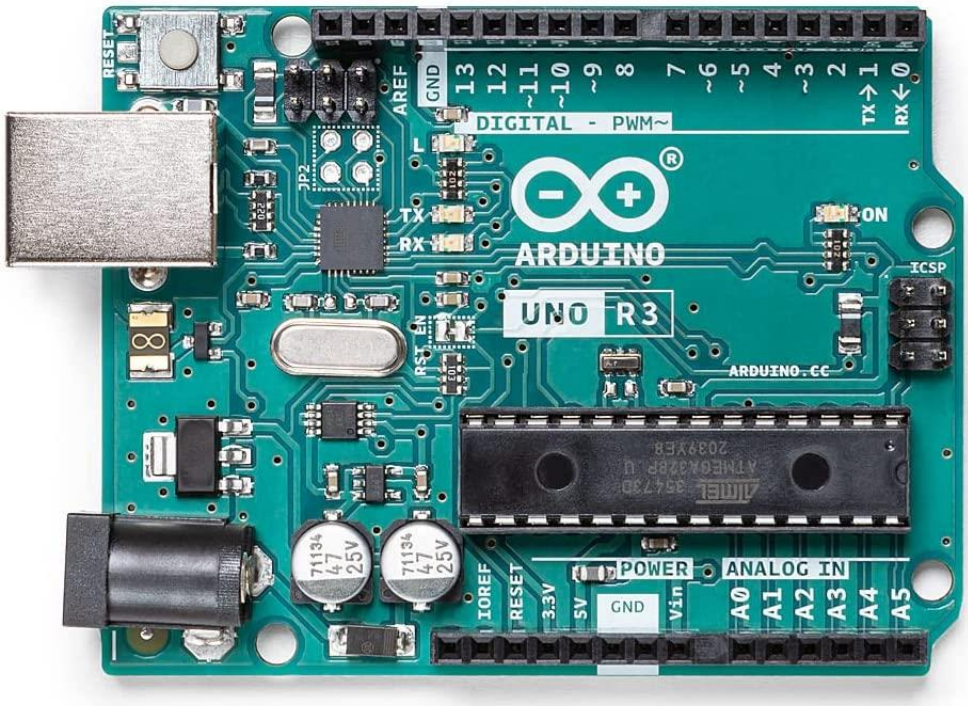


Loop instructions



Hardware & Software Requirements:-

- **Arduinouno**



The **Arduino Uno** is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc.[2][3] The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.[1] The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable.[4] It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo.[5][6] The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word "uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software.[1] The Uno board is the first in a series of USB-based Arduino boards;[3] it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases.[4] The ATmega328 on the board comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.[3]

While the Uno communicates using the original STK500 protocol,[1] it differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.[7]

- **LED**: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
- **VIN**: The input voltage to the Arduino/Genuino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V**: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- **3V3**: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND**: Ground pins.
- **IOREF**: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.
- **Reset**: Typically used to add a reset button to shields that block the one on the board.[7]

- **DC MOTORS**

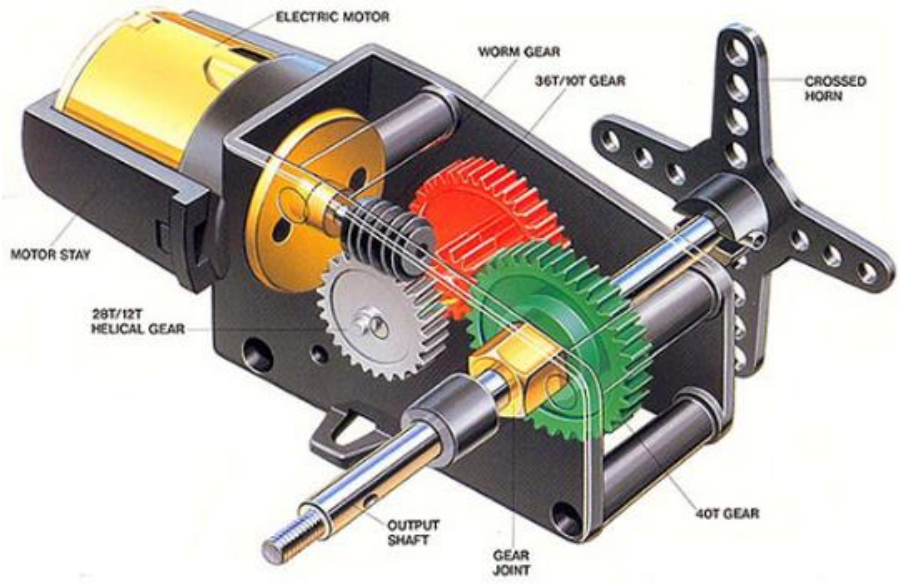
A **DC motor** is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

- **Car chassis:**

Chassis is a major component of a vehicle system. It consists of internal framework that supports man-made object. It is the underpart of the vehicle which consists of frame and running gear like Gare motors, transmission system, wheels etc.

The chasis we are using has two rear wheels which allow forward and backward movement and
Front roller which allows turning

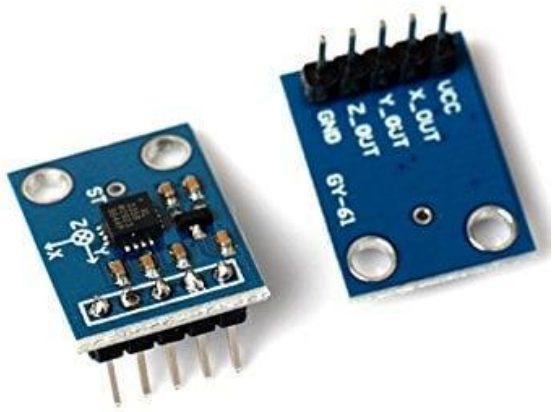


ACCELEROMETER

In short, an accelerometer is a three-axis acceleration measuring device. The accelerometer used here is ADXL335 and it has 3 axis (X Y Z).

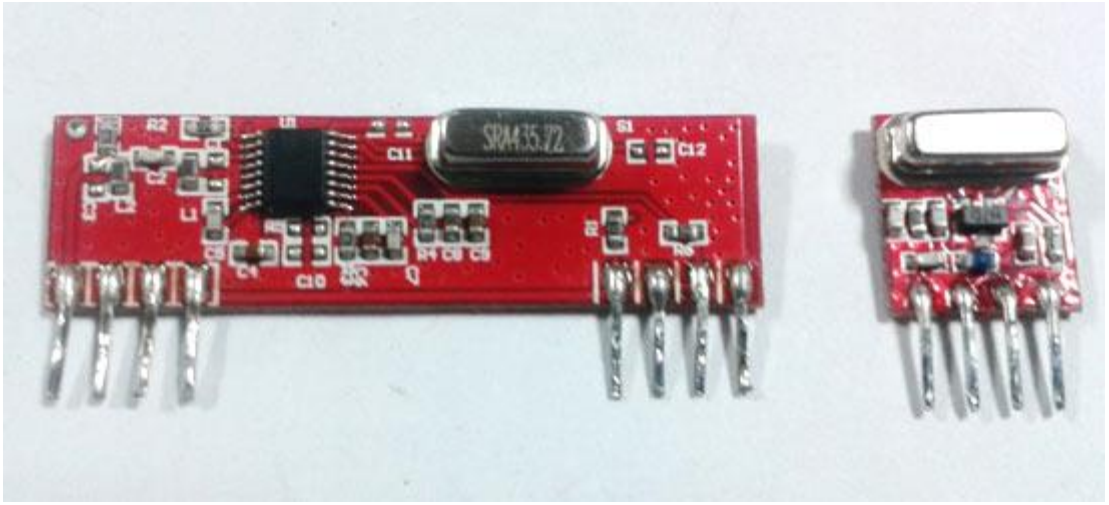
Almost all smartphones now have accelerometers (even though we are not going to take it from a smartphone). You definitely played motion games in your mobile (e.g Temple run) where the character in the game moves left and right when you tilt your phone left and right respectively it is done by the accelerometer.

There is another sensor called Gyroscope found in the smartphone which we don't need now.



RF 433

The 433 MHz RF transmitter and receiver module is **a pair of small RF (i.e. radio-frequency) electronic modules used to send and receive radio signals between any two devices**. The transmitter module sends the data from the transmitter end and the Receiver module receives that data at the receiver's end



It operates at a specific frequency of 433MHz. RF transmitter **receives serial data and transmits to the** receiver through an antenna which is connected to the 4th pin of the transmitter. When logic 0 applied to transmitter then there is no power supply in the transmitter. 433MHz FM RF Transmitter Module with Transmit Range **up to 300m**. Many remotes are operating in **433 MHz ISM band**, but also in 868 MHz (EU) or 915 MHz (US), toy remotes are usually operating in 40 MHz band, but may also operate in 27 band where citizen band radios are operating.

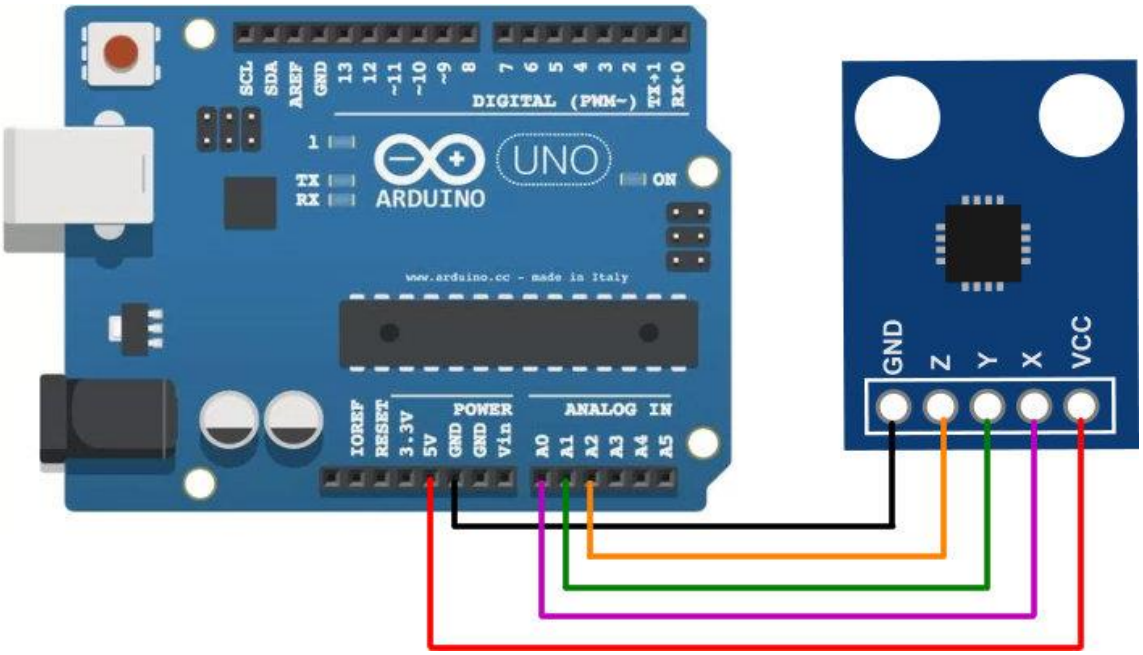
L293D(MOTOR DRIVER)

The L293D is a 16-pin Motor Driver IC which **can control a set of two DC motors simultaneously in any direction**. The L293D is designed to provide bidirectional drive currents of up to 600 mA (per channel) at voltages from 4.5 V to 36 V (at pin 8!). You can use it to control small dc motors - toy motors.

Battery and Wires

TRANSMITTER REGION

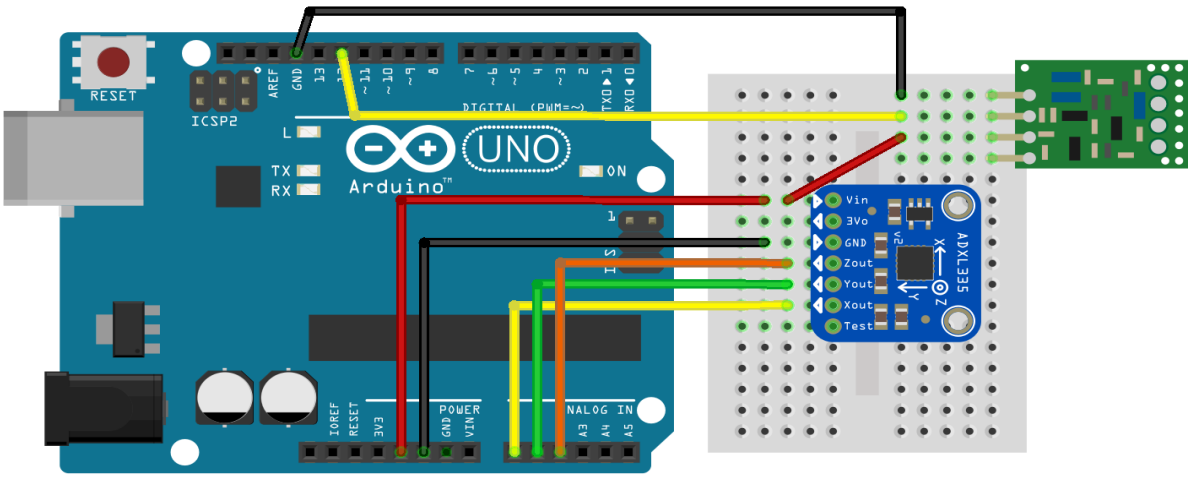
The transmitter section consists of an accelerometer that detects the hand gesture and sends the data to the Arduino. Later Arduino sends data to the Encoder IC in accordance with the data received from the accelerometer and the data is transmitted to the receiver. Wire up as per the below circuit:



RECEIVER REGION

The receiver circuit consists of 2 IC (HT12D decoder, L293D motor driver), RF receiver module.

Wire the circuit as per the above receiver schematic. There are 2 LEDs in the receiver board, one lights up when the power supply is given to the receiver and the other when the power supply is given to the transmitter circuit. The LED near the IC HT12D should light up and this provides you a valid transmission (VT) when power is given at the transmitter if not there is something wrong with your connection or your RF-TX-RX module.



ARDUINO CODE FOR INTERFACING

```
#define x A0
#define y A1
#define z A2

int x_val;
int y_val;
int z_val;

void setup() {
  // put your setup code here, to run once:
  pinMode(x, INPUT);
  pinMode(y, INPUT);
  pinMode(z, INPUT);
  Serial.begin(9600);
}

void loop()
{
  // put your main code here, to run repeatedly:
  x_val = analogRead(x);
  y_val = analogRead(y);
  z_val = analogRead(z);

  Serial.print("X: ");
  Serial.println(x_val);
  Serial.print("Y: ");
  Serial.println(y_val);
  Serial.print("Z: ");
  Serial.println(z_val);
  Serial.println();
  Serial.println("--------------------------------");
  Serial.println();
  delay(1000);
}
```

TRANSMITTER CODE

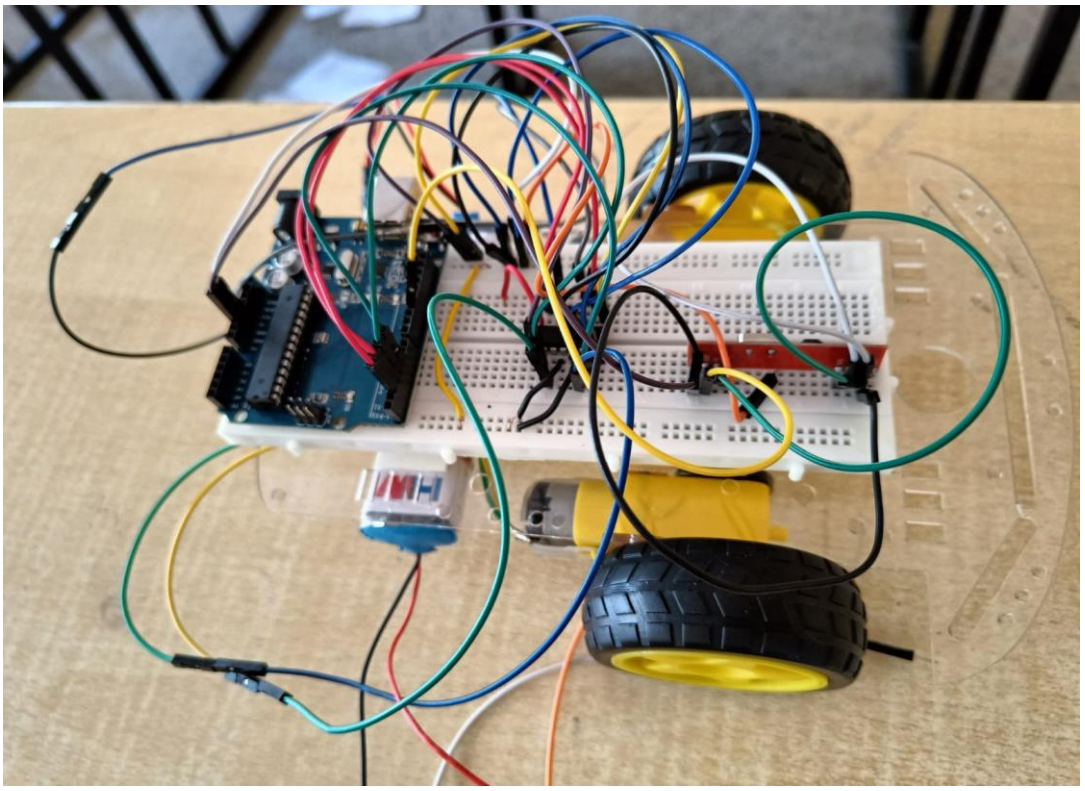
```
#include <VirtualWire.h>

#define x A0
#define y A1
#define z A2

char *data;

int x_val;
int y_val;
int z_val;

int x_val2;
int y_val2;
int z_val2;

void setup()
{
  vw_set_tx_pin(12);
  vw_setup(2000);
  pinMode(x, INPUT);
  pinMode(y, INPUT);
  pinMode(z, INPUT);
  Serial.begin(9600);
  x_val2 = analogRead(x);
  y_val2 = analogRead(y);
  z_val2 = analogRead(z);
}

void loop()
{
  x_val = analogRead(x);
  y_val = analogRead(y);
  z_val = analogRead(z);

  int x_axis = x_val - x_val2;
  int y_axis = y_val - y_val2;
  int z_axis = z_val - z_val2;
```

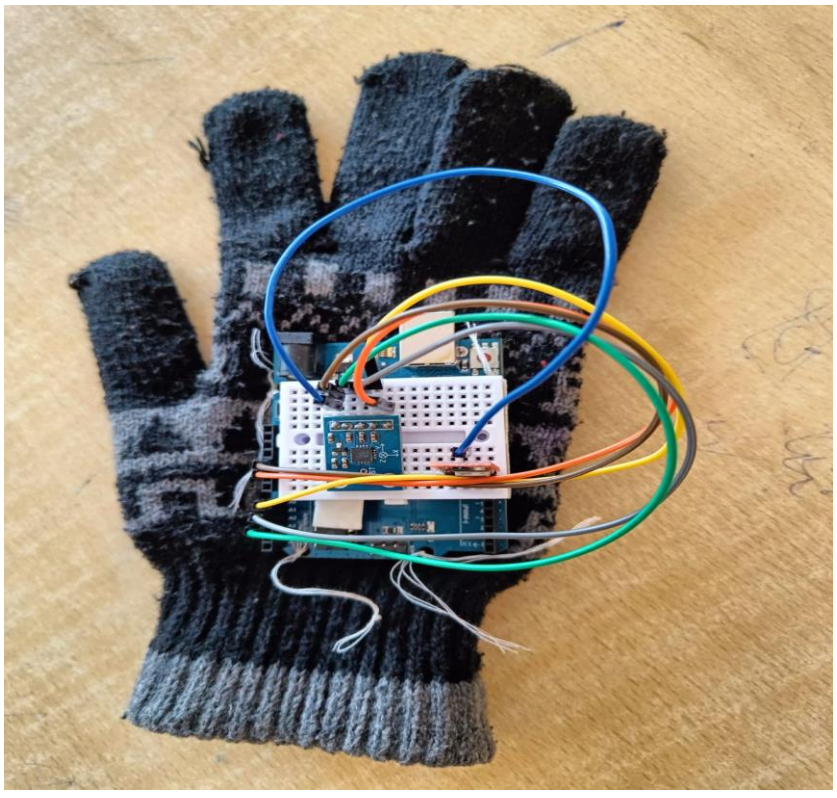
```
39
40    if(y_axis >= 60)
41    {
42      data="f";
43      vw_send((uint8_t *)data, strlen(data));
44      vw_wait_tx();
45      delay(500);
46      Serial.println("Forward");
47    }
48    else if(y_axis <= -60)
49    {
50      data="b";
51      vw_send((uint8_t *)data, strlen(data));
52      vw_wait_tx();
53      delay(500);
54      Serial.println("Backward");
55    }
56    else if(x_axis >= 60)
57    {
58      data="r";
59      vw_send((uint8_t *)data, strlen(data));
60      vw_wait_tx();
61      delay(500);
62      Serial.println("Right");
63    }
64    else if(x_axis <= -60)
65    {
66      data="l";
67      vw_send((uint8_t *)data, strlen(data));
68      vw_wait_tx();
69      delay(500);
70      Serial.println("Left");
71    }
72    else
73    {
74      data="s";
75      vw_send((uint8_t *)data, strlen(data));
76      vw_wait_tx();
76      vw_wait_tx();
77      delay(500);
78      Serial.println("Stop");
79    }
80  }
```

RECIEVER CODE

```
#include <VirtualWire.h>

#define m1 2
#define m2 3
#define m3 4
#define m4 5

void setup()
{
    vw_set_rx_pin(11);
    vw_setup(2000);
    pinMode(m1, OUTPUT);
    pinMode(m2, OUTPUT);
    pinMode(m3, OUTPUT);
    pinMode(m4, OUTPUT);
    vw_rx_start();
    Serial.begin(9600);
}

void loop()
{
    uint8_t buf[VW_MAX_MESSAGE_LEN];
    uint8_t buflen = VW_MAX_MESSAGE_LEN;

    if (vw_get_message(buf, &buflen))
    {
      if(buf[0]=='f')
      {
       digitalWrite(m1,HIGH);
       digitalWrite(m2,LOW);
       digitalWrite(m3,HIGH);
       digitalWrite(m4,LOW);
       Serial.println("Forward");
      }
      else if(buf[0]=='b')
      {
       digitalWrite(m1,LOW);
       digitalWrite(m2,HIGH);
       digitalWrite(m3,LOW);
       digitalWrite(m4,HIGH);
       Serial.println("Backward");
      }
      else if(buf[0]=='r')
      {
       digitalWrite(m1,HIGH);
       digitalWrite(m2,LOW);
       digitalWrite(m3,LOW);
       digitalWrite(m4,LOW);
       Serial.println("Left");
      }
      else if(buf[0]=='l')
      {
       digitalWrite(m1,LOW);
       digitalWrite(m2,LOW);
       digitalWrite(m3,HIGH);
       digitalWrite(m4,LOW);
       Serial.println("Right");
      }
      else if(buf[0]=='s')
      {
       digitalWrite(m1,LOW);
       digitalWrite(m2,LOW);
       digitalWrite(m3,LOW);
       digitalWrite(m4,LOW);
       Serial.println("Stop");
      }
    }
}
```

DESIGN AND IMPLEMENTATION



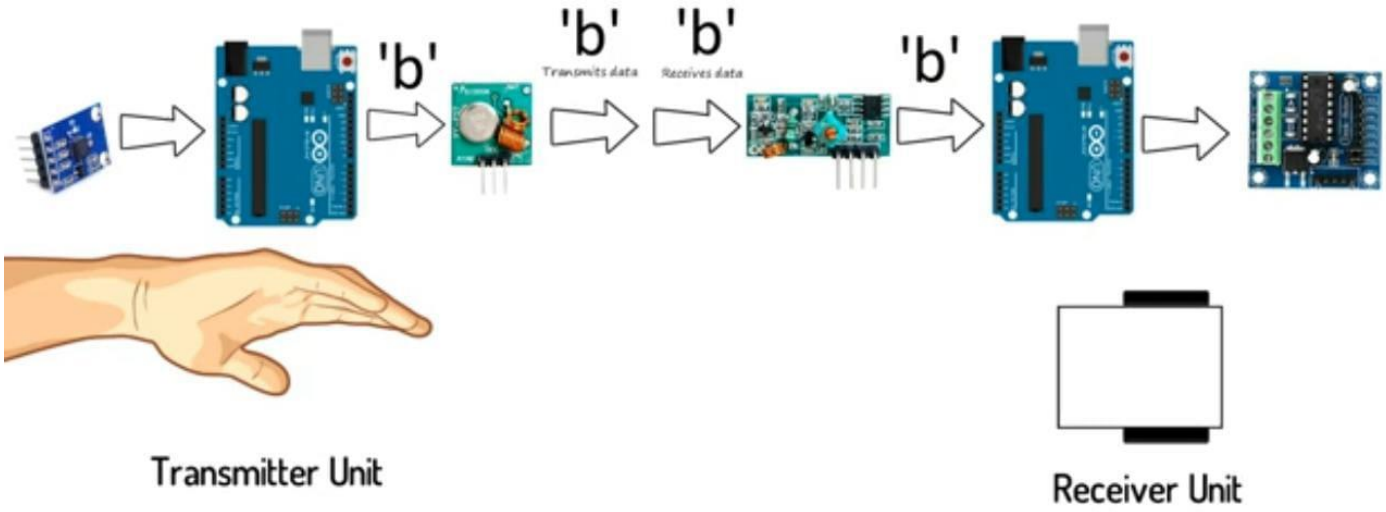


Circuit Diagram and Explanation

Gesture Controlled Robot is divided into two sections:

1. Transmitter part
2. Receiver part

In transmitter part an accelerometer and a RF transmitter unit is used. The signal is applied to HT12E encoder to encode data or converting it into serial form and then send this data by using RF transmitter At the receiver end we have used RF receiver to receive data and then applied to HT12D decoder. This decoder IC converts received serial data to parallel and then read by using Arduino . According to received data we drive robot by using BO motors in forward, reverse, left, right and stop direction. From the circuit the glowing of LED signifies that that both the regions of the circuit is working and proper connections are provided to the circuit The LED near the IC HT12D should light up and this provides you a valid transmission (VT) when power is given at the transmitter if not there is something wrong with your connection or your RF-transmitter or RF-receiver module Gesture controlled robot moves according to the user's hand movement recognized by the device in our hand. When we tilt hand in front side, the robot starts to moving forward and continues moving forward until the next command is given. When we tilt hand in the backside, the robot changes its state and start moving in the backwards direction until another command is given. When we tilt it



towards the left side, it will turn left till next command. When we tilt our hand in right side robot is turned to the right.

APPLICATIONS

- These robots are used in military applications to operate robots
- Since the RF433 module can operate over a range of 300m, this technology can be used for short range surveillance. It is easier to learn how to use and operate it as compared to others that require the use of buttons or keys.

- They robots are used in medical applications for the purpose of surgery
- This technology can be incorporated into wheel chairs to enable the physically disabled to move about without the help of another person. After further development, once the devices are made capable of recognizing even the slightest gestures we make, this technology can also be incorporated into surgeries

- These robotics are used in the construction field

- These robotics are used in industries to control trolly and lift.

- Wireless controlled robots are very useful in many applications like remote surveillance, military etc.

- Hand gesture controlled robot can be used by physically challenged in wheelchairs.

- Hand gesture controlled industrial grade robotic arms can be developed.

- SEARCH AND RESCUE OPERATIONS
- Compact gesture-controlled ground vehicles and aerial vehicles can be utilized in post-disaster search and rescue operations. Small sized robots will be able to fit into places where we cannot, and once the situation of the trapped civilian is clearer, the rescue team can arrive at the safest approach to make the operation a success.

RESULT

A Gesture Controlled robot with Arduino Uno microcontroller has been designed during this work, which may be controlled by human hand gestures. this needs to wear a little transmitting device on our hand included an accelerometer, which transmits particular commands to the robot to maneuver consistent with the users hand gesture and one receiver at the robot. The RF module usually works at a frequency of 434MHZ and also it has a range of 100meters. The transmission occurs at the rate of 1Kbps-10Kbps. The transmitted data is received by the RF receiver operated at the same frequency as that of the transmitter. Transmission through RF(Radio frequency) is always better than IR(Infrared) .

FUTURE SCOPE ·

In future we can design a wireless robot which can sense hand gesture by using wireless technologies. · It can be used in military applications as a robotic vehicle which can be handled by a soldier to avoid casualties. · Our system has shown the possibility that interaction with

machines through gestures is a feasible task and the set of detected gestures could be enhanced to more commands by implementing a more complex model of an advanced vehicle for not only in limited space while also in the broader area as in the roads too. • In the future, service robot executing many different tasks from private movement to a full-fledged advanced automotive that can make disabled to able in all sense.

COST OF PROJECT

Component	Cost
Arduino UNO	Rs 1500
RF Pair Module	Rs 180
R293D	Rs 90
Car Chassis	Rs 450
9V Battery	Rs 40
Cap	Rs 10
Cable	Rs 50
ADXL 335	Rs 425

REFERENCES AND LINKS

1. **https://ieeexplore.ieee.org/document/9092032**
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