HAND GESTURE CONTROLLED ROBOT USING ARDUINO

Thesis submitted in partial fulfilment of the
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In

ELECTRONICS AND COMMUNICATION ENGINEERING

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CERTIFICATE

This is to Certify that the project report entitled '**HAND GESTURE CONTROLLED ROBOT USING ARDUINO'** is submitted by A.M.P.Ujwala (15241A0401), G. Tirumala Saiteja (15241A0412), J. Vamshi Krishna (15241A0417), M.Harish (15241A0426),N.Sai Tanmayi (15241A0433) and Y. Sai Mounika (15241A0458) in partial fulfilment of the requirement for the award for the degree of **BACHELOR OF TECHNOLOGY** in Electronics and Communication Engineering during academic year 2018-2019, is a bonafide record of work carried out under our guidance and supervision.

The results embodied in this report have not been submitted to any other University or Institution for the award of any Degree or Diploma.

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DECLARATION

We hereby declare that this project report titled **Hand Gesture Controlled Robot using Arduino** submitted in partial fulfilment of the degree of **B.Tech in Electronics and Communication Engineering** is a record of original work carried out by us under the supervision of **Dr. N. Arun Vignesh**, and has not formed the basis for the award of any other degree or diploma, in this or any other Institution or University. In keeping with the ethical practice in reporting scientific information, due acknowledgements have been made wherever the findings of others have been cited.

Signature of the Student

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We would like to thank all our faculty and friends for their help and constructive criticism during the project period. Finally, we are very much indebted to our parents for their moral support and encouragement to achieve goals.

Yours Sincerely,

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Abstract

Recently, vigorous efforts have been carried out to develop intelligent and natural interfaces between users and computer-based systems built on human gestures. Gestures provide an intuitive interface to both human and computer. Thus, such gesture-based interfaces can not only substitute the common interface devices, but can also be utilized to extend their functionality.

In this project, a hand gesture-controlled car is designed with the help of Arduino. This project makes use of ADXL335, which is a 3-axes Accelerometer sensor and the microcontroller part is Arduino Nano. The movement of the hands is used to control the car rather than using a remote with buttons or a video game joystick. The project comprises of wireless transmission, where the bits from the hand movements is given to the car over RF wireless link (RF Transmitter-Receiver pair). This project mainly consists of two parts, one is the transmitter part and other is the receiver part. The transmitter will send the appropriate signal according to the placing of the accelerometer and the user's hand gesture and the receiver will get the signal and the robot will move in the desired direction. According to the tilt of the accelerometer sensor placed on the hand, it transmits the corresponding bits to the RF transmitter module and is taken at the receiver end which drives the gear motors in the desired direction. The car goes forward, backward, right, left when we tilt our hand to the forward, backward, right, left direction respectively. The robot halts when the hand is zero degrees with respect to the ground.

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CHAPTER-1

INTRODUCTION

1.1 Introduction

To make daily life easier and more effortless, we must take the help of technology which may be autonomous or manual. The life of humans will become much simple and smoother if the technology becomes hands free. If humans can control machines totally by their voice, gestures and other activities, then interactions will be trouble-free. Robots are sporting a crucial role in mechanization across some of the sectors such as construction, military, medical, navy, manufacturing, etc. After having done some basic prototypes such as line follower robot, mobile controlled robot, etc; we have designed gesture controlled robot which is accelerometer based by using Arduino Nano module. In this project we have used hand movements to steer the robot. For this sole purpose we have used ADXL335 accelerometer sensor which works solely on acceleration.

A Gesture controlled robot car is directed by using hand movements in place of any older methods such as videogame joysticks etc. Here, the only thing needed from a person operating, is to move their hand to control the robot car. A transmitting/sending module is used on your hand which carries RF 434MHz Transmitter module and the accelerometer. This will send the corresponding bits to the robot car so that it can undertake the desired task like travelling back, front, left, right and halt. All the above duties will be performed by simply moving the hand.

The present emerging technology in the field of science is Robotics. It is the fresh booming technology which is largely useful to the people in the future years. These days a large number of cordless robots are being developed and put to use in various applications. In order to increase the contribution of robots in our daily lives, we need to discover a productive way of exchanging information with robots. For this sole reason, there has been definite evolution in the area of human-machine connection. In order to enlarge the use of robot cars in locations where conditions are not definite like military rescue operations, robot cars can be used to follow the commands of a human operator and execute the job specifically. This suggests a logical approach of tracing and identification of hand movements which is directed to be used as human-robot connection interface.

Robots are controlled using hand gesture. Robots need helping hand to perform any functions from the humans. The main reason of using hand movements is that it gives an easier way of regulating and controlling the robot car. Through this feature, robot can be used as a wheelchair or as a spy robot or for surveillance. As human hand gestures are natural, with the help of wireless communication, it is easier to interact with the robot in a more-friendly way. The robot's movement depends on the movements made by hand.

The objective of this project is to build a wireless, hand gesture-controlled robot using an Arduino Nano, an accelerometer, an RF transmitter and a receiver set. The Arduino Nano microcontroller reads the analog output values i.e., x-axis and y-axis values of the accelerometer and converts that analog value to respective digital value. The values are given a specific function by the use of the Arduino software. The digital values are processed by the Arduino Nano microcontroller and according to the tilt of the accelerometer sensor placed on the hand, it sends the commands to the RF transmitter which sends the signal to the receiver. These signals are processed by the receiver end which drives the motor to a particular direction in which we have set it to move. The robot moves ahead, reverse, right and left when we tilt our palm to front, back, right and left respectively and the robot stops when our palm is parallel to the ground.

1.2 Proposed Work

The whole project is divided into two sections one is transmitter section and other is receiver section. The transmitter section consists of one Arduino Nano, one 3-axis accelerometer and one RF transmitter module. The receiver section consists of one RF receiver module, one motor driver IC, two 6V gear motors and two wheels. Here, two separate 5 volt power supplies are applied to both the sections through 7805 Voltage Regulator. Finally, the Arduino Nano reads the analog output values i.e., x-axis and y-axis values from the 3-axis accelerometer and converts the analog value to respective digital value. The digital values are processed by the Arduino Nano and send to the RF transmitter which is received by the RF Receiver and is processed at the receiver end which drives the motor to a particular direction. The robot moves forward, backward, right and left when the palm of the user is tilted in forward, backward, right and left respectively.

The Figure 1.1 shows the robot car chassis used in this project

Figure 1.1 Robot Car Chassis

1.3 Block Diagram of Hand Gesture Controlled Robot

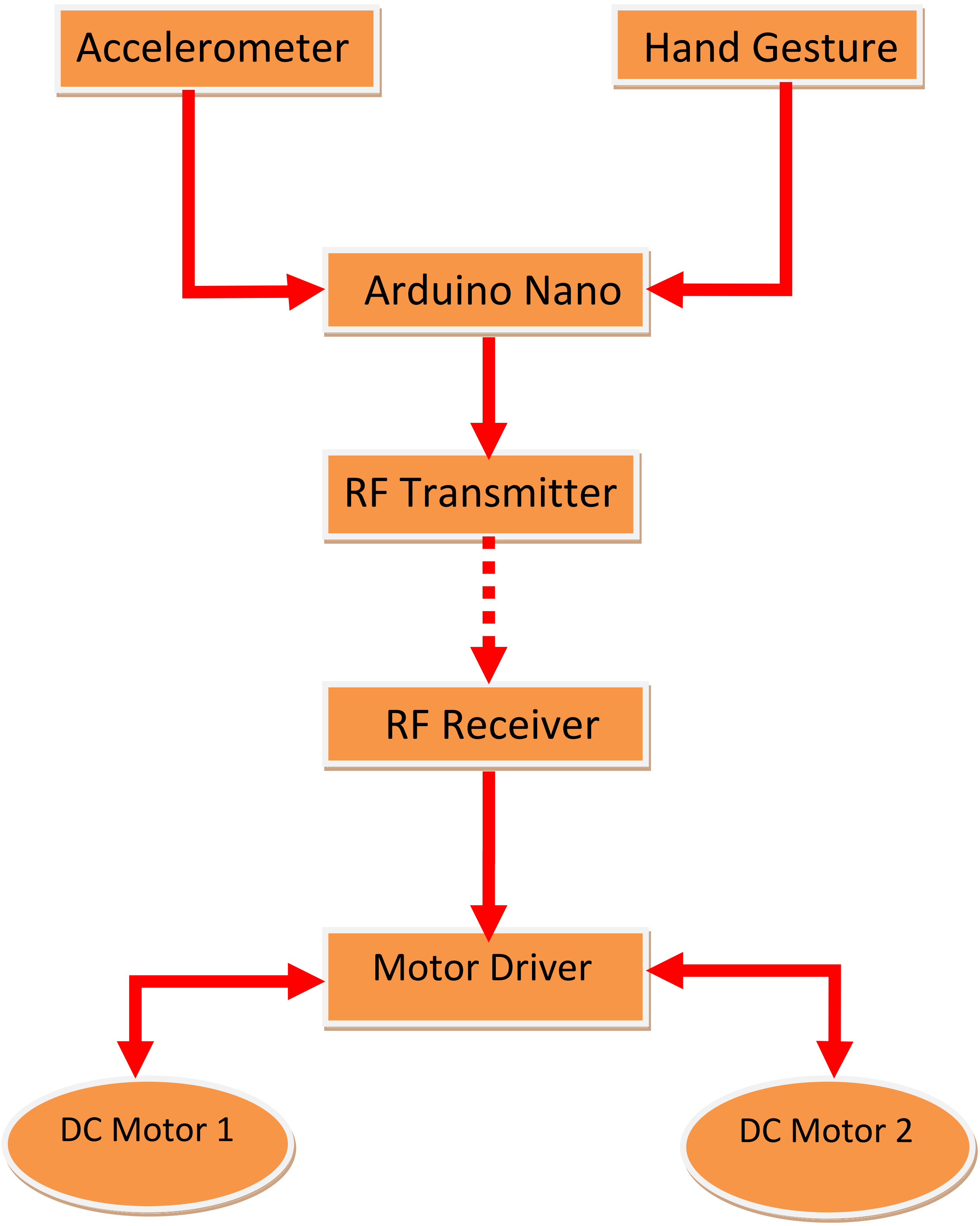


Figure 1.2 Block Diagram of Hand Gesture Controlled Robot

1.4 Human- Machine Interaction

An important characteristic of a successful robotic system is the Human-Machine interaction. In the early years, the only way to liaise with a robot was to program which required immense hard work. With the development in science and robotics, gesture-based recognition came into existence. Gestures emerge from any bodily movement but frequently arise from the hand. A gesture is an action that has to be seen by someone else and has to convey some piece of information. Gesture is usually considered as a movement of part of the body, especially a hand or the head, to express an idea or meaning. Gesture recognition can be considered as a way for computer to understand human body language. This has minimized the need for text interfaces and GUIs (Graphical User Interface). A Gesture controlled car moves according to hand gesture as we place transmitter board on our hand.

1.5 Objective of the Project

Nowadays, robotics is one of the rapidly advancing branches in the field of technology. Robotics is most widely used in automobiles, medical, construction and defense. But controlling the robot with a remote or a switch can be quite complicated. So, this project uses hand gestures to control the robot and is known as Accelerometer Based Gesture Control Robot. The objective of this project is to control the movement of the robot with hand gestures using an accelerometer.

1.6 Literature Survey

Using Memory box for Programming and management of a robot car is a tedious and time-consuming job that involves hardware knowledge. Therefore, the above project targets to have fresh and more instinctive ways for programming and managing a robot. In the scientific field, a large number of research ventures have been made to develop user-friendly teach pendants, executing user interfaces such as colour touch visuals, a 3D video game remote buttons. But these approaches are not productive to manage the robot as they do not give accurate results and give slow response time. Long ago, the designers of robot have made endeavours for developing “Human Machine Interfacing Device”. Using Gesture recognition idea, it is feasible to move a robot according to the desired direction. Accelerometer sensors are the prominent technologies used for human machine connection which prefer coherent movement sensitivity in various applications. Motion technology makes it trouble-free for the humans to connect with machines generally without any involvement caused due to the limitations of mechanical modules. Accelerometer-based movement recognition has already begun to become exceedingly popular over the last 10 years contrast to vision-based technique. The things that make it a useful tool to detect and recognize the human movements are its low cost and comparatively small size of the accelerometer sensors.

CHAPTER-2

HARDWARE REQUIREMENTS

2.1 Principle

In order to interpret the concept of working of Hand Gesture Controlled Robot, let us split the project into three parts.

- The first part is to obtain data from the ADXL335 Accelerometer Sensor with the help of Arduino Nano. The Arduino Nano constantly gets data from the ADXL335 sensor and based on the already-defined specifications, it transmits the data bits to the RF 434 MHz Transmitter.
- The second part of the project is the wireless communication between the RF Transmitter-Receiver pair. The Transmitter, upon getting the data bits from the Arduino Nano (through the Encoder IC), sends it through the RF link, i.e. to the Receiver.
- Finally, the third part of the project is unravelling the Data received by the Receiver and transmitting desired signals to the L293D IC, which will trigger the gear motors of the Robot car.

2.2 Circuit Design

The Circuit Design of the Hand Gesture Controlled Robot consists of two sections namely

- Transmitter Section
- Receiver Section

2.2.1 Transmitter Section

The Figure 2.1 shows the block diagram of the Hand Gesture Controlled Robot on the Transmitter side of our project.

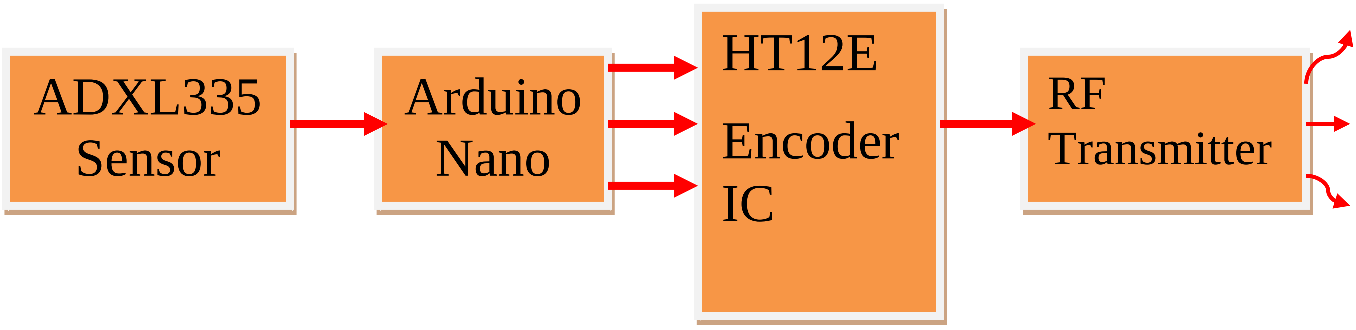


Figure 2.1 Block Diagram of Transmitter Section

Many factory related robots are capable of governing themselves as they are anticipated to operate at a high speed and with large precision. But few applications may involve semi-autonomous or man controlled machines. Some of the most commonly used control systems are voice recognition, touch controlled and the gesture controlled.

This is a kind of robot which can be accessed by our hand gestures. We just need to wear a small transmitting device on our hand which includes an acceleration meter. This will transmit an appropriate command according to our hand gesture to the robot and it performs accordingly.

2.2.2 Component Description in Transmitter Section

The Transmitter Section of the Robot car mainly consists of the following components

- Arduino Nano module
- RF 434MHz Transmitter
- HT-12E Encoder IC

- ADXL335 Accelerometer sensor

2.2.2.1 Arduino Nano

- Arduino Nano as shown in the figure 2.3 is a small, compatible, flexible and breadboard feasible microcontroller board, developed by Arduino and is headquartered in Italy, which is based on ATmega328P / ATmega168.
- It comes precisely with the same working principle as in Arduino Uno but quite compact in size.
- It comes with an operating voltage of 5V, still, the input voltage can change from 7V to 12V.
- Arduino Nano Pins contain 14 digital pins, 8 analog Pins, 2 Reset Pins and 6 Power Pins.
- Each of these Digital & Analog Pins are allocated with different functions but their key function is to be implemented as input or output.
- They behave as input pins when they are connected with sensors, but if you are driving some load then utilize them as output.
- Functions like pinMode() and digitalWrite() are utilized to control the performance of digital pins while analogRead() is used to manage analog pins.
- The analog pins come with a total resolution of 10bits which compute the value from 0V to 5V.
- Arduino Nano module comes with a crystal oscillator of frequency 16 MHz. It is used to create a clock of accurate frequency using sustained voltage.
- There is one disadvantage using Arduino Nano module i.e. it doesn’t come with power jack, means you cannot provide external power source through a battery.

- This module doesn't use conventional USB for interfacing with a computer; alternatively, it comes with Mini USB support.
- Small size and breadboard feasible nature forge this device as an ideal option for most of the applications where the sizes of electronic devices are of large concern.
- Flash memory is 16KB or 32KB that all depends on the ATmega board i.e. Flash memory is used for stockpiling the executable code.

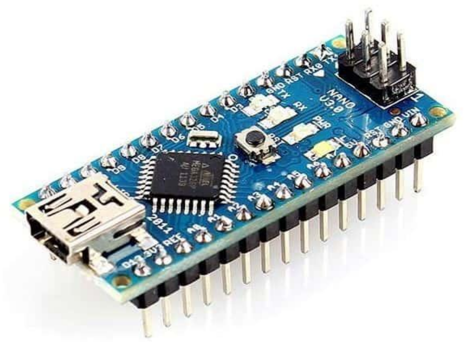


Figure 2.2 Arduino Nano

- The SRAM can differ from 2KB and EEPROM is 1KB for Atmega328.
- This board as shown in Figure 2.2 is quite identical to other Arduino modules available in the market, but the small size makes this module stand out from other modules.

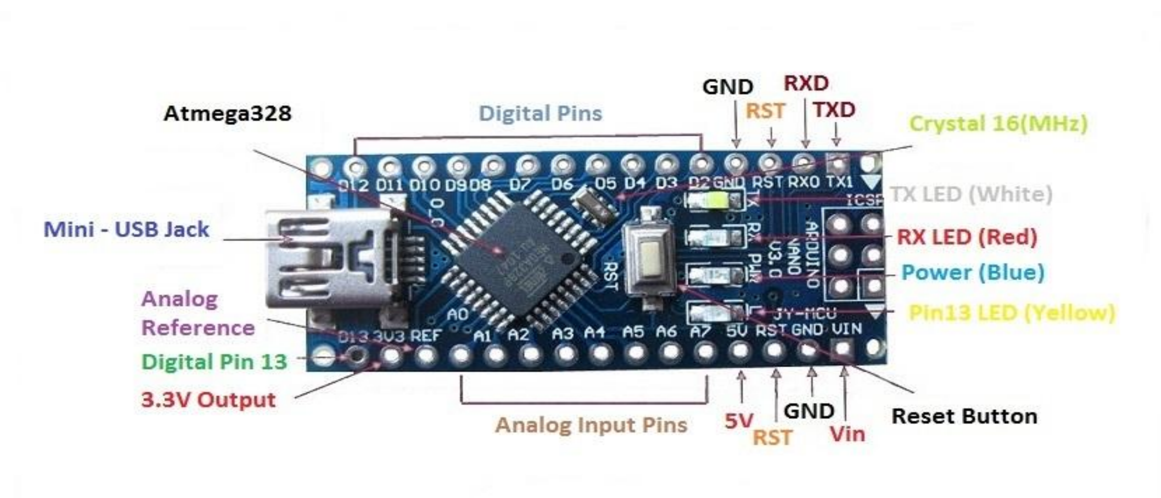


Figure 2.3 Arduino Nano Pin Description

- The Table 2.1 shows the specifications of Arduino Nano Board.

Microcontroller	Atmega328p/Atmega 168
Operating Voltage	5V
Input Voltage	7 – 12 V
Digital I/O Pins	14
PWM	6 out of 14 digital pins
Max. Current Rating	40mA
USB	Mini
Analog Pins	8
Flash Memory	16KB or 32KB
SRAM	1KB or 2KB
Crystal Oscillator	16 MHz
EEPROM	512bytes or 1KB
USART	Yes

Table 2.1 Arduino Nano Specifications

2.2.2.2 RF 434MHz Transmitter

- Radio Frequency (RF) is a rate of oscillation in the range of about 3 KHz to 300 GHz, which corresponds to the frequency of radio waves, and the alternating currents which carry the radio signals. Although radio frequency is a rate of oscillation, the term "Radio Frequency" or its abbreviation "RF" are also used as a synonym for radio – that is, to describe the use of wireless communication, as different to communication via electric wires. The RF module is working on the frequency of 434 MHz and has a range of 50-80 meters.

Figure 2.4 RF Transmitter Module

- The Transmitter as shown in figure 2.4 will not pull any power when sending logical zero bit while completely concealing the carrier frequency thus absorbing low battery power when in operation. When logical one bit is transmitted, the carrier is completely on to about 4.5mA with a 3V power supply. The data bit is thus transmitted serially from the RF transmitter which can be received by the desired receiver.

Pin	Function
1	GND
2	Data in
3	Vcc
4	ANT

Table 2.2 RF Transmitter pin description

2.2.2.3 HT12E Encoder IC

- HT12E as shown in the figure 2.5 is a 2^{12} series encoder IC for remote management applications. It is frequently used for radio frequency (RF) practices. By making use of the paired HT12E encoder and HT12D decoder we can send and receive 12 bits of parallel data bits bit-by-bit serially. HT12E solely converts 12-bit parallel data in to serial output bits which can be sent through the RF transmitter module. These 12-bit parallel data is split up into 8 address bits and 4 data bits.

- The 8-bit safety code for the data bit transmission and different receivers may be labelled using the transmitter with the help of above address pins.

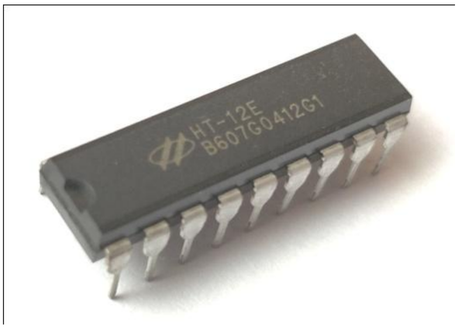


Figure 2.5 HT12E Encoder IC

- HT12E is able to handle in the voltage range from 2.4Volts to 12Volts and has a built-in oscillator which involves only an external resistor. The power utilization is very low, unessential current is 0.1µA at 5V Vdd and has high resilience against noise. It is available in 18 pin DIP (Dual Inline Package) and 20 pin SOP, but in this project we use 18 pin DIP IC.

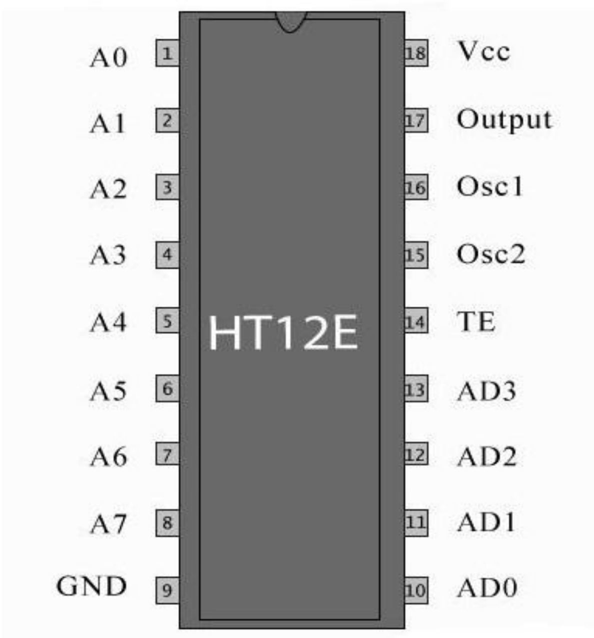


Figure 2.6 HT12E pin diagram

As shown in the figure 2.6, the functions of HT12E are described as follows:

- Vcc is the power supply pin which is used to connect positive power supply.
- OSC1 is the oscillator input pin and OSC2 is the oscillator output pin. OSC1 and OSC2 are interfaced with external resistor for the internal oscillator.
- TE is used for allowing the transmission and is an active low input.
- A0-A7 are the input address pins. With the help of these pins, we can provide a safety code for the data bits. These pins are left open.
- D8-D11 are the input data pins. These pins are interfaced to the Arduino Nano digital pins.
- DOUT is the serial data output of the encoder and can be interfaced to a RF 434 MHz Transmitter.
- The HT12E encoder begins a 4-word transmission cycle upon getting transmission enable signal on TE pin. This output cycle will replicate as long as the transmission is allowed. The encoder will be in the unessential mode when the transmission is disallowed. When the transmission enable (TE) signal shifts to HIGH, the encoder output finishes the current cycle and halts.

- The Figure 2.7 shows the flowchart of HT12E Encoder

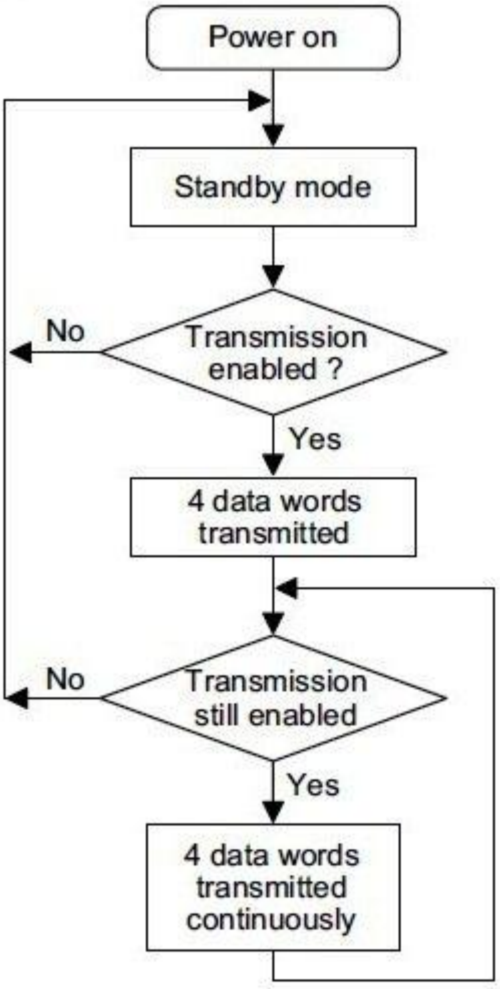


Figure 2.7 Flowchart of HT12E Encoder

- In this project, Rosc=750kΩ is used

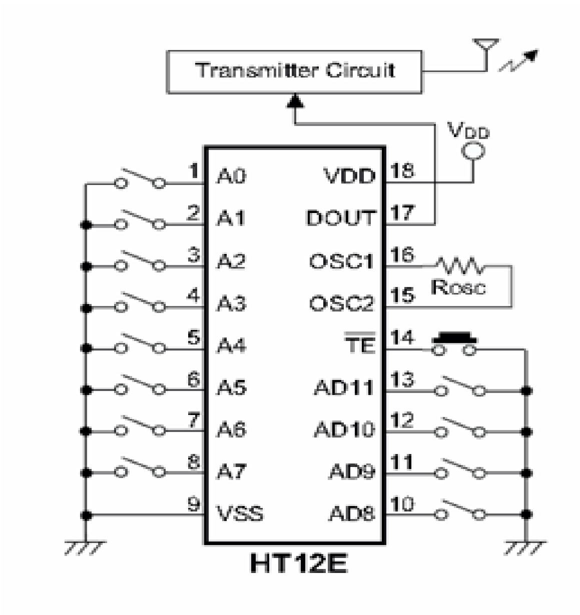


Figure 2.8 HT12E Application Circuit

2.2.2.4 ADXL335 Accelerometer Sensor

- An Accelerometer is an electromechanical sensor that computes acceleration forces. These forces may be vigorous caused by motion or vibration of the accelerometer or they could be stable, like the sustained force of gravity pulling at your feet. It is a type of sensor which documents the acceleration and generates analog data while moving in X, Y, Z axes direction.
- The ADXL335 is a fine, little, low power, absolute 3-axis accelerometer with signal governed voltage outputs. The product computes acceleration with a least full-scale range of ±3 g. It can compute the fixed acceleration due to gravity in tilt-recognizing applications, as well as varying acceleration resulting from motion, shock, or quiver. The user picks the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis. The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ).

- The Table 2.3 shows the ADXL335 Accelerometer pin description

Pin No	Pin Name	I/O	Details
1.	VCC	Power IN	Positive Power supply,5V Regulated Power
2.	GND	Power GND	Ground
3.	X	O/P	X channel output
4.	Y	O/P	Y channel output
5.	Z	O/P	Z channel output

Table 2.3 ADXL335 Accelerometer pin description

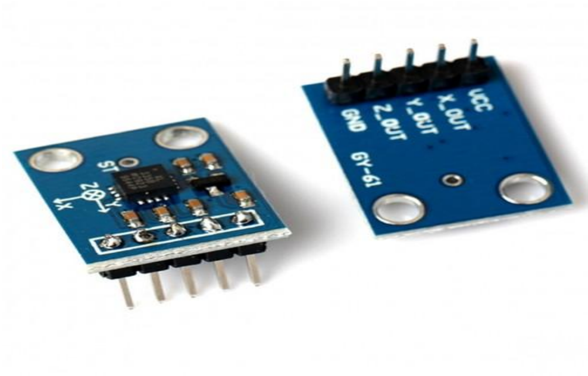


Figure 2.9 ADXL335 Accelerometer Sensor

- The ADXL335 is an absolute 3-axis acceleration computational system. It consists of a polysilicon surface-micro-machined sensor and a signal governing circuitry to execute an open-loop acceleration computational architecture. The ADXL335 has a measurement range of ±3 g atleast. The output signals are analog voltages that are directly proportional to acceleration.
- Polysilicon springs hang the structure over the surface of the wafer and it gives a resistance against acceleration forces. The accelerometer can compute the static acceleration of gravity in tilt-recognizing applications as well as varying acceleration resulting from motion, shock, or vibration. Diversion of the structure is computed using a differential capacitor that contains independent fixed plates and plates connected to the moving mass. The fixed plates are operated by 180° out-of-phase square waves.
- Acceleration diverts the moving mass and unbalances the differential capacitor resulting in a sensor output whose amplitude is directly proportional to acceleration. The demodulator output is boosted and brought off-chip through a 33 kΩ resistor. Phase-sensitive demodulation methods are then used to find the magnitude and phase of the acceleration. The user then places the signal bandwidth of the module by placing a capacitor. This filtering enhances computational resolution and helps avert aliasing.

- The Table 2.4 shows the ADXL335 Module specification

Interface :	3V3/5V Microcontroller
Voltage Requirement:	3 - 6V DC
Output format:	Analog output
Measuring range:	±3g
Measuring values(-3 to +3):	X (-274 to +325) Y (-275 to +330) Z (-275 to +310)

Table 2.4 ADXL335 Module Specification

- The ADXL335 uses a single structure for recognizing the X, Y, and Z axes. As a result, the three axes sense directions that are largely orthogonal and have small cross-axes responsiveness. Mechanically unbalanced sensor is fixed to the package and is the main source of cross-axis responsivity. Mechanical misalignment can, of course, be adjusted out at the system level.
- Rather than using another temperature compensation circuitry, creative design methods make sure that high performance is built in to the ADXL335. As a result, there are no quantization mistakes or non-monotonic behaviour, and temperature hysteresis is very less. Make sure that the inter-connection from the ADXL335 ground to the power supply ground is at low resistance because the noise transmitted through ground has same effect to the noise transmitted through VS.

2.2.3 Receiver Section

The Figure 2.10 shows the block diagram of Hand Gesture Controlled Robot for Receiver side.

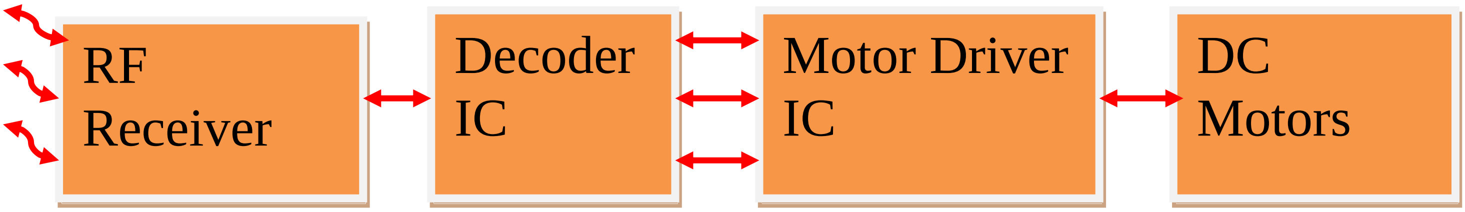


Figure 2.10 Block Diagram of Receiver Section

The Receiver section of the robot car contains an RF 434MHz Receiver module, HT-12D Decoder IC, L293D Motor Driver IC and a robot chassis parts of a car with two motors connected to their corresponding wheels.

HT-12D is the decoder IC that is frequently associated with RF modules. It transforms the serial data bits into parallel data bits received by the RF link. A0 to A7 (Pin 1 to Pin 8) are the address pins and should match the address pins of the encoder.

Since the address pins of encoder (HT-12E) are not grounded, the address pins of decoder also must not be grounded. The serial data bits from the Receiver is given to Din (Pin 14) of the HT12D decoder IC.

2.2.4 Component Description in Receiver Section

The Receiver Section of the robot mainly consists of the following components

- L293D Motor Driver IC
- HT12D Decoder IC
- 434MHz RF Receiver
- Geared Motors with Wheels
- Robot car Chassis

2.2.4.1 L293D Motor Driver IC

It is also known as dual H-Bridge IC. In the real world there are several kinds of motors accessible which work on various voltages. Actuators are those components which provide the movement to perform a job such as a motor. So, we need a motor driver IC for running them through the controller. The output from the input device (microcontroller) is a low current signal. The motor driver amplifies that current which can control and drive a motor. In most cases, a transistor can perform as a switch which drives the motor in a single direction. Figure 2.11 below is an L293D IC. Turning a motor ON and OFF involves only one switch to control a single motor in a single direction. We can reverse the direction of the motor by simply reversing the polarity. Out of many, one of the most often and intelligent development is a H-bridge circuit where transistors are organized in a shape that looks like the English alphabet "H". This can be obtained by using four switches that are arranged in a clever manner such that the circuit not only steers the motor, but also controls its direction.

- The Figure 2.11 shows the L293D pin description

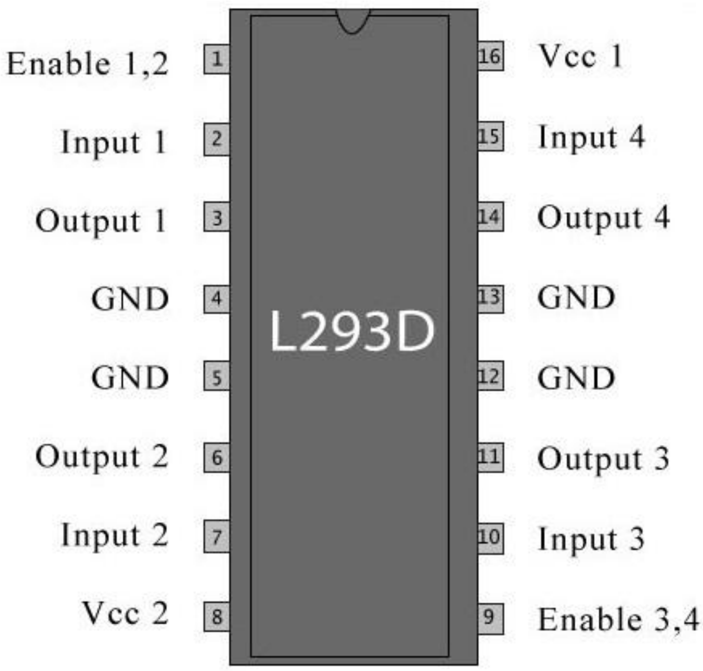


Figure 2.11 L293D IC pin description

The Table 2.5 shows the pin description of L293D IC

Pin No	Function	Name
1	Enable pin for Motor 1; active high	Enable 1,2
2	Input 1 for Motor 1	Input 1
3	Output 1 for Motor 1	Output 1
4	Ground (0V)	Ground
5	Ground (0V)	Ground
6	Output 2 for Motor 1	Output 2
7	Input 2 for Motor 1	Input 2
8	Supply voltage for Motors; 9-12V (up to 36V)	Vcc 2
9	Enable pin for Motor 2; active high	Enable 3,4
10	Input 1 for Motor 1	Input 3
11	Output 1 for Motor 1	Output 3
12	Ground (0V)	Ground
13	Ground (0V)	Ground
14	Output 2 for Motor 1	Output 4
15	Input2 for Motor 1	Input 4
16	Supply voltage; 5V (up to 36V)	Vcc 1

Table 2.5 L293D IC pin description

As seen in the figure 2.12 below, the circuit has four single pole switches A, B, C and D. Switching these ON and OFF can steer a gear motor in various ways.

- When switches A and D are on, motor rotates clockwise.
- When B and C are on, the motor rotates anti-clockwise.
- When A and B are on, the motor will stop.
- Switching off all the switches gives the motor a free wheel drive.

Switching on the switches A & C at the exact time or B & D at the exact time shorts the complete circuit. So, on any occasion, try not to do it.

The Figure 2.12 shows the H-Bridge Motor Driver circuit

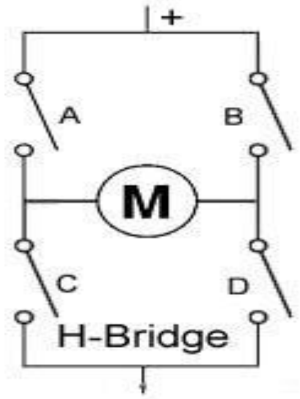


Figure 2.12 H-Bridge Motor driver circuit

- The Figure 2.13 shown is a dual H-bridge motor driver circuit (IC). Motor drivers behave as current amplifiers since they extract a low-current control signal and give a higher-current signal. This higher current signal is utilized to drive the corresponding gear motors.

Figure 2.13 L293D Motor Driver IC

L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction.

2.2.4.2 HT12D Decoder IC

HT12D is a 2^{12} series decoder IC for remote management applications fabricated by Holtek. It is frequently used for radio frequency (RF) cordless applications. HT12D solely converts serial data bits to its input (may be received through RF 434MHz receiver) to 12-bit parallel data. By making use of the paired HT12E encoder and HT12D decoder we can send and receive 12 bits of parallel data bits bit-by-bit serially. These 12-bit parallel data is split up into 8 address bits and 4 data bits. Using 8 address bits we can provide 8-bit safety code for 4-bit data and can be used to address different receivers by using the exact same transmitter.

Figure 2.14 HT12D Decoder IC

The Figure 2.14 shown above is a CMOS LSI IC and is very efficient to operate in a wide voltage range from 2.4Volts to 12Volts. Its power usage is least and has large immunity when compared with the noise. The received data is examined 3 times for more accuracy. It has a built-in oscillator, we only need a small external resistor.

The Pin Diagram of HT12D (Dual in package) is as follows

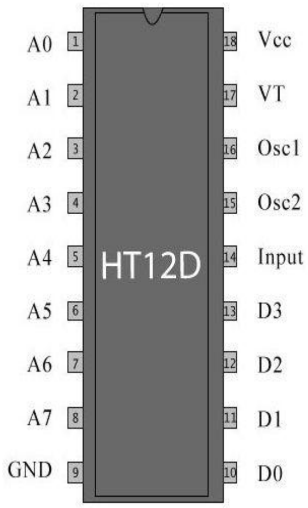


Figure 2.15 HT12D pin diagram

The Figure 2.15 above shows the pin diagram of HT12D Decoder IC

- IC's operating voltage can be in the range 2.4Volts to 12Volts. VSS is used to provide positive power supply to the IC.
- OSC1 is the oscillator input pin and OSC2 is the oscillator output pin. OSC1 and OSC2 are used to interface external resistor for internal oscillator of HT12D.
- A0– A7 are the address input pins. These pins are left open. Status of these pins should match with status of address pin in HT12E (used in transmitter) to receive the data. DIN is the serial data input pin and can be connected to a RF receiver output.
- D8– D11 are the data output pins. Status of these pins can be VSS relies upon the received serial data bits through DIN pin.
- VT stands for Valid Transmission. This output pin will be HIGH when valid data bits are available at D8 – D11 data output pins.
- The Figure 2.16 shows the Typical application circuit of HT12D and in this project, Rosc=33kΩ is used

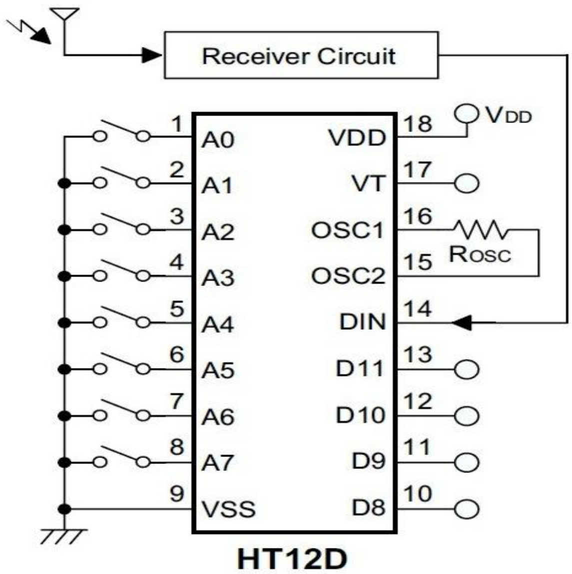


Figure 2.16 HT12D Application circuit

- The Figure 2.17 shows the Flowchart of HT12D Decoder

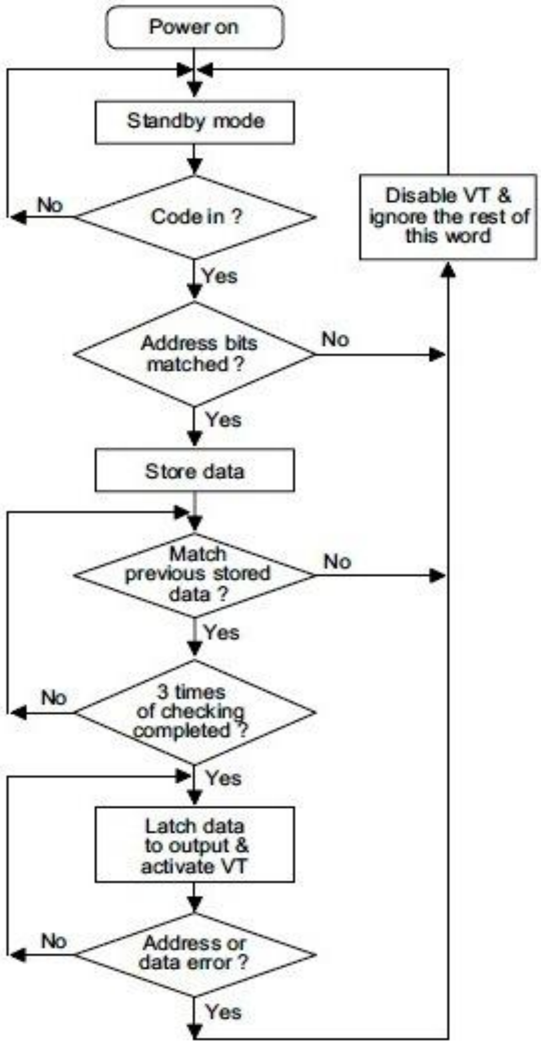


Figure 2.17 Flowchart of HT12D Decoder

2.2.4.3 RF 434MHz Receiver

- An RF Receiver is a small electronic component used to get radio signals between two devices. In an embedded system it is frequently used to share information with any other device wirelessly. For various applications, the most of the time the choice is RF since it does not need line of sight for its operation.

- The Figure 2.18 shown below is the RF Receiver Module

Figure 2.18 RF Receiver Module

- RF module, as the name suggests, it makes use of radio frequency range to send signals. These signals are sent at a frequency of 434MHz. A receiver can receive these signals only if it is synced to that frequency. This circuit uses the RF link (Tx/Rx) for making a wireless remote, which could be utilized to drive an output from a far-away place.
- The Table 2.6 shows the pin description of RF Receiver

Pin No	Function	Name
1	Ground (0V)	Ground
2	Serial data output pin	Data
3	Linear output pin; not connected	NC
4	Supply voltage; 5V	VCC
5	Supply voltage; 5V	VCC
6	Ground (0V)	Ground
7	Ground (0V)	Ground
8	Antenna input pin	ANT

Table 2.6 Pin Description of RF Receiver

- A four-channel encoder/decoder pair is used in this system. The circuit can be utilized for developing Remote device control systems. The input signals, at the transmitter side, are taken through four switches while the outputs are monitored on a set of four LEDs corresponding to each input switch. The outputs from the receiver can drive corresponding relays connected to any household appliance.

2.2.4.4 Gear Motors and Wheels

- A machine that converts DC power into mechanical power is known as a DC motor. The Figure 2.19 shows a DC Motor. DC motors have a revolving armature winding but non-revolving armature magnetic field and a stationary field winding or permanent magnet. Its operation is based on the principle that when a current carrying conductor is placed in a magnetic field, the conductor experiences a mechanical force. Different connections of the field and armature winding provide different speed/torque regulation features. The speed of a DC motor can be controlled by changing the voltage applied to the armature or by changing the field current.

Figure 2.19 DC Motor

- A Geared DC Motor has a gear assembly devoted to the motor. The speed of motor is measured in terms of rotations of the shaft per minute and is termed as RPM. The gear assembly helps in increasing the torque and dropping the speed. Using the correct arrangement of gears in a gear motor, its speed can be controlled to any required figure. This concept of minimising the speed with the help of gears and increasing the torque is known as gear reduction.

- The Figure 2.20 below shows a Geared DC Motor

Figure 2.20 Geared DC Motor

- The decrease in speed is inversely relative to the increase in torque. This association means that, in this sort of device, if the torque were to double, the speed would decrease by one half. Reducing the speed put out by the motor while increasing the quantity of applied torque is an important feature of the reduction gear trains found in a gear motor.
- Small electric motors, such as the gear motor, are able to move and stand very heavy loads because of these reduction gear trains. While the speed and ability of larger motors is greater, small electric motors are sufficient to bear these loads.
- The Figure 2.21 shows the motors and wheels used in this project

Figure 2.21 Gear motors with wheels

2.2.4.5 Robot Car Chassis

- The Figure 2.22 below shows the Robot Car Chassis parts used in this project

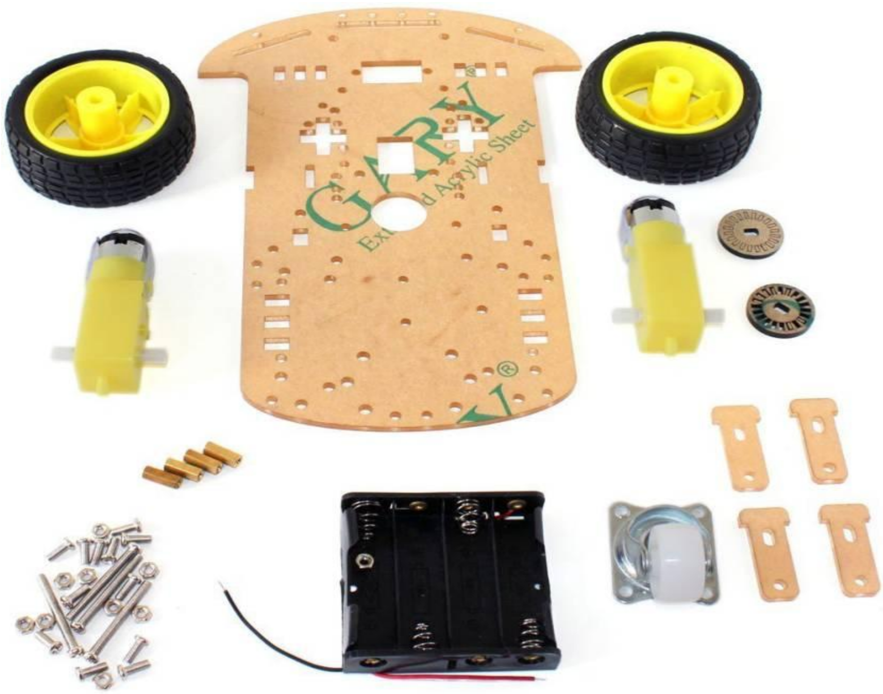


Figure 2.22 Robot car chassis parts

- The Figure 2.23 shows the assembled version of the above chassis parts

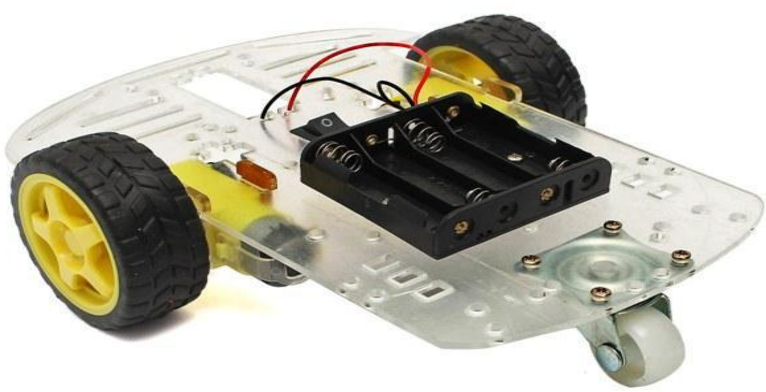


Figure 2.23 Assembled Chassis

CHAPTER-3
SOFTWARE REQUIREMENTS

3.1 Introduction to Arduino IDE

- Arduino IDE is an open source software that is largely used for writing and compiling the code into the Arduino devices.
- It is simply accessible for Operating systems such as MAC, Windows, Linux and also executes on the Java Platform that comes with built-in functions and instructions that play an important role for debugging, editing and compiling the code in the environment.
- It is a formal Arduino software, making code compilation too simple that even a normal person with no previous technical knowledge can get on with the learning process.
- There are a range of arduino modules obtainable in the market, including Arduino Uno, Arduino Mega, Arduino Nano, Arduino Micro and many more.
- The Figure 3.1 shows the desktop logo for the Arduino IDE

Figure 3.1 Arduino IDE Logo

- Each of them consists of a microcontroller on the board module that is previously programmed and it accepts the particulars in the form of exe-code.
- The Arduino IDE assists the languages such as C and C++ using special commands of code formatting. The Arduino IDE provides maximum software libraries, which provide many frequent input and output procedures.
- The Integrated Development Environment mainly consists of two parts.
- Editor and Compiler where former is utilised for writing the executable code and later is utilised for compiling and uploading the executable code into the Arduino Board.
- The primary code, also known as a sketch, done on the IDE platform will finally generate a Hex File which is then transmitted and uploaded in the microcontroller of the given Arduino board module.

3.2 How to Download Arduino IDE

One can download the Arduino IDE from Arduino’s official website. As I mentioned earlier, the software is accessible for normal operating systems like Windows, Linux, and MAC, so make perfectly sure you are downloading the correct version of the Arduino IDE that is easily feasible with the given operating system.

- If you target to download Windows application version, make perfectly sure you have Windows 8.1 or Windows 10 versions, as app version is not feasible with Windows 7 or older versions of this operating system.

3.3 Different Sections in Arduino IDE

The IDE environment is primarily divided into three parts

- 1. Menu Bar

- 2. Text Editor
- 3. Output Pane

The Figure 3.2 below shows the description of Arduino IDE

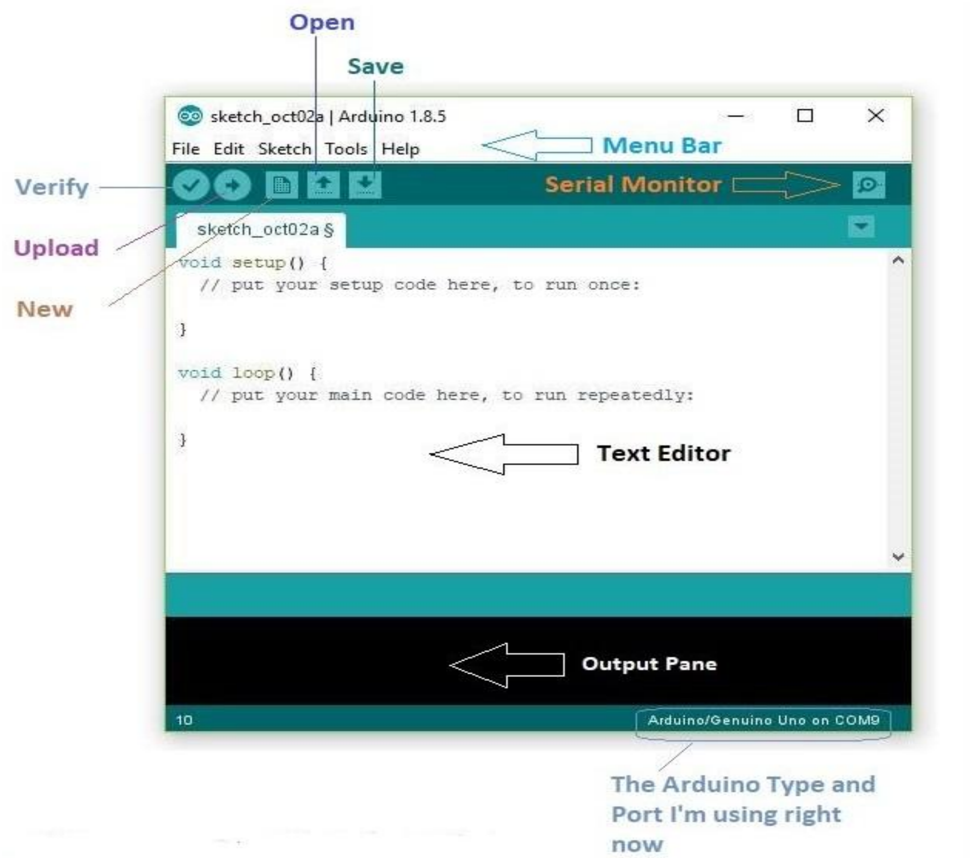


Figure 3.2 Description of Arduino IDE

- The button present at the top right corner is a Serial Monitor – A distinct pop-up window that behaves as an independent output terminal and performs a key role for transmitting and getting the Serial Data bits. You can also go to the Tools panel and click on the Serial Monitor in the drop down box, or pressing Ctrl+Shift+M all at once will unlatch it instantly. Your Arduino Board should be interfaced to your computer/laptop with the help of a USB cable in order to begin the Serial Monitor. The Serial Monitor will actually aid us to debug the written codes where you can get to know how your program is operating.

➢ You need to pick the baud rate of the Arduino Module you are utilizing right now in the serial monitor at the bottom right corner.

➢ In order to upload the executable code, you must pick the pertinent board you are utilizing and the ports for that particular operating system. As you click on the Tools in the Menu bar, it will unlatch such as the figure 3.3 below

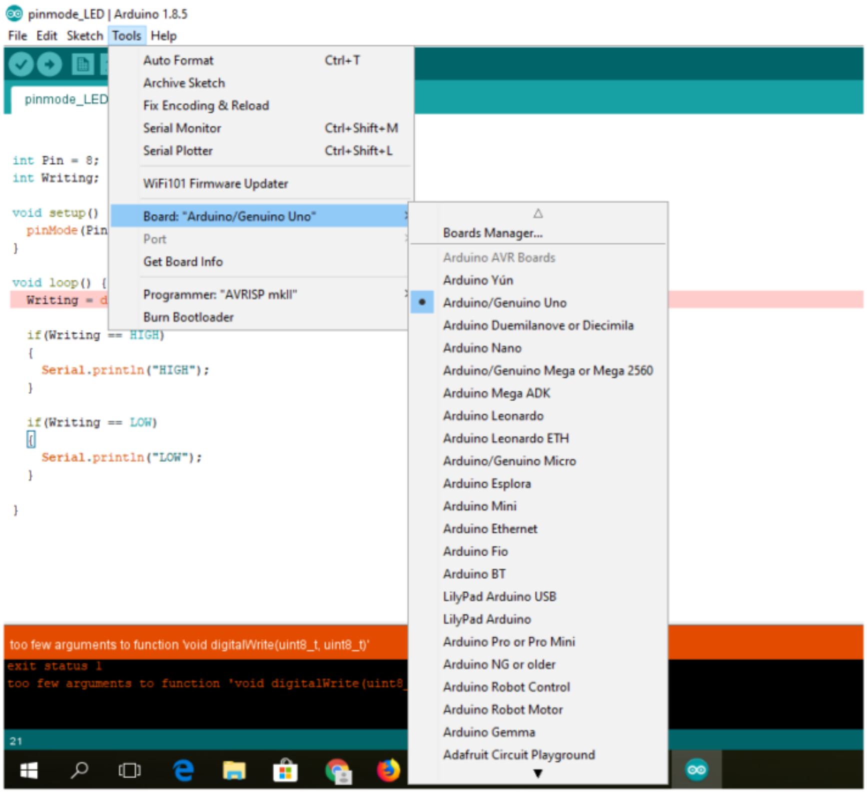


Figure 3.3 Board selection in Arduino IDE

➢ Just proceed to the “Board” section and pick the board module you target to work on with. Likewise, COM1, COM2, COM4, COM5, COM7 or higher are reticent for the serial and USB board. You can peer for the USB serial device in the port part of the Device Manager of the windows operating system.

- The Figure 3.4 below shows the COM4 that I have utilized for my project, specifying the Arduino Nano with COM4 port at the bottom right corner of the screen which is highlighted in the red coloured box.

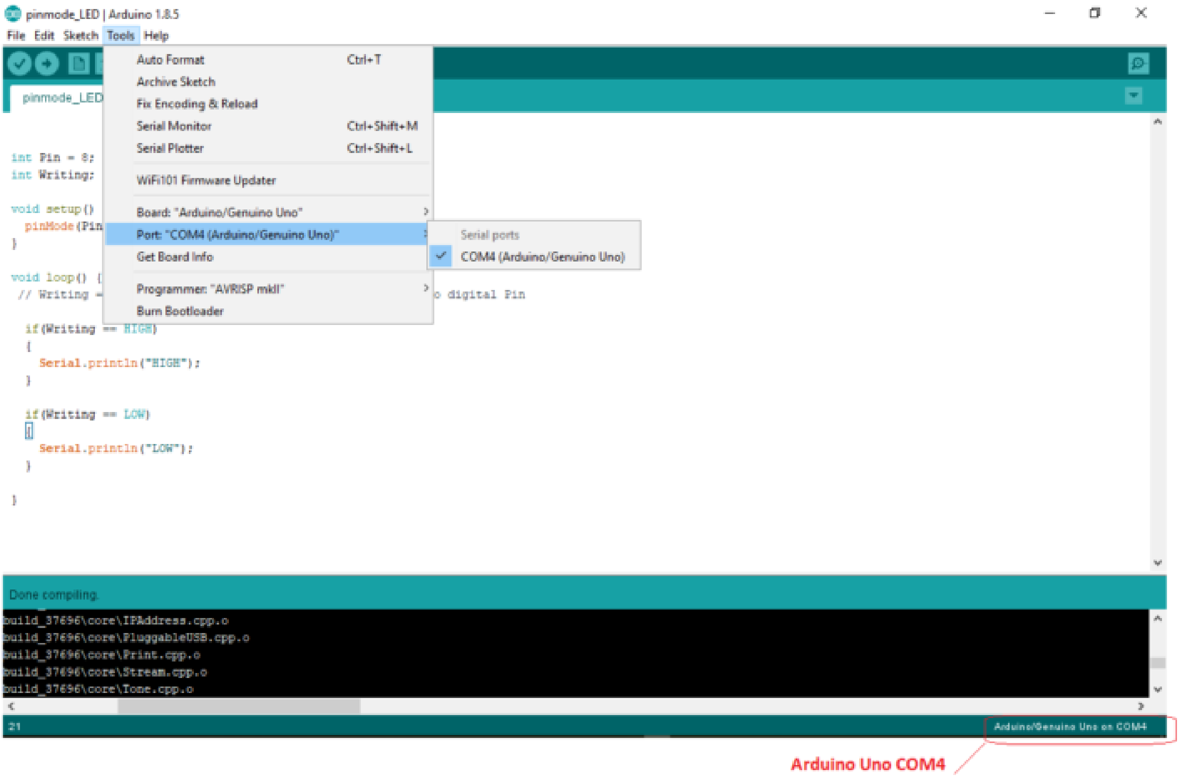


Figure 3.4 Port selection in Arduino IDE

3.4 Executable Code

```
// these constants describe the pins. They won't change:
const int xpin = A1;            // x-axis of the accelerometer
const int ypin = A2;            // y-axis
const int zpin = A3;            // z-axis
long x;
long y;
long z;
```

```
void setup() {
// initialize the serial communications:
Serial.begin(9600);
pinMode(7,OUTPUT);
pinMode(8,OUTPUT);
pinMode(9,OUTPUT);
pinMode(10,OUTPUT);
}
void loop() {
// print the sensor values:
x=analogRead(xpin);
Serial.print(x);
// print a tab between values:
Serial.print("\t");
y=analogRead(ypin);
Serial.print(y);
// print a tab between values:
Serial.print("\t");
z=analogRead(zpin);
Serial.print(z);
Serial.println();
if((x>=360 && x<=380) && (y>=360 && y<=375))        //neutral
{
digitalWrite(10,LOW);
digitalWrite(9,LOW);
digitalWrite(8,LOW);
digitalWrite(7,LOW);
}
else if((x>=365 && x<=375) && (y>=410 && y<=440))     //front
```

```
{
digitalWrite(10,HIGH);
digitalWrite(9,LOW);
digitalWrite(8,HIGH);
digitalWrite(7,LOW);
}
else if((x>=360 && x<=375) && (y>=290 && y<=320))     //back
{
digitalWrite(10,LOW);
digitalWrite(9,HIGH);
digitalWrite(8,LOW);
digitalWrite(7,HIGH);
}
else if((x>=300 && x<=330) && (y>=360 && y<=380))     //left
{
digitalWrite(10,LOW);
digitalWrite(9,LOW);
digitalWrite(8,HIGH);
digitalWrite(7,LOW);
}
else if((x>=395 && x<=440) && (y>=360 && y<=375))       //right
{
digitalWrite(10,HIGH);
digitalWrite(9,LOW);
digitalWrite(8,LOW);
digitalWrite(7,LOW);
}
}
```

CHAPTER-4
IMPLEMENTATION

4.1 Circuit Design of Transmitter Section

- The Transmitter part of the Robot car as shown in the figure 4.1 contains an Arduino Nano board, ADXL335 Accelerometer Sensor, Encoder HT12E IC and a 434MHz Radio Frequency Transmitter. The interconnection between Arduino nano and ADXL335 sensor takes place via the x, y, z axes pins of ADXL335 accelerometer sensor which are again connected to the A1,A2,A3 pins of Arduino Nano.

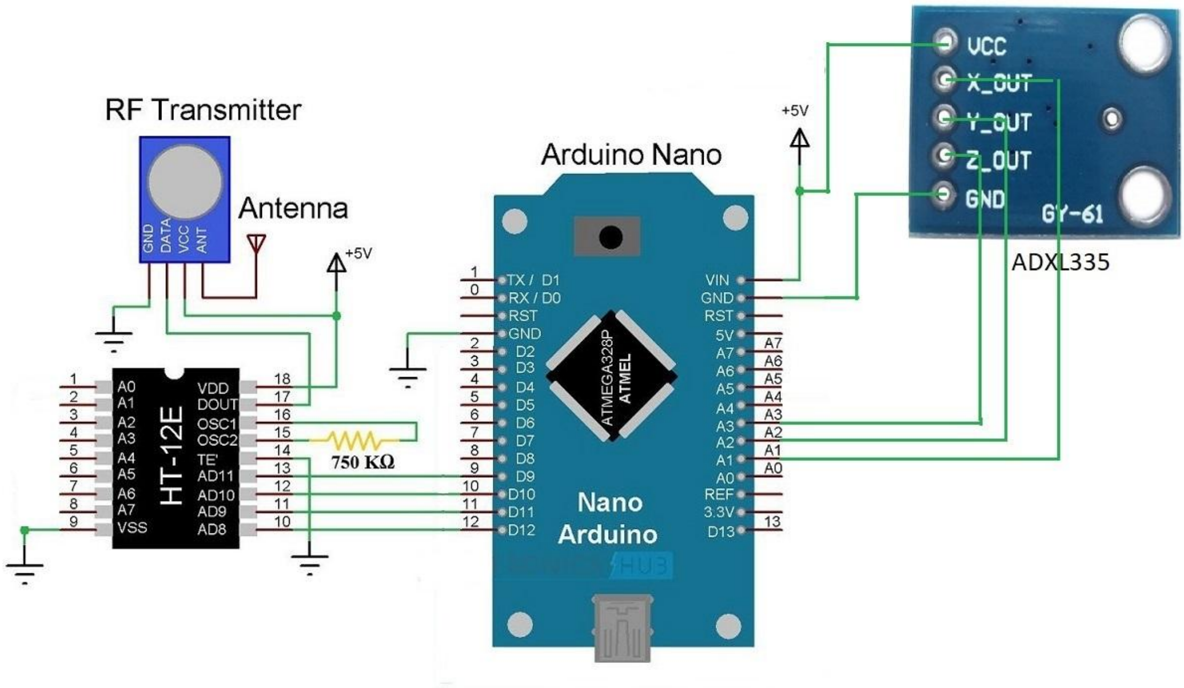


Figure 4.1 Circuit Design of Transmitter Section

- HT12E is a Holtek's Encoder Integrated Circuit that is frequently related with Transmitter module. It transforms the 12-bit parallel data bits into serial data bits. The 12-bit data bits are split up into address and data bits.

A0 to A7 (Pin 1 to Pin8) are the address bits and they are utilized for safe transmission of the data bits. These pins are left open in this project.

- Pins 10 to 13 (AD8, AD9, AD10 and AD11) are the data pins of HT12E. They accept the four word parallel data bits from outside source like a controller (Arduino Nano in this case). They are interfaced to the pins D12, D11, D10 and D9 of Arduino Nano respectively.
- TE' is the transmission enable pin and is always an active low pin. The data bits are sent as long as the TE' is low. Hence, Pin 14 (TE') is also connected to ground in the final circuit.
- The encoder HT12E IC has an internal oscillator circuit between the pins 16 and 15 (OSC1 and OSC2). A 750KΩ resistor is interfaced between these pins to allow the oscillator to run. Dout (Pin 17) is the serial data-out pin. It is interfaced to the data-in pin of the RF Transmitter.

4.2 Circuit Design of Receiver Section

- The Receiver part of the robot car as shown in the figure 4.2 contains a 434MHz RF Receiver, Decoder HT12D IC, Motor Driver L293D IC and a robot chassis parts with two motors connected to two wheels.
- HT12D is the decoder Integrated Circuit that is frequently linked with the RF Receiver side. It transforms the serial data bits received by the RF link into the parallel data bits. A0 to A7 (Pin 1 to Pin 8) are the address pins and should be matched with the address pins of the encoder HT12E IC.
- Since the address pins of encoder (HT-12E) are not grounded, the address pins of decoder also should not be grounded. The serial data bits from the output of the RF Receiver are given to the Din (Pin 14) of the decoder IC.
- HT12D has an internal oscillator and an outside external resistor of 33KΩ is interfaced between OSC1 and OSC2 (Pins 16 and 15). Pin 17 (VT) indicates a valid transmission pin of data and this pin will be logic HIGH when a valid data is present on the data pins of the Decoder. A green LED in series

with a 330Ω resistor is connected to this pin and eventually to the ground in this project, to indicate the valid data transmission.

- Pins 10 to 13 (D8, D9, D10 and D11) of HT12D are the parallel data-out pins. They are interfaced to the input pins of the motor driver L293D IC (Pins 2, 7, 10 and 15 respectively).

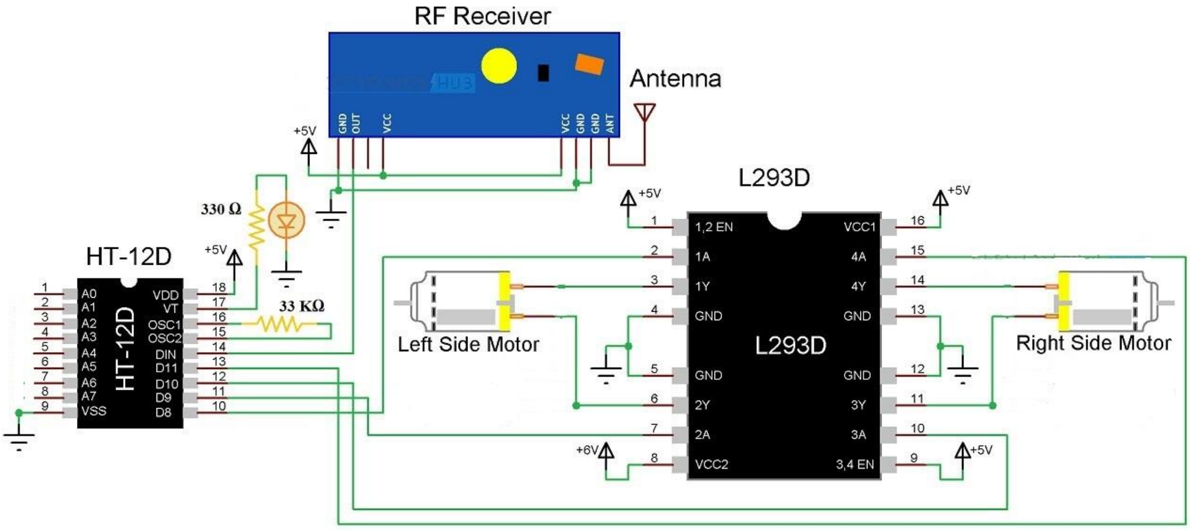


Figure 4.2 Circuit Design of Receiver Section

- Motor driver L293D IC is utilized to give the required current (for both reverse and forward directions) to the gear motors. Pins 1 and 9 are the enable pins and are connected to VCC (+5v) for its operation to start, along with Pin 16 (which is the logic supply). Pins 3 – 6 and 11 – 14 are the outputs and are interfaced to the two gear motors.
- Pin 8 is the Motor Supply Pin and is interfaced to a separate power supply. Hence, you will need two power supplies in the Receiver Section; one 9v battery for the Circuit operation and one 6v battery box for the motors.

4.3 Working Principle

- In this project, a robot car that is controlled by the gestures made by the hand is developed. The Working of the robot car is explained as follows.

- As indicated earlier, the gesture controlled robot car is a cordless operated robot and has two sections: Transmitter and Receiver. When the robot is given the appropriate power supply, the transmitter section, which contains an Arduino nano module, ADXL335 sensor, HT12E Encoder and RF transmitter, will constantly monitor the ADXL335 Accelerometer sensor.
- This data is taken by the Arduino nano board, which then sends the corresponding data bits to the Encoder, based on the direction of the ADXL335 Sensor. The parallel data bits received by the encoder are converted into serial data bits and this serial data is sent by the RF Transmitter module.
- At the receiver section, the RF Receiver gets the serial data and sends it to the Decoder IC. The Decoder will transform the serial data to parallel data bits and this parallel data bits are given to the motor driver IC. Based on the data, the movement of the gear motors, and hence the movement of the robot is defined.

- The Figure 4.3 below shows the Breadboard implementation of the project

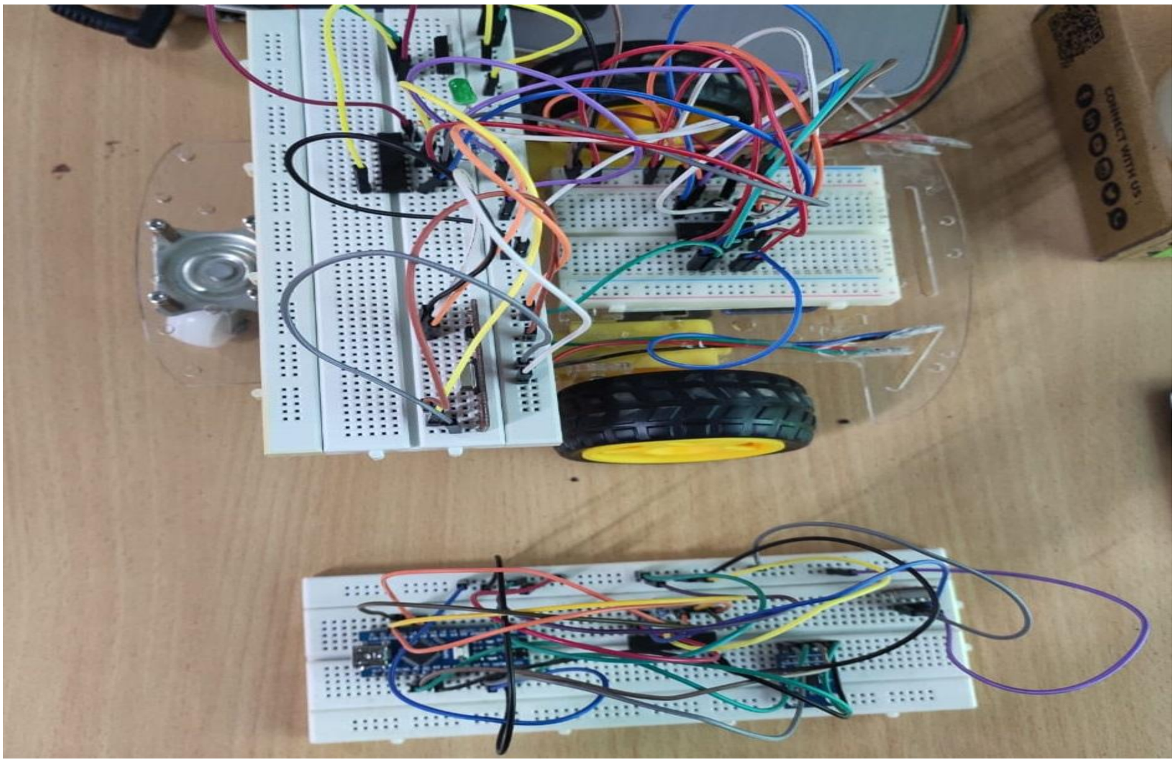


Figure 4.3 Breadboard implementation of the project

4.4 Flowchart of Hand Gesture Controlled Robot

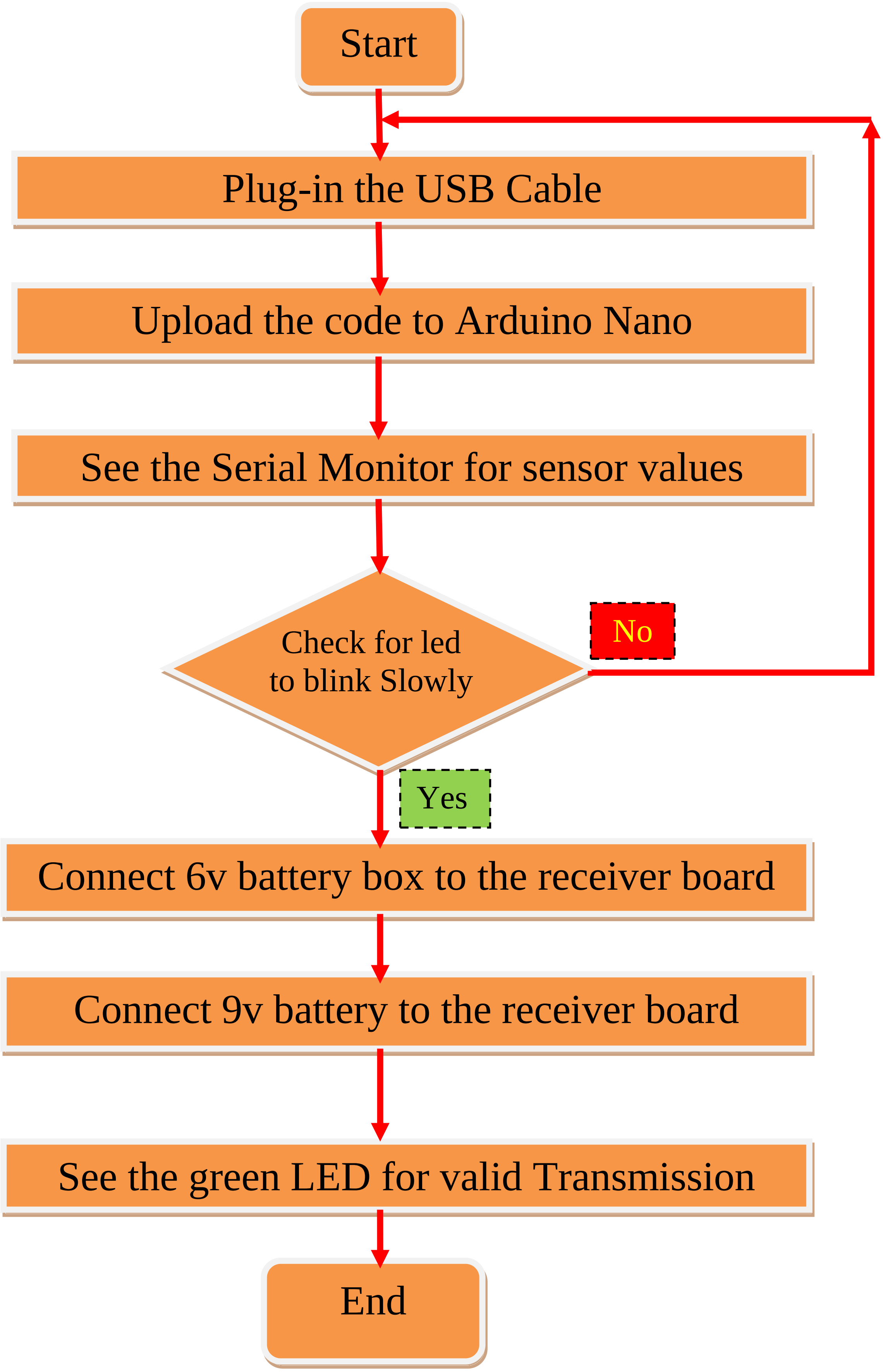


Figure 4.4 Flowchart of Hand Gesture Controlled Robot

CHAPTER-5
SIMULATION AND RESULT

5.1 Code Simulation in Arduino

- The Arduino IDE has a built-in feature which is used to compile the code we write.
- The next part is to compile the executable code into the machine language code that the Arduino IDE runs.
- The Figures 5.1 and 5.2 shows that the code is compiled successfully.

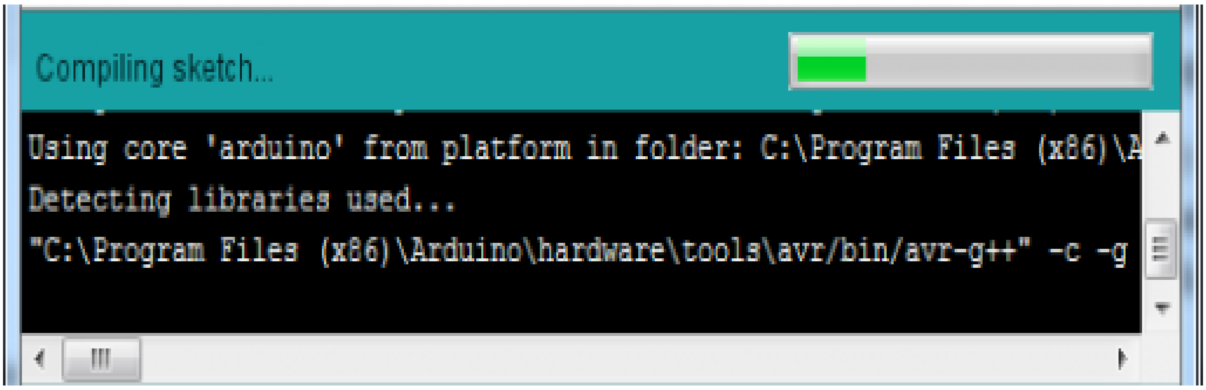


Figure 5.1 Code Compiling Sketch

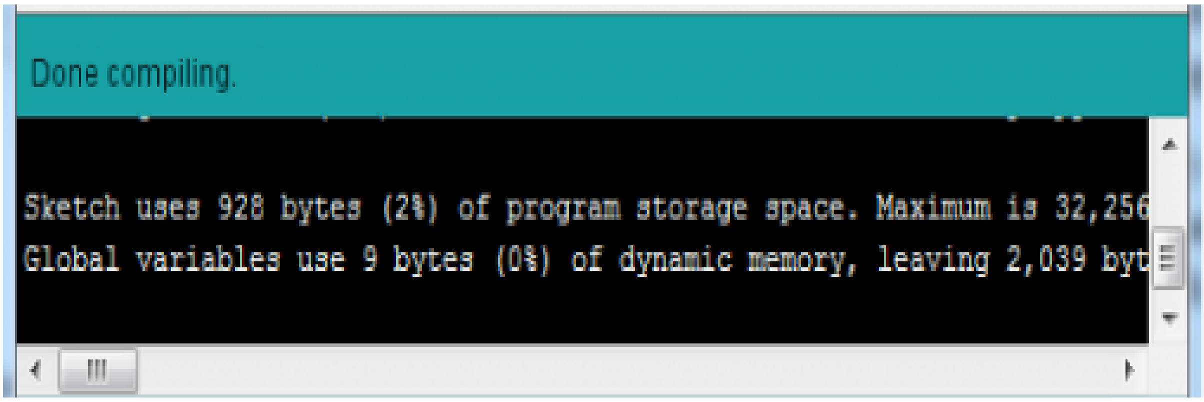


Figure 5.2 Code Compiled Sketch

➢ The Figure 5.3 shows that the code is uploaded successfully.

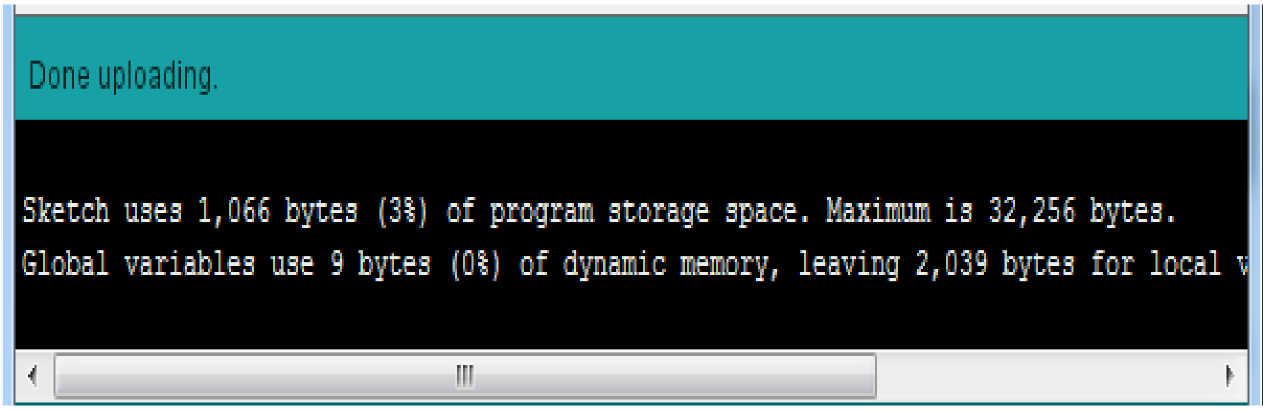


Figure 5.3 Code Uploaded

5.2 Hand Gestures used in this project

➢ The Figure 5.4 below shows the hand gestures used in this project

Figure 5.4 Hand Gestures used in this project

5.3 Results on Breadboard

- The following pictures show the connections for our project on a breadboard.

5.3.1 Transmitter Section

- The Figure 5.5 shows the connections given for the transmitter side of our project

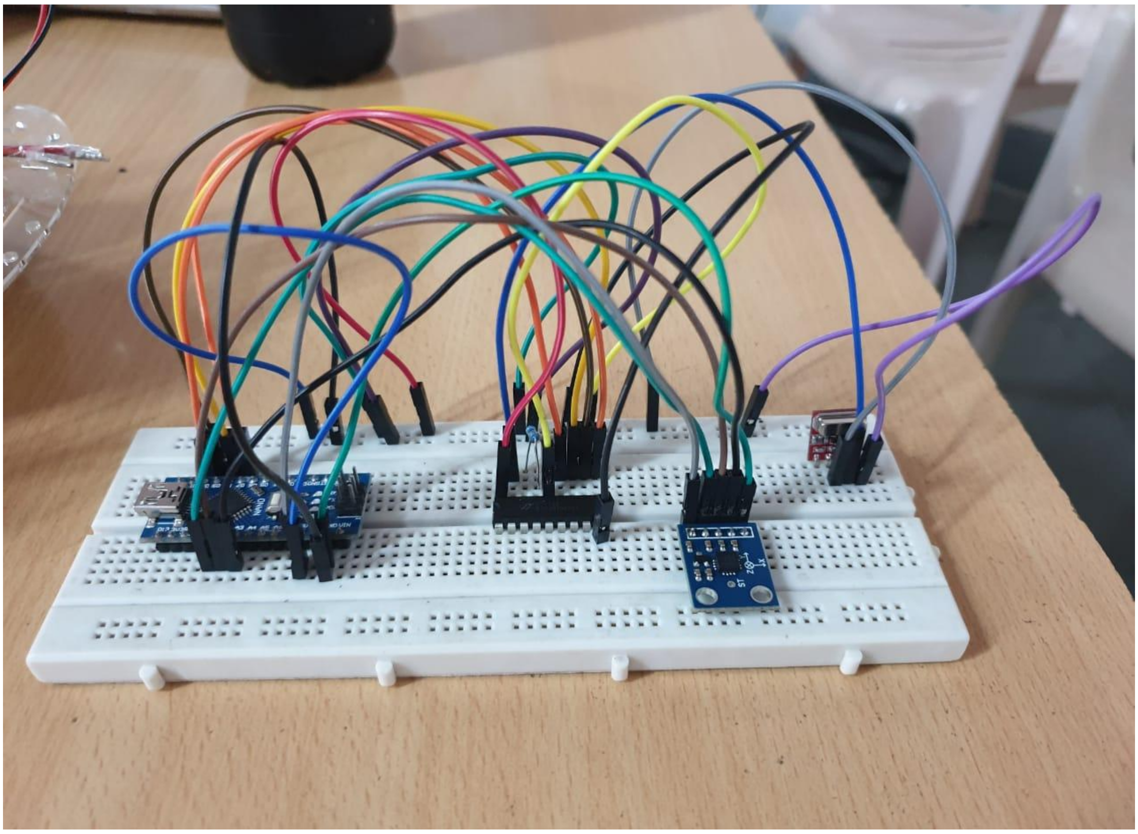


Figure 5.5 Breadboard implementation of Transmitter Section

The Explanation of the Transmitter section is as follows:

The ADXL335 Accelerometer sensor has x,y,z pins which give the acceleration in those respective axes. So, according to our hand gesture, for example, let us say we tilted our hand in the front direction then the accelerometer will provide some random x,y,z values. We give these values as the input to the Arduino nano through its analog pins. Now, According to the code we dumped earlier into the microcontroller, these analog values are converted into digital values called bits. These bits are coming out of the Arduino parallelly but the RF transmitter and receiver pair communicate serially, we need to use a parallel to serial converter and the most widely used one is HT12E Encoder IC (for 4 bits). After the conversion, the 4 serial bits are given to the data pin of the RF transmitter module which transmits these bits to the receiver module.

5.3.2 Receiver Section

The Figure 5.6 shows the connections given for the Receiver side of our project

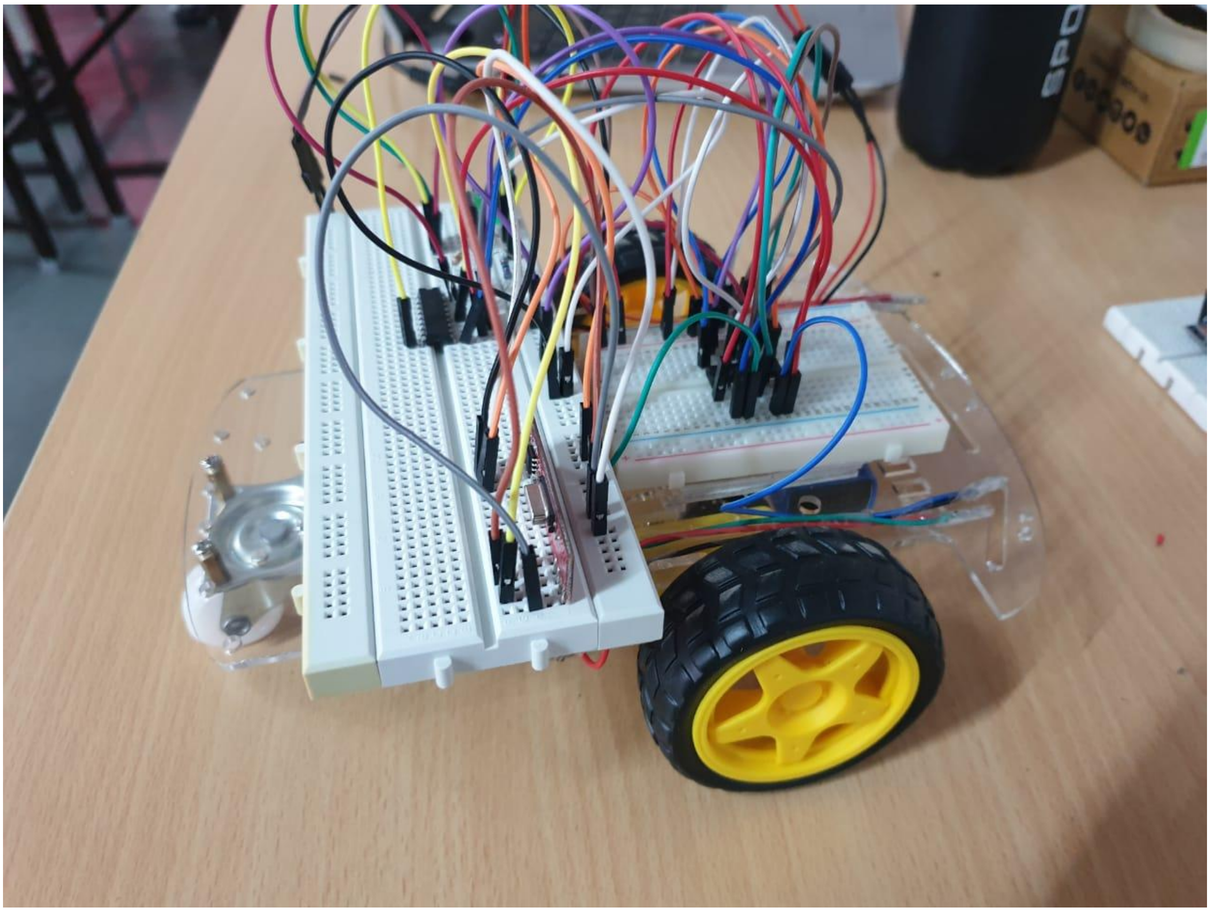


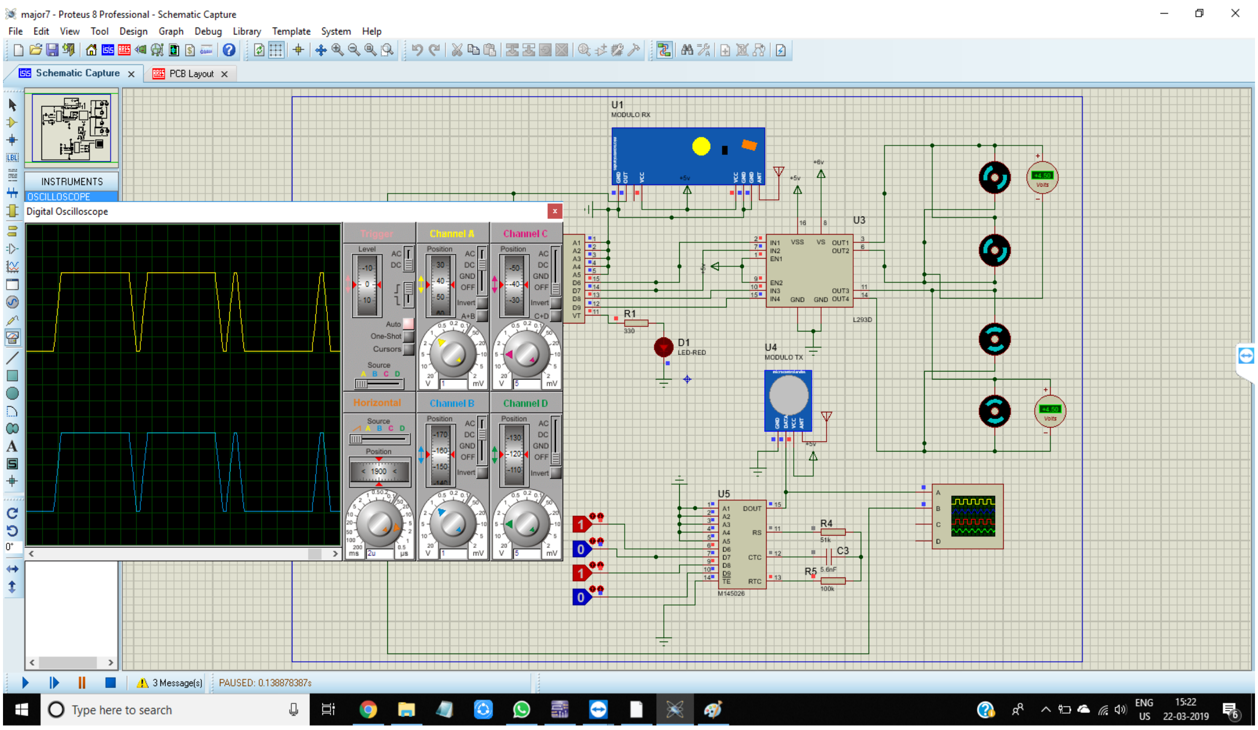
Figure 5.6 Breadboard implementation of Receiver Section

The Explanation for the Receiver section is as follows:

As explained earlier, four bits will get transmitted towards the receiver side. The RF Receiver receives these four bits through its antenna pin and since we need the bits to be parallel again, we need to have a serial to parallel converter and the most widely used one is HT12D Decoder IC (for 4 bits). The data pin of the receiver is connected to the data-in pin of the decoder. The decoder converts the serial bits into parallel and these bits are given to the L293D motor driver IC to drive the gear motors in a particular direction according to the gesture at the transmitter side and its corresponding bits at the receiver side.

5.4 Oscilloscope Waveforms

The Figure 5.7 shows the data bits from Encoder(Yellow) and Decoder(Blue) respectively



Encoder output Decoder Output

Figure 5.7 Data bits from Encoder and Decoder

The Figure 5.8 shows the ASK modulated waveform from ANT pin of RF 434MHz Transmitter

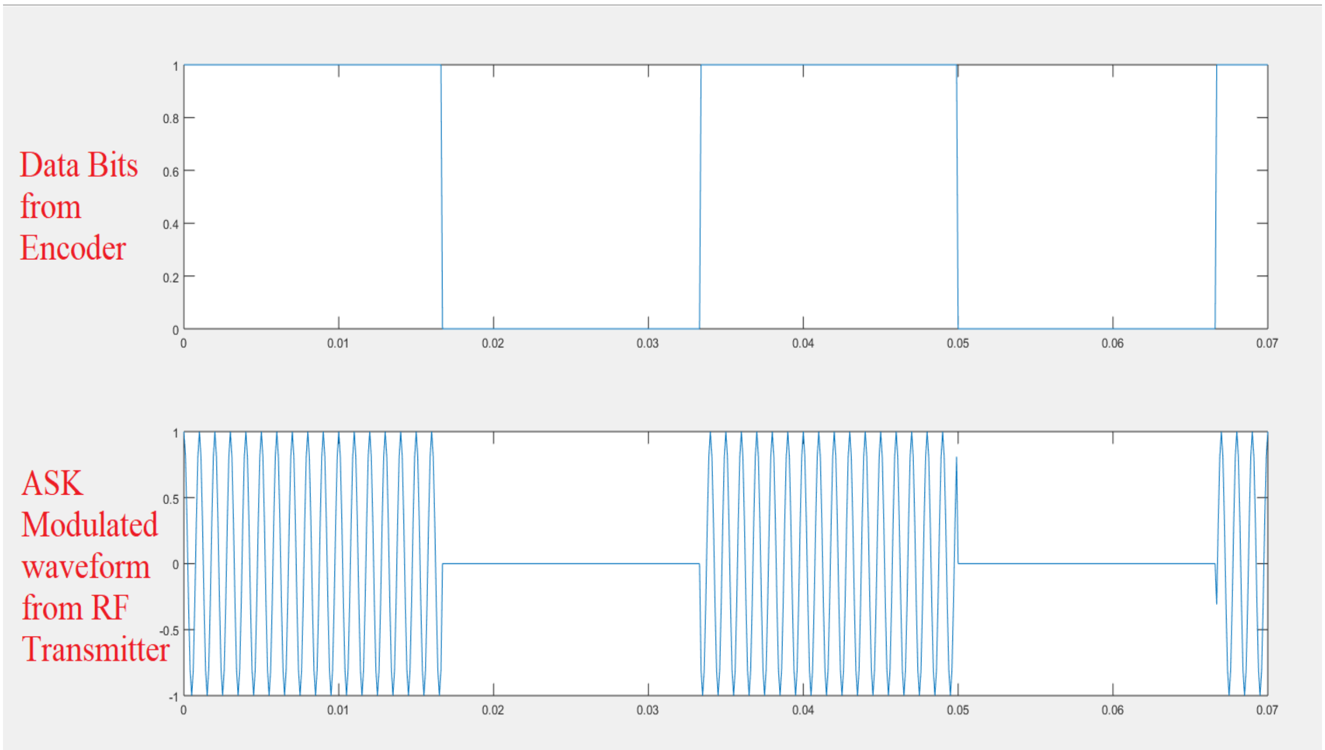


Figure 5.8 ASK Modulated waveform from RF Transmitter

CHAPTER-6

CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

- Hand Gesture Control is an example of relationship between man and robot in its own way and in the race of man versus robot. Further taking the technology to the upper level from voice sensing robots and wired connections to wireless hand movement controlled technology. There is a rapid growth in application designs considering gesture recognitions into the account.
- The ADXL335 accelerometer sensor selected to be the input component of this project and it captures the human movements. When contrasted with the other input components, accelerometer is simpler to work on and it gives the feasibility to control a robot car by wireless means. The low cost and little set-up time are other pros of the system designed but an important disadvantage to examine is that the reliability of the system. Physical hardship to the user is kept away as far as possible through the use of 3-axis accelerometer as with the motion of the hand, the user gets the capability and liberty to rotate the robot into the desired direction.
- We achieved our objective without any hurdles i.e. the control of a robot using gestures. The robot is showing desired responses whenever we move our hand in the desired direction. For managing the robot remotely, Holteks' encoder-decoder pair (HT12E and HT12D) together with a 434MHz transmitter-receiver pair is used.

- The Comparative analysis of three kinds of gesture recognition technologies is as follows

Vision-Based Gesture Recognition	Finger Gesture Recognition	Accelerometer based Gesture Recognition
It basically used in the field of Service Robotics & the researchers finally designed a Robot performing the required task. They designed a gesture-based interface to control a robot equipped with a manipulator.	The aim is to make it feasible to interact with a portable device or a personal computer through the recognition of finger gestures.	It has become increasingly popular. The low cost & relatively small size are the two major factors that make it an effective tool to detect and recognize human body gestures.

Table 2.7 Comparative Analysis

- The vision based gesture recognition system is implemented and they designed a robot which performs the task of cleaning, through interfacing between robot and manipulator. The Finger gesture recognition makes use of fingers to interact with system. The Accelerometer based hand gesture recognition makes use of accelerometer as a tool to detect and recognise human gestures.
- Finally, we conclude that our project is better than the existing project which is based on MPU6050 Accelerometer. Since, MPU6050 is a 6 axis device; it is mainly used in the applications such as drones. Our project requires a two-dimensional accelerometer, so we used an ADXL335 Accelerometer.

6.2 Limitations

- The batteries on the board take a lot of space and are also quite hefty. We can use either some secondary power supply for the batteries on board or replace the current DC gear Motors with ones which consume less power.
- As we are using RF link for wireless transmission, the range is quite constricted; nearly 50-80m. This problem can be resolved by using a GSM board module for wireless transmission. The GSM basic facilities are located all over the world. GSM will not only give wireless connectivity but also quite a huge range for non interrupted communication.

6.3 Future Scope

- Future work will be constructed upon the developments of the correctly recognized hand gestures. One method might be to introduce a gyroscope into the system, in order to separate the acceleration due to gravity from the inertial acceleration and second method is that we can install a GPS in the project to trace the place and position of the robot car. The use of more accelerometers connected to the arms of robot is feasibility.
- A Camera on board can be installed for supervision of the robot from distant places. All we need is a wireless camera which will telecast the vivid picture and the receiver module which will provide live streaming constantly.

6.4 Applications

- Military application to manage robotic machines.
- Medical application for surgery purposes and more.
- Construction of buildings and to go into a region where humans cannot.
- Industrial application for trolley control, lift control, etc.

CHAPTER-7

REFERENCES

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