Palestine Polytechnic University

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# Accelerometer Based Gesture Controlled Robot

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# Abstract

Robotics industry is rapidly growing every day, and mobile robots gained a special interest in recent years because it can be adopted to solve a wide range of problems in our modern and automated life. Our project "accelerometer based gesture controlled robot", is a mobile robot .Which should deal with request from the user through the transmitter part and make a response to it .

This can be done by controlling the robot using accelerometer sensor .which initiate the signal and send it with RF transmitter ,and then this signal can be received in second part of robot which analyze it and the robot will move in a special direction depend on this signal .

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# Chapter 1: Introduction

## 1.1 Overview

Robots became one of the most widely and important technique that use in various fields in our life like construction, military, medical and manufacturing .We have developed this accelerometer based gesture controlled robot depends on Arduino Uno and accelerometer.

In this project we have used hand motion to drive the robot. For this purpose we have used accelerometer which works on acceleration . The main goal of this project is to control the movement of the robot with hand gesture using accelerometer.

## 1.2 Motivation

The most important thing that led us to do this project is to going into the robots world . In fact controlling is one of the important thing that computer science aim to dealing with.

And in this project we can solve the problem of access something all near . Sometimes people who are in the same area and they cannot deliver a few simple things to each other, this robot can do that.

## 1.3 Objectives

1.The main goal of this project is to control the movement of the robot with hand gesture using accelerometer.

2.This project can be used as a basic for other projects with advanced applications.

3.To deliver small thing between persons at the same area without transferred one on them to the second.

4.To examine our ability of working as a group without facing any problem.

## 1.4 Description of the project

At the first, the receiver part of the robot should be able to take commands from the transmitter part ,and then can make response to this commands.

After that. The robot will move depends on this command .the transmitter part will contain the accelerometer which is the most important part ,the accelerometer will determine the direction depends on its circuit design .

Then, the RF Transmitter will take this direction and send it as a command .the RF Receiver will receive this command and send it to the controller .the controller will analyze the command and do a movement depends on this command .

When we tilt the hand to the right the robot will walk to the right direction ,or to the left it will walk to the left direction and so on for forward and back directions .

### 1.5 List of requirement

We can summarize our project requirement as:

1. We need to use Microcontroller to control the robot .we may use arduino as a microcontroller .
2. Also the main important component is the accelerometer to detect the directions .
3. RF Pair to transmit and receive the command .
4. Also ,we will need the software program for the arduino .

### 1.6 Expected result

We expect to accomplish the following at the end of the project :

1. The mobile robot that can move depends on hand movement by taking commands and make response .
2. The robot who can transfer small thing from point to other at the same region.
3. A startup robot that can be the basic for other projects with additional functions.

### 1.7 Literature Review

There is a little similarity projects to our project in our University . it do nearly the same function but it used different technique.

The project is named "Smartphone Wi-Fi Controlled Toy Car". The project is about controlling a toy car over a Wi-Fi network from a Smartphone . this is basically done using the accelerometer sensor that is built in all Smartphones.

**Difference between our project and this project**

1.They used a Smartphone but we don't .

2.They done the controlling by Android Application through a WebSocket.

3.We will control our project by Arduino microcontroller program.

4.They used built-in Accelerometer by in our project we will interface the sensor directly.

# Chapter 2: Background

## 2.1 Overview

In this chapter describe the hardware and software component of the accelerometer based gesture control robot, and small description of system design.

## 2.2 Hardware component

### 2.2.1 Accelerometer

Here the most important component is accelerometer. Accelerometer is a 3 axis acceleration measurement device with +-3g range. This device is made by using polysilicon surface sensor and signal conditioning circuit to measure acceleration. The output of this device is Analog in nature and proportional to the acceleration. This device measures the static acceleration of gravity when we tilt it. And gives an result in form of motion or vibration.

Pin Description of accelerometer

1. VCC 5 volt supply should connect at this pin.
2. X-OUT This pin gives an Analog output in x direction
3. Y-OUT This pin give an Analog Output in y direction
4. Z-OUT This pin gives an Analog Output in z direction
5. GND Ground
6. ST This pin used for set sensitivity of sensor

### 2.2.2 RF Pair

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).

Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources.

The RF module is often used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder. HT12E-HT12D are some commonly used encoder/decoder pair ICs.

**Pin Description:**

**RF Transmitter**

| **Pin No** | **Function** | **Name** |
|---|---|---|
| 1 | Ground (0V) | Ground |
| 2 | Serial data input pin | Data |
| 3 | Supply voltage; 5V | Vcc |
| 4 | Antenna output pin | ANT |

Table 2.1: Pin Description for RF Transmitter.

**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 2.2: Pin Description for RF Receiver.

### 2.2.3 Arduino UNO

The Arduino Uno is a microcontroller board based on the ATmega328 .It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.

Revision 3 of the board has the following new features:

- 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible with both the board that uses the AVR, which operates with 5V and with the Arduino Due that operates with 3.3V. The second one is a not connected pin, that is reserved for future purposes.
- Stronger RESET circuit.
- ATmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.[1]

### 2.2.4 Motor driver

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC.

It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence H-bridge IC are ideal for driving a DC motor.

In a single L293D chip there are two h-Bridge circuit inside the IC which can rotate two dc motor independently. Due its size it is very much used in robotic application for controlling DC motors. Given below is the pin diagram of a L293D motor controller.

There are two Enable pins on l293d. Pin 1 and pin 9, for being able to drive the motor, the pin 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for right H-Bridge you need to make the pin 9 to high. If anyone of the either pin1 or pin9 goes low then the motor in the corresponding section will suspend working. It's like a switch.[2]

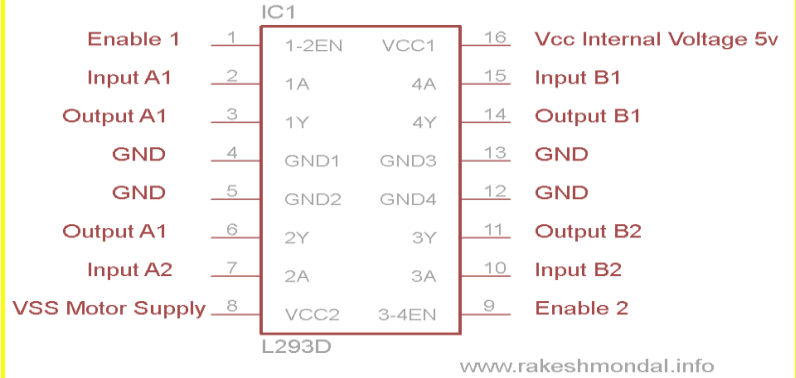



Figure2.1:pin description for motor driver

### 2.2.5 DC Motors

A motor is an electrical machine which converts electrical energy into mechanical energy. The principle of working of a DC motor is that "whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force". The direction of this force is given by Fleming's left hand rule and it's magnitude is given by F = BIL. Where, B = magnetic flux density, I = current and L = length of the conductor within the magnetic field.[3]

### 2.2.6 Robot Chassis

A four-wheel vehicle. we will place the receiver part component on it. such as microcontroller(Arduino Uno) and RF receiver and others.

Figure 2.2:robot chassis.[4]

### 2.2.7 Power supply

Which it 9 volt Battery for both transmitter and receiver parts of the robot .

### 2.2.8 Encoder and Decoder

**HT12E** is an encoder integrated circuit of 212 series of encoders. They are paired with 212 series of decoders for use in remote control system applications. It is mainly used in interfacing RF and infrared circuits. The chosen pair of encoder/decoder should have same number of addresses and data format.

Simply put, HT12E converts the parallel inputs into serial output. It encodes the 12 bit parallel data into serial for transmission through an RF transmitter. These 12 bits are divided into 8 address bits and 4 data bits.

HT12E has a transmission enable pin which is active low. When a trigger signal is received on TE pin, the programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium. HT12E begins a 4-word transmission cycle upon receipt of a transmission enable. This cycle is repeated as long as TE is kept low. As soon as TE returns to high, the encoder output completes its final cycle and then stops.

**HT12D** is a decoder integrated circuit that belongs to 212 series of decoders. This series of decoders are mainly used for remote control system applications, like burglar alarm, car door controller, security system etc. It is mainly provided to interface RF and infrared circuits. They are paired with 212 series of encoders. The chosen pair of encoder/decoder should have same number of addresses and data format.

In simple terms, HT12D converts the serial input into parallel outputs. It decodes the serial addresses and data received by, say, an RF receiver, into parallel data and sends them to output data pins. The serial input data is compared with the local addresses three times continuously. The input data code is decoded when no

error or unmatched codes are found. A valid transmission in indicated by a high signal at VT pin.

HT12D is capable of decoding 12 bits, of which 8 are address bits and 4 are data bits. The data on 4 bit latch type output pins remain unchanged until new is received.[5]

## 2.3 Software component

Arduino Software ( IDE) :

contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuine hardware to upload programs and communicate with them.

The program that be written using IDE is called sketch.[6]

## 2.4 Design constraints

- The maximum distance between the transmitter part and receiver part should be within the RF range.
- Robot path planning needs to be clear from constraints.

# Chapter 3: System Design

## 3.1 Overview

This chapter discusses the design option of hardware and software, and conceptual design of the system such as block diagram of the hardware component of the system.

## 3.2 Brief description of the system

Our Robot will be designed to be able to move in different places and so far. That's mean we can send it from point to other depend on our hand motion.

To do so, the Accelerometer based gesture controlled robot moves according to the movement of hand as we place the accelerometer on users hand.

When we tilt hand with an accelerometer in front of the robot, then the robot starts moving forward until the next movement is given. When we tilt hand in backward direction, then the robot changes its direction and state. Then it starts moving in backward direction until the next signal is given. When we tilt hand on left side, then the robot moves into left side until the next signal is given .In the same way, when we tilt hand in right side, then the robot moves right side.

The accelerometer will out analog signal which should be converted to digital value, then it will be encoded by the encoder and then sent to RF Transmitter as a signal.

The RF Receiver will receive this signal and send it to the decoder then to the microcontroller which will send it to the motor driver.

### 3.3 Design options

#### 3.3.1 Hardware design

As we mention, system consist of the Accelerometer, RF Receiver, RF Transmitter module and microcontroller.

**Accelerometer**:

Advantages:

1- Simple to install
2- Good response at high frequencies
3- Stand high temperature
4- Small size
5- Low cost

Disadvantages:

1- Sensitive to high frequency noise
2- Require external power

**Controller**

We have using Arduino Uno.

Advantages:

1- Can be easily brought in Palestine
2- Ready to use
3- Ease of use
4- The Arduino Uno has built in pin outs for providing you with 5v, 3.3V, ground, analog input, digital output, SPI, I2C which comes in handy
5- Free IDE available for Arduino
   Same as software side, as it is open source

### 3.3.2 Communication between Arduino and Accelerometer.

**We have two choices to use RF pairs and Bluetooth.**

Bluetooth:

Advantages:

1- Bluetooth are the robustness, low cost.

2- Its simplicity of use.

3-It is better on security than RF pairs.

4- The processing power and battery power that Bluetooth requires in order to operate is very low

Disadvantages:

1-Short range, Bluetooth can only cover short distance range of approximately 30 to 60 feet. But this range is not the same for all connections. It depends on the nature of the devices and the version that they operate upon

2-Slow data speed.

RF pairs:

Advantages:

1- It is a solution for Bluetooth ,and long range.
2- It has different penetration through the walls of the buildings or houses based on the frequency. Hence used for radio and television transmission and for cellular mobile phone service.
3- Does not require linear amplifiers in the transmitter.

Disadvantages:

1- Requires more complicated demodulator.

**Selected Technique:**

We choose the RF Pairs because of its advantage and it is more suitable.

### 3.3.2 Software design

We will use the Arduino software (IDE) to write the code .

## 3.4 Detailed design

### 3.4.1 System diagram

Figures 3.1 shows the block diagram of the transmitter section, and 3.2 show block diagram of receiver section.

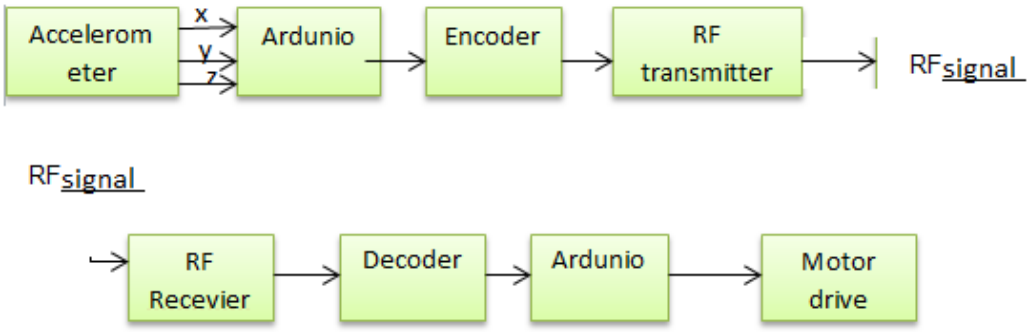



Figure 3.1:System diagram

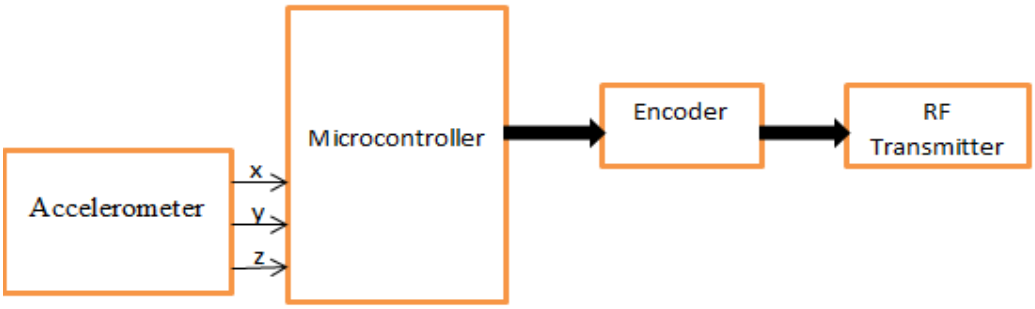



Figure 3.2:Block diagram of Transmitter part.

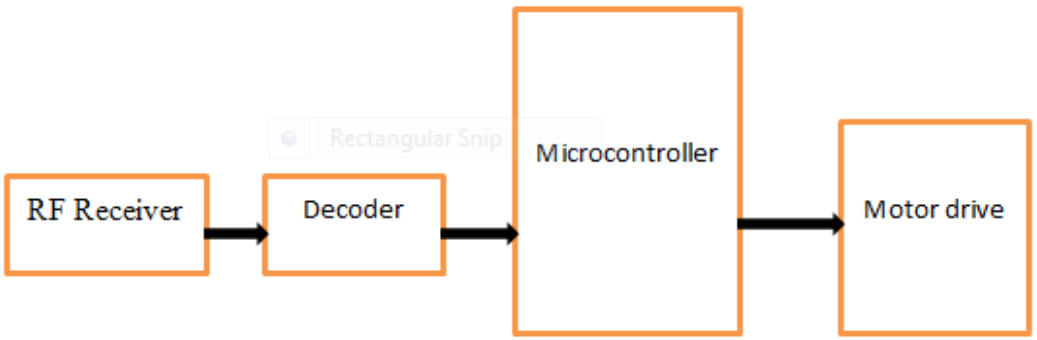



Figure 3.3:Block diagram of Receiver part.

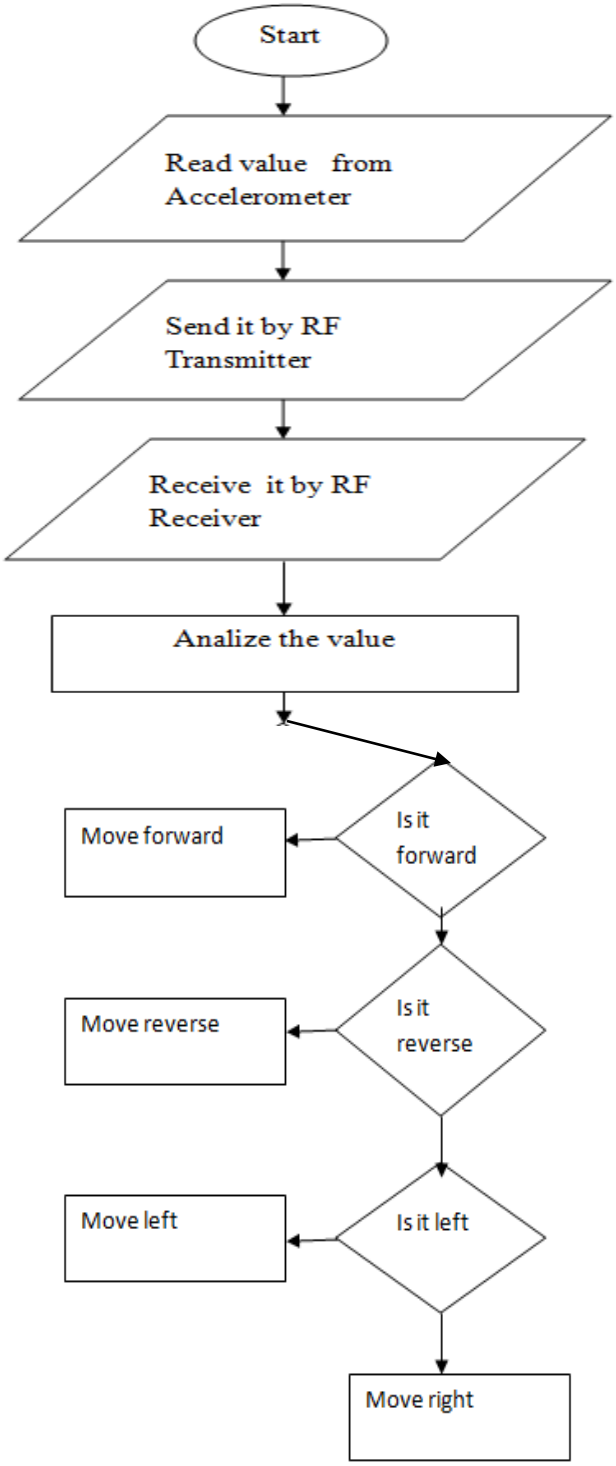



Figure 3.4:System flowchart

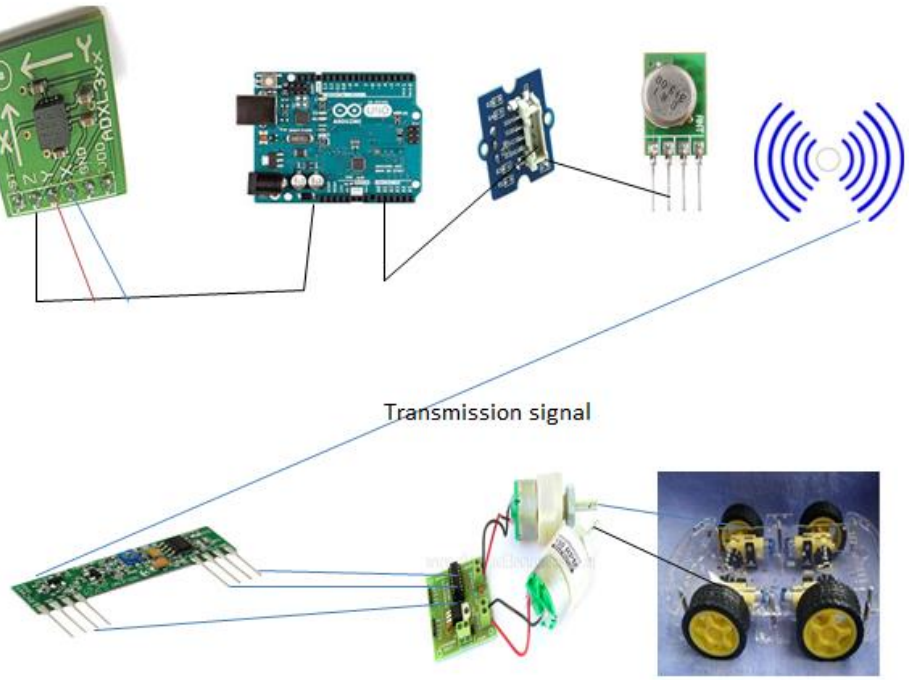
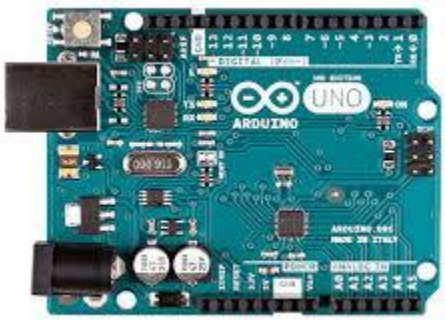



figure3.5:Schematic diagram

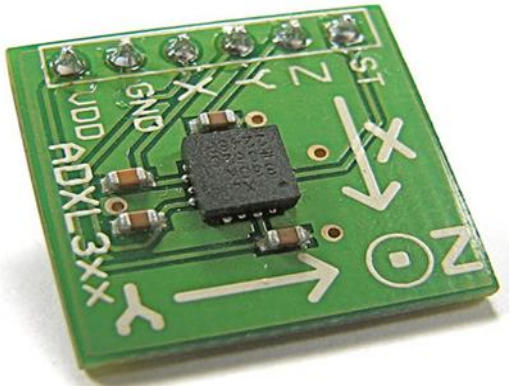
# Conclusion

At this stage. We finished the theoretical part of the project in terms of the general idea, design and initial study tools and how they work. The next phase in the next semester will be the practical applying of the project and test it to achieve the desired idea of the project .

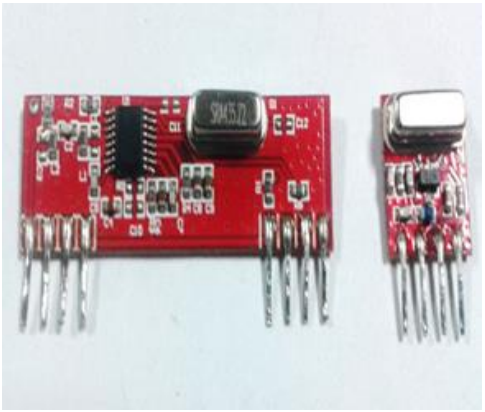
# Appendix




(a) Arduino UNO




(b) Accelerometer



(c) RF Transmitter

(d) RF Receiver


(e) Motor Driver

(f) robot chassis

(g) connection USB wire

# References

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[6] **Arduino Software (IDE)** ,https://www.arduino.cc/en/Guide/Environment

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