TUBLESS TYRE PRESSURE MONITORING USING ARDUINO

A PROJECT REPORT

Submitted By

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BONAFIDE CERTIFICATE

Certificated that this project report "**TUBELESS TYRE PRESSURE MONITORING USING ARDUINO" is** bonafide work done by the following students under my supervision.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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ABSTRACT

The project proposes a method to implement tyre pressure monitoring and accident avoiding system in vehicles. At exceptional state to ensure the safety of driving, which is life safeguard pre-warning system for passengers and drivers. The unit includes Barometric sensor, an Arduino Uno, Arduino Nano, RF module, LCD and Buzzer. TMPS unit displays real-time tire pressure of the tyres. Warning is generated whenever tyre pressure crosses the minimum threshold level.

ACKNOWLEDGEMENT

We feel glad to take this opportunity to cordinally Acknowledge a number of people who provide us a great support during our project.

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Finally, we thank our parents, staff and friends who helped us to completing this project successfully.

CHAPTER I

1. INTRODUCTION

The tyre pressure monitoring system (TPMS) implemented in the vehicles to monitor the variations in tyre pressure. The safety of the driving improves as TPMS automatically detects the tyre pressure in real-time and give warning to the drivers to take measure that prevents bursting of the tyre thereby avoiding the possibility of an accident. Tyre bursting is an important concern for the drivers since it is very difficult to prevent. The tyre burst is mainly caused by abnormal tyre pressure.

According to the **DECCAN HERALD,**
Issued on: **Sep 26 2015, 02:13am IST**
Topic: **Accidents due to tyre bursts serious issue: Govt**

"Incidents of vehicles having advanced features meeting with accidents due to tyre bursts on good condition road, is worrisome. In 2014, 1.39 lakh people were killed in road accidents against 1.37 lakh in 2013"

1.1 OBJECTIVES

The main objectives of our project are
To monitor the air pressure of the tubeless tyre and indicating pressure status to the rider.

To implement a low cost and efficient TPMS to any sort of vehicles

Eliminating road accidents due to tyre burst.

1.2 LITERATURE REVIEW

As we take literature survey of TPMS system, then we find number of systems and technology which are implemented using Indirect TPMS or by using wired communication. In some cases, the system has established a communication through Bluetooth. An such systems and technology are not much more affordable and comfortable to use and to perform practically. In now a days people need system which is less affordable in size as well as in the cost.

1.3 EXISTING METHOD

TPMS was used to measure the tyre pressure using Arduino Uno and a Barometric sensor. Results of pressure sensor will be displayed onto an LCD. This system will alert the driver by giving a warning sign or with a buzz sound. The connection between the sensor and Arduino Uno is wired.

1.3.1 DISADVANTAGES

- Wired communication.
- Less precise due to wired communication.
- Implementation of TPMS is a tedious process.
- Can be damaged very easily.

1.4 PROPOSED METHOD

- User can monitor the tyre pressure wirelessly (RF).
- The system has a Wireless communication enabled.
- Results of pressure sensor will be displayed onto an LCD.
- This system will alert the driver by giving a warning sign or a buzz sound.

1.4.1 ADVANTAGES

- Wireless communication.
- Precision is high.
- No necessity for pressure check (TYRE).
- Low cost.
- Improved mileage.
- Increases the confident of rider

CHAPTER 2

2.PROPOSED SYSTEM

2.1 BLOCK DIAGRAM

2.1.1 TRANSMITTER

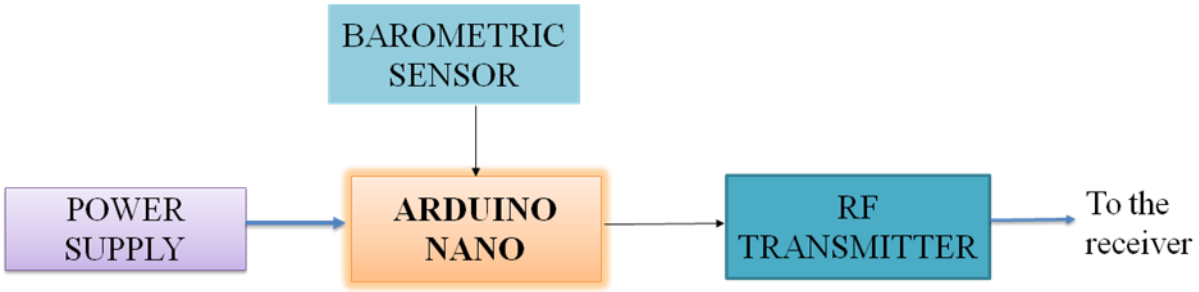


Fig: 2.1.1 Block diagram of Transmitter part

2.1.2 RECEIVER

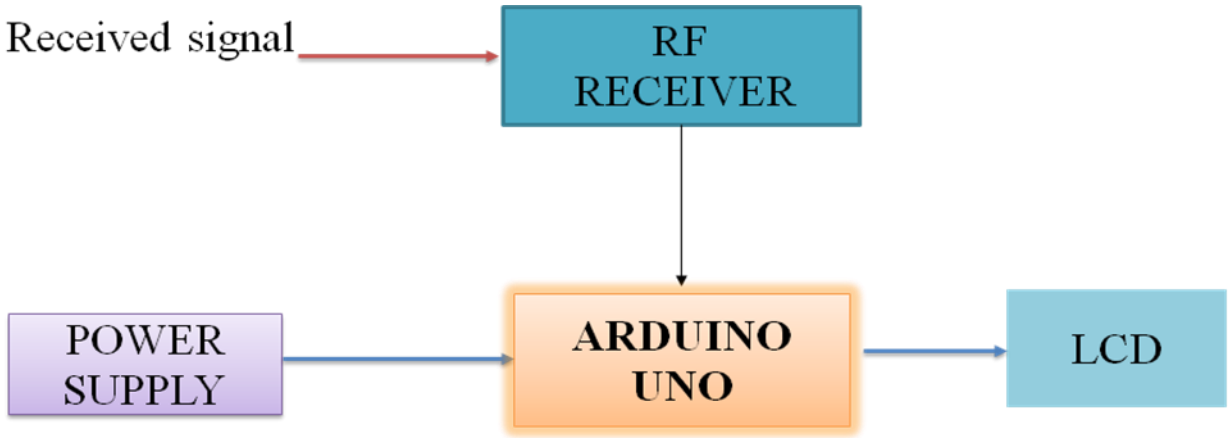
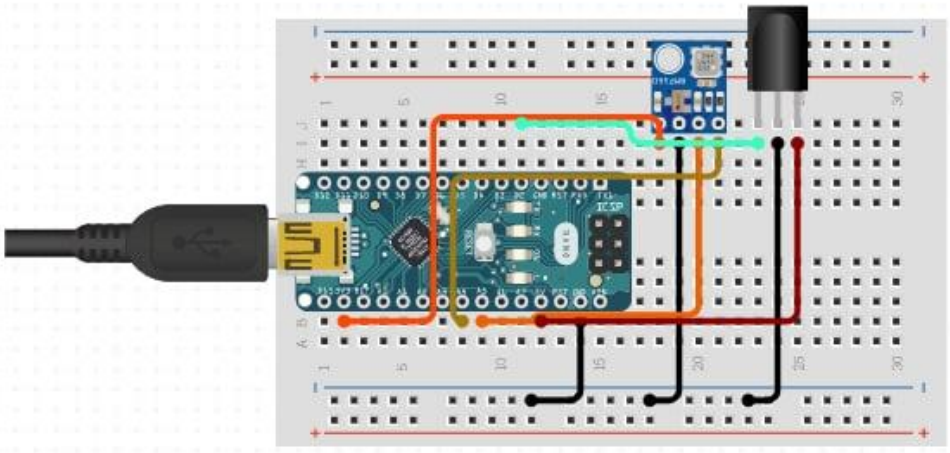


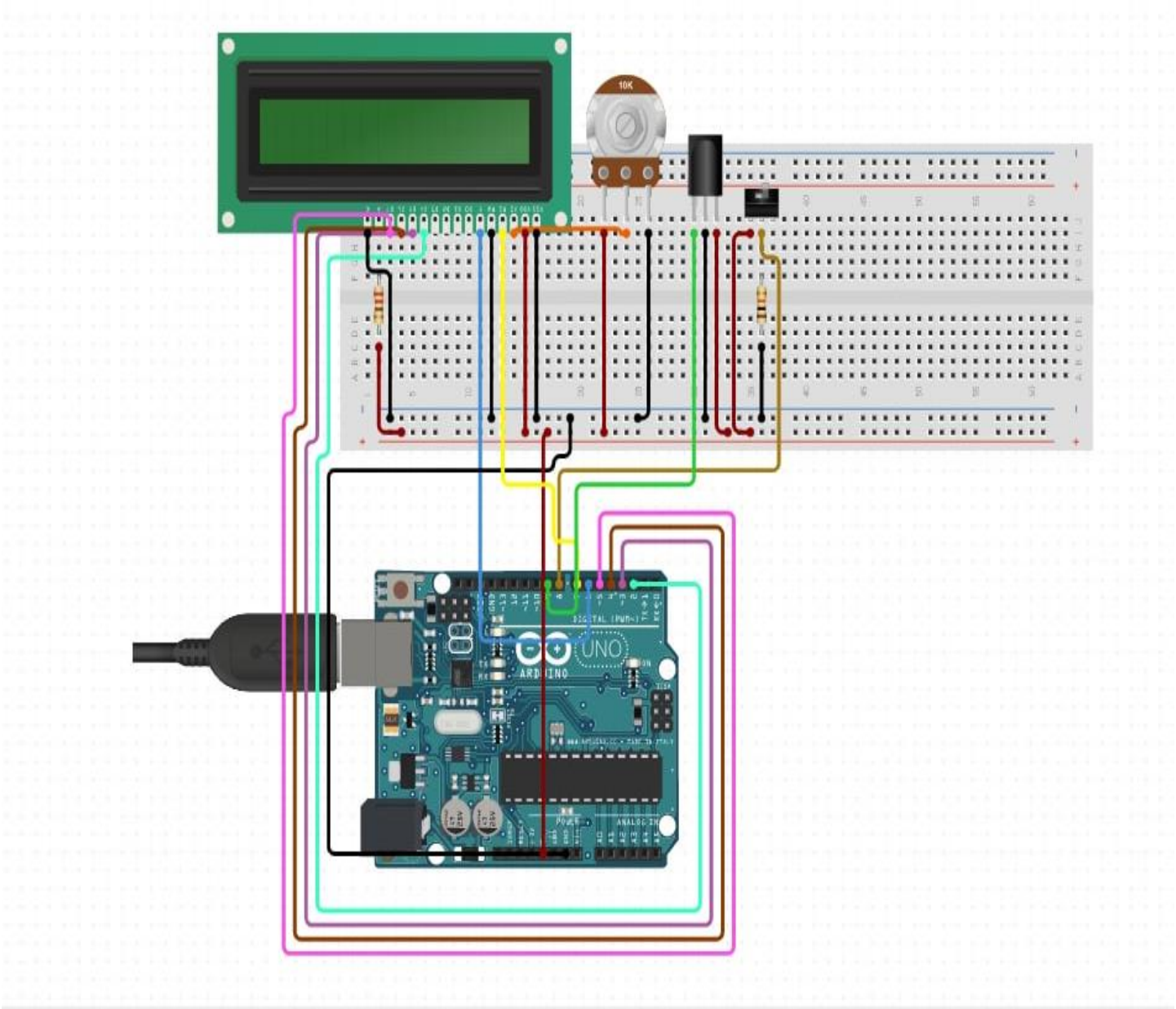
Fig:2.1.2 Block diagram of Receiver part

2.2 CIRCUIT DIAGRAM

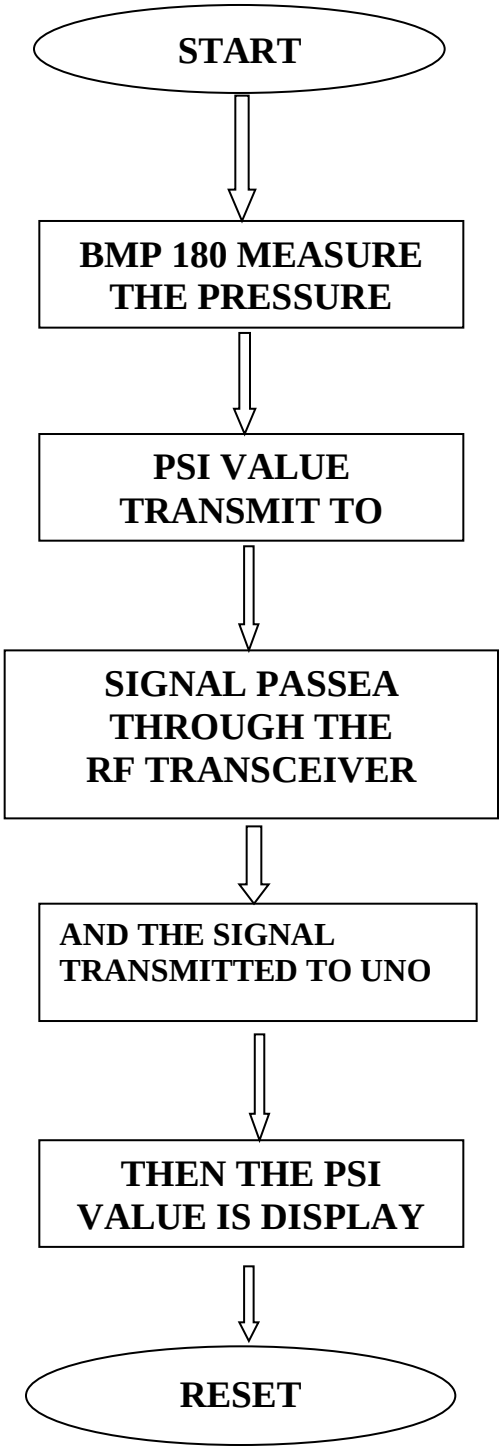
2.2.1 TRANSMITTER



2.2.2 RECEIVER



2.3 FLOW CHART



CHAPTER 3

HARDWRE & SOFTWARE DETAILS

3.1 Arduino Controller

3.1.1 Introduction

Arduino is an opensource platform based around programmable development boards that can be integrated into a rang of simple and complex project. The Arduino family consists of different types of development boards, with the most common being the Arduino UNO.

An Arduino contains a microcontroller which can be programmed to sense and control device in the physical world. The microcontroller is able to interact with a large variety of components such as LEDs, motors and displays. Because of its flexibility and sustainability, Arduino has become a popular prototyping development board which is widely used across the world.

Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low-cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step-by step instructions of a kit, or sharing ideas online with other members of the Arduino community.

3.1.2 Types of Arduino Boards

There are many types of Arduinos available in the market but all the board have one thing in common: they can be programmed using the Arduino IDE. The reasons for different types of boards are different power supply requirements, connectivity options, their applications etc.

Arduino boards are available in different sizes, from factors, different no. of I/O pins etc. Some of the commonly known and frequently used Arduino boards are Arduino, Arduino-mega, Arduino Nano, Arduino Micro and Arduino Lilypad.

There are add-on modules called Arduino shield which can be used to extend the functionalities of the Arduino boards. Some of the commonly used shields are Arduino proto shield, Arduino Wi-Fi shield and Arduino Yun Shield

3.1.3 Arduino UNO

The UNO is the best board to get started with electronics and coding. If this is your first experience tinkering with the platform, the UNO is the most robust board you can start playing with. The UNO is the most used and documented board of the whole Arduino family.

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, 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 an AC-to-DC adapter or battery to get started. You can tinker

with your UNO without worrying too much about doing something wrong, worst-case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Arduino NANO

The Arduino NANO is a small, complete, and breadboard-friendly board based on the ATmega328P (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source. The ATmega328 has 32 KB, (also with 2 KB used for the bootloader. The ATmega328 has 2 KB of SRAM and 1 KB of EEPROM. Each of the 14 digital pins on the Nano can be used as an input or output, using pin Mode (), digital Write (), and digital Read () functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt () function for details.

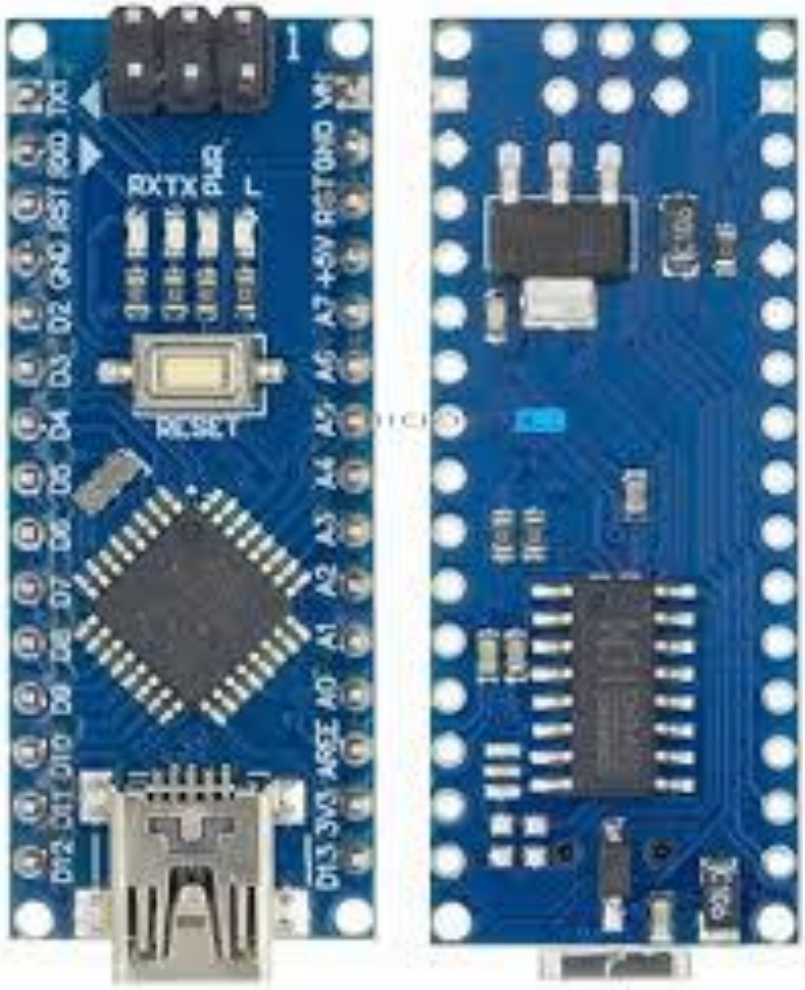
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog Write () function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.
- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Nano has 8 analog inputs, each of which provide 10 bits of resolution (i.e., 1024 different values). By default, they measure from ground to 5 volts, though is it possible to change the upper end of their range using the analog Reference () function. Analog pins 6 and 7 cannot be used as digital pins. Additionally, some pins have specialized functionality:

- I2C: A4 (SDA) and A5 (SCL). Support I2C (TWI) communication using the Wire library (documentation on the Wiring website).

There are a couple of other pins on the board:

- AREF. Reference voltage for the analog inputs. Used with analog Reference ().
- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

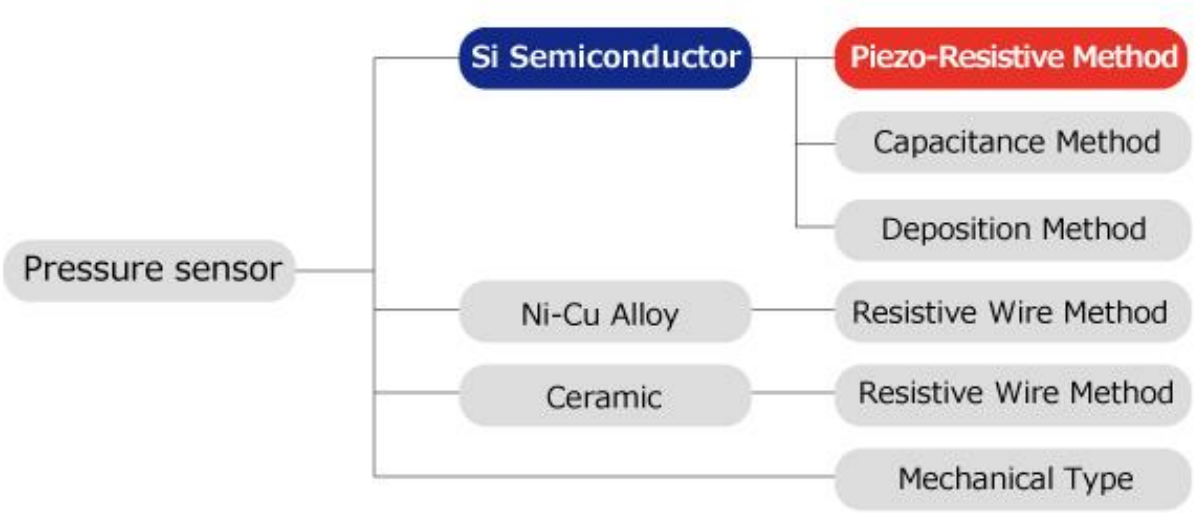


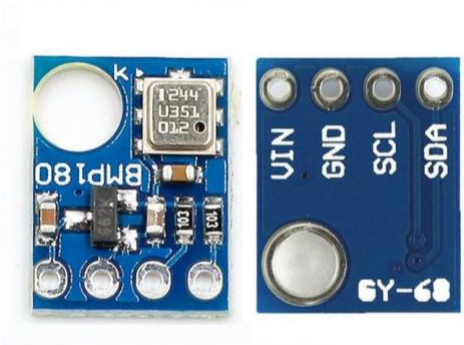
Microcontroller	ATmega328

Architecture	AVR
Operating Voltage	5 V
Flash Memory	32 KB of which 2 KB used by bootloader
SRAM	2 KB
Clock Speed	16 MHz
Analog IN Pins	8
EEPROM	1 KB
DC Current per I/O Pins	40 mA (I/O Pins)
Input Voltage	7-12 V
Digital I/O Pins	22 (6 of which are PWM)
PWM Output	6
Power Consumption	19 mA
PCB Size	18 x 45 mm
Weight	7 g

BAROMETRIC SENSOR:

A barometric pressure sensor is a sensor that detects atmospheric pressure. Various types of pressure sensors exist utilizing different materials and methods as shown below based on the pressure values to be measured. Among these, sensors that detect atmospheric pressure are called barometric pressure sensors.





VCC	+3.3v
GND	Ground (-)
SDA	Serial Data
SCL	Serial Clock

3.2.2 Working

In older sensors, barometers used liquids to measure atmospheric pressure. One of the oldest types of barometers used mercury, which would raise or lower within a column in response to pressure changes. As technology advanced, the aneroid barometer was invented. This type of barometric pressure sensor utilizes an aneroid cell that expands or contracts when the atmospheric pressure changes. This movement causes the levers to amplify, which results in display pointers indicating the pressure reading on the front display.

Many of today's modern barometers utilize microelectromechanical system (MEMS) technology, making them capable of measuring pressure in a more compact and flexible structure. This allows them to be used in smaller applications such as mobile devices and watches. A MEMS barometric pressure sensor detects atmospheric pressure based on how it affects its diaphragm. The more the diaphragm deforms, the higher the pressure.

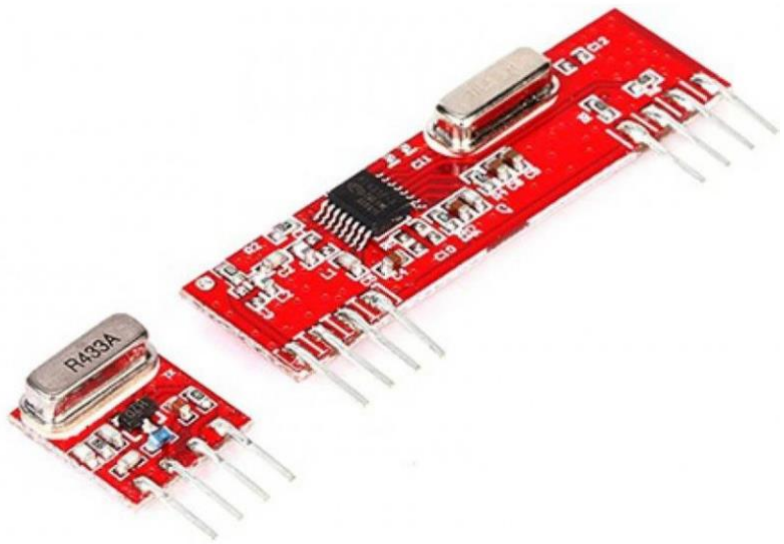
3.2.3 FEATURES:

1. Pressure range: 300 to 1100hPa (hpa – Hecto Pascal)
2. 3.4Mhz I2C interface
3. Pressure conversion time: 5msec
4. Operating voltage of BMP180: 1.3V – 3.6V
5. Peak current: 1000uA
6. Consumes 0.3uA standby
7. Operating temperature: -40ºC to +80ºC

3.3 RF TRANSMITTER AND RECEIVER:

3.3.1 Introduction

An **RF module** (**radio** frequency **module**) is a (usually) small electronic device used to transmit and/or receive **radio** signals between two devices. In an embedded system it is often desirable to communicate with another device wirelessly.



3.3.2Working

TRANSMITTER

This little module is a transmitter. The heart of the module is the **SAW resonator** (SAW – Surface Acoustic Wave) which is tuned for 433.xx MHz operation. There is a switching transistor and a few passive components, that's it.

When a logic HIGH is applied to the DATA input, the oscillator runs producing a constant RF output carrier wave at 433.xx MHz and when the

DATA input is taken to logic LOW, the oscillator stops. This technique is known as **Amplitude Shift Keying.**

RECEIVER:

The Receiver consists of a RF tuned circuit and a couple of OP Amps to amplify the received carrier wave from the transmitter. The amplified signal is further fed to a PLL (Phase Lock Loop) which enables the decoder to "lock" onto a stream of digital bits which gives better decoded output and noise immunity.

3.3.3 Specifications

- Frequency Range: 433.92 MHz
- Modulation: ASK (Amplitude Shift Keying)
- Input Voltage: 5V
- Price: $1 to $2

3.4 LCD Display 16×2

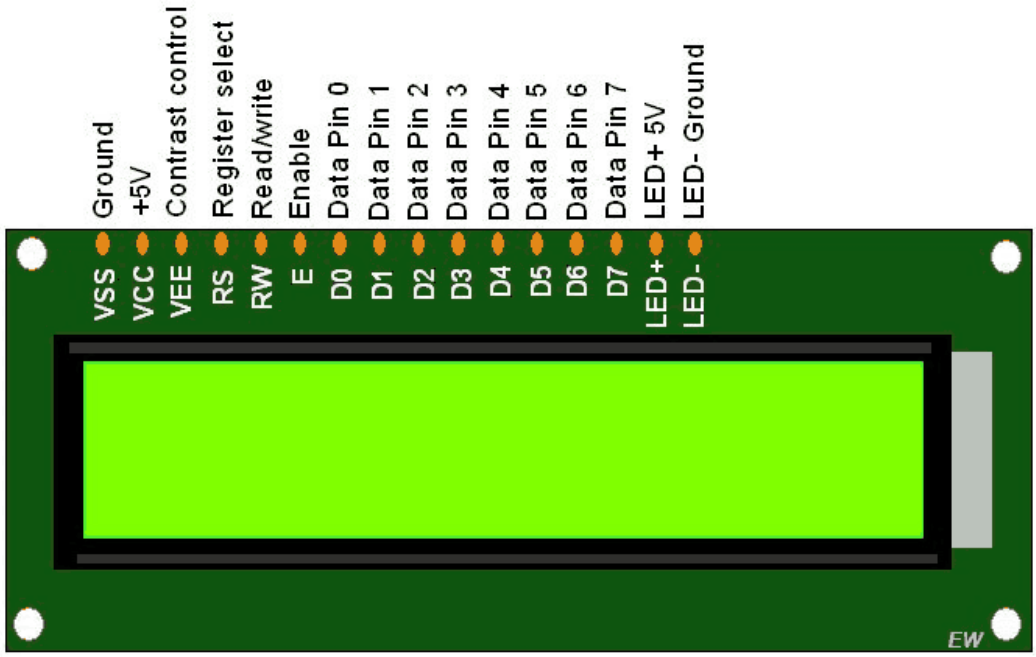
3.4.1 Introduction

LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. Most of us would have come across these displays in our day-to-day life, either at PCO's or calculators. The appearance and the pinouts have already been visualized above now let us get a bit technical.

16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots. A Single character with all its Pixels is shown in the below picture.

3.4.2 Working

Now, we know that each character has (5×8=40) 40 Pixels and for 32 Characters we will have (32×40) 1280 Pixels. Further, the LCD should also be instructed about the Position of the Pixels. Hence it will be a hectic task to handle everything with the help of MCU, hence an **Interface IC like HD44780**is used, which is mounted on the backside of the LCD Module itself. The function of this IC is to get the **Commands and Data** from the MCU and process them to display meaningful information onto our LCD Screen. You can learn how to interface an LCD using the above-mentioned links. If you are an advanced programmer and would like to create your own library for interfacing your Microcontroller with this LCD module then you have to understand the HD44780 IC is working and commands which can be found its datasheet.



3.4.3 Features of 16×2 LCD module

- Operating Voltage is 4.7V to 5.3V
- Current consumption is 1mA without backlight
- Alphanumeric LCD display module, meaning can display alphabets and numbers
- Consists of two rows and each row can print 16 characters.
- Each character is built by a 5×8-pixel box
- Can work on both 8-bit and 4-bit mode
- It can also display any custom generated characters

Available in Green and Blue Backlight

Pin No	Pin Name	Pin Description
Pin 1	GND	This pin is a ground pin and the LCD is connected to the Ground
Pin 2	VCC	The VCC pin is used to supply the power to the LCD
Pin 3	VEE	This pin is used for adjusting the contrast of the LCD by connecting the variable resistor in between the VCC & Ground.
Pin 4	RS	The RS is known as register select and it selects the Command/Data register. To select the command, register the RS should be equal to zero. To select the Data, register the RS should be equal to one.
Pin 5	R/W	This pin is used to select the operations of Read/Write. To perform the write operations the R/W should be equal to zero. To perform the read operations the R/W should be equal to one.
Pin 6	EN	This is a enable signal pin if the positive pulses are passing through a pin, then the pin function as a read/write pin.
Pin 7	DB0 to DB7	The pin 7 contains total 8 pins which are used as a Data pin of LCD.
Pin 15	LED +	This pin is connected to VCC and it is used for the pin 16 to set up the glow of backlight of LCD.
Pin 16	LED –	This pin is connected to Ground and it is used for the pin 15 to set up the glow of backlight of the LCD.

3.5.1 Buzzer

An audio signaling device like a beeper or buzzer may be electromechanical or Piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

3.5.1 Working

The working principle of a buzzer depends on the theory that, once the voltage is given across a piezoelectric material, then a pressure difference is produced. A piezo type includes piezo crystals among two conductors.

Once a potential disparity is given across these crystals, then they thrust conductor & drag the additional conductor through their internal property. So, this continuous action will produce a sharp sound signal.

`

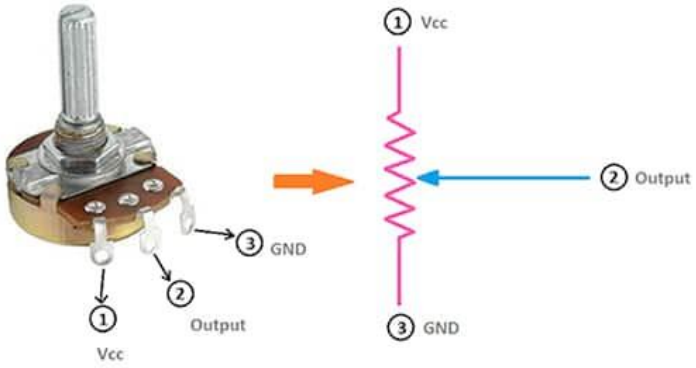
3.6 potential Metter:

The potentiometer is basically a long piece of uniform wire across which a standard cell is connected. In the actual design, the long wire is cut into several pieces and it is placed side by side and connected at the ends with a thick metal strip. The current flowing through the wire can be varied using a variable resistance (rheostat) connected to the circuit. The resistance can be changed manually for measuring the potential difference. The potential difference between any two points in a circuit is the amount of work done in bringing the charge from the first point to the second point. When there is a potential difference there will be a current flow in the circuit.

The potentiometer is an instrument used for measuring the unknown voltage by comparing it with the known voltage. It can be used to determine the emf and internal resistance of the given cell and also used to compare the emf of different cells. The comparative method is used by the potentiometer. The reading is more accurate in a potentiometer.

3.6.1 Working

The basic principle of the potentiometer is that the potential drop across any section of the wire will be directly proportional to the length of the wire, provided the wire is of the uniform cross-sectional area and a uniform current flow through the wire.



3.5 Software

3.5.1 Arduino IDE

The Arduino Integrated Development Environment - or 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 hardware to upload programs and communicate with them. Arduino IDE is a lightweight, cross-platform application that introduces programming to novices. It has both an online editor and an on-premise application, for users to have the option whether they want to save their sketches on the cloud or locally on their own computers.

While Arduino IDE is highly-rated by users according to ease of use, it is also capable of performing complex processes without taxing computing resources.

With Arduino IDE, users can easily access contributed libraries and receive up-to-date support for the latest Arduino boards, so they can create sketches that are backed by the newest version of the IDE.

3.5.2 Features

The Arduino Integrated Development Environment - or 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 hardware to upload programs and communicate with them.

CHAPTER 4

4. Experimental Result

4.1 Coding

Transmitter

```
#include <RH_ASK.h> //radio head library (it provides complete object-oriented library for sending and receiving signals
#include <SPI.h> //serial peripheral interface (synchronous serial data protocol which used to communicate one or more devices over short distance)
#include <Wire.h> // i2c protocol (2wire interface)
#include <SFE_BMP180.h> //

SFE_BMP180 bmp180;

int Altitude = 533; //reference number to BMP 180 about the sea level altitude


RH_ASK rf_driver; // Create Amplitude Shift Keying Object
String output;

void setup ()
{
  Serial.begin(9600); //serial monitor to check the arduino
  bool success = bmp180.begin(); // to check the sensor is working or not

  rf_driver. init(); // Initialize ASK Object
  if (success)
  {
    Serial.println("BMP180 init success");
  }

}
void loop()  //read the sensor input make some conversions then encode the data and transmit
```

```
{
  char status;
  double T, P;
  bool success = false;

  status = bmp180.startTemperature();

  if (status != 0) {
    delay(1000);
    status = bmp180.getTemperature(T);

    if (status != 0) {
      status = bmp180.startPressure(3);

      if (status != 0) {
        delay(status);
        status = bmp180.getPressure(P, T);

        if (status != 0) {
          float comp = bmp180.sealevel(P, Altitude);
          float a = (comp* 0.0145037738);

          output = String(a);
          static char *msg = output.c_str();

          rf_driver.send((uint8_t *)msg, strlen(msg));
          rf_driver.waitPacketSent();

          Serial.print("Pressure: ");
          Serial.print(a);
          Serial.println(" psi");
        }
      }
    }
  }
```

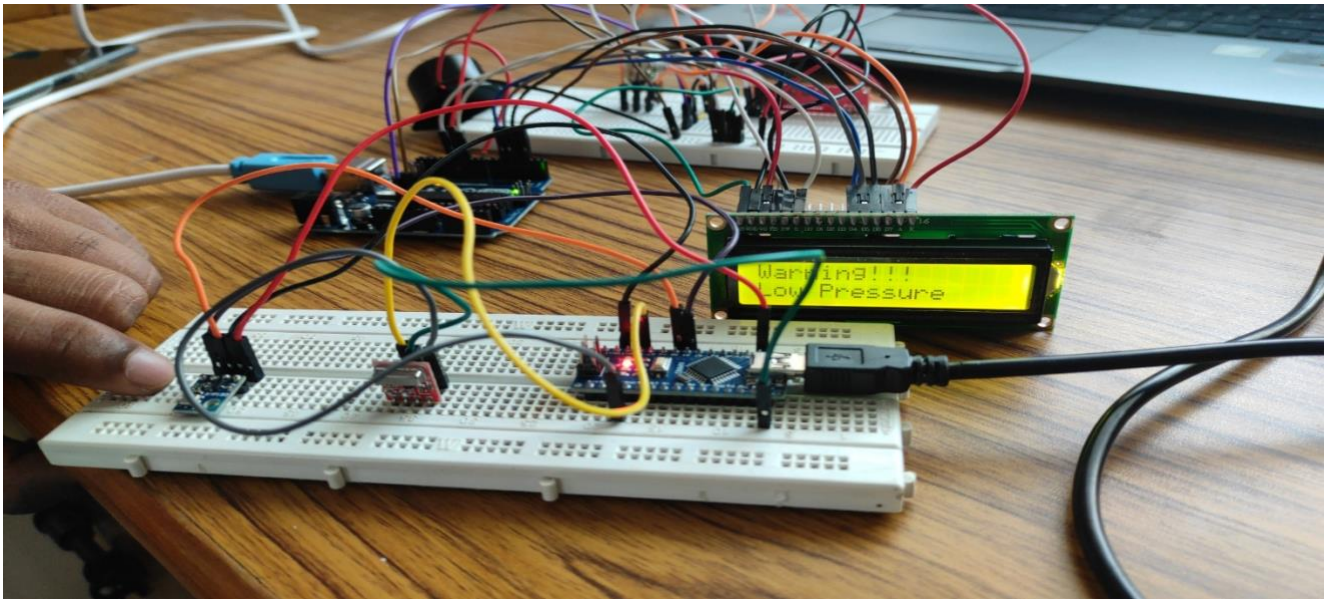
Receiver

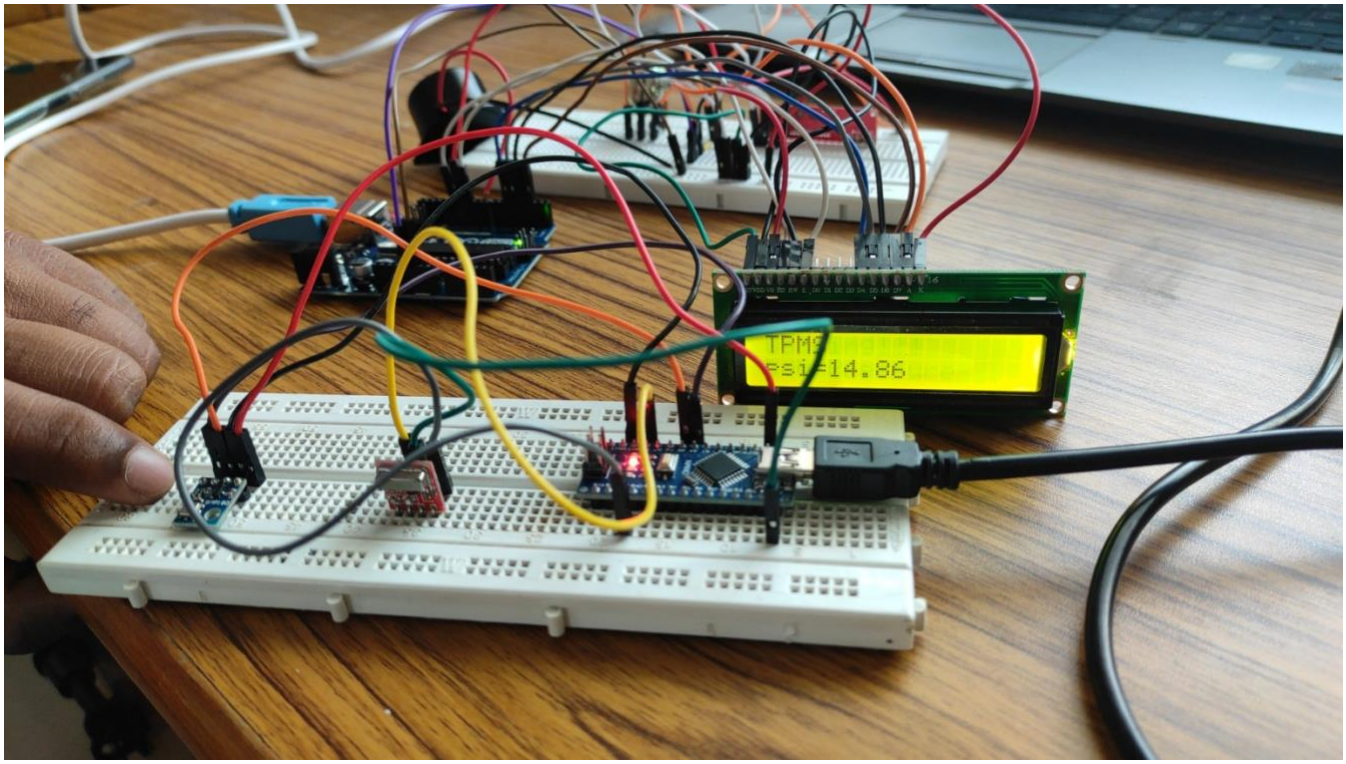
```
#include <RH_ASK.h> // Include dependant SPI Library
#include <SPI.h>

#include <LiquidCrystal.h> // initialize the library by associating any needed
LCD interface pin



const int rs = 12, en = 10 ,d4 = 5, d5 = 4, d6 = 3, d7 = 2; // with the arduino
pin number it is connected to
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);


String conversion; // Define output strings


String str_out; //String str_temp;


RH_ASK rf_driver; // Create Amplitude Shift Keying Object
String a;

void setup()
{
  pinMode(8, OUTPUT); //Buzzer pin

  lcd.begin(16,2); //Tell Arduino to start your 16 column 2 row LCD

  lcd.setCursor(0,0); //Set LCD cursor to upper left corner, column 0, row 0
  lcd.print("Rx Status OK"); //receiver check

  lcd.setCursor(0,1); //Set LCD cursor to upper left corner, column 0, row 1
  lcd.print("Waiting for tx"); //transmitter check
```

```
  rf_driver.init(); // Initialize ASK Object

  Serial.begin(9600); // Setup Serial Monitor
}

void loop() // get the message from the receiver and decode it then display in
LCD
{

    uint8_t buf[6]; // Set buffer to size of expected message
    uint8_t buflen = sizeof(buf);


    if (rf_driver.recv(buf, &buflen)) // Check if received packet is correct size
    {

      // Message received with valid checksum
      // Get values from string

      // Convert received data into string
      str_out = String((char*)buf);

      // Split string into two values
      for (int i = 0; i < str_out.length(); i++)
      {
      conversion = str_out.substring(i);

      lcd.clear();
      lcd.setCursor(0,0);
      lcd.print("TPMS");

      lcd.setCursor(0,1);
      lcd.print("psi=");
      lcd.print(conversion);
```

```
      a = (conversion);


      if (a<="14.85")
      {
        tone(8, 3000, 500);
        delay(50);
        tone(8, 1000, 500);
        delay(20);
        tone(8, 2000, 500);
        delay(50);

        lcd.clear();
        lcd.setCursor(0,0);
        lcd.print("Warning!!!");
        lcd.setCursor(0,1);
        lcd.print("Low Pressure");
      }
      else
      {
      digitalWrite(8, LOW);
      }
      break;
      }
    }
}
```

4.2 Hardware result





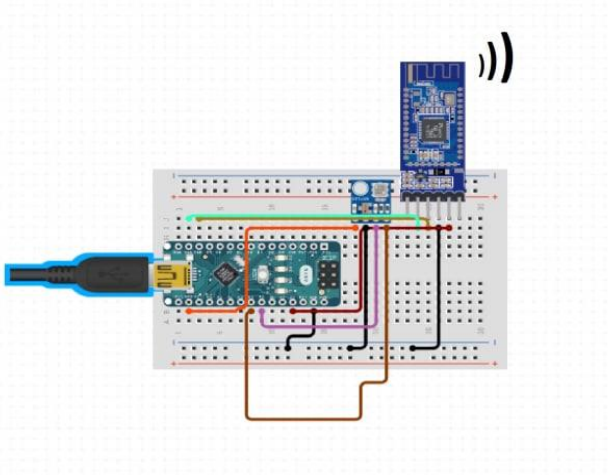
CHAPTER 5

5.1 Conclusion

This system utilizes integration techniques to provide a solution to measures real-time tyre pressure, temperature and also alerts the driver about improperly inflated tyres. This system is an essential feature in all the vehicles. The system ensures calibrated tyre pressure which is important for tyre life, reduce number of accidents, proper handling of vehicle. Further this system can be developed into nano sized and implement water resistant property to ensure safety of the bike riders.

5.2 Future Scope

With the help of arduino nano,barometric sensor and Bluetooth we can transmit the pressure value of the tubeless tyre to the mobile phone by using the graphical use interface (GUI). It will be reduce the reducing size. And it is cost efficient .



Graphical user interface, is a form of user interface that allows users to interact with electronic devices through graphical icons and audio indicator such as primary notation, instead of text-based UIs, typed command labels or text navigation. GUIs were introduced in reaction to the perceived steep learning curve of CLIs (command-line interfaces), which require commands to be typed on a computer keyboard

The actions in a GUI are usually performed through direct manipulation of the graphical elements. Beyond computers, GUIs are used in many handheld mobile devices such as MP3 players, portable media players, gaming devices, smartphones and smaller household, office and industrial controls. The term GUI tends not to be applied to other lower-display resolution types of interfaces, such as video games (where HUD (head-up display) is preferred), or not including flat screens like volumetric displays because the term is restricted to the scope of 2D display screens able to describe generic information, in the tradition of the computer science research at the Xerox Palo Alto Research Centre.