CHAPTER 1

INTRODUCTION

An automated weather sensor Rover is an instrument that measures and records meteorological parameters using sensors without intervention of humans. The measured parameters can be stored in a built-in data logger or can be transmitted to a remote location via a communication link. Today, automated weather stations are available as commercial products with variety of facilities and options. Automated weather stations have been developed in universities by interfacing meteorological parameter monitoring sensors to microcomputer/commercially available data loggers with communication devices or through serial and parallel ports to obtain hard copies of weather data. Recently, the University of Colombo developed an automated weather station with USB communication facility and a built-in data logging facility. The system used wired communication to transfer data to the monitoring station through the computer's built-in USB interface. The present work is a further extension of the earlier developments. Here we mount weather station on a moving Rover which enables to detect threats during research before the involvement of humans. The main objective of this work is to develop a standalone modular weather sensor Rover with a remote communication facility to capture and transmit meteorological parameters.

Remotely monitoring of environmental parameters is important in various applications and industrial processes. In earlier period weather monitoring systems are generally based on mechanical, electromechanical instruments which suffer from the drawbacks like poor rigidity, need of human intervention, associated parallax errors and durability. Kang and Park have developed monitoring systems, using sensors for indoor climate and environment based on the parameters mentioned in 2000. Combination of these sensors with data acquisition system has proved to be a better approach for temperature and relative humidity monitoring in 2005. Vlassov in 1993 introduces the usage of surface acoustic wave's devices as temperature sensor. This demand the development of a microcontroller based embedded system for weather monitoring. Such a system should monitor and provide data for remote examine. The collected data by weather monitoring system can easily be exported to a PC via a serial port to make subsequent data analysis or graphic and digital storage thus automatic data collection is possible without giving up PC resources.

CHAPTER 2

LITERATURE SURVEY

The Weather sensor rover unit is a locomotive unit which senses the environmental factors such as Temperature, Humidity, Soil Moisture, Rainfall, Pressure and Gas. The factors are detected based on various sensors used. The various sensors utilized in this model are MQ2 Gas Sensor, DHT11 Temperature and Humidity Sensor, BMP Pressure Sensor, Rainfall Sensor, Soil and Moisture Sensor. The Microcontroller used here is Arduino Nano. The System uses chassis which is specialized for adapting itself to uneven surfaces with its flexible components. This model is used mainly in research activities to monitor environmental aspects and it also acts as a probing device where threats are detected at first at the places of research before humans can enter.

The creation of this model is a result of various references. Some of the websites are Instructable.com,arduino.cc,Wikipedia.com etc.

This model finds similarity with Curiosity-The Mars Rover Mission which is a major project of NASA in the history of space technology and is a major step in the field of space research. This model is a miniature of Curiosity. This model is entitled only for terrestrial research in determining the environmental aspects of the places where it is hard for the humans to reach.

Arduino NANO is an open source project used for building electronic projects. It consists of both a physical programmable circuit (microcontroller) and a piece of software called IDE (integrated development environment). Unlike most previous programmable circuit board, the Arduino does not need a separate piece of hardware in order to load new code onto the board, simply we can use a USB. Arduino board operates on an external power of 6 to 20 Volts. The popularity of Arduino is because of its wiring platform, lighter weight, and low-cost version. Thus, the embedded system of Weather Sensor Rover is achieved.

CHAPTER 3

DESIGN

3.1 Requirement specification

Requirements specification in systems engineering and software engineering is the direct result of a requirements analysis and can refer to

3.1.1 Hardware requirements specification.

3.1.2 Software requirements specification.

3.1.1 Hardware requirement specification:

3.1.1.1 ARDUINO Nano: It is a small, complete and breadboard-friendly board based on AT mega328(Arduino Nano 3.x). It is 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.

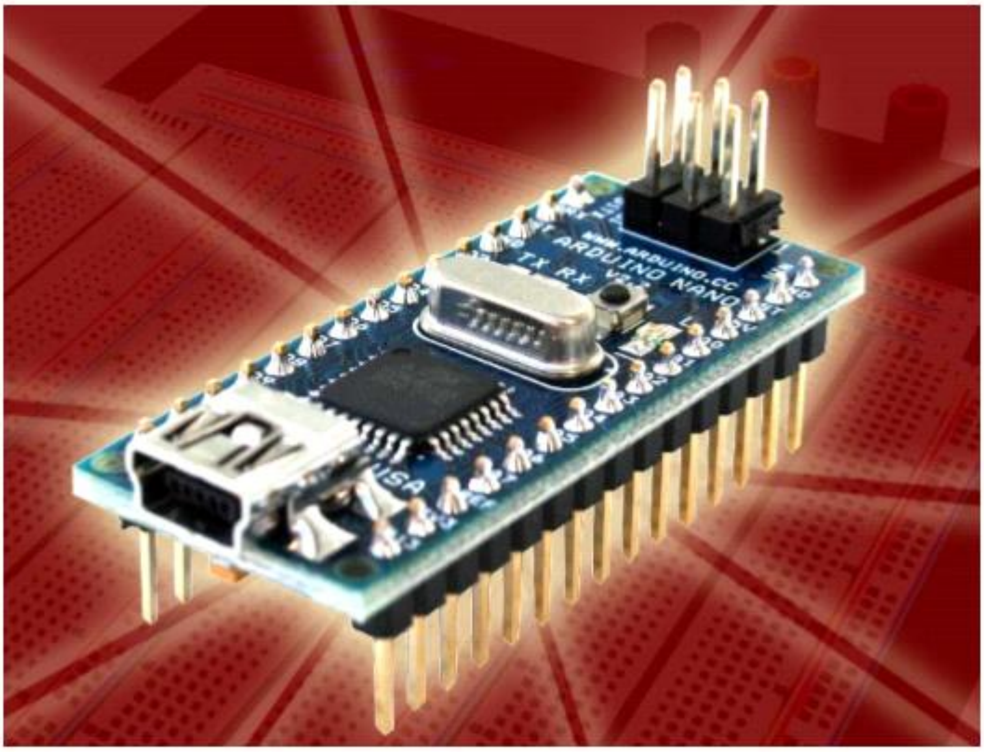


Fig 3.1.1.1(a): Arduino Nano

Arduino Nano Pin Layout

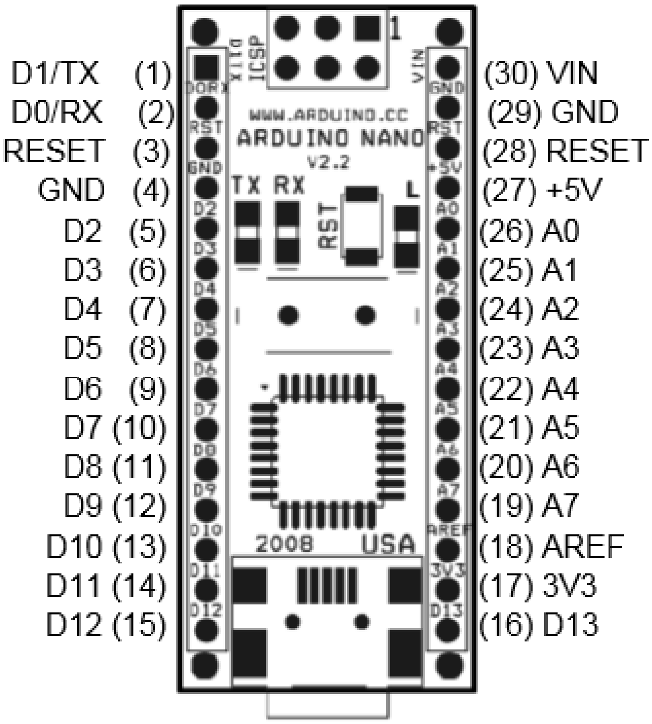


Fig 3.1.1.1(b): Arduino pin configuration

Pin No.	Name	Type	Description
1-2, 5-16	D0-D13	I/O	Digital input/output port 0 to 13
3, 28	RESET	Input	Reset (active low)
4, 29	GND	PWR	Supply ground
17	3V3	Output	+3.3V output (from FTDI)
18	AREF	Input	ADC reference
19-26	A7-A0	Input	Analog input channel 0 to 7
27	+5V	Output or Input	+5V output (from on-board regulator) or +5V (input from external power supply)
30	VIN	PWR	Supply voltage

Fig 3.1.1.1(c): Arduino pin Description

3.1.1.2 Gas Sensor: Sensitive material of MQ-6 gas sensor is SnO which with lower conductivity in clean air. MQ-6 gas sensor has high sensitivity to Propane, Butane and LPG, also response to Natural gas. The Sensor could be used to detect different combustible gas, especially Methane; it is with low cost and suitable for different application. The Gas Sensor is shown in below Fig 3.1.1.2

Fig 3.1.1.2: MQ2 Gas Sensor

3.1.1.3 Soil Moisture Sensor: Soil moisture sensors measure the volumetric water content in soil. soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture.

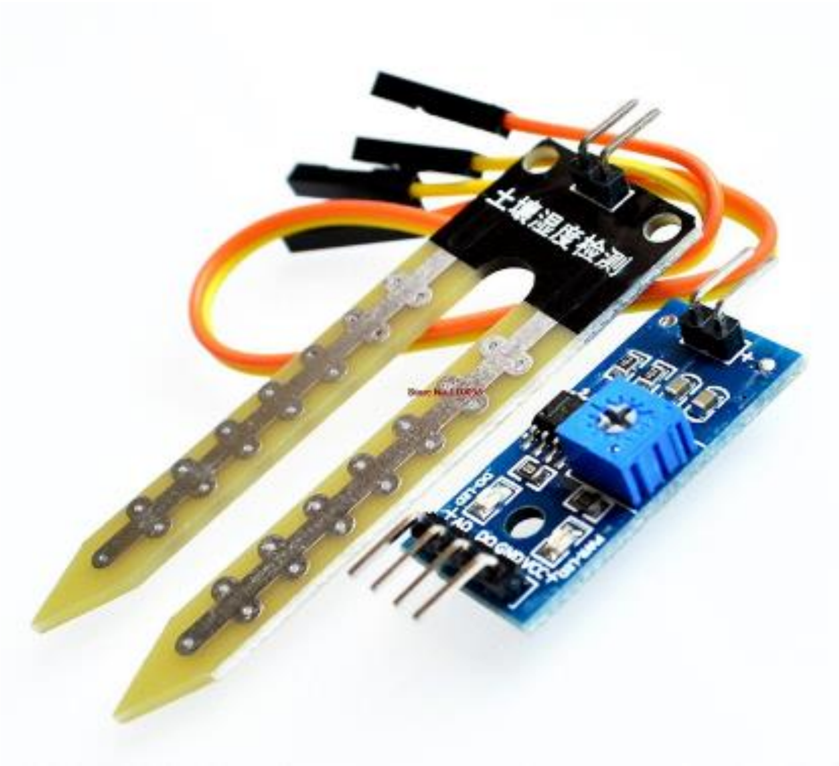


Fig 3.1.1.3: Soil Moisture Sensor

3.1.1.4 Rain Sensor: The rain sensor module is an easy tool for rain detection. It can be used as a switch when raindrop falls through the raining board and also for measuring rainfall intensity. The module features, a rain board and the control board that is separate for more convenience, power indicator LED and an adjustable sensitivity though a potentiometer.

Fig 3.1.1.4: Rain sensor

3.1.1.5 Humidity Sensor: Humidity sensor works on the principle of relative humidity and gives the output in the form of voltage. This analog voltage provides the information about the percentage relative humidity present in the environment. A miniature sensor consisting of a RH sensitive material deposited on a ceramic substrate. The AC resistance (impedance) of the sensor decreases as relative humidity increases. The Humidity Sensor is shown in below Fig.

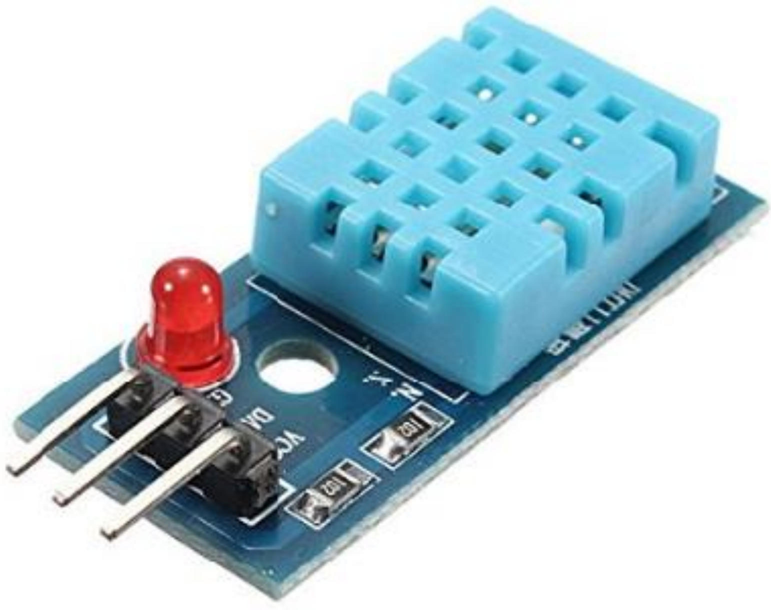


Fig 3.1.1.5: DHT11 Temperature and Humidity Sensor

3.1.1.5 Temperature sensor: The DHT11 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in .C). If the temperature is high, then the fan will on and vice versa. The Temperature Sensor is show in fig 3.1.1.5

3.1.1.6 RF module: 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. This wireless communication may be accomplished through optical communication or through radio frequency (RF) communication. For many applications the medium of choice is RF since it does not require line of sight. RF communications incorporate a transmitter or receiver.

Fig 3.1.1.6: RF Transmitter

3.1.1.7 Motors: DC motors are used in the chassis for the movement of Rover.

3.1.1.8 ROVER Chassis: 4*4 Rover chassis is used for the movement of Rover the uneven surfaces. The flexibility of the chassis is attained by its components such as shock absorbers.

3.1.1.9 Batteries: It is used in providing power supply to the system.

3.1.1.10 Computer: It used for programming the circuit and obtaining the results.

3.1.2 Software requirement specification:

3.1.2.1 ARDUINO IDE with ARDUINO Serial Monitor:

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software and Serial Monitor is the window and it is part of the Arduino IDE software. Its job is to allow you to both send messages from your computer to an Arduino board (over USB) and also to receive messages from the Arduino.

CHAPTER 4

IMPLEMENTATION

4.1 Block diagram:

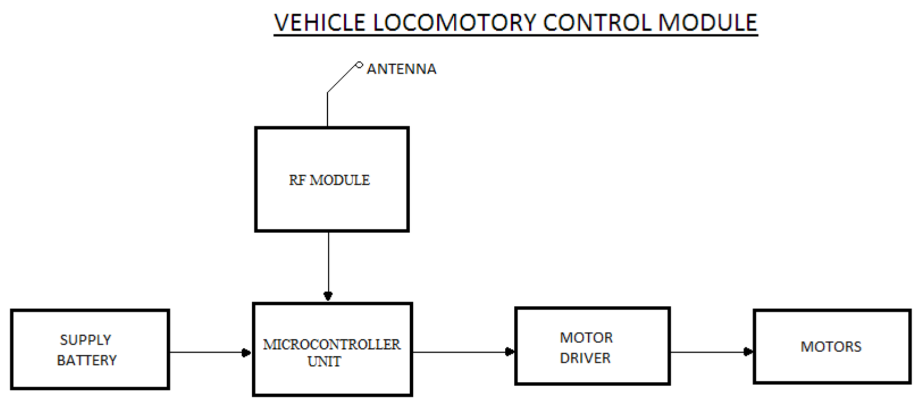


Fig 4.1.1 Vehicle Locomotory Control Module

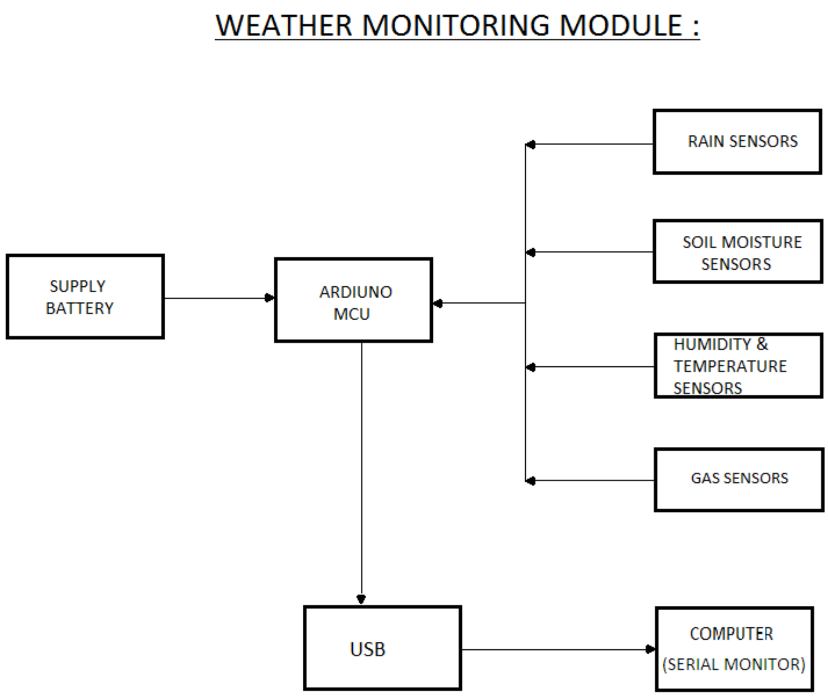


Fig 4.1.2 Weather Monitoring Module

4.2 Model:

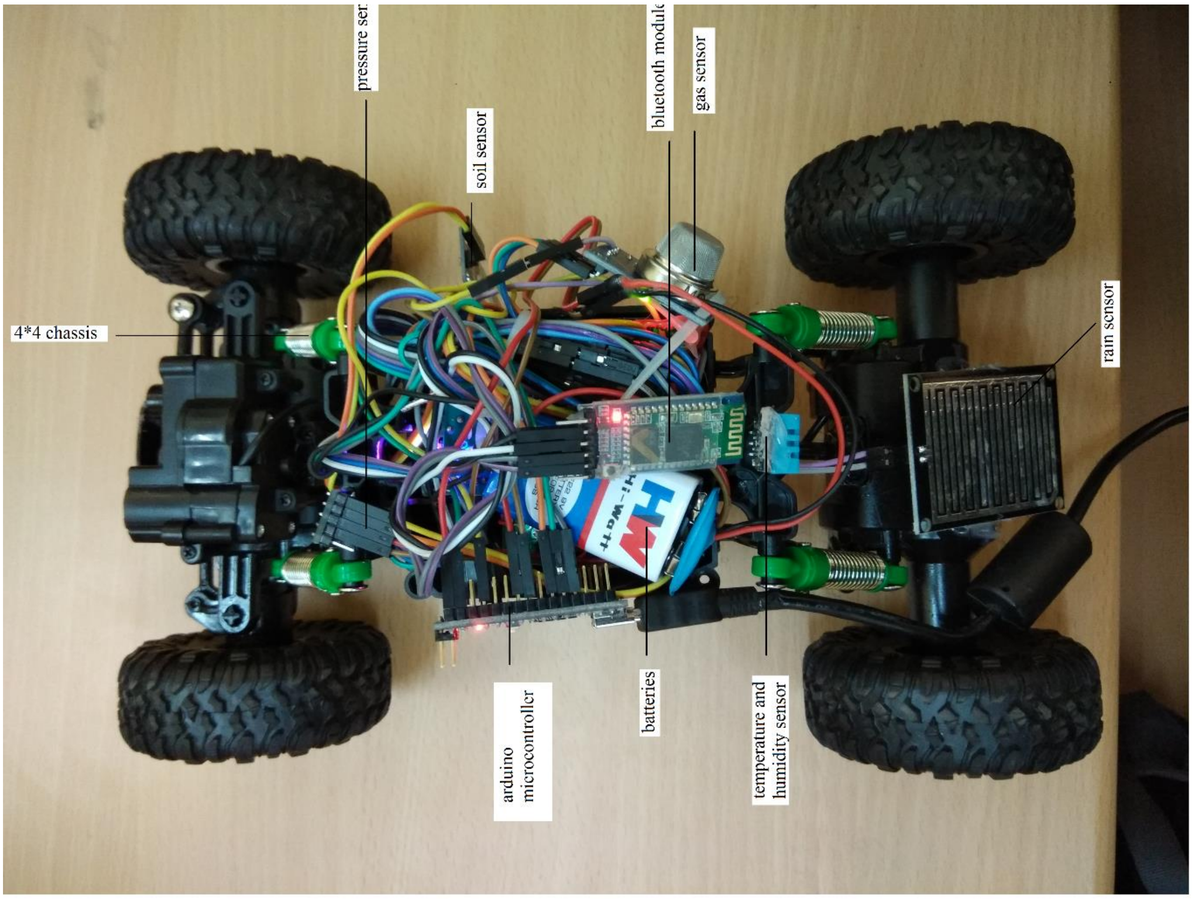


Fig 4.2 Model of Weather Sensor Rover Unit (WSRU)

4.3 Working:

Weather sensor rover unit is implemented using two modules such as Vehicle locomotory module and Weather monitoring module. The Vehicle locomotory module consists of RF transmitter and receiver for the movement of vehicle. The Weather Monitoring module consists of various sensors to monitor various aspects of environment. The Sensors used here are DHT11 Temperature and Humidity Sensor, Pressure Sensor, MQ2 Gas Sensor, Soil Moisture Sensor and Rainfall Sensor. The Sensors are connected to Arduino Microcontroller through Jumper Wires. The pin connections of sensors to arduino Microcontroller are as follows:

Sensors	**Microcontroller**

BMP180(Pressure)

+vcc	+5v
GND	GND
SDA	A4
SCL	A5

DHT11 (Temperature & Humidity)

+	+5v
-	GND
D	D2

Rain Sensor

Vcc	+5v
GND	GND
A0	A0

Soil Sensor

Vcc	+5v
GND	GND
A0	A1

Gas Sensor

Vcc	+5v
GND	GND
A0	A2

Bluetooth

Vcc	5v
GND	GND
TX	RX
RX	Tx

Where,

- Vcc and + are the pins for the positive terminals of power supply.
- GND and - are the pins for the negative terminals of power supply.
- D is the output pin for digital signal at temperature and humidity.
- D2 is the input pin for the digital data signal at Arduino microcontroller.
- A0 is the output pin at sensors for analog data signal.
- A0, A1, A2, A4 are the input pins for analog data signal at Arduino microcontroller.
- RX is the pin for the signal receiving at Arduino microcontroller and Bluetooth module.
- TX is the pin for the signal transmission at Arduino microcontroller and Bluetooth module.

Microcontroller is programmed using computer (Arduino IDE) connected through serial USB port and also the readings can be obtained from the microcontroller using Arduino serial monitor in a computer through serial USB port.

4.4 Code:

```
/*
Pin Configuration
Rain Drop       A0
Soil Humidity A1
SDA             A4
SCL             A5
DHT11 Data    D2
gas sensor      A2
*/
int result [6];                          //Sensor aza array
#include <Wire.h>        //Including wire library
#include <SFE_BMP180.h>   //Including BMP180 library
#define ALTITUDE 3       //Altitude where I live (change this to your altitude)
SFE_BMP180 pressure;     //Creating an object
#include <DHT.h>         //Including DHT11 library
#define DHTPIN 2         //Define DHT11 digital pin
#define DHTTYPE DHT11     //Define DHT TYPE which is DHT11
DHT dht(DHTPIN, DHTTYPE); //Execute DHT11 library
void setup() {
Serial.begin(9600); //Starting serial communication
Serial.println("Program started");
//Analog setup
pinMode(A0, INPUT);      //Soil
```

```
pinMode(A1, INPUT);      //Rain
pinMode(A2, INPUT);      //Gas
//BMP180 Setup
if (pressure.begin())    //If initialization was successful, continue
 {Serial.println("BMP180 init success");
 Serial.print("AWS :");
 Serial.print("\t");
 Serial.print("Rain Drop\t");
 Serial.print("Soil Hum\t");
 Serial.print("Pressure \t");
 Serial.print("Gas sensing \t");
 Serial.print("Air Hum\t");
 Serial.print("\t");
 Serial.println("Temp \t");}
else                    //Else, stop code forever
  {
    Serial.println("BMP180 init fail");
    while (1);
  }
//DHT11 setup
dht.begin();
}
void loop() {
//analog setup
```

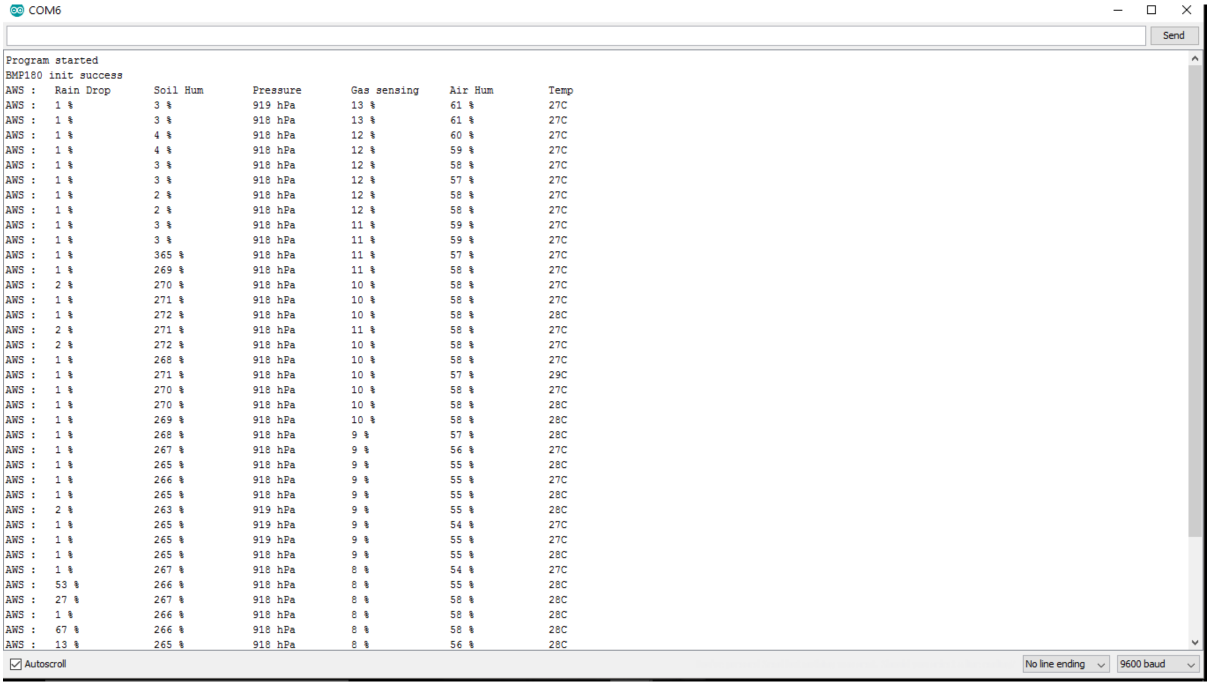
```
int A_Rain = analogRead(A0);
int A_Soil = analogRead(A1);
int A_Gas = analogRead(A2);
A_Rain = map(A_Rain, 800, 1023, 100, 0);
A_Soil = map(A_Soil, 400, 1023, 100, 0);
A_Gas = map(A_Gas, 60, 1023, 0, 100);
result[0]=A_Soil;
result[1]=A_Rain;
result[5]=A_Gas;
//bmp180 setup
char status;
double T, P, p0;
status = pressure.startTemperature();
if (status != 0) {
  delay(status);
  status = pressure.getTemperature(T);
  if (status != 0) {
  status = pressure.startPressure(3);
   if (status != 0) {
    delay(status);
    status = pressure.getPressure(P, T);
    if (status != 0) {
     p0 = pressure.sealevel(P, ALTITUDE);
     result[2]=p0;
```

```
    }}}}
result[3] = dht.readHumidity();
result[4] = dht.readTemperature();
Serial.print("AWS : ");
Serial.print(" \t");
Serial.print(result[0]);
Serial.print(" %\t");
Serial.print("\t");
Serial.print(result[1]);
Serial.print(" %\t");
Serial.print("\t");
Serial.print(result[2]);
Serial.print(" hPa \t");
Serial.print(result[5]);
Serial.print(" %\t");
Serial.print("\t");
Serial.print(result[3]);
Serial.print(" %\t");
Serial.print("\t");
Serial.print(result[4]);
Serial.println("C \t");
delay(5000);
}
```

CHAPTER 5

RESULTS

The readings obtained in Arduino serial Monitor is shown in the figure below :




```
Program started
BMP180 init success
AWS :   Rain Drop       Soil Hum        Pressure        Gas sensing     Air Hum         Temp
AWS :   1 %             3 %             919 hPa         13 %            61 %            27C
AWS :   1 %             3 %             918 hPa         13 %            61 %            27C
AWS :   1 %             4 %             918 hPa         12 %            60 %            27C
AWS :   1 %             4 %             918 hPa         12 %            59 %            27C
AWS :   1 %             3 %             918 hPa         12 %            58 %            27C
AWS :   1 %             3 %             918 hPa         12 %            57 %            27C
AWS :   1 %             2 %             918 hPa         12 %            58 %            27C
AWS :   1 %             2 %             918 hPa         12 %            58 %            27C
AWS :   1 %             3 %             918 hPa         11 %            59 %            27C
AWS :   1 %             3 %             918 hPa         11 %            59 %            27C
AWS :   1 %             365 %           918 hPa         11 %            57 %            27C
AWS :   1 %             269 %           918 hPa         11 %            58 %            27C
AWS :   2 %             270 %           918 hPa         10 %            58 %            27C
AWS :   1 %             271 %           918 hPa         10 %            58 %            27C
AWS :   1 %             272 %           918 hPa         10 %            58 %            28C
AWS :   2 %             271 %           918 hPa         11 %            58 %            27C
AWS :   2 %             272 %           918 hPa         10 %            58 %            27C
AWS :   1 %             268 %           918 hPa         10 %            58 %            27C
AWS :   1 %             271 %           918 hPa         10 %            57 %            29C
AWS :   1 %             270 %           918 hPa         10 %            58 %            27C
AWS :   1 %             270 %           918 hPa         10 %            58 %            28C
AWS :   1 %             269 %           918 hPa         10 %            58 %            28C
AWS :   1 %             268 %           918 hPa         9 %             57 %            28C
AWS :   1 %             267 %           918 hPa         9 %             56 %            27C
AWS :   1 %             265 %           918 hPa         9 %             55 %            28C
AWS :   1 %             266 %           918 hPa         9 %             55 %            27C
AWS :   1 %             265 %           918 hPa         9 %             55 %            28C
AWS :   2 %             263 %           919 hPa         9 %             55 %            28C
AWS :   1 %             265 %           919 hPa         9 %             54 %            27C
AWS :   1 %             265 %           919 hPa         9 %             55 %            27C
AWS :   1 %             265 %           918 hPa         9 %             55 %            28C
AWS :   1 %             267 %           918 hPa         8 %             54 %            27C
AWS :   53 %            266 %           918 hPa         8 %             55 %            28C
AWS :   27 %            267 %           918 hPa         8 %             58 %            28C
AWS :   1 %             266 %           918 hPa         8 %             58 %            28C
AWS :   67 %            266 %           918 hPa         8 %             58 %            28C
AWS :   13 %            265 %           918 hPa         8 %             56 %            28C
```

Variations of readings when soil moisture sensor is dipped in wet soil:-

```
Program started
BMP180 init success
AWS :   Rain Drop      Soil Hum       Pressure       Gas sensing    Air Hum        Temp
AWS :   1 %            3 %            919 hPa        13 %           61 %           27C
AWS :   1 %            3 %            918 hPa        13 %           61 %           27C
AWS :   1 %            4 %            918 hPa        12 %           60 %           27C
AWS :   1 %            4 %            918 hPa        12 %           59 %           27C
AWS :   1 %            3 %            918 hPa        12 %           58 %           27C
AWS :   1 %            3 %            918 hPa        12 %           57 %           27C
AWS :   1 %            2 %            918 hPa        12 %           58 %           27C
AWS :   1 %            2 %            918 hPa        12 %           58 %           27C
AWS :   1 %            3 %            918 hPa        11 %           59 %           27C
AWS :   1 %            3 %            918 hPa        11 %           59 %           27C
AWS :   1 %            365 %          918 hPa        11 %           57 %           27C
AWS :   1 %            269 %          918 hPa        11 %           58 %           27C
AWS :   2 %            270 %          918 hPa        10 %           58 %           27C
AWS :   1 %            271 %          918 hPa        10 %           58 %           27C
AWS :   1 %            272 %          918 hPa        10 %           58 %           28C
AWS :   2 %            271 %          918 hPa        11 %           58 %           27C
AWS :   2 %            272 %          918 hPa        10 %           58 %           27C
```

Variations of readings when rain sensor is exposed to rain :-

```
AWS :   1 %            266 %          918 hPa        9 %            55 %           27C
AWS :   1 %            265 %          918 hPa        9 %            55 %           28C
AWS :   2 %            263 %          919 hPa        9 %            55 %           28C
AWS :   1 %            265 %          919 hPa        9 %            54 %           27C
AWS :   1 %            265 %          919 hPa        9 %            55 %           27C
AWS :   1 %            265 %          918 hPa        9 %            55 %           28C
AWS :   1 %            267 %          918 hPa        8 %            54 %           27C
AWS :   53 %           266 %          918 hPa        8 %            55 %           28C
AWS :   27 %           267 %          918 hPa        8 %            58 %           28C
AWS :   1 %            266 %          918 hPa        8 %            58 %           28C
AWS :   67 %           266 %          918 hPa        8 %            58 %           28C
AWS :   13 %           265 %          918 hPa        8 %            56 %           28C
```

Variations of readings when carbon dioxide is detected by Gas sensor:-

AWS :	1 %	3 %	918 hPa	12 %	57 %	27C
AWS :	1 %	2 %	918 hPa	12 %	58 %	27C
AWS :	1 %	2 %	918 hPa	12 %	58 %	27C
AWS :	1 %	3 %	918 hPa	11 %	59 %	27C
AWS :	1 %	3 %	918 hPa	11 %	59 %	27C
AWS :	1 %	365 %	918 hPa	11 %	57 %	27C
AWS :	1 %	269 %	918 hPa	11 %	58 %	27C
AWS :	2 %	270 %	918 hPa	10 %	58 %	27C
AWS :	1 %	271 %	918 hPa	10 %	58 %	27C
AWS :	1 %	272 %	918 hPa	10 %	58 %	28C
AWS :	2 %	271 %	918 hPa	11 %	58 %	27C
AWS :	2 %	272 %	918 hPa	10 %	58 %	27C
AWS :	1 %	268 %	918 hPa	10 %	58 %	27C

Variations of readings in room temperature :-

AWS :	1 %	269 %	918 hPa	11 %	58 %	27C
AWS :	2 %	270 %	918 hPa	10 %	58 %	27C
AWS :	1 %	271 %	918 hPa	10 %	58 %	27C
AWS :	1 %	272 %	918 hPa	10 %	58 %	28C
AWS :	2 %	271 %	918 hPa	11 %	58 %	27C
AWS :	2 %	272 %	918 hPa	10 %	58 %	27C
AWS :	1 %	268 %	918 hPa	10 %	58 %	27C
AWS :	1 %	271 %	918 hPa	10 %	57 %	29C
AWS :	1 %	270 %	918 hPa	10 %	58 %	27C
AWS :	1 %	270 %	918 hPa	10 %	58 %	28C

CHAPTER 6

APPLICATION

Implementation of this system will have following application:

- used in research activities.
- used to study various aspects of environment such as humidity, temperature, soil moisture, fire, rain, etc.
- Detection of various factors of environment such as fire, rain, humidity, temperature, soil moisture, etc.
- alternate and safest way to explore places where humans cannot reach.
- research tool for exploration.
- Agriculture field monitoring.
- Industrial purpose.
- Enhanced for monitoring & controlling of atmosphere conditions.
- discover various aspects of environment of the places unreachable by humans like minefields, excavated caves, etc.
- can be used as a probing tool to predict the fore coming threats at unfamiliar places.

CHAPTER 7

FUTURE ENHANCEMENT

- Can include wireless weather monitoring system.
- Can include data logging system to store and compare weather data for future use and analysis.
- Can use as a underwater tool or a drone instead of Rover to monitor different ecosystems like swamps and tree ecosystem.
- Can be used during natural calamities (Fire, Earth Quake etc.) to detect living beings by PIR (Passive Infrared) Sensor.
- Can use RF Camera Module to obtain Real Time Video to control the Rover. Adding of more sensors to monitor other environmental parameters such as Soil PH Sensor, CO2 and oxygen Sensor while allowing the replacing of current sensors if a wider range of measurements is desired.
- Integration of additional monitoring devices such as a Wi-Fi camera to monitor growth of agricultural product.
- Also the data can be uploaded to web server continuously.

CHAPTER 8

CONCLUSION

This project demonstrates Design and Implementation of Weather Monitoring & Controlling System used for controlling the devices as well as monitoring the environmental parameters. Embedded controlled sensor networks have proven themselves to be a reliable solution in providing remote control and sensing for environmental monitoring systems. The sensors have been integrated with the system to monitor and compute the level of existence of gas, temperature and humidity in atmosphere using information and communication technologies. The sensors can upload the data using serial Communication. The Weather Sensors mounted on a flexible and locomotory chassis enables the system to move on uneven surfaces and detect the forecoming threats during research.

CHAPTER 9

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