BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 416 (January 2022) **A2**
Microprocessor and Embedded Systems Laboratory

Final Project Report

Real Time Environmental Monitoring System

Evaluation Form:

STEP	DESCRIPTION	MAX	SCORE
1	Report (Format, Reference)	10	
2	Design Method and Complete Design (Hardware Implementation)	15	
3	Video Demonstration	10	
4	Novelty of Design	15	
5	Project Management and Cost Analysis	10	
6	Considerations to Public Health and Safety, Environment and Cultural and Societal Needs	10	
7	Assessment of Societal, Health, Safety, Legal and Cultural issues relevant to the solution	10	
8	Evaluation of the sustainability and impact of designed solution in societal and environmental contexts	10	
9	Individual Contribution (Viva)	20	
10	Team work and Diversity	10	
	TOTAL	120	

Signature of Evaluator: _____

Academic Honesty Statement:

IMPORTANT! Please carefully read and sign the Academic Honesty Statement, below. <u>Type the student ID and Write your name in your own handwriting</u>. *You will not receive credit for this project experiment unless this statement is signed in the presence of your lab instructor.*

"In signing this statement, We hereby certify that the work on this project is our own and that we have not copied the work of any other students (past or present), and cited all relevant sources while completing this project. We understand that if we fail to honor this agreement, We will each receive a score of ZERO for this project and be subject to failure of this course."

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1 Abstract

Environmental monitoring system is defined as a system that monitors the overall quality of an environment. The vital parameters which define the environment qualities are humidity, temperature and air quality. Environment temperature and humidity defines how an environment behaves in aspect of comfort level for human being. As temperature and humidity increases, the comfort level of human being decreases. Also, heatwaves are considered as disasters, so much that UK recently recognized it as fatal with an average of 1200 deaths in a day during heat periods [1]. Temperature and humidity levels are vital parameters for human beings to survive. Human beings can survive in a maximum of 42.3ºC of temperature [2]. As global warming has become an issue, it's important to monitor temperature of the environment and take necessary steps the deescalate the fatal situation. The same goes for air quality. Industrial revolution in the last century has started degradation in air quality around the globe [3]. As particles harmful to human being increases in the environment, the air quality decreases while air pollution increases. Human beings depend severely on air quality as they literally breath in it. Harmful particles of gases can cause heart diseases, lung cancer and respiratory diseases [4]. Thus, it has become vital to monitor air quality before breathing in them as well. In this report, we propose an Arduino based system that can check the vital environmental parameters and report to the cloud-based server. The server can be further used to get data and take steps to improve the air quality and overall global warming. The solar based system is a solution for sustainability as the system can operate automatically. Overall, this cheap and practical system can be used to monitor environment quality of a particular place for better human comfort and survival.

2 Introduction

"**Real Time Environmental Monitoring System**" has pretty much of a self-explanatory name. The system, as can be assumed from the name, monitors various environmental parameters in real time and send data to the cloud using GSM network. As for the environmental parameters, we're focusing on three vital parameters for human survival. Temperature, humidity and air quality. Temperature increase has been a global issue since the start of industrial revolution but in recent years it has become deadly [1,3]. The air pollution is also increasing exponentially with so many automobiles and factories emitting CO_2, CO and various deadly gases to the environment. Our monitoring system of the environment offers a sustainable, automated solution for observing the environmental parameters. For this project, we're using an Arduino UNO as the main controller. The UNO board has a microcontroller as the main controlling unit. The microcontroller on the board is a ATMega328 chip which is an 8-bit RISC processor [5]. As for measurement of the environmental parameters, various sensors are used. For temperature and humidity sensing, DHT11 sensor has been used [6]. As for air quality monitor, the MQ135 air quality sensor has been used [7]. Finally, to send the data to the server, GSM network has been used. As Wi-Fi is not an available solution for every place in this planet, GSM network seems to be a better solution for sending data. As for the GSM module, SIM900A has been used. The GSM module can connect to the internet using a simple mobile sim card. Relays are used to build the final circuit while 3 LiPo batteries are used to power up the entire system. As for automated charging system, solar power is used. The solar can charge the batteries using charging module TP4056 [9].

3 Design

As mentioned in the introduction of the report, the following parts have been used to build the entire system.

a) Arduino UNO board (ATMega328, 8-bit RISC processor).

b) DHT11 temperature and humidity sensor.

c) MQ135 air quality sensor.

d) SIM900A GSM module.

e) 5V Relay board (each board containing 4 relays).

f) 2 units of 6V solar panel.

g) 2 units of TP4056 battery charging modules.

h) Boost converter.

i) MOSFET 7805CV

j) Capacitors.

3.1 Design Method

The circuit consists of two major design parts. One being the main Arduino board connected with the sensors and GSM module to receive data and upload them to the cloud. This part of the system is pretty straight-forward. The Arduino code controls and receives data from the sensors while uploading them to the internet through GSM module. We've used 'thingspeak' server for uploading the data. The thingspeak server automatically plots the uploaded data by which, the operator can observe and take decisions.

The second major part of the design is the charging system. While the main controlling and uploading system is pretty straight-forward, the charging system is as complex as it could get. The GSM module requires high current while connecting to the network. While booting up, a single battery can't deliver enough current to the GSM module. We observed a highest of almost 0.8A current drawn by the module while connecting to the network. The value was observed using oscilloscope. As a single battery wasn't sufficient to deliver this high rating of current, two batteries in series have been used. A regulator circuit is used at the end of batteries so that the GSM module doesn't get fired up due to high voltage. This arises another problem in the charging section of the design. The charging module can't charge up two batteries while it's in series mode. So, relays have been used to change the battery configuration to parallel in state of charging [figure 2]. To control the relays, the Arduino had to be powered up by a separate battery for itself [figure 1]. At last, two solar panels in series are used to power up the charging circuits using two different battery charger modules. The first charger module charges up the Arduino battery and the second one charges the two batteries used to power up the GSM and the sensors [figure 1].

Overall, the design of the circuit consists of three batteries, one powering up the Arduino and the rest powering up the GSM and sensors. While in charging mode, the relays disconnect batteries from the GSM and sensors to save energy. While in discharging mode, the batteries work in parallel to feed energy to the GSM and sensors using two charging modules. Thus, by setting pre-determined time for both charging and discharging, the system can operate in definite intervals for indefinite time, thus sending data automatically within an interval set by the operator

3.2 Circuit Diagram

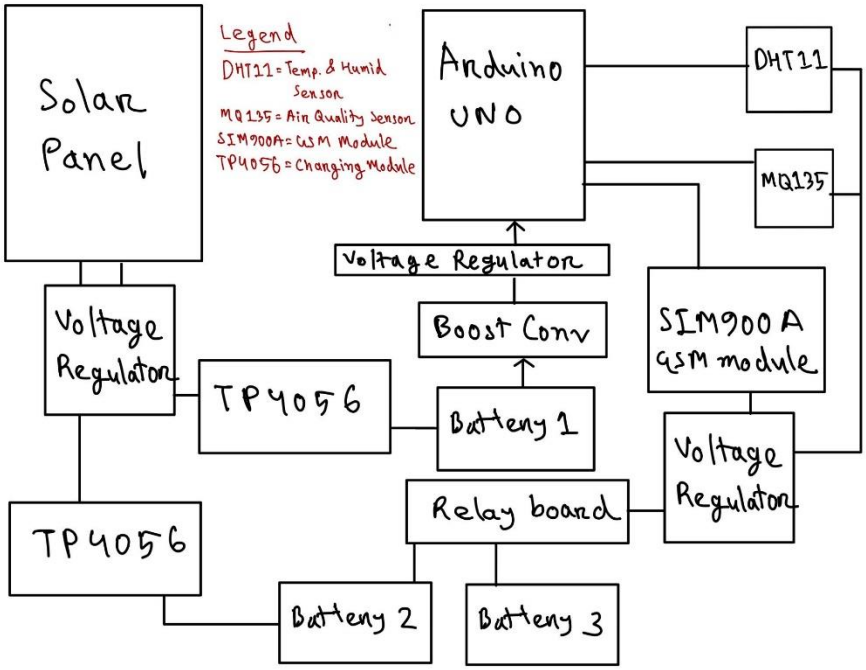

Figure 1: Simple circuit diagram of the system.

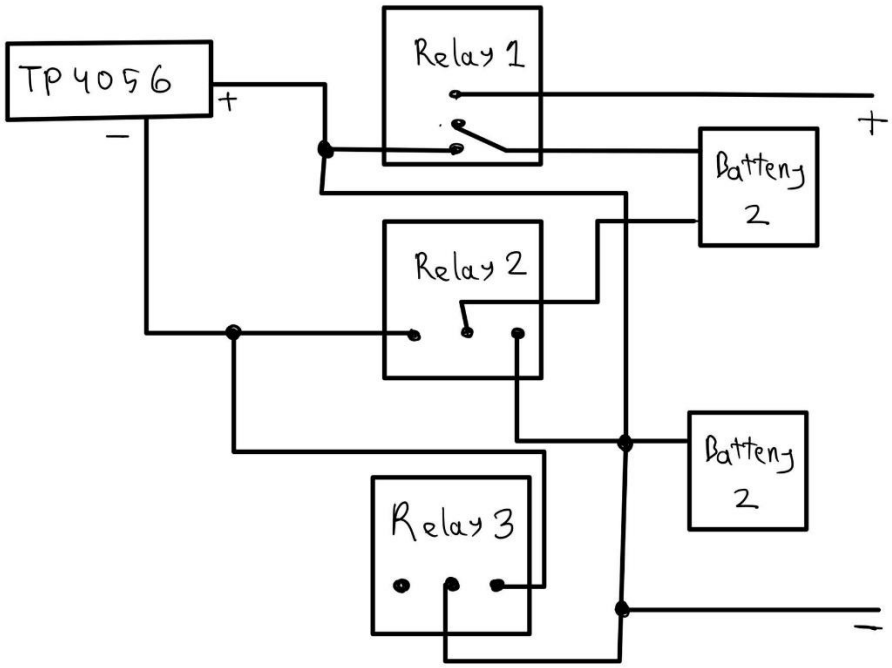

Figure 2: Relay Connection to Battery 2 and 3.

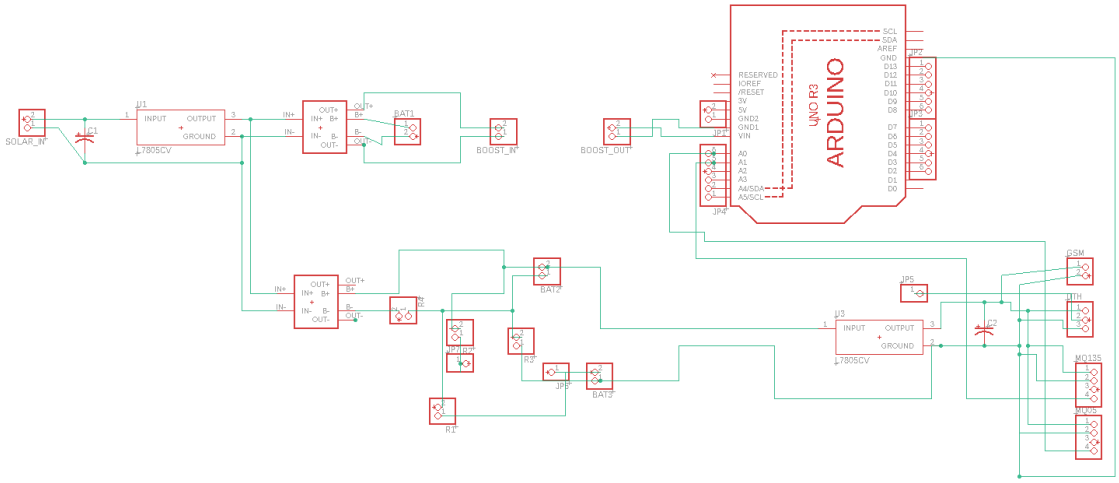

Figure 3: Circuit schematic

3.3 Full Source Code of Firmware

```
#include <SoftwareSerial.h>
SoftwareSerial gprsSerial(2, 3);

#include <MQ135.h>
#include <DHT.h>


#define PIN_MQ135 A1 // MQ135 Analog Input Pin
#define DHTPIN A2 // DHT Digital Input Pin
#define DHTTYPE DHT11 // DHT11 or DHT22, depends on your sensor

MQ135 mq135_sensor(PIN_MQ135);
DHT dht(DHTPIN, DHTTYPE);

float temperature, humidity; // Temp and Humid floats, will be measured by the
DHT
float correctedPPM;

int state_off = 1, state_on = 0;
int r1 = 5, r2 = 6, r3 = 7;


void setup() {
gprsSerial.begin(9600); // the GPRS baud rate
Serial.begin(9600);

pinMode(r1, OUTPUT);
pinMode(r2, OUTPUT);
pinMode(r3, OUTPUT);

dht.begin();
delay(1000);
}


void loop()
{


//////////////////////////////////////////POWER ON GSM
Serial.println("POWER ON GSM:");
Serial.println("...");
digitalWrite(r1, state_on);
digitalWrite(r2, state_on);
digitalWrite(r3, state_on);
delay(30000);

//////////////////////////////////////////READ SENSOR VALUES
Serial.println("READ SENSOR VALUES:");
Serial.println("...");
sensor_read();

Serial.print("Temperature = ");
Serial.print(temperature);
Serial.println(" °C");
Serial.print("Humidity = ");
Serial.print(humidity);
Serial.println(" %");
Serial.print("particles = ");
Serial.print(correctedPPM);
Serial.println(" ppm");


//////////////////////////////////////////////SEND DATA
Serial.println("SEND DATA:");
Serial.println("...");
send_data();

//////////////////////////////////////////////POWER OFF THE GSM
Serial.println("POWER OFF THE GSM:");
digitalWrite(r1, state_off);
digitalWrite(r2, state_off);
digitalWrite(r3, state_off);
Serial.println("...");
delay(60000);

}


void send_data()
{

if (gprsSerial.available())
Serial.write(gprsSerial.read());

gprsSerial.println("AT");
```

```
delay(1000);

gprsSerial.println("AT+CPIN?");
delay(1000);

gprsSerial.println("AT+CREG?");
delay(1000);

gprsSerial.println("AT+CGATT?");
delay(1000);

gprsSerial.println("AT+CIPSHUT");
delay(1000);

gprsSerial.println("AT+CIPSTATUS");
delay(2000);

gprsSerial.println("AT+CIPMUX=0");
delay(2000);

ShowSerialData();

gprsSerial.println("AT+CSTT=\"airtelgprs.com\"");//start task and setting the
APN,
delay(1000);

ShowSerialData();

gprsSerial.println("AT+CIICR");//bring up wireless connection
delay(3000);

ShowSerialData();

gprsSerial.println("AT+CIFSR");//get local IP adress
delay(2000);

ShowSerialData();

gprsSerial.println("AT+CIPSPRT=0");
delay(3000);

ShowSerialData();

gprsSerial.println("AT+CIPSTART=\"TCP\",\"api.thingspeak.com\",\"80\"");//start
up the connection
delay(6000);

ShowSerialData();

gprsSerial.println("AT+CIPSEND");//begin send data to remote server
delay(4000);
ShowSerialData();

String str = "GET
https://api.thingspeak.com/update?api_key=MSOGKMFNU1MTFFVY&field1=" +
String(temperature) + "&field2=" + String(humidity) + "&field3=" +
String(correctedPPM);
Serial.println(str);
gprsSerial.println(str);//begin send data to remote server

delay(4000);
ShowSerialData();

gprsSerial.println((char)26);//sending
delay(5000);//waitting for reply, important! the time is base on the condition
of internet
gprsSerial.println();

ShowSerialData();

gprsSerial.println("AT+CIPSHUT");//close the connection
delay(100);
ShowSerialData();
}
void ShowSerialData()
{
while (gprsSerial.available() != 0)
Serial.write(gprsSerial.read());
delay(5000);

}




void sensor_read()
```

```
{
humidity = dht.readHumidity();
temperature = dht.readTemperature();

// Check if any reads failed and exit early (to try again).
if (isnan(humidity) || isnan(temperature)) {
Serial.println(F("Failed to read from DHT sensor!"));
return;
}

float rzero = mq135_sensor.getRZero();
float correctedRZero = mq135_sensor.getCorrectedRZero(temperature, humidity);
float resistance = mq135_sensor.getResistance();
float ppm = mq135_sensor.getPPM();
correctedPPM = mq135_sensor.getCorrectedPPM(temperature, humidity);
delay(1000);

}
```

Table: Source Code for the main program

4 Implementation

4.1 Description

As mentioned in the design method, the circuit has two major parts. The parts have already been discussed in design method section. To implement the circuit, a PCB was designed and rendered in 3D [figure 5]. The PCB works as a Arduino shield, that sits on top of the Arduino mentioned, allowing us to access all the input and output ports and others. The PCB design has been given below in figure 4. The 3D rendering of the design can be accessed and downloaded from [this] link.

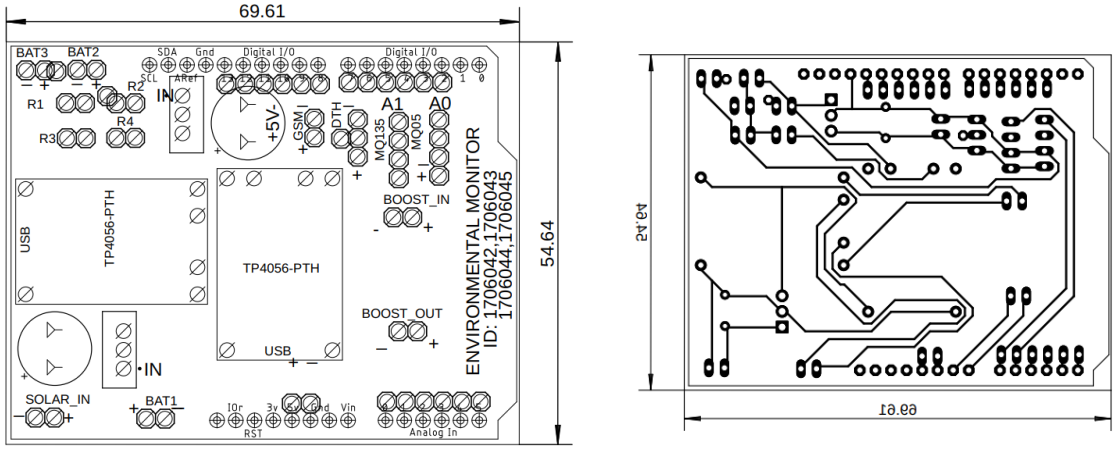

Figure 4: (Left) PCB top view and (Right) PCB bottom view with copper wirings.

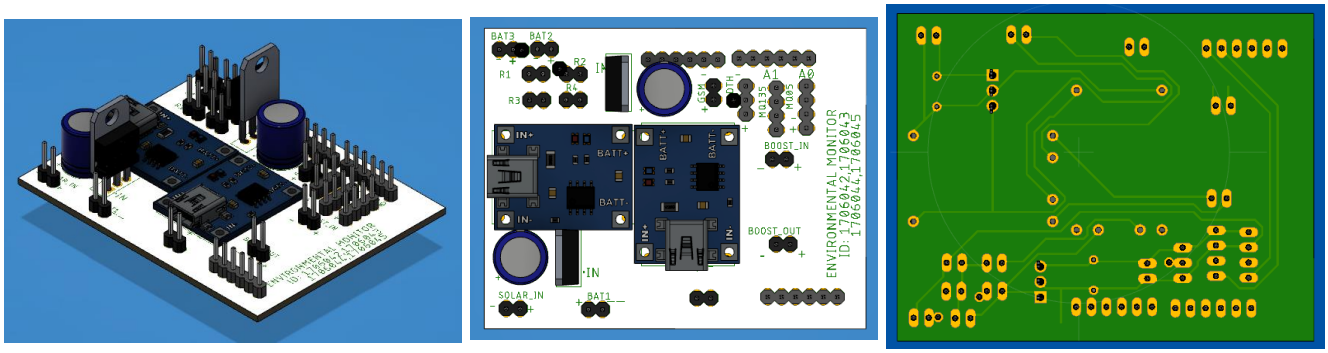

Figure 5: PCB 3D rendering image (left) home view, (middle) top view, (right) bottom view with windings.

The whole system without the casing looked something like this:

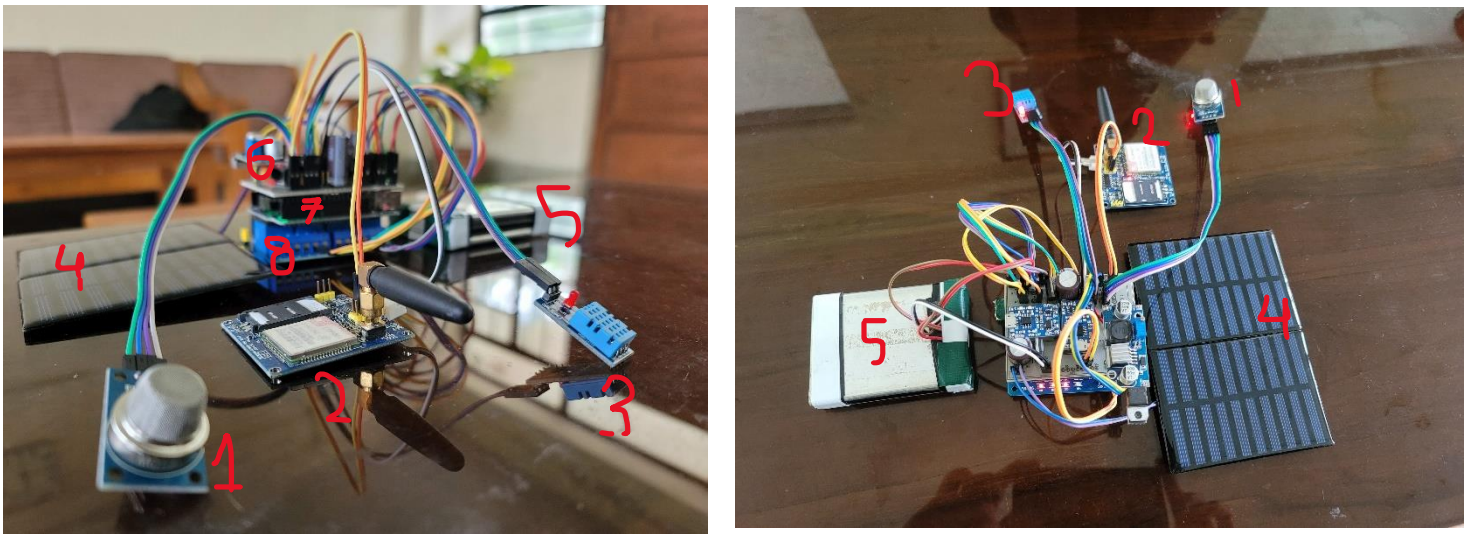

Figure 6: The whole system without casing

The numbers show components used for the implementation of the project as followed:

1. MQ135 Air Quality Sensor
2. SIM900A GSM Module
3. DHT11 Temperature and Humidity Sensor
4. Solar panel
5. Batteries
6. PCB
7. Arduino Uno
8. Relay Board

4.2 Results

After successful implementation of the whole system, during our trial runs, the system detected temperature, humidity and air quality in real time and sent to thingspeak. As can be seen in figure 7, the thingspeak environment can plot the data and show comparison. The values according to time can also be fetched by simply tapping on the desired point.

The temperature in the given environment is plotted in Celsius unit, which is the most convenient unit for temperature measurement. The humidity sensor measures relative humidity of the place in percentage. The air quality sensor measures the amount of harmful particles available in the air in ppm unit. As per rating, 400 to 750 ppm is good for health. 750 ppm to 1200 ppm is somewhat harmful and 1200 ppm to above is extremely harmful and can be deadly for health [10].

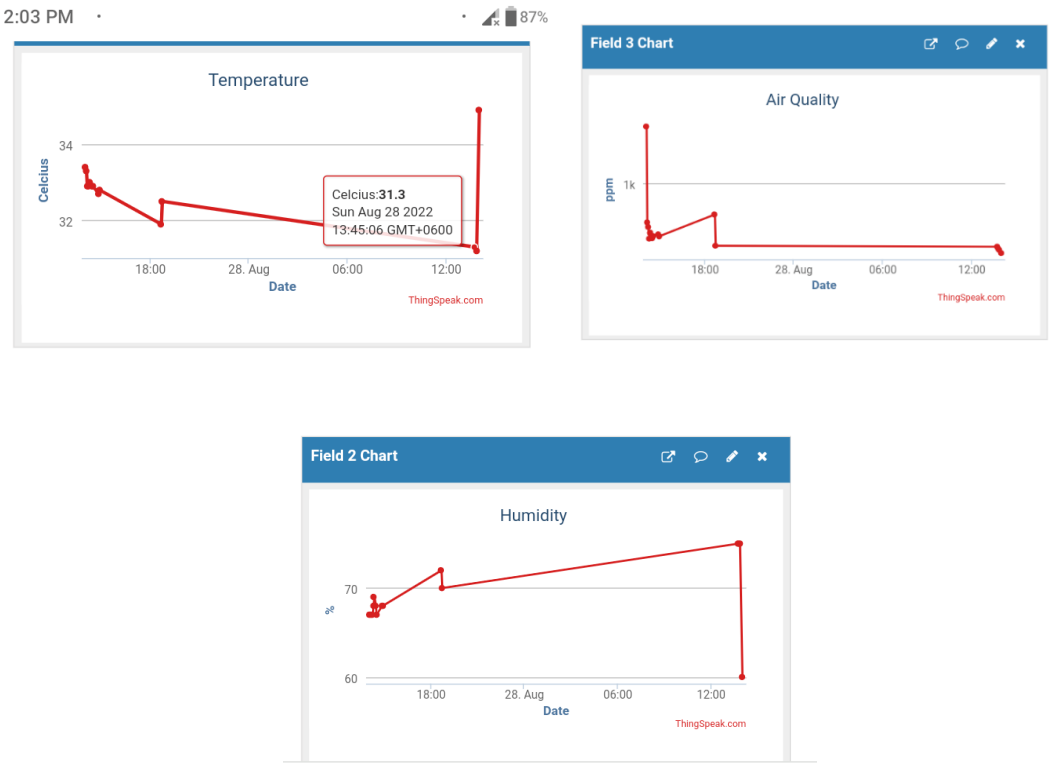

Figure 7: Implemented results in thingspeak platform. (Top Left) Temperature plot, (Top Right) Air Quality index in ppm unit, (Bottom Middle) Relative Humidity.

4.3 GitHub Link

A repository was created with all relevant files and codes for the system. The repository is named as Environment Monitoring System. The link to the GitHub repository as given below.

https://github.com/Kabir5296/EnvironmentalMonitoringSystem.git

4.4 YouTube Link

A YouTube video was created describing all parts of the project and details. The following link can be used to view the video.

(YOUTUBE LINK GOES HERE)

5 Design Analysis and Evaluation

5.1 Novelty

For the first time we introduced a solar powered environment monitor at a very low cost. We also introduced a feasible battery charging method so that both Arduino and GSM module can be powered.

Arduino runs at 5V dc and drives mA currents. But GSM module drives almost 2A current when it starts. Therefore, it is impossible to power GSM module and Arduino from same battery. In Addition, the batteries are to be in parallel connection when they are charged through solar panel. But from this connection the starting current of GSM module cannot be achieved.

To address this problem, we have used relays. In charging condition, they set the batteries in parallel and after a certain interval they set the batteries in series when discharging happens. One battery was only for Arduino and two for GSM module. The designed PCB to integrate all the components is completely new.

5.2 Project Management and Cost Analysis

5.2.1 Bill of Materials

Name of Component	Units	Price
Arduino Uno	**2**	**800**
DHT11 Temperature & Humidity Sensor	**1**	**155**
MQ135 Air Quality Sensor	**1**	**160**
SIM900A GSM Module	**3**	**800**
5V 4 Chanel Relay	**1**	**250**
6V Solar Panel	**3**	**560**
TP4056 Battery Charging Module	**3**	**100**
Boost Converter	**1**	**120**
MOSFET 7805 CV	**5**	**50**
Capacitors 1000uF, 35V	**4**	**40**
Male Header	**4**	**20**
PCB Print	**2**	**230**
Total		**3285**

5.2.2 Calculation of Per Unit Cost of Prototype

Name of Component	Units	Price (tk)
Arduino Uno	**1**	**800**
DHT11 Temperature & Humidity Sensor	**1**	**155**
MQ135 Air Quality Sensor	**1**	**160**
SIM900A GSM Module	**1**	**800**
5V 4 Chanel Relay	**1**	**250**
6V Solar Panel	**2**	**560**
TP4056 Battery Charging Module	**2**	**100**
Boost Converter	**1**	**120**
MOSFET 7805 CV	**3**	**50**
Capacitors 1000uF, 35V	**2**	**40**
Male Header	**3**	**20**
PCB Print	**1**	**230**

Total		**3285**

5.2.3 Calculation of Per Unit Cost of Mass-Produced Unit

In case of mass production, the cost of components can be reduced by 30%. In this case labour cost will be added. Labour cost would be 5% of each unit. Therefore, per unit cost would be-

3285-3285*.3+3285*0.05= 2792 tk

5.2.4 Timeline of Project Implementation

Date	Work Done
29 June 2022	Assembled Arduino with temperature and humidity sensor and air quality sensor
20 July 2022	Wrote code for the setup and get data
3 August 2022	Assembled Arduino with GSM Module and tried to upload data to server
10 August 2022	Modification in battery supply for high current demand of GSM module
13 August 2022	PCB of basic circuit was designed
17 August 2022	Battery charger circuit was connected to the whole system using single charging module
19 August 2022	Alternate solution using realys for battery charging circuit. Two charging modules were used
20 August 2022	PCB designed from scratch to make room for modifed circuit. Two charging modules used this time
27 August 2022	System final trial using solar power

29 August 2022	PCB 3D rendering
30 August 2022	Github repository created
30 August 2022	Casing made using sheets, Final trail done.

5.3 Practical Considerations of the Design to Address Public Health and Safety, Environment, Cultural, and Societal Needs

5.3.1 Considerations to Public Health and Safety

While designing the device we had to consider the following issues about pubic health and safety-

1) The device should not release any harmful component to the environment while working.

2) The sensors and modules used in this device should be health hazard free.

3) The lifetime of the batteries should be increased so that less batteries are dumped.

4) There should not be any risk of electric shock or harmful radiation

5.3.2 Considerations to Environment

We have to keep in mind some facts about environment-

1) The device should be run by renewable energy such solar energy

2) No harmful gases are released to the environment.

3) No heat is released.

4) it doesn’t change any characteristic of the environment.

5.3.3 Considerations to Cultural and Societal Needs

Every innovation requires a big market to bring in positive change in human life. Same is the case with our device. We had to keep in mind what type of people will be interested to use this device, what people actually need. Our project can bring huge change to cultural societal norms. As of now, in Bangladesh littering the environment is very much common. Littering the environment results in huge pollution, that contributes to global warming and air pollution directly. With our device, the data can be used as a proof of such hazardous effects. Thus, steps can be taken to change peoples' behavior of littering and change the norm. Awareness can be increased regarding this issue and our device will play a vital role in it.

5.4 Assessment of the Impact of the Project on Societal, Health, Safety, Legal and Cultural Issues

5.4.1 Assessments of Societal Issues

As the population is growing day by day, the number of industries and factories is also increasing. The increased number of industries will release more garbage to the environment. Therefore, in every industry the environment monitor device should be installed. In this way, the activities of the industry can be controlled. Besides, in agriculture fields, household, educational institute everywhere environment monitoring is needed. As our device is both power efficient and cost-effective and requires no internet or direct power line connection, it can be installed everywhere by anyone.

5.4.2 Assessments of Health and Safety Issues

Our device releases no harmful component to the environment. It is completely safe to use. As the batteries are charger through solar energy, the battery life is increased. All the sensors and modules used in this project are health hazard free.
Environment has a vital effect on human health. Using this power efficient and affordable device, the important parameters of environment can be monitored and analyzed easily.

The temperature and humidity sensor takes the temperature and humidity reading from the environment. The MQ165 (Gas sensor) takes the reading of CO_2 and some other harmful gases whether they are above the threshold or not. None of these components have any negative effect on environment. Besides we have used GSM module to send the data to the server which is also environment friendly. We have used LIPO batteries to power up our device. A solar system is installed to charge the batteries. There the battery life is increased which is a positive thing for environment.

5.4.3 Assessments of Legal Issues

There are 5 environmental laws to wit [11]-

- Environmental Impact Assessment Law (PD 1586)
- Toxic Substances and Hazardous Waste management Act (RA 6969)
- Clean Air Act of 1999 (RA 9003)
- Ecological Solid Waste Management Act (RA 9003)
- Clean Water Act (RA 9275)

This device emits no harmful element to the environment rather provide us important data about air quality. No fuel is used, power by solar energy, less battery dumps. It doesn't affect any parameter of air and water. It doesn't create any ozone depletion elements. Therefore, we can claim our device completely environment friendly.

5.4.4 Assessments of Cultural Issues

The environment monitor regularly monitors the air quality, temperature and humidity of the atmosphere. Using ThingSpeak we can analyze these data and have a clear view about the atmospheric condition. For example, how good or bad the condition, how much risky the environment is to the health of people. Now, people in a particular area may not believe what an expert says or ask them to do. But if they can see result in front of their eyes, it will bring about positive change in their norms and culture so that they don't pollute the environment.

5.5 Evaluation of the Sustainability and Impact of the Designed Solution in the Societal and Environmental Contexts

5.5.1 Evaluation of Sustainability:

In the era of industrialization and global warming, environment monitor is a must. Our product is sustainable because-

Accuracy: It can continuously read the accurate data and send it to the server where the data can be analyzed and understandable results can be produced

Energy Efficient: Our product is run by LIPO battery which is charged by 2 6V solar panels. By using renewable energy.

Cost Effective: This product is affordable by the target customers (Factories, Wealther monitoring center, Different Institute, Agricultural sectors)

Durability: The device is guaranteed to last for years without any additional maintanace.

No Internet Connection: As GSM module is used to send the data to server no internet connection is required.

5.5.2 Evaluation of Impact of Design in Societal Context

Our social activities have great impact on our environment. By using an accurate, durable and affordable environment monitor we can know the condition of our environment. We can modify our activities to keep our environment sound. In modern era, it is impossible to stop the production in factories, to stop using air conditioner. At this point we can optimize our activities. For example, if an area already has high temperature and humidity, we should not make a burning ground or cemetery there.

5.5.3 Evaluation of Impact of Design in Environmental Context

The design of our device is compact and light. It neither emits any harmful elements nor changes any parameter of the environment. It can read the accurate data and using GSM module, send them to the server. It used renewable energy to charge the batteries. It is completely an environment friendly device.

6 Reflection on Individual and Teamwork

6.1 Individual Contribution of Each Member

1706042 Monirul Islam:

Assembled the circuit including Arduino, temperature and humidity sensor and gas sensor. Wrote the code for GSM module and sending data to the server. Designed the circuit to set the batteries in both charging ad discharging condition. Designed the PCB for the whole system.

1706043 Fariza Siddiqua:

Wrote the code for Arduino in initial setup. Designed the circuit by using two more batteries in series to meet the current demand for GSM Module. Gave the final battery charger connection. Helped in building the relay system.

1706044 Shuvro Chowdhury:

Assembled the circuit to run the GSM Module. Helped to build the battery charging system using solar. Did research to charge and discharge the battery. Collected all the components.

1706045 A F M Mahfuzul Kabir:

Assembled the circuit to run GSM Module. Did the 3D rendering of the initial PCB. Figured out the charging connection from series to parallel. Implemented the idea of using two charging modules.

6.2 Mode of Teamwork

We had to search for different available circuit and projects on internet, gathered knowledge about the overall IoT system. Then we did online meetings via google meet. Discussed on the project and divided the work among us.

After mid break, we gathered all the components and sat at the guest room of Sher-e-Bangla Hall and worked together. When we faced problem running the GSM module, we tested the circuit using larger capacitor in Power Electronics lab. Finally, we found out a solution and made it.

6.3 Diversity of Statement

Four of us have diverse past experiences of work. Monirul Islam was the most expert among us in case of building circuits. He has done several personal and competition-based projects before. Therefore, he has an excellent skill in doing projects.

Shourav is also an expert in building cicuits, finding out solutions quickly, 3D rendering.

Fariza helped to gather information about previous projects, components and worked in building the battery charging system using solar.

Shuvro worked parallelly in all sectors. Collected all the components as early as possible. Helped to bulid the battery charging circuit.

6.4 Logbook of Project Implementation

Date	**Milestone achieved**	**Individual Role**	**Team Role**	**Comments**
29 June, 2022	Assemble Arduino with temperature & humidity sensors and air quality sensor.	Monirul Islam (42) assembled the circuit and tested using the code.	While Monirul assembled the circuit, Fariza wrote the code.	Worked without any issues.
20 July, 2022	Write code for the setup and get data.	Fariza Siddiqua (43) wrote code for the initial setup.	Same as above.	Worked without any issues.
3 August, 2022	Assemble Arduino with GSM module	Shuvro Chowdhury (44) and	Monirul was parallelly writing code	Didn’t work. The GSM module draws high

	and try to upload data to server.	Mahfuzul Kabir (45) assembled and tried to run the GSM.	for GSM module and uploading the data to server.	amount of current while connecting to the network. Arduino wasn't enough alone to provide such current.
10 August, 2022	Modification in battery supply for high current demand of GSM module.	Monirul Islam (42) and Fariza Siddiqua (43) designed the solution circuit by using two more batteries in series to meet the current demand.		GSM worked and connected to the network. GSM could send data to the server.
13 August, 2022	PCB of basic circuit designed for the Arduino shield and connected the circuit.	PCB was designed by Monirul Islam (42) and printed.	3D rendering of the initial PCB was done by Mahfuzul Kabir (45).	The PCB was functioning properly.
17 August, 2022	Battery charger circuit connected to the whole system using single charging module.	Fariza Siddiqua (43) and Shuvro Chowdhury (44) did internet in search for battery charging system using solar.	The group assembled the circuit as found from internet research and tried to charge the batteries.	Problem arises as batteries in series can't be charged by the charging module. This issue makes the PCB printed before obsolete.
19 August, 2022	Alternate solution using relays for battery charging circuit. Two charger module was used.	Monirul (42), Fariza (43) Kabir (45) figured together the relay system for changing connection from series to parallel while charging.	The group with joint effort completed the circuit and tested for any errors.	Worked without any issue.
20 August, 2022	PCB designed from scratch to make room for modified circuit. Two charging modules used this time.	PCB was designed by Monirul Islam (42)	Once done printing and delivery, the PCB was used to finalize the final circuit by the whole group.	Worked without any issues.
27 August, 2022	System final trial using solar power.		The whole group tested	Worked without any issues.

			the circuit in broad daylight. Charging and discharging was tested along with data uploading to the server.	
29 August, 2022	PCB 3D Rendering	PCB 3D rendering was done by Mahfuzul Kabir (45) Shuvro Chowdhury (44)		Screenshots were taken for addition to report and slide and GitHub repository.
30 August, 2022	GitHub repository created	GitHub Repository was created by Mahfuzul Kabir (45).	The group one by one uploaded all files in the repository.	The GitHub repository link is given in section 4.3
30 August, 2022	Casing made using sheets. Final Trial.	Casing box was made by Monirul (42) and Shuvro (44)		

7. References

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