AN AUTOMATED SOIL TEMPARATURE, HUMIDITY & CO2 DETECTION SYSTEM

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Science in Computer Science and Engineering

By

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ABSTRACT

The Soil is one of the key elements that affect the crop growth and yields during the entire agricultural cycle starting from seeding to harvesting. Farmers are well aware of the importance of prior knowledge of soil conditions and its crop specific suitability, but they generally lack the tool to measure and manage the variations in soil characteristics more precisely. To solve this kind of problem our research is about to measurements of soil temperature, humidity and CO2 gases present at soil. We propose a device that is able to monitor the soil temperature, humidity and CO2 and at the same time gives result that is collected from input. This device named Automated Soil temparature, humidity and CO2 detection system gives real time data of the soil temperature, humidity and Co2. It has one temperature sensor, one CO_2 sensor and one humidity sensor which is assembled with these multiple sensors operated by AVR microcontroller unit (MCU).It gathers the reading in signals from various sensors and identifies the amount of temperature, humidity and CO2 gases of soil. Here the parameters are converted into data values by means of Arduino Mega Microcontroller. And these values get stored and used on future prediction for measuring soil quality .This research paper presents how this system is built, components and device diagram and future scope. Overall performance is evaluated through experimental tests by getting the real time temperature amount, humidity amount or CO2 amount in soil to investigate reliability.

Keyword: sensors, signals, microcontroller, soil, experiments.

Approval

The thesis report —AN AUTOMATED SOIL TEMPARATURE, HUMIDITY & CO2 DETECTION SYSTEM is submitted by MD. KHORSHED ALAM ID:CSE 051 06511, to the Department of Computer Science & Engineering, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science (B.Sc.) in Computer Science & Engineering and as to its style and contents.

Board of Examiner's Name, Signature and Date:

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Supervisor's Signature and Date:

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Nazia Hossain

Date:

Declaration

I, hereby, declare that the work presented in this Thesis is the outcome of the investigation performed by us under the supervision of Dr. Mohammad Shaharia Bhuyan, Assistant Professor, Department of Computer Science & Engineering, Stamford University Bangladesh. I also declare that no part of this thesis and thereof has been or is being submitted elsewhere for the award of any degree or Diploma.

Signature and Date:

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MD. KHORSHED ALAM

Date:

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At first I would like to thank the almighty ALLAH for giving me ability, chance and such cooperating supervisor. With His mercy, today I am completing my thesis work successfully.

I would like to take the opportunity to express my gratitude to Dr. Mohammad Shaharia Bhuyan, my respected supervisor. Although he was always loaded with several other activities, he gave me more than enough time in this work. He not only gave me time but also proper guidance and valuable advice whenever I faced with some difficulties. His comments and guidance helped me in preparing my thesis report.

I would like to thank all my respected teachers, who inspired me in every step. I am also thankful to my friends who helped me in a number of ways by providing various resources and moral support.

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1. INTRODUCTION

1.1 Overview

Agriculture is the backbone of Bangladeshi economy. As without agriculture living is quite impossible since agriculture provides the main source of food for us. But as the farmers are not that much educated they can't find out the real problem of soil easily and also the unavailability of experts from government end of caring out agriculture activities is rare. The automation in all kind of industries leads to industrial growth. Here agriculture process needs to be automated. In this proposed system we will work on an automated system that will find out soil situation for the farmers. So seeding, planting, fertilizing weeding, harvesting will be much easier on the success of this research.

1.2 Research Background

Countries like Bangladesh whose market is mainly based on agriculture and the climatic environment is isotropic and is not able to make full use of agricultural assets. Agriculture using automation techniques like Automatic water dripping system, Automatic chemical spray system and Automatic chemical preparation system can do agriculture efficiently and lead to increase in crop production and quality. So thinking on that we are planning to make a device that will give proper information/ real time data of soil temperature, humidity, CO_2 and elements those are present in the soil of a specific area. Through this we will be able to find out if the soil quality is standard or not. We have planned this whole process in two phases. In the first phase we will find out the data of soil temperature, humidity, CO_2 and in the second phase we will find out the elements those are needed in soil to be standard soil. In this paper we will work with the first phase that is finding out real time data of soil temperature, humidity, CO_2. And will keep the second phase for future research.

1.3 Problem Statement

The Soil is one of the key elements that affect the crop growth and yields during the entire agricultural cycle starting from seeding to harvesting. Farmers are well aware of the importance of prior knowledge of soil conditions and its crop specific suitability, but they generally lack the tool to measure and manage the variations in soil characteristics more precisely. Further farmers also face various problems in traditional soil testing methods such as high costs, poor monitoring point scalability, poor mobility etc. In order to mitigate the above-mentioned problems, this research paper describes design and development of a system and method for remote monitoring of multiple soil parameters in real-time. This proposed device which is now at simulation phase will make an opportunity to the farmers to know the quality of the soil of their crop field and also will be able to determine the perfect crops and fertilizer for their soil in future.

1.4 Thesis Objectives

Thesis objectives are set to achieve an optimized design of a new device or system that can give -

- Data of soil temperature , humidity and CO2
- Real time data
- User friendly output

For limited resources, the objective of this proposed thesis was set mostly on simulation level but besides research work a device prototype is also on its initial level of work through which we are trying to get Co2, temperature and humidity reading of real time.

1.5 Motivations

Agriculture is the biggest employment sector in Bangladesh. As of 2016, it employs 47% of the total labor force and comprises 16% of the country's GDP [19]. The performance of this sector has a fatal influence on major macroeconomic objectives like employment generation, poverty alleviation, human resources development and food security. So automation and precision agriculture studies are very necessary for our agricultural improvement.

Besides action has been taken to launch satellite (Bangabandhu-1) from Bangladesh Telecom Regulatory Commission [18]. And Bangladesh’s first nano-satellite Brac Onnesha launched into space already [5]. So satellite farming concept is also going to be proposed in Bangladesh in near future. And on that proposal our proposed thesis can be very useful if that is maintained by a database.

1.6 Research Methodology

The development of such complex system goes in several developing cycles with respect of feedbacks between individual parts of the system. Throughout the present study thesis objectives will be accomplished following the Gantt chart and work flow diagram

1.6.1 Gantt Chart of research:

Gantt chart of research work conducted for:

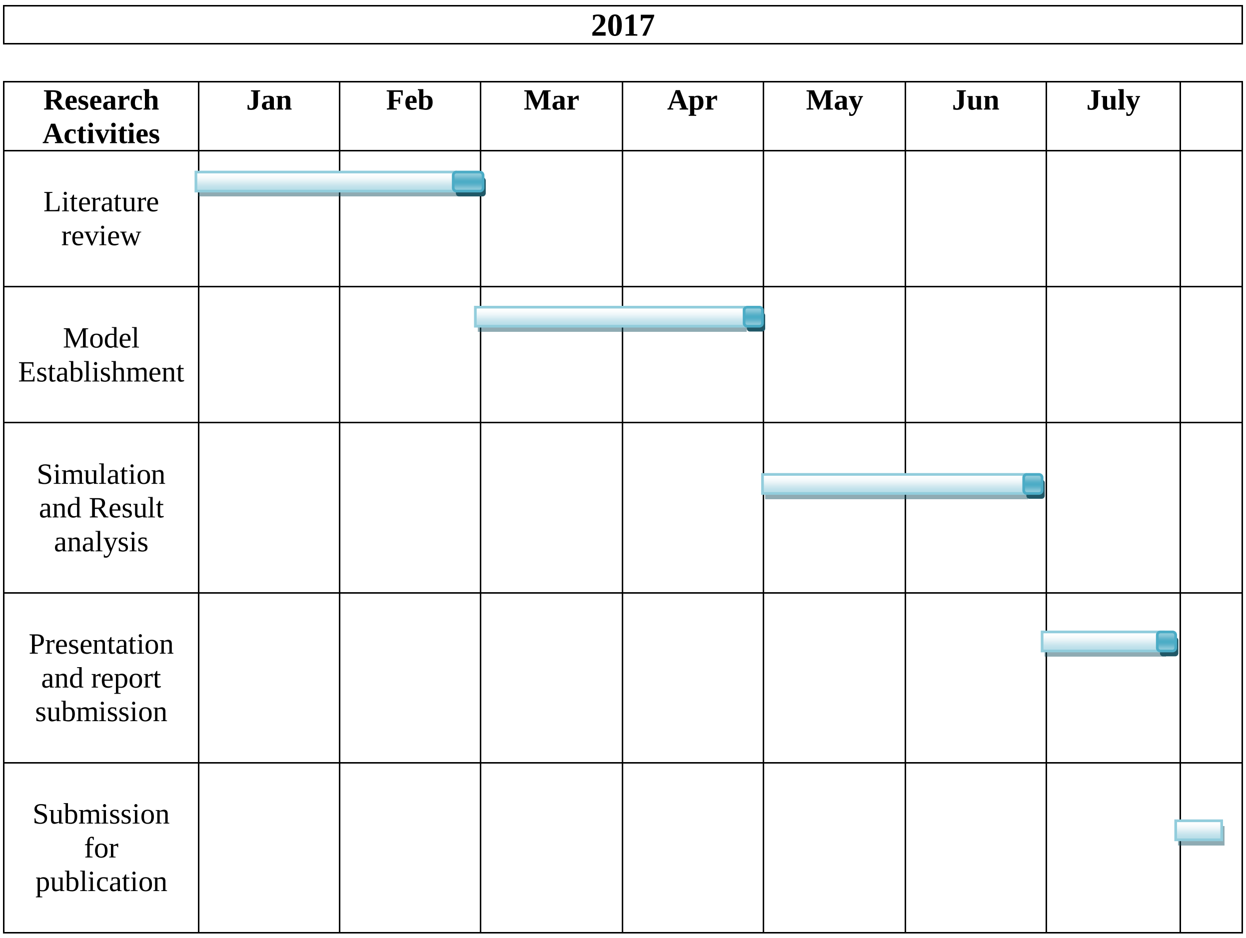

Figure 1.1: Gantt chart of conducted research work

1.6.2 Planned Millstones:

- February 2017: Completion of Literature review
- April 2017: Model Establishment
- June 2017: Completion of Simulation and Result analysis.
- July 2017: Presentation and report submission.
- August 2017: Submission for publication of the research paper.

1.6.3 Flow chart of the research work

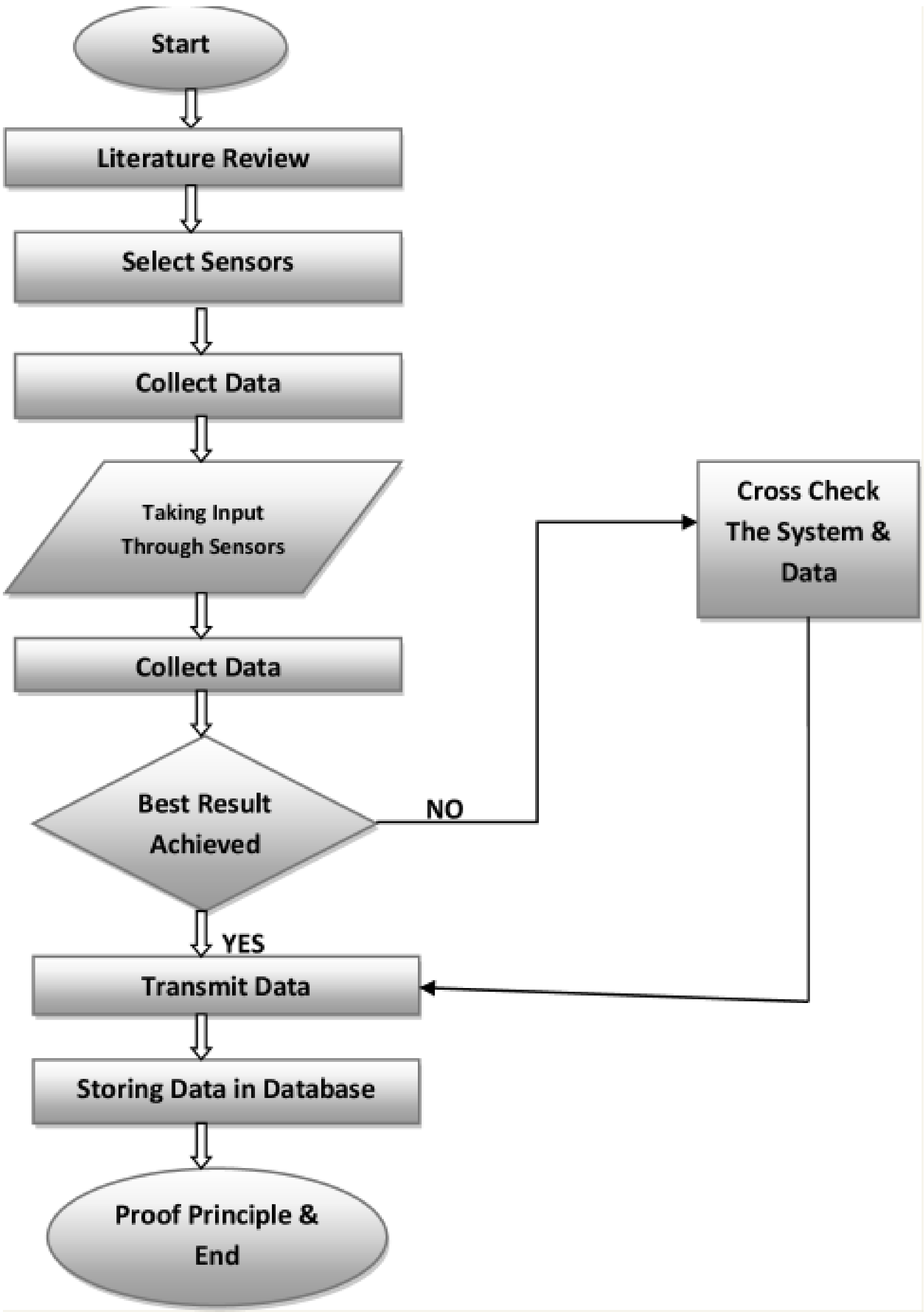

Figure 1.2: Flow chart of the research work conducted for this thesis

1.7 Contribution of the research

1.7.1 How the research is advanced from previous one

Till now all the previous research those are conducted regarding soil and soil elements are mainly focused on major elements of soil. Besides the research work those have been done with soil temparature, humidity and Co2 have not done in combined. But in our proposed research work we will work with all the elements of soil including soil temparature, humidity and Co2. And in the first phase we are working with soil temparature, humidity and Co2 in this thesis work. And this will give real time data all along.

1.7.2 Advanced benifit of this research from previous one

With the help of this research we will be able to get real time soil data all along and with those data it can be very easy and perfect to predict proper fertilizer and plants for proper soil . Besides which elements is missing for standard soil and how that can be solve it will be easily detarmined after full implimantation.

1.8 Organization of thesis

The organization of the thesis as per research work conducted is explained hereafter.

To start with, a comprehensive literature review was conducted. Chapter 2 details a review of the relation of temperature, humidity and Co2 with soil. Some information of previous research work and findings from there is also included in this chapter.

In Chapter 3, system description and overall information of the proposed device are documented here. The devise uses an arduino mega based system with different sensors as per needed from the literature. Besides system flow diagram and device diagram is included here.

Chapter 4 will show overall information of each equipment that is used to build the system.

Chapter 5 shows research methodologies of the proposed work.

Chapter 6 discusses the results of the analysis conducted in chapter 5, and compare to identify best results.

Chapter 7 concludes the thesis with a detailed guideline of future research to complete the development process of the proposed system and the limitation and problem faced in this work.

2. LITERATURE REVIEW

2.1 Overview

Eight major elements, Al, Fe, Ti, Ca, Mg, Mn, K, and Na were determined by INAA (Instrumental neutron activation analysis). In most of the cases, research was conducted for these elements and to detect these elements from soil. But temperature, humidity and CO2 are also very important part of soil to and plant growth. So in this research we are working with temperature, humidity and CO2 of soil as the first phase of our research work which is unique from previous conducted research. In this chapter we have tried to give a short description of relationship and effects of these elements with soil and some past research activity which were conducted earlier.

2.2 Case Studies

We have gone through some articles about smart irrigation, soil element detection and topics related to this and we have seen that apart from other countries in the world only India has emphasized on this issue as they are also give priority to the agriculture. We are far behind them. From all those articles we have taken the following three cases as our base case.

CASE 1

According to the project done in India [23] 'Automatic Irrigation System' written by Shagun Agarwal, Suyash Pandey, Shravan Kumar, Kunal Chaudhery we got to know that they embarked on the design of the Weather Station. They have said that 'We are doing development of low-cost water monitoring system in soil consisting of soil moisture level sensor. For sensing level of soil moisture we have used famous and efficient probes. It is a circuit sensor that can be used to measure soil moisture with an electrical output proportional to the water in soil. And with increase and decrease in soil moisture level in the soil we are controlling it through motor pump which will exact the water in/out when it will sense decrease in soil moisture and vice versa'.

From their project we have come to know about the soil moisture or humidity sensor but our thinking was little bit different as we not implemented soil moisture sensor but used other sensor to get more statistics instantly. We have already discussed what sensors we have used in our system.

CASE 2

From another research named Wireless Soil Multi-parameters Remote Monitoring and Alerting System [2] we got to know that they have worked on a system which is based on usage of state of art embedded and wireless communication technology for remote monitoring of multiple soil parameters in real-time and providing an alert to the user for critical conditions. Through their system they worked on specific soil parameters such as soil moisture, soil temperature, soil pH, ambient temperature, light, and water Level.

From their research we have come to know about the soil temperature sensor and multi parameter activity. But we have planned to work with differently. They focused on communication alerting system but we are focusing to get real time data of three parameters which are temperature, humidity and CO_2.

CASE 3

Students of Brac University Bangladesh conducted a research[23] in 2014. On that research they took the idea of using soil moisture sensor for detecting the water presence in the roots of the plant. Along with that we used hsm-20g for measuring humidity and temperature, yl69 for measuring soil moisture, an analog ph sensor to measure the scale of ph and also an Ldr sensor to measure the sunlight intensity. So according to them, their overall system is very helpful to the farmers as they will get all the state instantly. And we thought an automation system like them but we took soil temperature, humidity and CO_2 in our consideration.

2.3 Problem Scenario & Our Research

Agriculture production system is a complex interaction of seed, soil, water, fertilizers, and pesticides etc. Hence, the optimum use of natural resources such as soil and water are essential for the sustainable agricultural growth. Out of the mentioned resources, soil is the key resource that influences the crop growth and yields. Soil fertility and soil specific crop suitability have always been considered as the key factor to be looked upon by the farmers for getting better crop yields. As farmers generally lack the tools to measure, map and manage the variations in soil characteristics more precisely [1, 2]. In their endeavors' to get the maximum crop yields; the farmers usually apply fertilizers and other chemical supplements in their farmland without understanding the actual crop specific needs.

In addition, the farmers require precise and accurate information about their farmland condition at the right time via easily accessible means governed by automation. As a step to mitigate these kind of problems we are proposing a system that can give real time data of temperature, humidity and CO_2 of soil all along in a same time. The system continuously sense and analyze the soil conditions by monitoring the variations in soil multi parameters (CO_2, Humidity, and Temperature) over the time.

To understand the existence of similar solutions in the commercial market, we have studied a number of sensors/probes/instruments/ devices and their detailed specifications. The detailed information on these devices and systems has been given in table 2.1[6]-[11]. Few foreign vendors and manufacturers provide products that provide sensing for one or two parameters but these are very costly items [15] .

Table 2.1 Different soil elements measurement device and their price [15]

System/ Device	**Feature/Specification**	**Measurement/ Cost**
Lutrom ph 220s soil pH Meter [6]	Measurement range : 0 to 14 pH x 0.01 pH, LCD Digital Display, Auto calibration, DC 1.5 V*4PC battery, Soil pH electrode, **O.T**: 0 to 50°C; **P. C**: 4.8mA **L: 1m, Wt:** 20grams/ .48lb (included electrode)	Only pH/ 46Euros
ph-212-Lutron Soil pH meter [7]	14 pH x 0.01 pH, LCD Digital Display, DC 9V battery, Calibration knob, Any connector with pH electrode, water resistant **P.C**: 2.0 mA; **O.T:** 0 to 50°C; **Wt: 196gm**	Only pH/ 59 Euros
3-in-1 meter [8]	No battery required, electrode is provided	Measures soil pH, Soil moisture & light/720 Rs
Soil ph-moisture Meter [9]	No battery required. Measuring pH range: 3-8% Measuring moisture range: 1-8% ; Precision: ±1% ;Precision: ±0.2 pH Suitable for surface test/Analog Display	Measures soil pH, Soil moisture & light,
HI 99121 Direct Soil pH Meter [10]	pH, Oxidation Reduction Potential(ORP),Temperature, inside depth - 5.9 inches, **Waterproof; Wt:** 205grams; **Battery**: 1.2V AAA; Digital display	pH/$333.21
EC-5 Soil Moisture Smart Sensor - S-SMCM005 (Available With data loggers) [11]	**Soil Probe Dimensions**: 89 x 15 x 1.5 mm (3.5 x 0.62 x 0.06 in.); **L**: 5 m (16 ft); **P.C**: 2.5VDC - 3.6VDC @ 10mA **O.T. :** -40° to 60°C, Analog Output	Moisture/ Unknown
TMC20-HD [15]	Data Logger compatible (For mobile devices via Bluetooth)	Unknown/$39

	O.T: -40° to 50°C **L:** 1.8mts;**Analog sensor; S.V.:600VAC**	
THERM200 from Vegetronix	**L:** 2 meter ; **P.C.**< 3mA; Data-loggers compatibility with its own as well as 3'rd party	Unknown/ $31.95
RT-1 from Decagon Devices	**O.T.**: -40° to 80°C **L:**5m Data Logger compatibility	Unknown/$20

O.T: operating temperature; L: Length; S.V.: supply voltage
Wt: weight; P.C: power consumption

2.4 Previous Research Gap & New Proposal

The majority of the prior research activity or devices or instruments measure either of any one soil parameter such as soil temperature, moisture, soil electrical conductivity (EC) & pH or any two. Further, the instruments used for measurement of soil moisture and temperature provide the data in the analogue form and only a few gives digital data. In addition, most of the available soil pH meters are electrode based and provides the data in the analogue form and only a few gives digital output. Further, the existing devices or instruments operate only in one mode and mostly have no provision for multimode communication with a user-friendly mobile app. Hence, there is a need for a system which can overcome the disadvantages of prior art.

Our system is assembled with multiple sensors operated by microcontroller unit (MCU).It gathers the reading in signals from various sensors for a specific area, and identifies the amount of temperature, humidity and CO2 gases around us. The parameters such as temperature amount, humidity amount or CO2 amount are measured for a specific place using sensors. These parameters are converted into data values by means of Arduino Mega Microcontroller. And these values can be stored and used on future prediction for measuring soil quality and choosing perfect crops for a specific kind of soil. This paper presents how this system is built, components and connection diagram and implementation logic. Overall performance is evaluated through experimental tests by getting the real time temperature amount, humidity amount or CO2 amount in soil to investigate reliability. This system will store all the data in the computer for future inspection

2.5 Co2 Effects

According to scientists more carbon remains in soil than in the atmosphere and all plant life combined; there are 2,500 billion tons of carbon in soil, compared with 800 billion tons in the atmosphere and 560 billion tons in plant and animal life [17]. "If we treat soil carbon as a renewable resource, we can change the dynamics," says Goreau. "When we have erosion, we lose soil, which carries with it organic carbon, into waterways. When soil is exposed, it oxidizes, essentially burning the soil carbon. We can take an alternate trajectory.” And to do so we need to know the data of Co2 at soil that can be used later [17].

2.6 Humidity Effects

Water vapor is one of the most significant variables affecting the crop growth. Humidity is important to plants because it partly controls the moisture loss from the plant. The leaves of plants have tiny pores, CO2 enters the plants through these pores, and oxygen and water leave through them. Transpiration rates decrease proportionally to the amount of humidity in the air. This is because water diffuses from areas of higher concentration to areas of lower concentration [22]. Due to this phenomenon, plants growing in a dry room will most likely lose its moisture overtime.

The damage can be even more severs when the difference in humidity is large. The humidity control is complex because if temperature changes then relative humidity changes inversely. Temperature and humidity are controlled by the same actuators. The main priority is for temperature control because it is the primary factor in the crop growth .Based on the inside relative humidity value the temperature set-point can be adjusted to control the humidity within a determined range. Hence to control the required humidity is very complex task. For proper control of humidity internal air can be exchange with outside air by properly controlling ventilations of the greenhouse [20].

2.7 Temperature Effects

As we know all the living plants depend on temperature of air we have taken this issue into our account. Sometimes temperatures are used in connection with day length to manipulate the flowering of plants. Temperatures alone also influence flowering. Thermo period refers to daily temperature change. Plants produce maximum growth when exposed to a day temperature that is about 10 to 15°F higher than the night temperature. This allows the plant to photosynthesize (build up) and respire (break down) during an optimum daytime temperature, and to curtail the rate of respiration during a cooler night. High temperatures cause increased respiration, sometimes above the rate of photosynthesis. This means that the products of photosynthesis are being used more rapidly than they are being produced. For growth to occur, photosynthesis must be greater than respiration. Similarly humidity is also an important factor for soil and plant growth. All plants inhale carbon dioxide through their leaves. This gas is used in photosynthesis. As the plant opens its leaf pores to take in carbon dioxide, some of the moisture in the leaf can escape. Thus the plants sweat water vapor into the air whenever they breathe.

Different crop species have different optimum growing temperatures and these optimum temperatures can be different for the root and the shoot environment and for the different growth stages during the life of the crop. Since we are usually interested in rapid crop growth and development, we need to provide these optimum temperatures throughout the entire cropping cycle. A team of researcher says if a greenhouse were like a residential or commercial building, controlling the temperature would be much easier since these buildings are insulated so that the impact of outside conditions is significantly reduced [21]. We have added a table that describes some information about some crops and their suitable temperature in our thesis paper.

Table 2.2 Different soil temperature for different plants [3]

Crop	Minimum Temperature (°C)*	Optimum Temperature (°C)*	Days to Germination
Celery	4	21-23	10-14
Bean, Snap	15	23-29	7
Beet	4	23	7-14
Carrot	4	23-26	12-15
Cole Crops (Cabbage, Cauliflower, Broccoli, etc)	4	18-29	5-10
Cucumber	15	21-29	7-10
Eggplant	15	21-29	10
Lettuce	0	18-21	7-10
Melon	15	26-30	5-10
Onion (bulb)	0	21-23	10-14
Onion (bunch)	0	15-20	10-14
Pea	4	18-21	7-14
Pepper	15	23-29	10
Pumpkin	15	21-23	7-10
Radish	4	18-21	5-7
Spinach	0	21	7-14
Sweet Corn	10	21-29	7-10
Swiss Chard	4	20-23	7-14
Tomato	10	23-26	7-14
Turnip/Rutabaga	15	18-21	7-14

3. SYSTEM DESCRIPTION

3.1 Overview

Many research papers were written individually about the soil temperature, humidity or Co2. And besides in most of the cases research works were conducted focusing on major elements of soil only. In our proposed thesis work we are first time focusing on getting

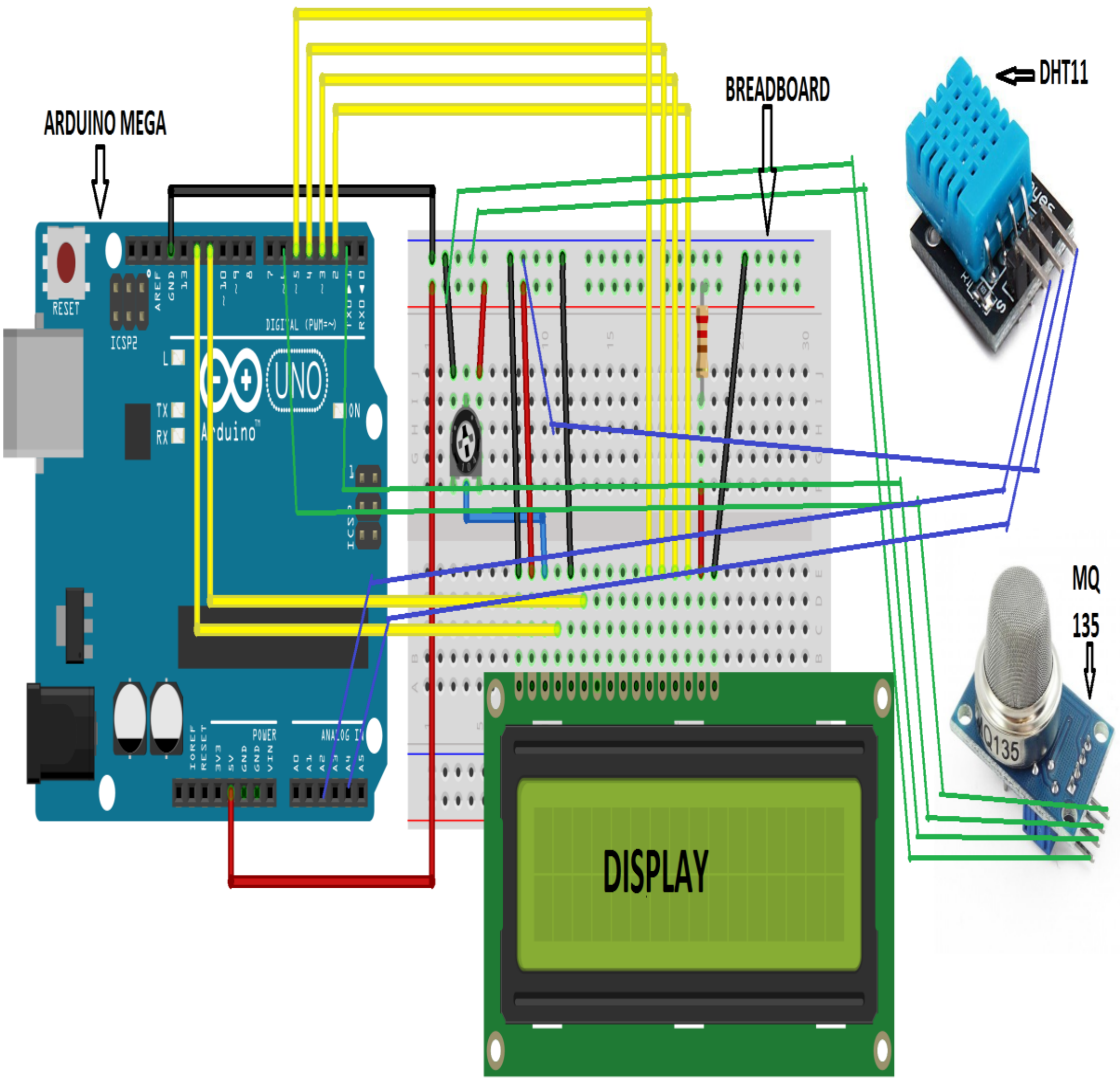

Figure 3.1: Device diagram

data of soil temperature, humidity and Co2 all together from soil and also showing output in a very user friendly way. Our device is able to monitor the soil elements and at the same time give result that is collected from input. This device gives real time data of the soil temperature, humidity and Co2. This device has one temperature sensor, one CO_2 sensor and one humidity sensor.

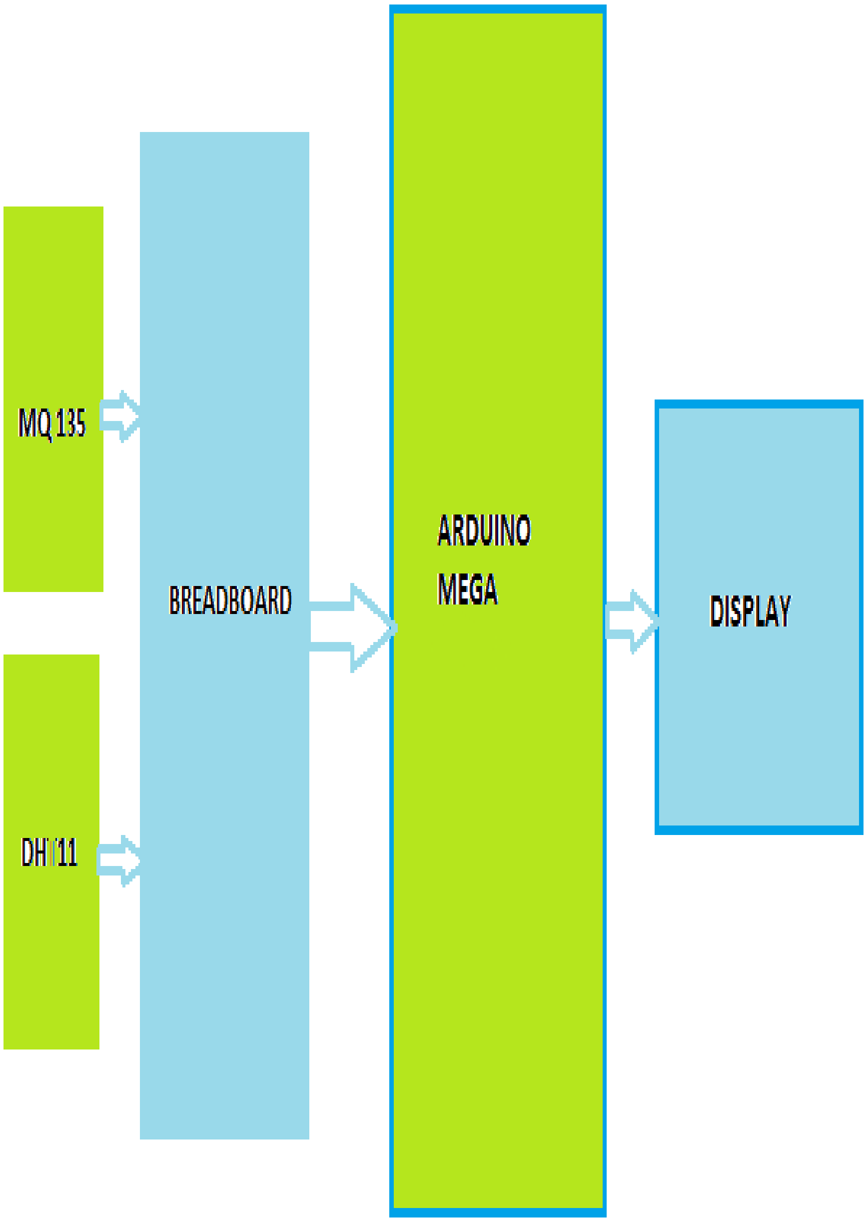

Figure 3.2: System diagram

The method of this device is very simple and basically it is a prototype which is a part of our final prototype. As because resources are not that much available we are working with our first phase of work which is included to find out real time data of soil temperature, humidity and Co2. A system diagram is shown in figure 3.2for the system implementation.

3.2 System Information

One sensor is used to detect the CO2 gas. Similarly for detecting temperature and humidity another sensor has been used. The system is designed in such a way to detect the presence of temperature, humidity and CO2 gases. The system uses two sensors namely DHT11 and Mq-135 for the detection of these elements in soil. An Arduino mega board microcontroller is used for processing. Arduino senses the elements amount by receiving inputs from the two sensors.

The whole system is developed using Arduino language in Arduino environment and python. The components of the system are:

- Arduino Mega
- DHT11 (Humidity & temperature sensor)
- MQ-135 (CO2 Sensor)
- Bread Board
- LCD
- Jumper Wire
- Arduino Environment & language
- Python Environment & language
- Laptop
- CoolTerm

At first the system will turned on and checked sensor is working or not. If the sensor worked then the sensors take the input from the environment else it will go back and recheck the sensor. For different temperature different plants grow well. The temperature sensor will give real time data. Similarly humidity sensor and Co2 sensor will give us the data. After getting all the information it will show those data on the display.

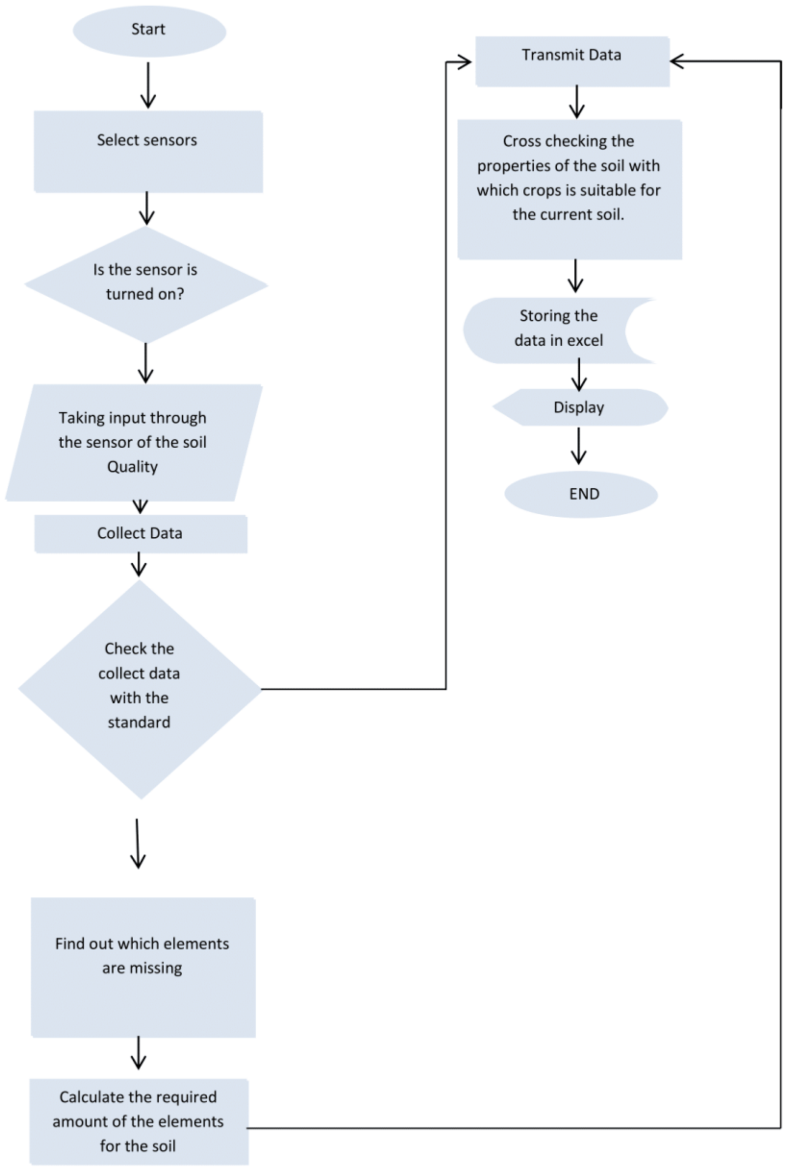

Figure 3.3: Data Flow Diagram

4. SYSTEM EQUIPMENT DESCRIPTION

4.1 Overview

Here in this chapter description of all the equipments used to build the system are given individually. To get the real time data we had to choose these equipments and will try to collaborate these equipments with our future work activity.

4.2 Arduino Mega

The Arduino Mega is a microcontroller board based on the ATmega1280. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, 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 Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

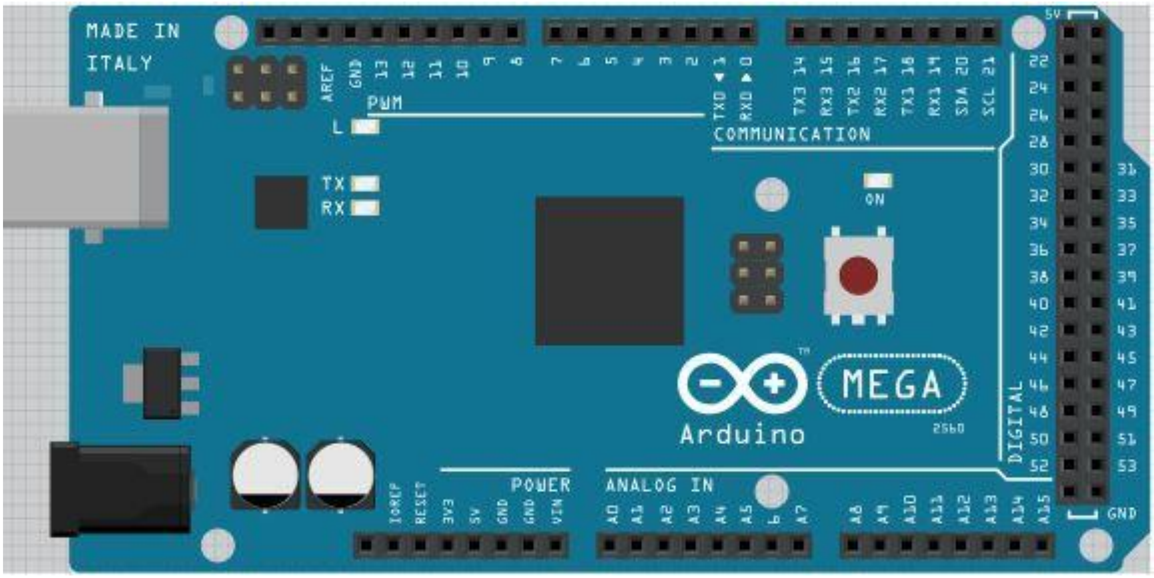

Figure 4.1 Arduino Mega

4.3 MQ-135

In this project, MQ135 are are suitable for detecting various gases including CO2. Structure and configuration of MQ-135 gas sensor is composed by micro AL2O3 ceramic tube, Tin Dioxide (SnO2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. It possess following feature: detection range of 10-2000 ppm, Fast response, long life and Simple drive circuit. The enveloped MQ-135 has 6 pin, 4 of them are used to fetch signals, and other 2 are used for providing heating current. Figure 5 shows the picture of MQ-135 gas sensor.

Figure 4.2 MQ 135

4.4 Jumper Wire

A jump wire (also known as jumper, jumper wire, jumper cable, DuPont wire, or DuPont cable – named for one manufacturer of them) is an electrical wire or group of them in a cable with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

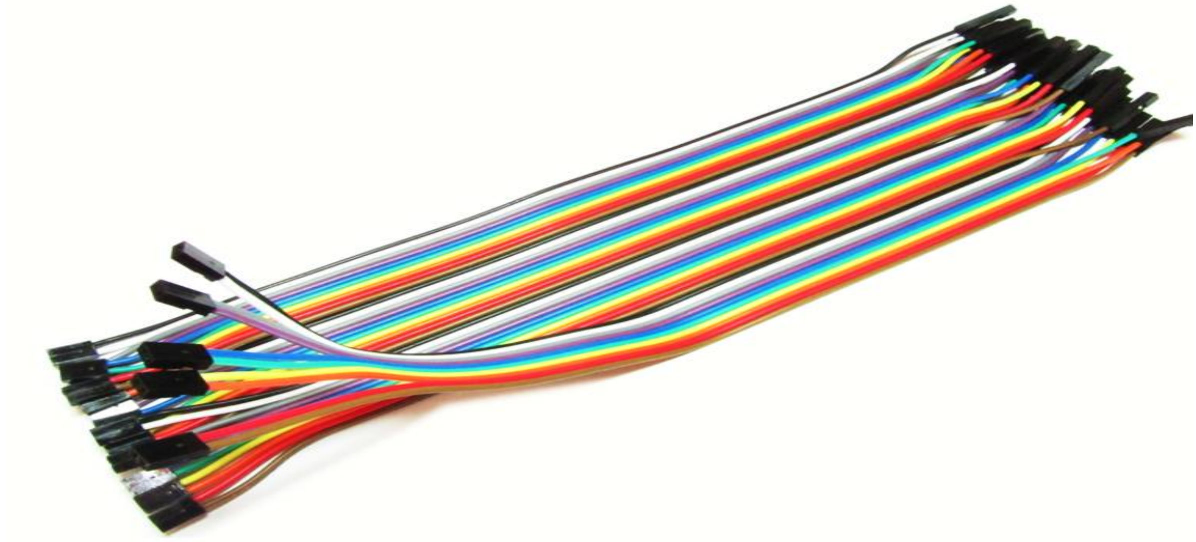

Figure 4.3 Jumper Wire

4.5 DHT11

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the temperature and humidity, and spits out a digital signal on the data pin (no analog input pins needed). It’s fairly simple to use, but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old. It is good for 20-80% humidity readings with 5% accuracy and good for 0-50°C temperature readings ±2°C accuracy [4].

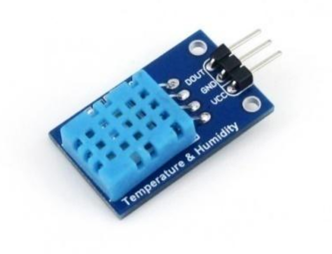

Figure 4.4 DHT11

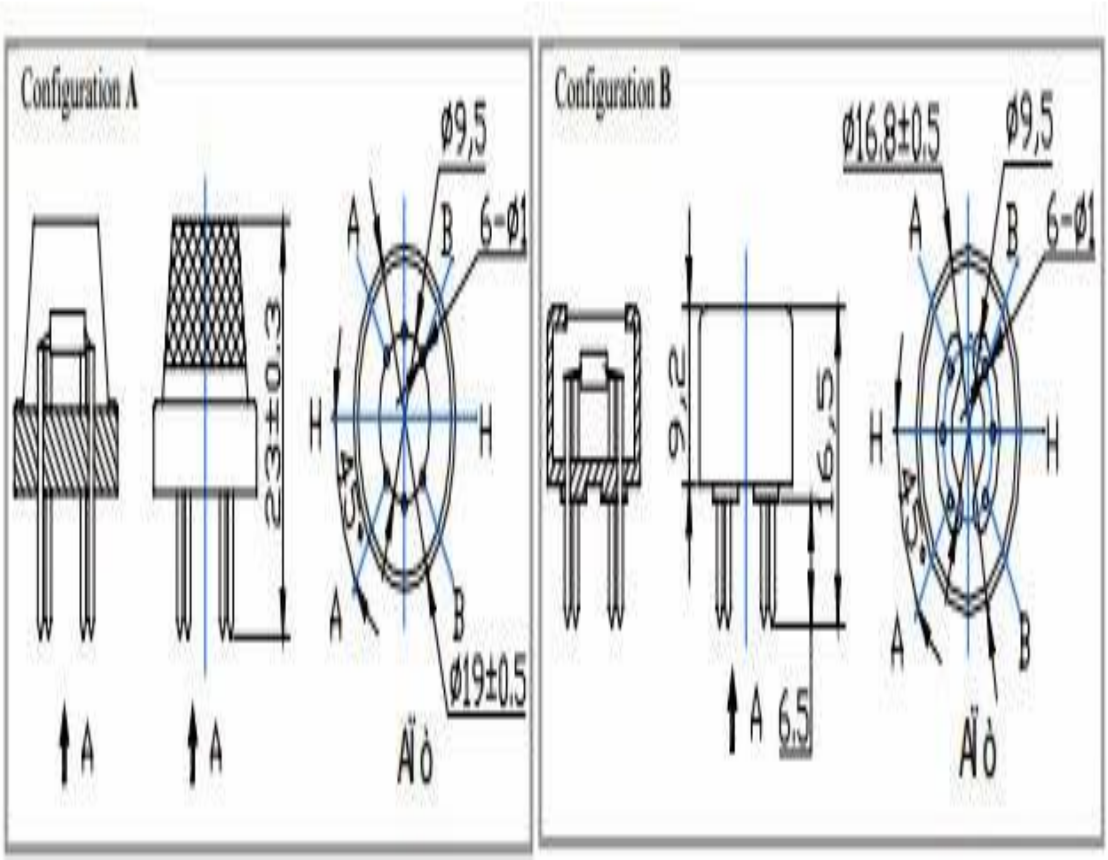

Figure 4.5 Circuit diagram of DHT11
Figure 4.6 Circuit diagram of MQ-7

5. METHODOLOGY

5.1 Overview

The device follows simple techniques which are available in online. The view of circuit diagram is shown in figure 5.1.Here only used if else, while and some mathematical equations. Project's basic principle of working is the sensing of data from the sensor and save data in "Cool Term" Process the digital data and display it on LCD. At the same time this device will give real time data to which will be save in Cool Term.

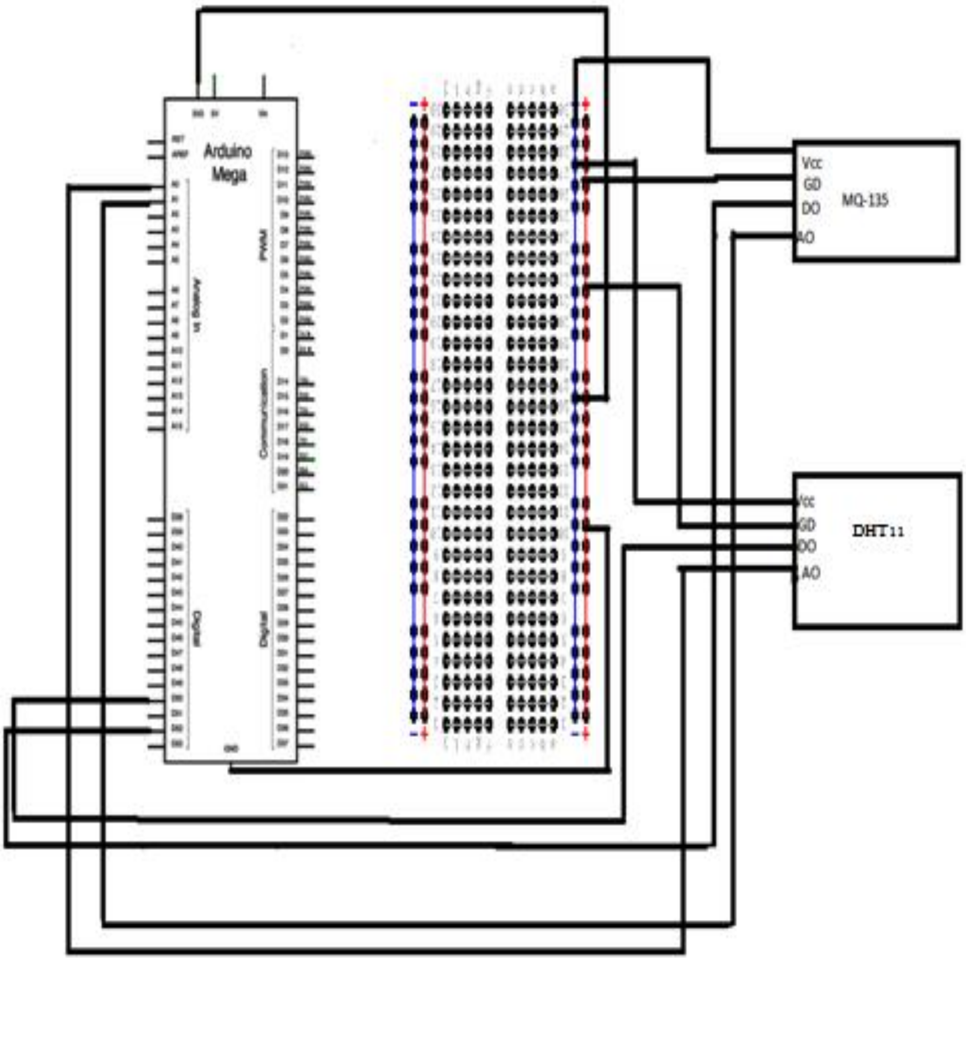

Figure 5.1 Circuit Diagram

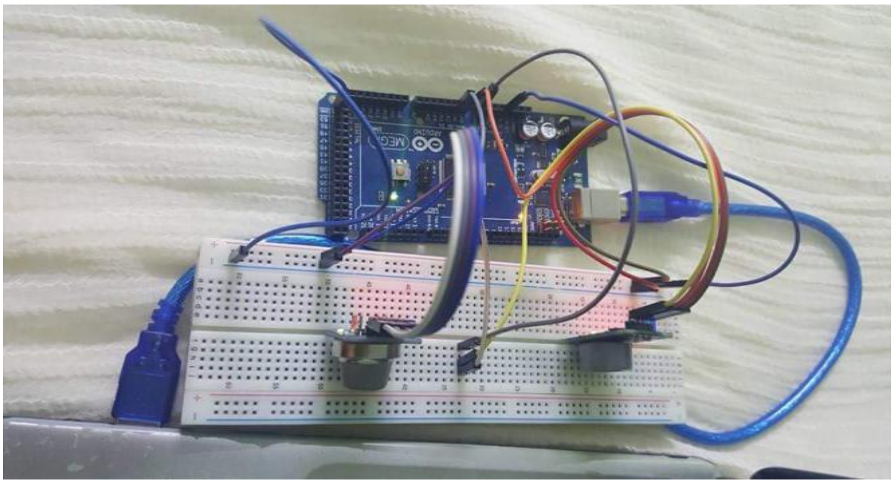

Figure 5.2 View of Circuit Setup

5.2 Measuring Co2

The **Carbon Di Oxide** is measured by MQ135 sensor. It is sensitive for CO_2.The power is within 2.5V ~ 5.0V. MQ-135 is very sensitive for CO_2 gas.MQ-135 is a semi-conductor. It is connected with Arduino throw a bread boar and wires in series. After connection it gives the CO_2 value in ppm. The resulting value will be saving in cool term throw the python IDE. It is discussed in next part. The wiring figure is shown in figure 5.2.

5.3 Measuring Humidity and Temperature

The Temperature and Humidity is measured by DTH11 sensor. It is based on DHT11 sensor module. It is powerful but easily use. The sensor comprises a resistance-type humidity sensor and a NTC temperature measuring element, and it is connected with a high-performance 8-bit microcontroller. The calibration-coefficient is saved in the OTP memory to provide accurate temperature readings. The sensor has small size and low power consumption, and the signal transmission distance is up to 20 meters. The current temperature can be easily read by Arduino. The wiring figure is shown in figure 5.2.

5.4 Data collecting, saving and Real time graphs

After sensors activated it started to monitor the soil elements. The total code is done by Arduino language and used Arduino 1.6.9 IDE. Here it only process the sensor input and output, sensors standard threshold and find out the data of Temparature, Humidity and CO2.

We used python for fetching data from Arduino mega and give the real time graph of the elements. Then the reading is saved on cool term in a excel file for further investigation.

6. RESULTS AND DISCUSSION

6.1 Overview

To experiment the project the device is experimented at day time and night time. The samples were also taken from different places to record it. When the sensors sense the reading it passes the information. And the whole data will be saved for further experiments. The experiment results are shown in different figures from 6.1 -6.7.

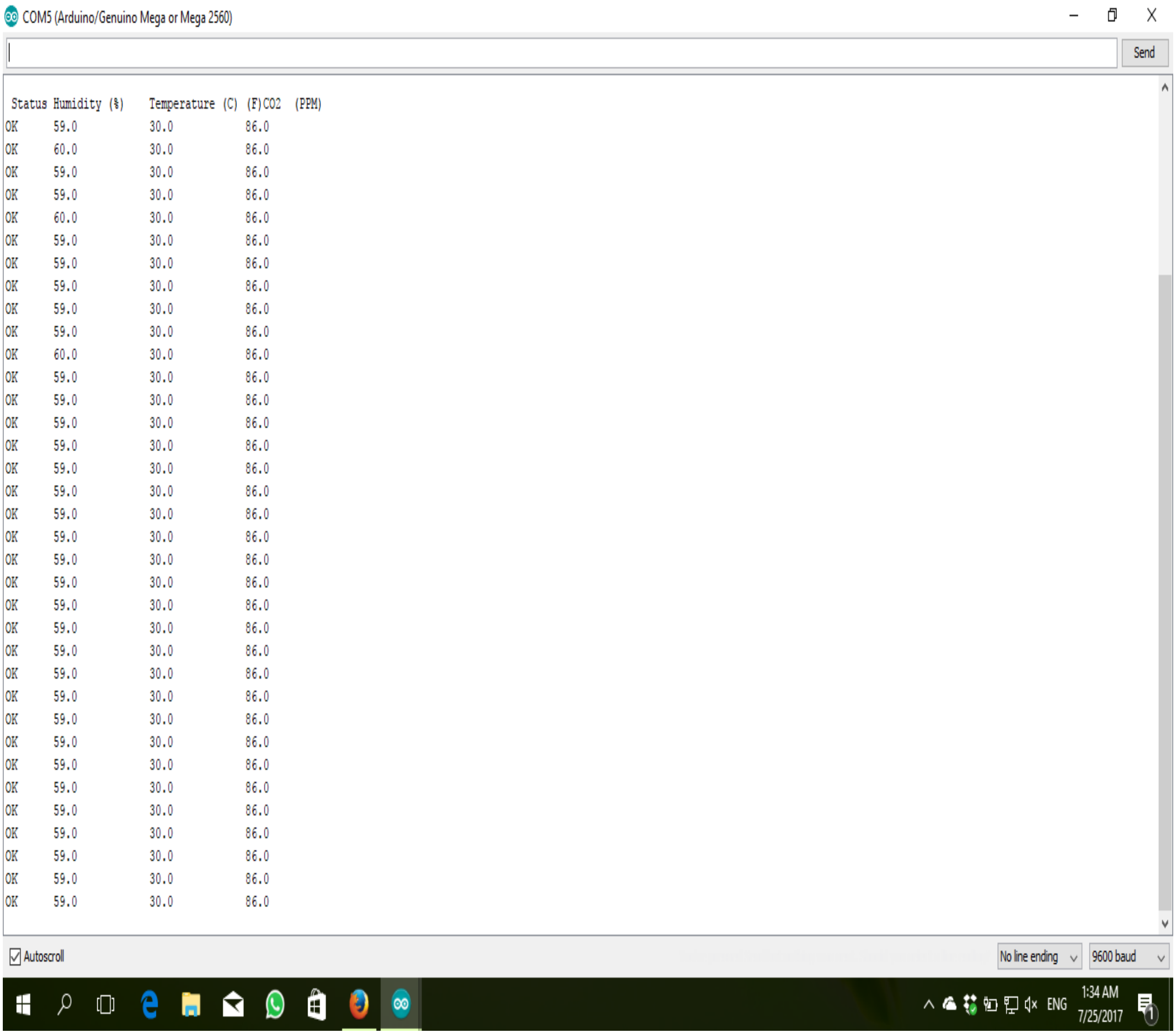

Figure 6.1 Result View of Data

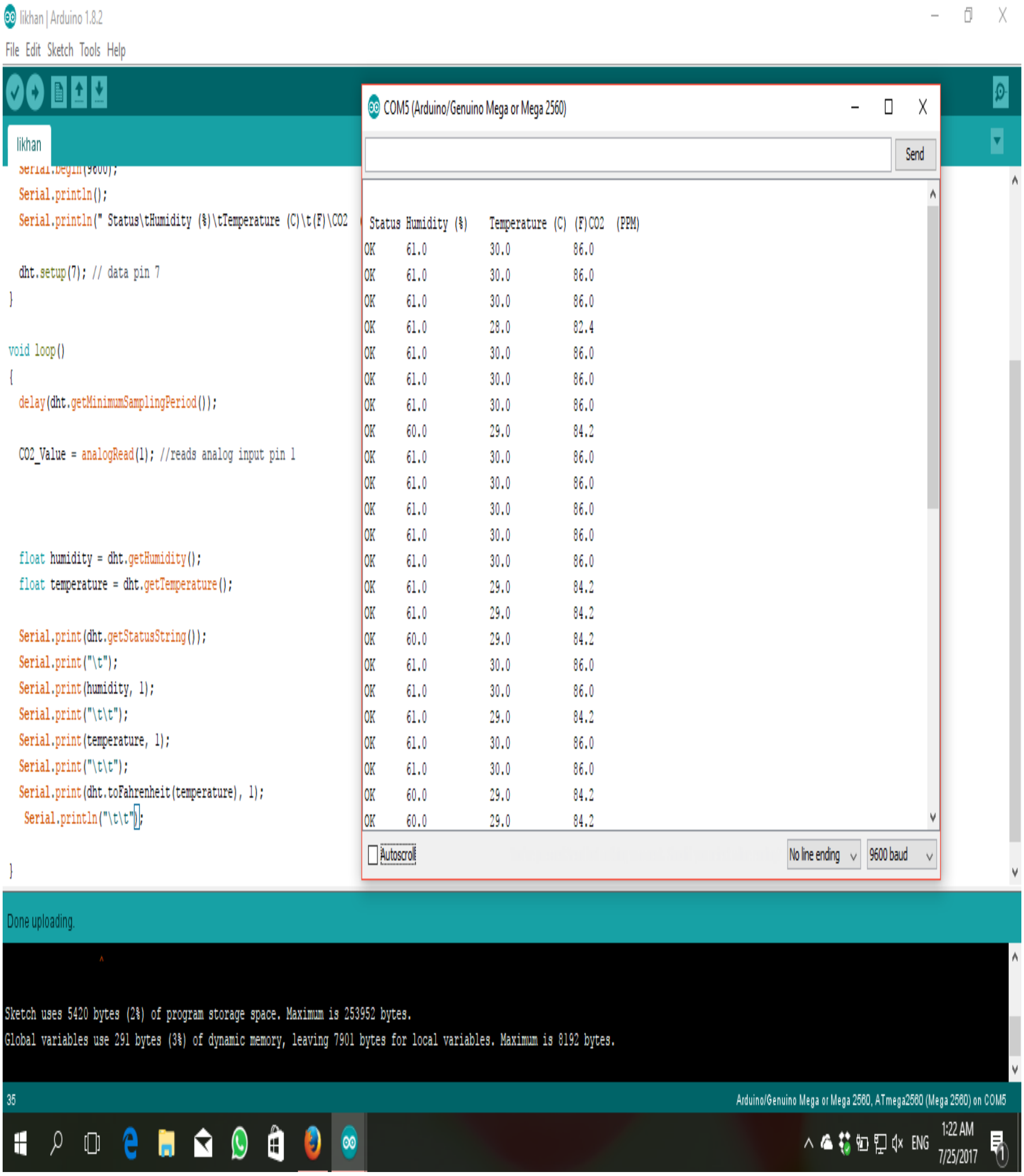

Figure 6.1.1 Result Views of Data with code

6.2 Real Time Graph

Now we will show some real time graph of data (Humidity, Temperature and Co2). These data were collected in day and night in this both times as it makes difference of data of availability of humidity, temperature and Co2 in day and night.

6.2.1 Humidity

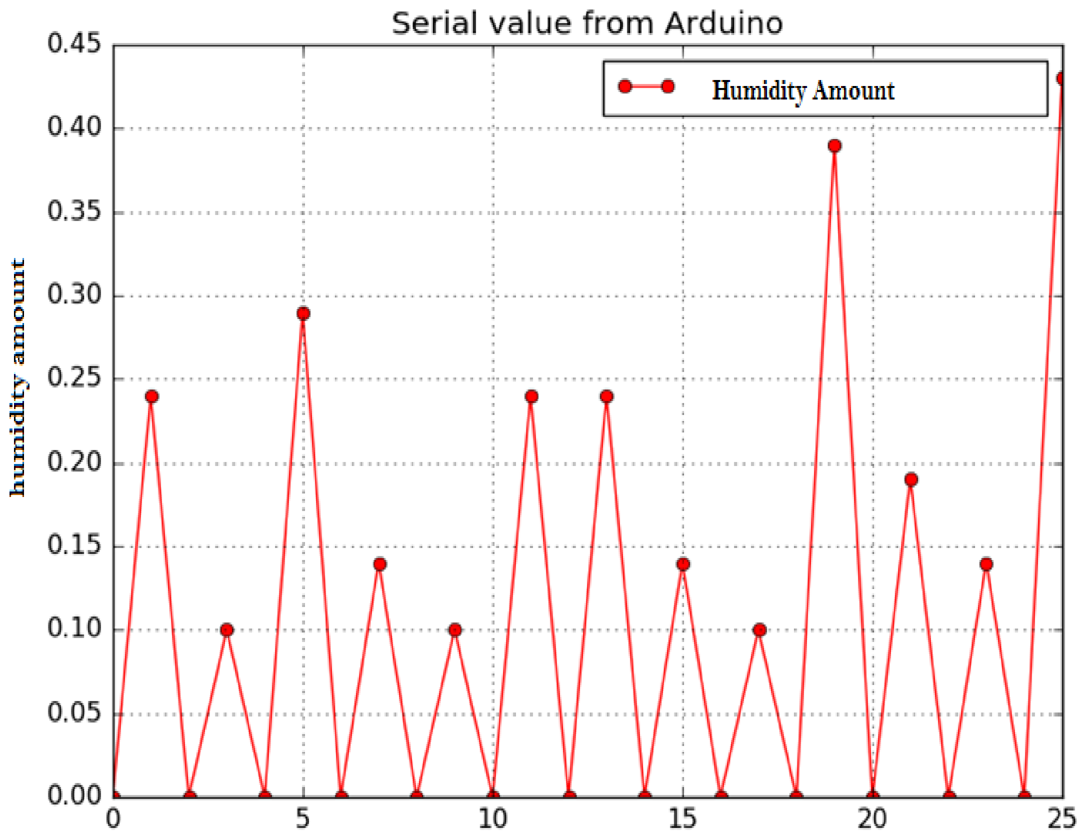

Figure 6.2 Humidity at Day

In Figure 6.2 data view of humidity is shown. It is data view at daytime. At day humidity remains low in comparison of at night.

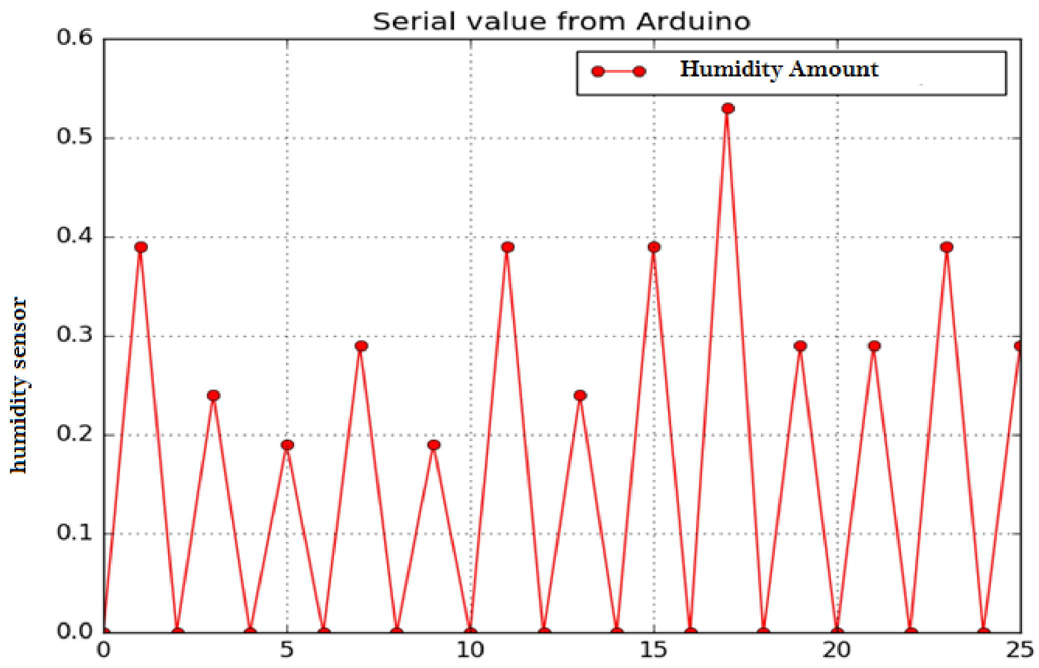

Figure 6.3 Humidity at Night

In Figure 6.3 data view of humidity is shown. It is data view at nighttime. At night humidity remains high in comparison of at night. At night soil takes less temperate and get situation (like dew drops) that increase humidity.

6.2.2 Temperature

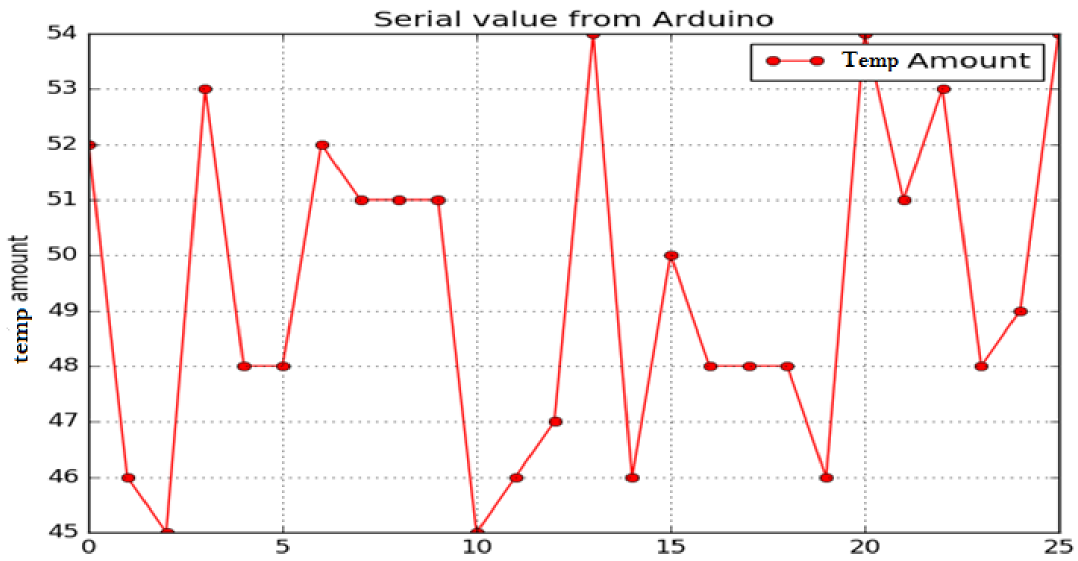

Figure 6.4 Temperature at Day

In Figure 6.4 data view of temperature is shown. It is data view at daytime. At day temperature remains high in comparison of at night.

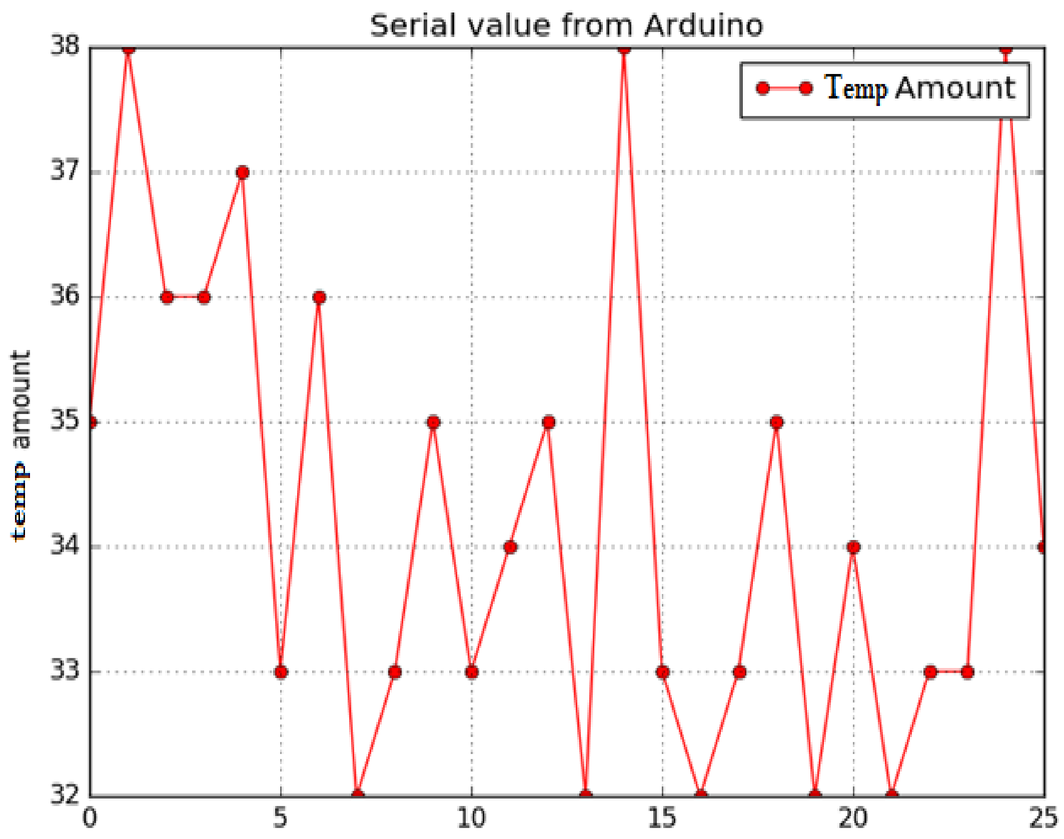

Figure 6.5 Temperature at Night

In Figure 6.5 data view of temperature is shown. It is data view at nighttime. At night temperature remains low in comparison of at night.

6.2.3 Carbon Di Oxide

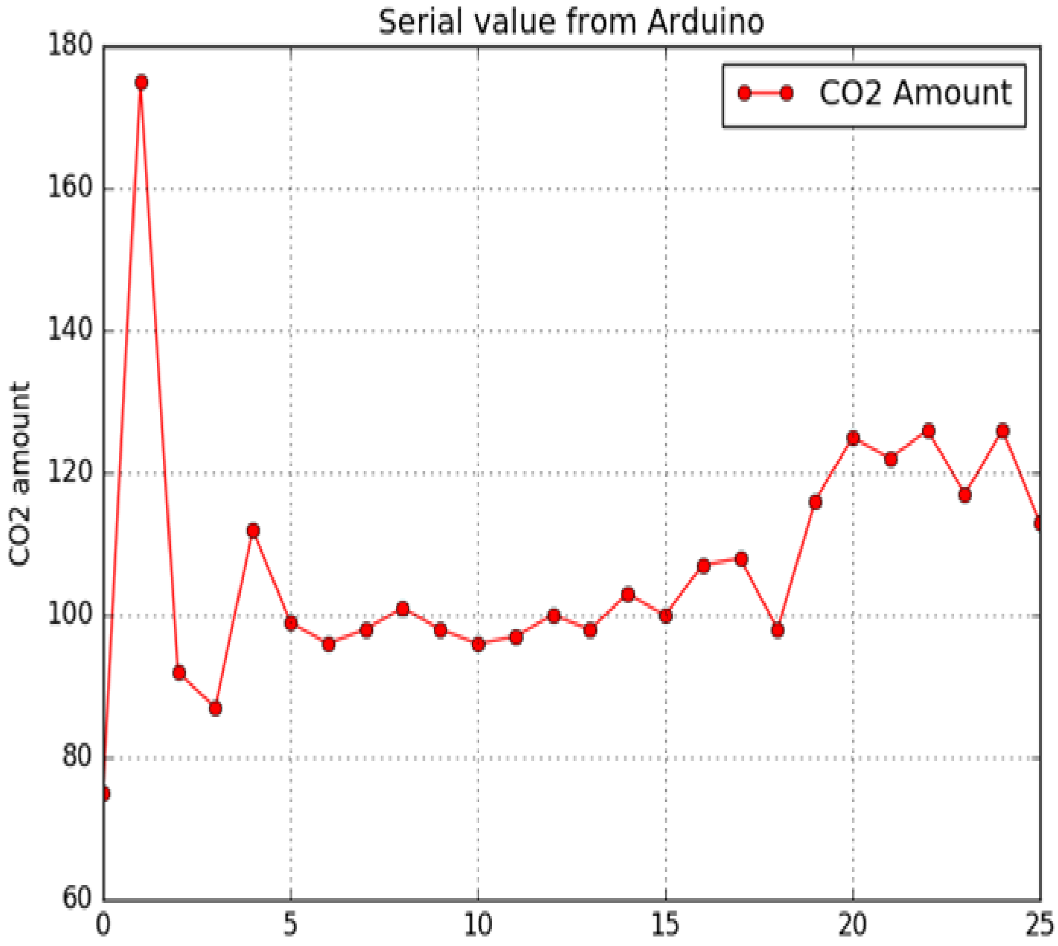

Figure 6.6 Co2 at Day

In Figure 6.6 data view of Carbon Di Oxide is shown. It is data view at daytime. At day Carbon Di Oxide remains high in comparison of at night.

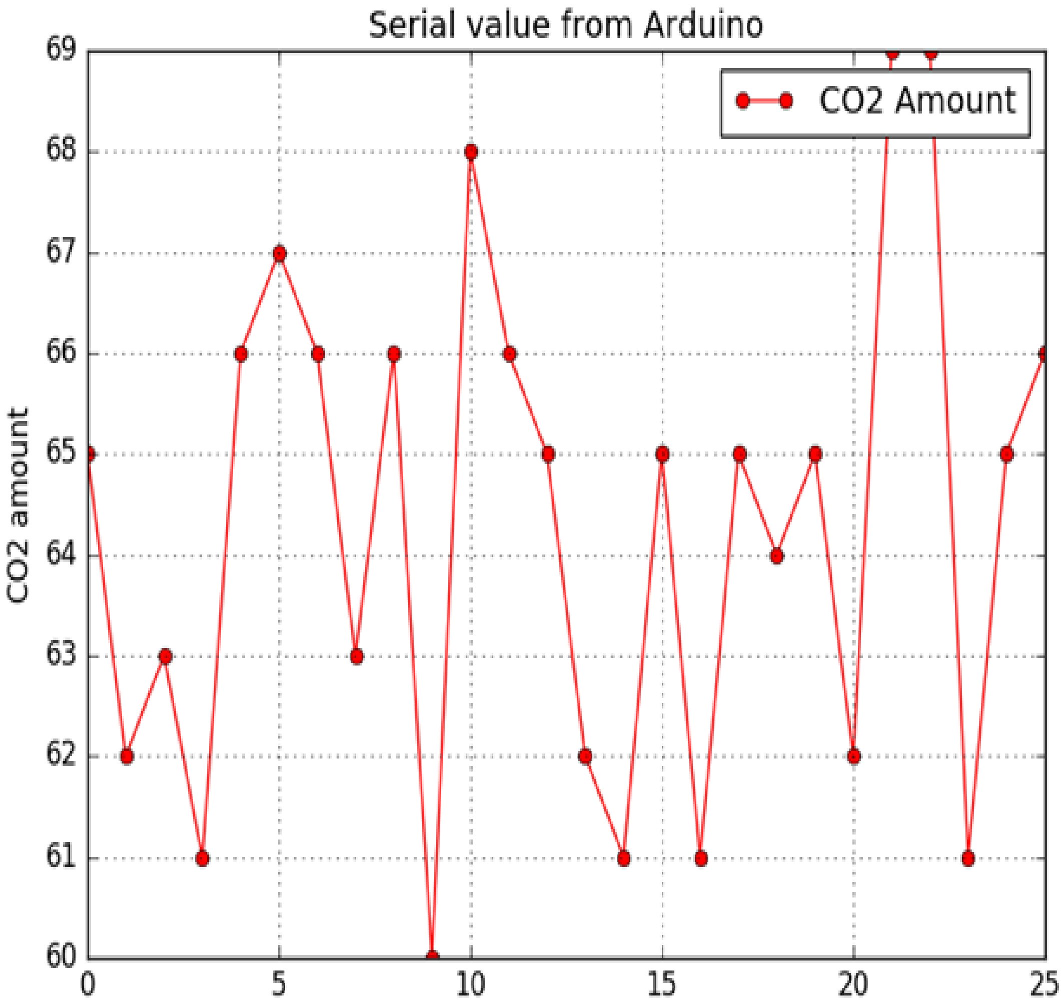

Figure 6.7 Co2 at Night

In Figure 6.7 data view of Carbon Di Oxide is shown. It is data view at nighttime. At night Carbon Di Oxide remains low in comparison of at night.

Table 6.1 Different Soil Reading

Data Reading	Day	Night
Temperature	High	Low
Humidity	Low	High
CO2	High	Low

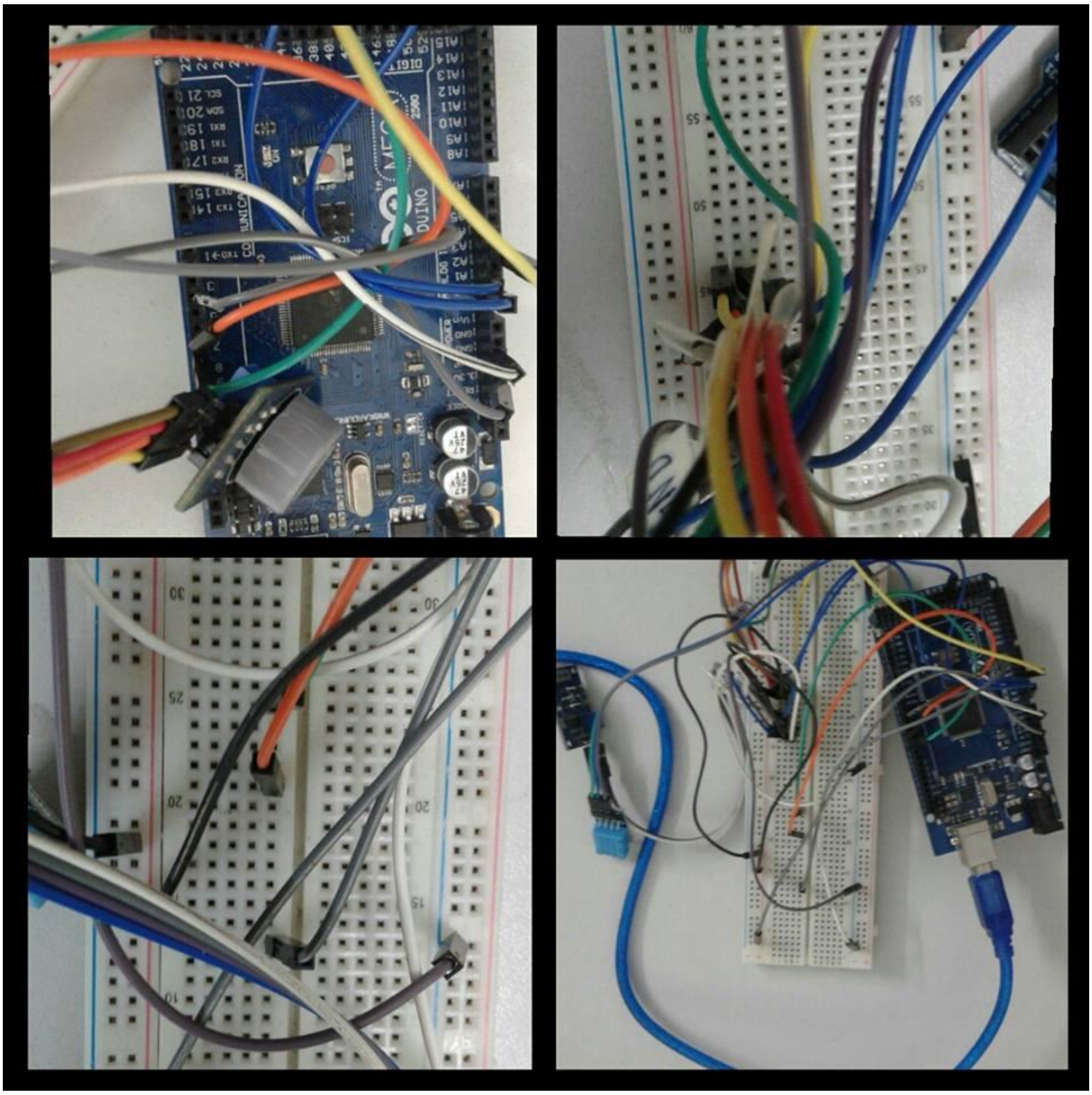

Figure 6.8 a view of prototype

From our case studies we got to know that they were focused on either moister, ph, moister or temperature. But in our proposed system we are focused on soil temperature, humidity and CO_2. They didn’t take the reading at day and night both time. In our work we have take that on our consideration and showed the reading of the data on a form of graphical view that was taken at both day and night.

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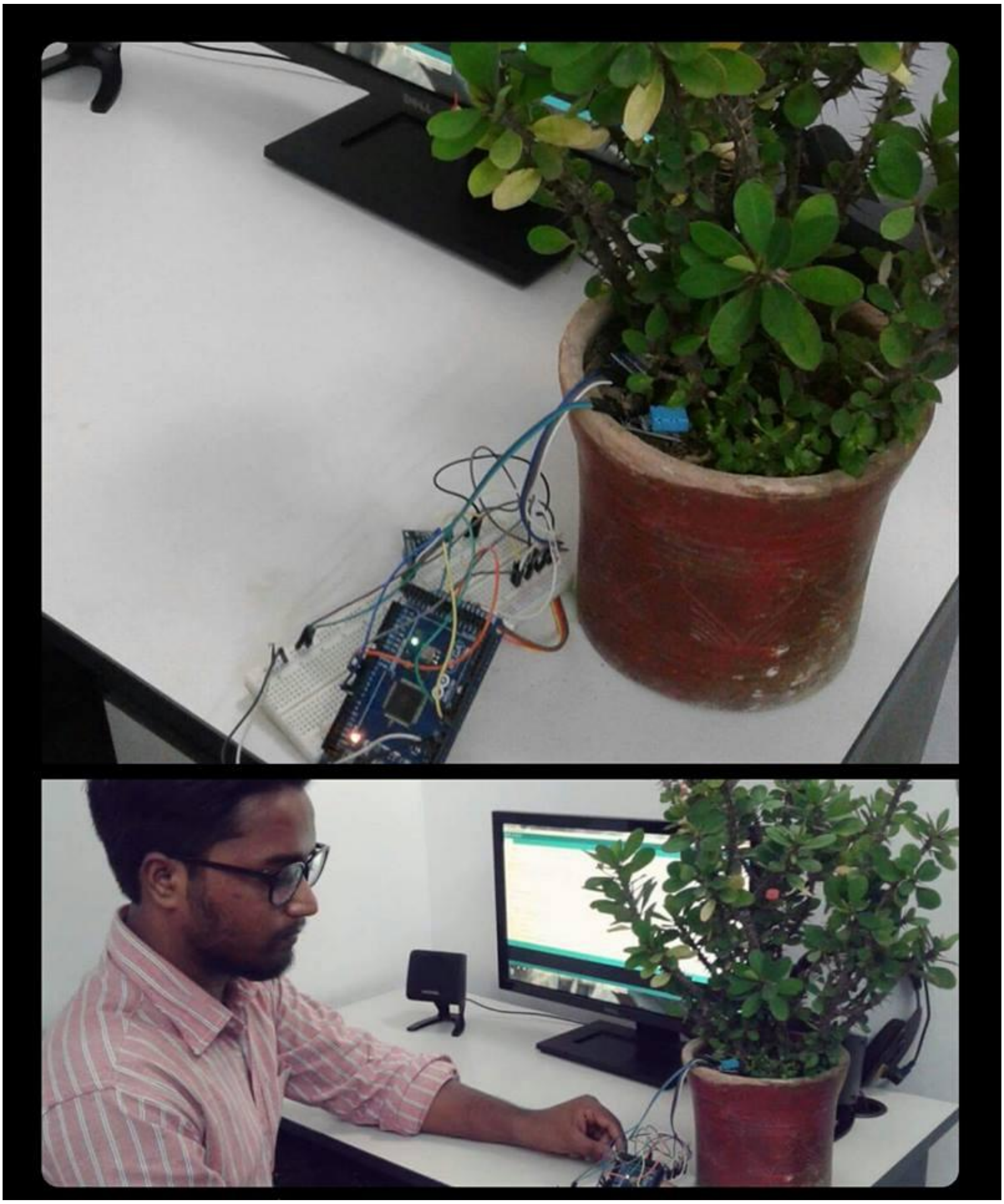

Figure 6.8.1 view of prototype

7. CONCLUSION AND FUTURE RESEARCH

7.1 Discussion

All we wanted before starting this thesis work is to make a model that can be very effective in our country's agriculture sector. And to do so we have conducted our research in that way so that it can be accurate and real time as much as it can be possible. We have some future plan to take this research activity to the next level also.

7.2 Contributions

This study describes a path of work for automation and agriculture collaboration. Mechanism of the system is discussed and reviewed in this report.

This study shows that

- Along with all the considered elements of soil; information of temperature, humidity and Co2 of soil is also very important to know .
- If we can get the proper information of these considered data, our contribution in crop harvesting will be very high.
- It is possible to set a milestone for future research on automation in agriculture at Bangladesh.

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7.3 Limitations

- Limited Sensor Availability
- Limited Academic Facility
- Limited Previous Academic Research History

7.4 Future research

In this thesis we have worked with temperature, humidity and Co2 reading of soil. But we have some future research plan and those plan steps are included with:

1) Research with eight major elements, Al, Fe, Ti, Ca, Mg, Mn, K, and Na those were determined by INAA (Instrumental neutron activation analysis).
2) Collaborating all those elements of INAA and temperature, humidity and Co2 together.
3) Implementation of a device that can give real time data of all these elements all together.
4) Establish a concept to create and save a database from where all tha data can be used for future research and prediction.
5) Collaborating our work with **Satellite Farming.**

The aim is to make some difference in our current agriculture process so that agriculture can be more productive but with easy and accurate working procedure.

7.5 Conclusion

The research work conducted for this thesis concluded with a satisfactory result to carry out the research work in future. The objectives set for this thesis have been achieved successfully. Despite facing issues with necessary training and limited resource, the work done in this research is to establish a concrete base for the proposed concept of the soil data.

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