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PROJECT: SMART PLANT MONITORING SYSTEM USING PLX-DAQ

BVI2112 TECHNOLOGY DATA ACQUISITION AND ANALYSIS I

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

The project basically deals with data collection and analysis of growth and health parameters in plants. The smart plant monitoring using DAQ system will be able to gather real-time information on data such as temperature, humidity, light intensity, and soil moisture, among others. The system uses data acquisition and analysis to ensure real-time information data can be recorded perfectly and timely intervention, such as watering and light adjustments. The smart plant monitoring using DAQ system relies on data acquisition data streamer, collecting real-time temperature, humidity, light and soil moisture data. This step allows users to identify problems and take preventative steps quickly, minimize manual efforts as well and make the best use of resources like watering depending on moisture levels. The platform provides automated alerts and notifications when critical changes arise and analyses data to improve care strategy. Mature processes are integrated into automated systems, which respond to changing conditions for improved plant health and productivity.

1.2 PROBLEM STATEMENT

For the past few years, plant care has become a challenge for individual increasing time constraints and limited knowledge of optimal environmental conditions for plant growth. Conventional method of monitoring plants requires significant attention and are often prone to errors, such as overwater and underexposure to the light.

Moreover, many existing monitoring system lack of the real time data logging and visualization, which are crucial for making time and informed decisions about plant health. These systems often fail to integrate multiple environmental factors like temperature, humidity, soil moisture, and light intensity.

This project developing a Smart Plant Monitoring System the use sensor DHT11, soil moisture, and LDR sensor for capture real time and communicate to PLX-DAQ for effective data logging and analysis. The system aims to provide an efficient solution for optimizing plant care with the minimal manual intervention.

1.3 OBJECTIVE

- To design a cost-effective system for monitoring environmental conditions essential for plant growth and health
- To develop an automatic monitoring system to saving time and more organized
- To provide a real time data logging light intensity, temperature, humidity and soil moisture level of plant to enable data-driven decision making

1.4 SCOPE & LIMITATION PROJECT

1.4.1 DATA MONITORING:

The project captures the data environmental using:

- Temperature using DHT 11 sensor
- Soil moisture level using the soil moisture sensor
- Lighting intensity using the LDR sensor

1.4.2 COLLECTING DATA AND STREAMING:

- For analysis and visualization, the recorded data is sent in real time to a data streamer
- To find trends in the environmental, the system allows for the basic analysis and visualization for the data
- An Arduino Mega is used in the system implementation for data streaming and processing

1.4.3 SENSOR ACCURACY:

- The sensor like DHT 11, Soil moisture, and LDR is the cheap sensor with limited precision compared to sensor use in industry
- Environmental factors are the biggest may affect the sensor performance like extreme temperature or humidity

1.4.4 RANGE AND SCALABILITY:

- The system is limited to monitoring with the physical range of the sensor and the Arduino setup
- The data streamer may have the limitations to handling a large volume of data or complex visualization

CHAPTER 2

LITERATURE

2.1 CONVENTIONAL METHODS ON MANUAL OBSERVATIONS

Plant care has become increasingly challenging due to time constraints and limited knowledge of optimal growth conditions. Conventional monitoring methods demand significant attention and are prone to errors, such as overwatering and insufficient light exposure. Existing studies highlight similar challenges, with traditional systems lacking real-time data integration and visualization, resulting in delays and ineffective decisions regarding plant health.

Moreover, many monitoring systems fail to consider multiple environmental factors like temperature, humidity, soil moisture, and light intensity simultaneously, further limiting their effectiveness. This project addresses these gaps by developing a Smart Plant Monitoring System using sensors like DHT11, soil moisture, and LDR sensors to capture real-time data. The system integrates with PLX-DAQ for efficient data logging and analysis, offering a robust and optimized solution for plant care with minimal manual intervention.

2.2 COMPONENTS

This is a short description of component used in this project such as Arduino Mega 2560, Soil moisture, DHT11 and LDR sensors.

2.2.1 ARDUINO MEGA 2560

Figure2.1 Arduino Mega 2560

The Arduino Mega is a microcontroller board based on. It has 54 digital input/output pins (of which 15 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 an AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila. The Arduino Mega is used to interfaces with various sensors like (DHT11, LDR, soil moisture sensor, etc.) to collect real-time data on environmental factors like temperature, humidity, light intensity, and soil moisture.

SPECIFICATIONS

Table 2.1 Specifications of Arduino Mega 2560

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
LED_BUILTIN	13
Length	101.52 mm
Width	53.3 mm
Weight	37 g

PIN I/O DIAGRAM

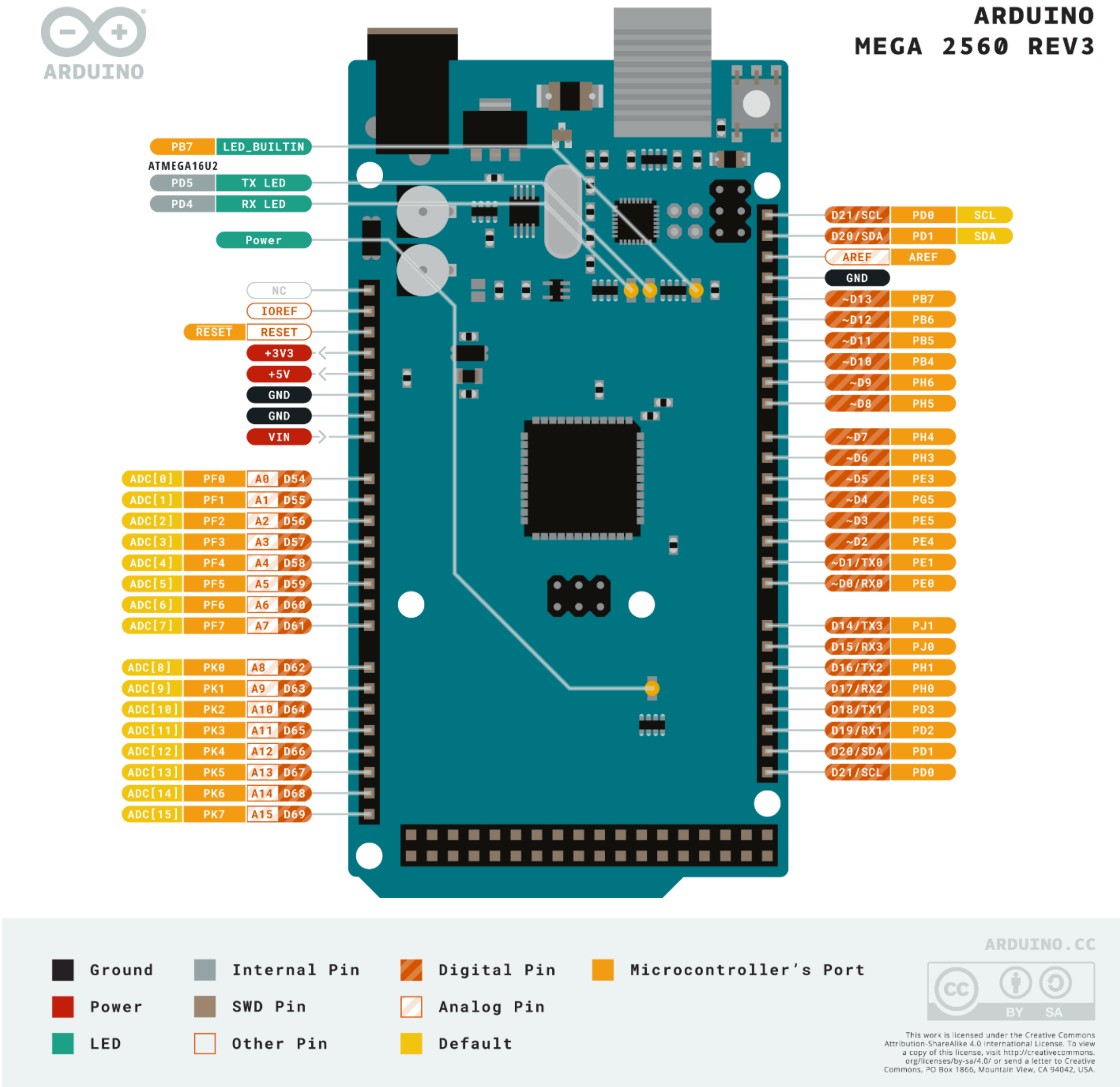


Figure 2.2 Arduino Mega Pin I/O Diagram

2.2.2 SOIL MOISTURE SENSOR

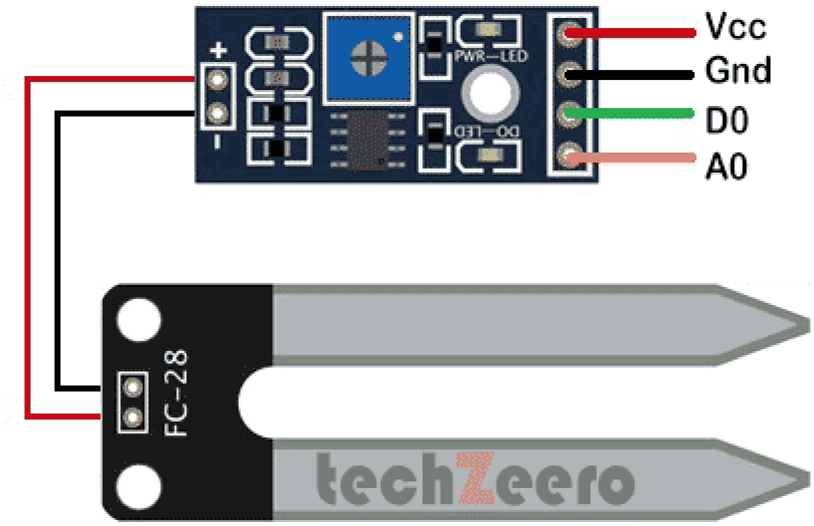


Figure 2.3 Soil Moisture Sensor

The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content.

The relation among the calculated property as well as moisture of soil should be adjusted & may change based on ecological factors like temperature, type of soil, otherwise electric conductivity. The microwave emission which is reflected can be influenced by the moisture of soil as well as mainly used in agriculture and remote sensing within hydrology.

SPECIFICATIONS

Table 2.2 Specifications of Soil Moisture Sensor

Input Voltage	5V
Input Current	<20mA
Type of interface	Analog
Board Size	3.2 cm x 1.4 cm
Working Temperature	10°C~30°C

Soil moisture to Arduino Mega Connection

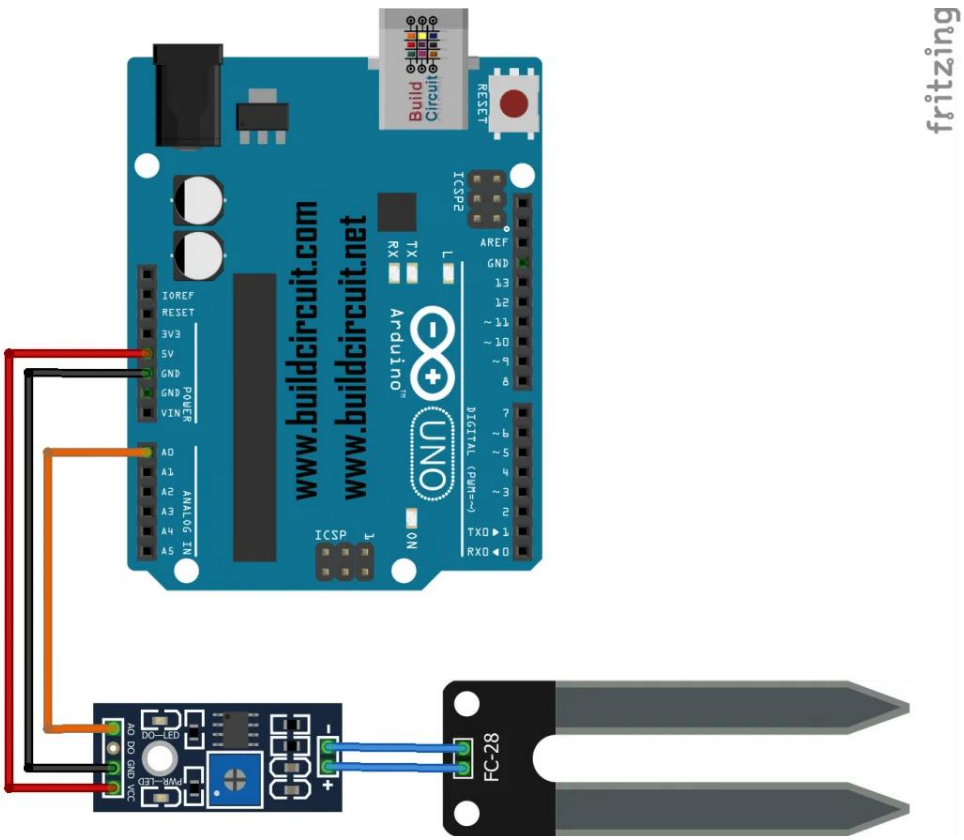


Figure 2.4 Example of connection between Soil Moisture to Arduino Mega

Table 2.3 Soil Moisture connection to Arduino Mega

Soil Moisture	Arduino Mega
Vcc	5V
Gnd	Gnd
DO	-
AO	A0

2.2.3 SENSOR DHT 11

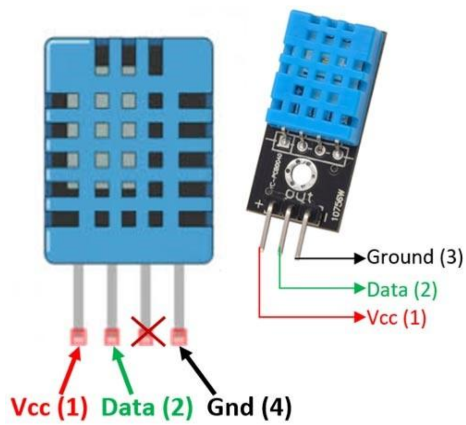


Figure 2.5 Example of DHT 11 and pin DHT11

DHT11 is the most common sensor that is usually used by students and makers out there. The main function of this sensor is to measure the temperature and humidity of the surroundings. The sensor is also factory calibrated and hence easy to interface with any microcontrollers like Arduino. The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%. The DHT11 sensor can either be purchased as a sensor or as a module. Either way, the performance of the sensor is the same. The sensor will come as a 4-pin package out of which only three pins will be used whereas the module will come with three pins as shown below. The only difference between the sensor and module is that the module will have a filtering capacitor and pull-up resistor inbuilt.

DHT 11 Adopt special digital module acquisition technology and temperature and humidity sensing technology to ensure high reliability and excellent long-term stability. The sensor is composed of a resistance liquid contact element and an NTC temperature measuring element and is connected to a high-performance 8-bit microcontroller. Therefore, the product has the advantages of high quality, ultra-fast response, strong anti-interference ability, and high-cost performance. The single-wire serial interface makes system integration simple and fast. Ultrasmall size, low power consumption, and a signal transmission distance of more than 20 meters make it the best choice for any application, even the most demanding ones. The product is easy to connect and can be plugged directly into the sensor expansion board.

Specification

Table 2.4 Specification of DHT11

Operating Voltage	3.0V to 5.5V
Operating Current	0.3mA (measuring)
Output	Serial data
Temperature Range	0°C to 50°C
Humidity Range	20% to 90%
Resolution	Temperature and Humidity both are 16-bit
Accuracy	±1°C and ±1%

DHT11 to Arduino Mega Connection

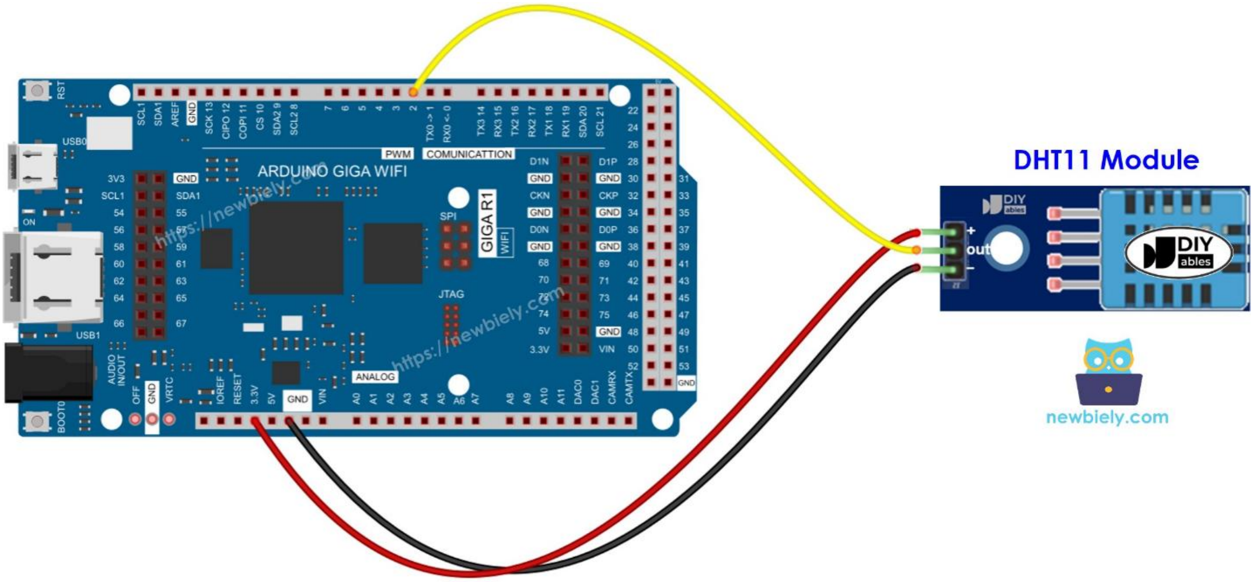


Figure 2.6 Example connection between Arduino Mega and DHT11

Table 2.5 DHT11 Module connection to Arduino Mega

DHT 11	**Arduino Mega**
VCC	5V
GND	GND
OUT	D2

2.2.4 LDR SENSOR

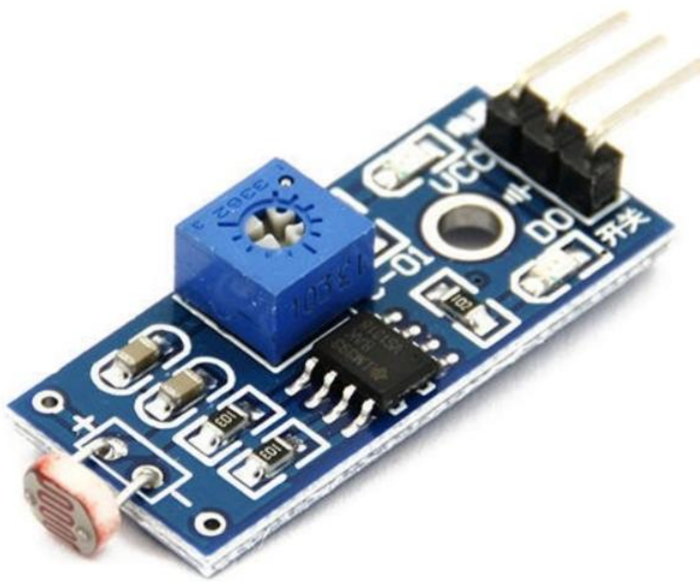


Figure 2.7 LDR Sensor

LDR full form Light Dependent Resistor. LDR is a simple device that can be used to detect light level and respond to light. When there's more light, its resistance goes down, and when there's less light, its resistance goes up. LDR light sensor is also known as a photoresistor, photocell, or photoconductor. In the dark, it has a very high resistance, sometimes up to 1M ohm, but when the LDR sensor is exposed to light, the resistance drops drastically, to as low as a few ohms, depending on the light intensity. The sensitivity of LDR varies with the wavelength of the light applied and are nonlinear device.

Light Dependents Resistor or LDR is a transducer that senses light intensity and converts it into electric current. It has two electrodes, one of which acts as the cathodes while the other acts anode. The resistance of LDR decreases when exposed to a certain level or amount of radiant energy such as sunlight and artificial light. This property makes them suitable for use in applications like solar panel controller, security system, and variable lighting controls by changing their value according to variations in ambient illumination conditions.

Specification

Table 2.6 Specification LDR sensor

Operating Voltage	3.3V to 5.5V
Operating Current	15mA
Output Digital	0V to 5V, adjustable trigger level from preset
Output Analog	0V to 5V based on light falling on the LDR
Size	33mm x 15mm x 2mm

LDR to Arduino Mega Connection

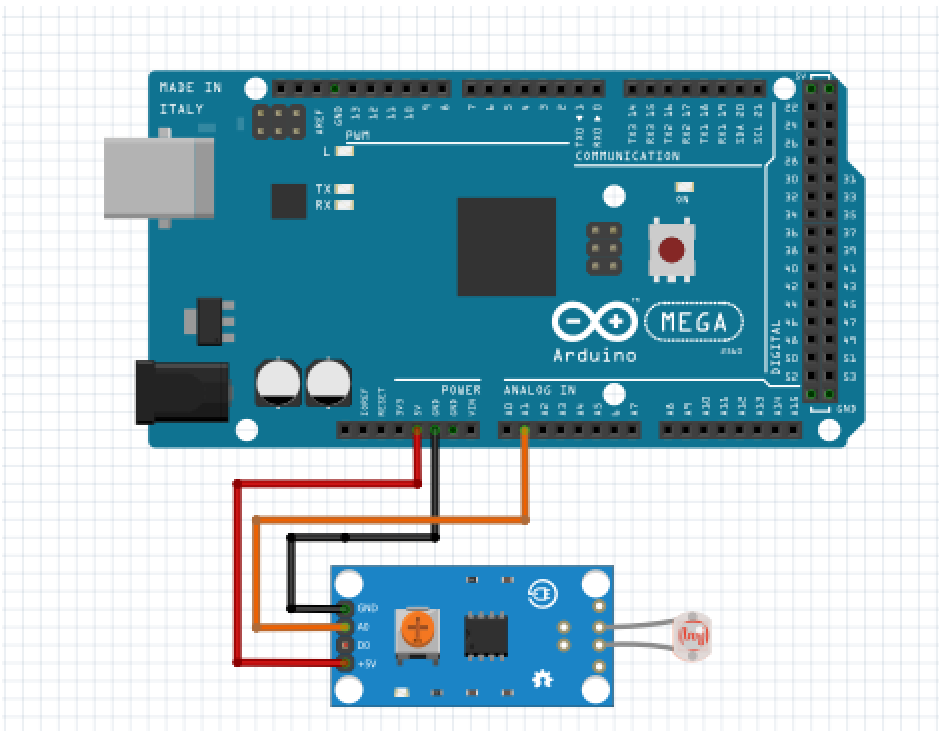


Figure 2.8 Example connection between Arduino Mega and LDR

Table 2.7 LDR sensor Module connection to Arduino Mega

LDR Module	Arduino Mega
VCC	5V
GND	GND
A0	A1
D0	-

2.3 PREVIOUS STUDIES

2.3.1 ARDUINO-BASED SOIL MOISTURE TESTING SYSTEM’

Sounder. Jeevan, N Deepa (2023) ‘Arduino-Based Soil Moisture Testing System’. Designed a system that automatically senses the soil moisture conditions and nourishes them without any need for human involvement. It will automatically monitor the soil and reduce water waste and increase plant growth. Arduino and Soil moisture sensor are used in this project to solve these soil moisture problems, and the major benefits is that the system’s operation can be altered according to the condition of crops, soil, weather situation, and all kind of soil moisture problem.

2.3.2 SMART PLANT MONITORING SYSTEM USING IoT

Sreeram Sadasivam, Viswanath Vadhri, Supradha Ramesh (2015). People in this technological era want to connect with all things in their life, for example the household plants in the urban areas which get neglected in their busy schedules. The Internet of Things is the platform of machines and digital devices which help to transmit data without any human involvement. Also, with the rapid demand for applications of IoT in various fields, this project is done by using IoT. It has the design and implementation of a Smart Plant Monitoring System using a soil moisture sensor, temperature and humidity sensor, relay module, Wi-Fi module, Blynk app, etc. This project detects changes in the moisture, temperature and light conditions in and around the plant, and performs a machine-based curation on the plant by providing necessary irrigation and illumination for the plant.

2.4 PROJECT THEORY

2.4.1 PLX-DAQ (Parallax Data Acquisition Tool)

Parallax Data Acquisition tool (PLX-DAQ) software add-in for Microsoft Excel acquires up to 26 channels of data from any Parallax microcontrollers and drops the numbers into columns as they arrive. PLX-DAQ provides easy spreadsheet analysis of data collected in the field, laboratory analysis of sensors and real-time equipment monitoring. Any microcontrollers connected to any sensor and the serial port of a PC can send data directly into Excel with a real time data logging. PLX-DAQ has the following features:

i. Plot or graph data as it arrives in real time using Microsoft Excel
ii. Record up to 26 columns of data
iii. Mark data with real time (hh:mm:ss) or seconds since reset
iv. Read / Write any cell on a worksheet
v. Read / Set any of 4 checkboxes on control the interfaces
vi. Example code for the BS2, SX (SX/B) and Propeller available
vii. Baud rates up to 128K
viii. Support Com1-15

System Requirements

i. Microsoft Windows 98
ii. Microsoft Office/Excel 2000 to 2003
iii. May not work with newer software; no longer supported

CHAPTER 3

METHODOLOGY

3.1 PROJECT DESIGN

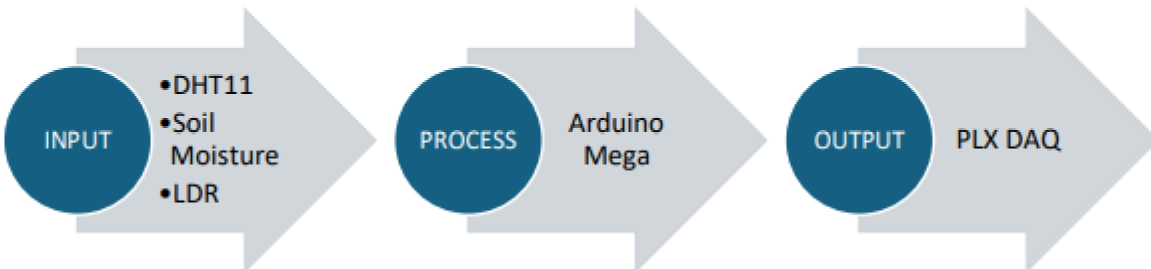


Figure 3.1 Project Design

The figure above shows the operation for this project which consists of input, process and output blocks. In the input block there are several sensors namely DHT11, Soil Moisture, and LDR. Each of these components plays an important role in monitoring the plant environment to ensure that the plant is in the right condition and ensure the health of the plant. DHT11, as a sensor that detects the temperature and humidity around plants, there are several plants that are sensitive to the temperature and humidity of the environment. Therefore, DHT11 can assist farmers in determining the right place for the plant to be planted. Soil moisture is to monitor the soil moisture in the plant so that the moisture is maintained whether it is not too moist and too dry. It is good for someone who is not skilled in caring for plants because they can know the right time for the plant to be watered. In addition, farmers can identify whether the soil they want to plant is fertile soil or not. The LDR is to monitor the light intensity of the plant. It is used to ensure that plants get adequate lighting, especially those grown in indoor areas. For the process block, Arduino Mega is used to process the data obtained from the three sensors and send it to excel via serial communication. The data processed by the microcontroller will be analyzed and action will be taken on abnormalities in the plant environment. The output used on this project is PLX-DAQ software, this software plays an important role in displaying the data obtained from serial communication. The software provides an interesting function, which is to connect the serial with excel, all the data obtained will enter excel and can be recorded and analyzed by looking at changes in the readings of the three sensors.

3.2 PROJECT DEVELOPMENT & IMPLEMENTATION

In the development and implementation of this project, they have software development, hardware development, data logging and data analysis in the project.

3.2.1 SOFTWARE DEVELOPMENT & IMPLEMENTATION

i) Programming

In developing programming, using an Arduino IDE software, the C language was used to develop programming of this project.

- Syntax to include library DHT11

```
#include <DHT.h>
```

Figure 3.2 Code for library DHT 11

- Syntax to define pin all sensor

```
#define DHTPIN 2
#define DHTTYPE DHT11
#define SOIL_MOISTURE_PIN A0
#define LDR_PIN A1
```

Figure 3.3 Code for Pin all sensor

- Syntax to Initialize the DHT11

```
DHT dht(DHTPIN, DHTTYPE);
```

Figure 3.4 Code for initialize DHT11

- Syntax to transfer data between the Arduino and PLX-DAQ

```
Serial.begin(9600);
```

Figure 3.5 Code for transfers data to PLX-DAQ

- Syntax to send command to PLX-DAQ

```
Serial.println("CLEARSHEET");
Serial.println("LABEL,Time,Temperature (°C),Humidity (%),Soil Moisture,Light Intensity");
```

Figure 3.6 Code for command PLX-DAQ

- Syntax to initialize the Sensor as input

```
pinMode(SOIL_MOISTURE_PIN, INPUT);
pinMode(LDR_PIN, INPUT);
```

Figure 3.7 Code for initialize sensor

- Syntax to Read DHT11 data

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

Figure 3.8 Code for read DHT11

- Syntax to Read Soil Moisture data

```
int soilMoisture = analogRead(SOIL_MOISTURE_PIN);
```

Figure 3.9 Code for read soil moisture

- Syntax to Read Light Intensity

```
int lightIntensity = analogRead(LDR_PIN);
```

Figure 3.10 Code for read light intensity

- Syntax to print data to serial for PLX-DAQ

```
Serial.print("DATA,TIME,");
Serial.print(temperature);
Serial.print(",");
Serial.print(humidity);
Serial.print(",");
Serial.print(soilMoisture);
Serial.print(",");
Serial.println(lightIntensity);
```

Figure 3.11 Code for print data to serial

ii) Simulation & Design

There are two software used in the section, namely Thinkercad to simulate the project and Fritzing to design our project:

a) Thinkercad

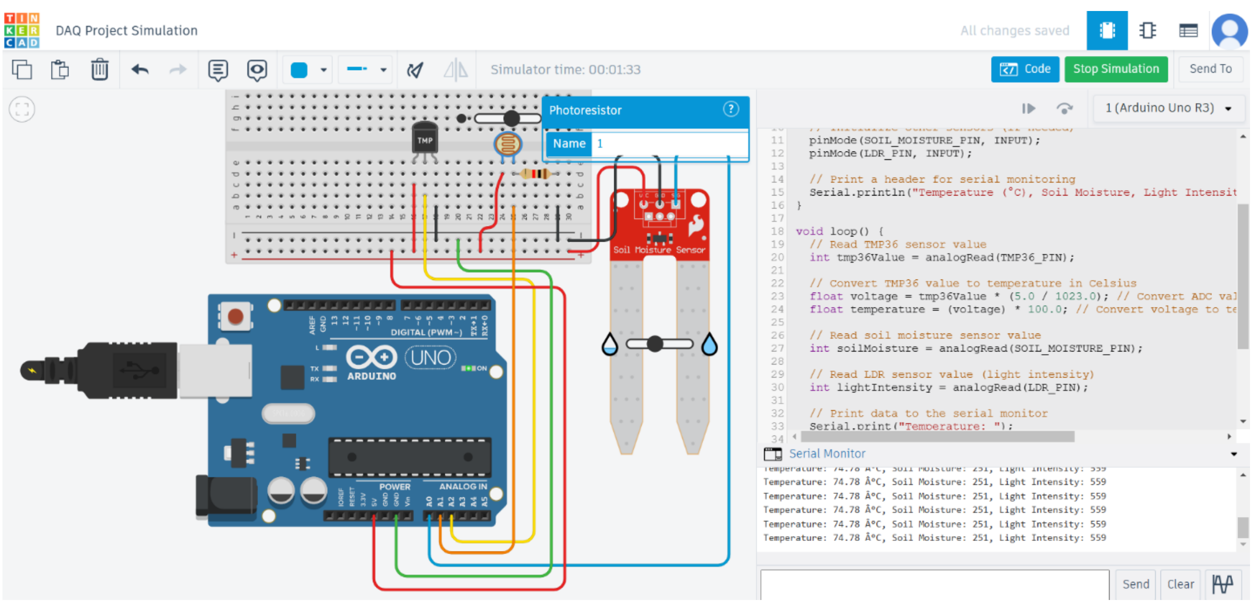


Figure 3.12 Project Simulation using Thinkercad

Simulations were made on this project using Thinkercad software to prepare the initial setup before doing the assembly on the breadboard. This is intended to detect any errors in the code and test the components to see how they work. In this thinkercad we just using the TMP36 because of in this software its don’t have a DHT11.

b) Fritzing

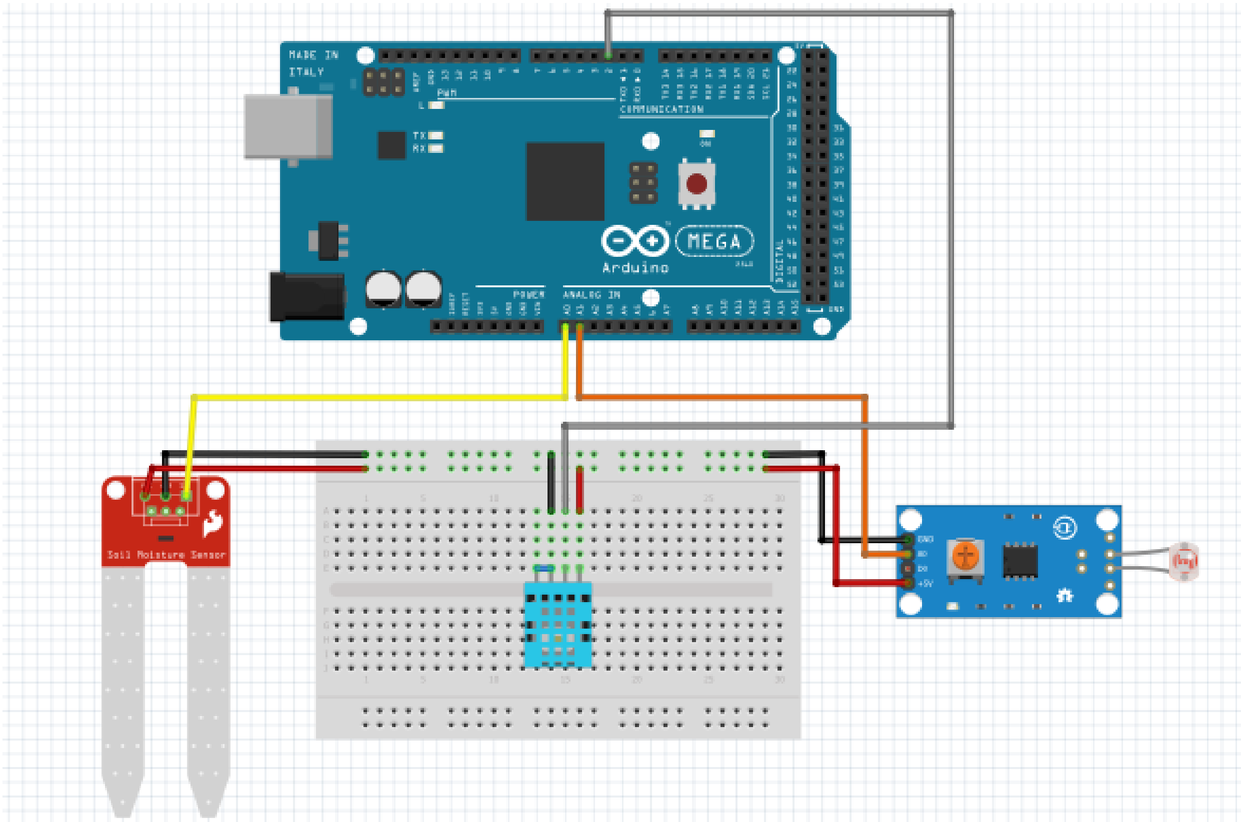


Figure 3.13 Project Design Using Fritzing

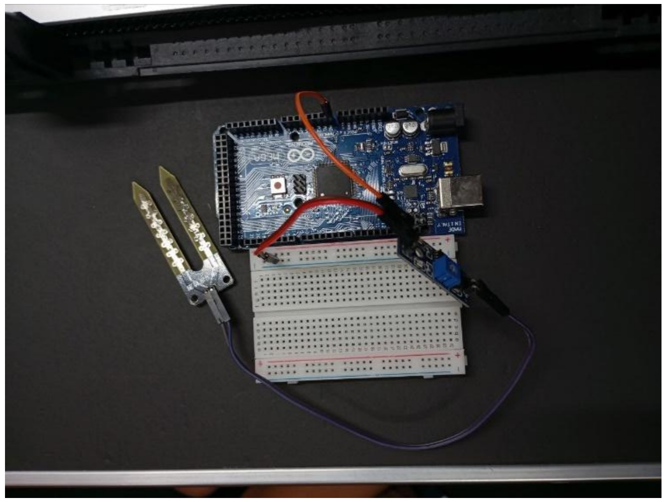
Fritzing was used for designing our project using an appropriate component. Using DHT11 and LDR that have module to representing what our project looks like in actual real life. This is because Fritzing is a good software for electronics design and prototyping platform that easily create and document our project.

3.2.2 HARDWARE DEVELOPMENT STEP

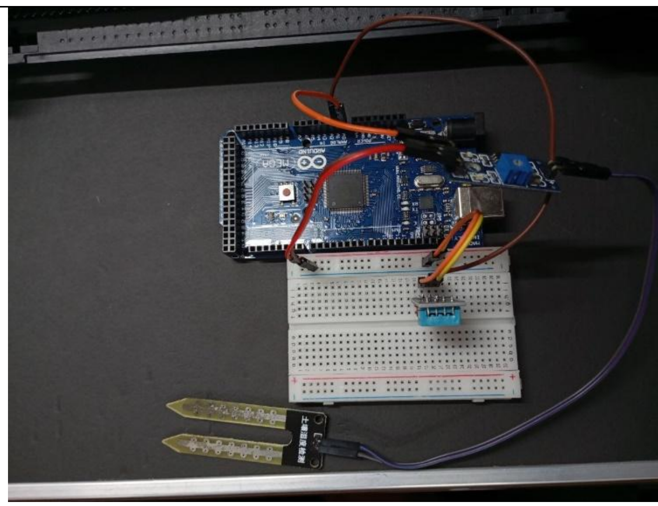
Table 3.1 Project Development & Implementation

<table>
<tr><th>NO</th><th>WORK STEP</th><th>ATTACHMENTS</th></tr>
<tr><td>1</td><td>Connect the soil Moisture Sensor to the Arduino Mega

Connection pin:

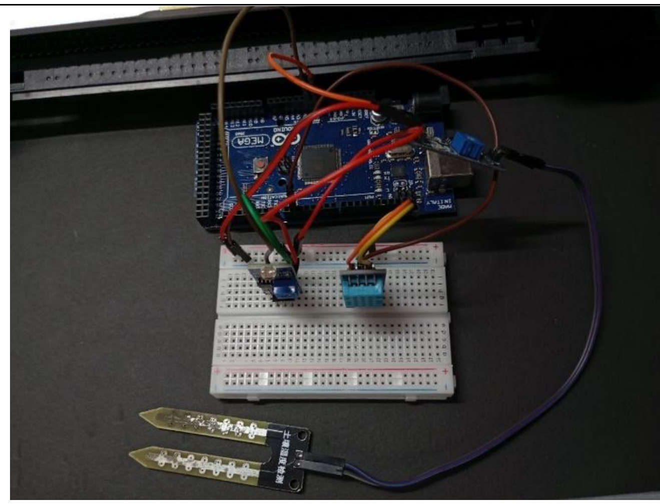
<table><tr><th>Soil Moisture</th><th>Arduino Mega</th></tr><tr><td>VCC</td><td>5V</td></tr><tr><td>GND</td><td>GND</td></tr><tr><td>A0</td><td>A0</td></tr></table></td><td></td></tr>
<tr><td>2</td><td>Connect the DHT 11 to Arduino Mega

Connection pin:

<table><tr><th>DHT 11</th><th>Arduino Mega</th></tr><tr><td>VCC</td><td>5V</td></tr><tr><td>GND</td><td>GND</td></tr><tr><td>Out</td><td>D2</td></tr></table></td><td></td></tr>
</table>

<table>
<tr>
<td>3</td>
<td>Connect the LDR Sensor Module to Arduino Mega

Connection pin:

<table>
<tr><th>LDR Sensor Module</th><th>Arduino Mega</th></tr>
<tr><td>VCC</td><td>5V</td></tr>
<tr><td>GND</td><td>GND</td></tr>
<tr><td>OUT</td><td>A1</td></tr>
</table>
</td>
<td></td>
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</table>

3.2.3 DATA LOGGING

Data logging is an important process in the success of this plant monitoring project, it involves data collection and analysis of data on the plant environment. This logging data is made with the aim of continuously monitoring the plant environment by reducing human involvement in real time to several parameters that have been shown, namely temperature, humidity, soil moisture and light intensity for trend analysis and decision-making.

The data captured by the sensor with a predetermined time interval i.e., every two seconds new data will be captured and continuously. The Arduino Mega processes the data and uses the "Serial. Print" command in the C++ programming to set the format of how the data will be logged to the PLX-DAQ serially. The data will be sorted into columns for each parameter to make it more organized and easier to analyze and PLX-DAQ could display real-time for each captured data. PLX-DAQ will input the data into an excel file in CSV (Comma Separated values) format as it is lightweight and compatible with analysis tools, and it is easy to import into an Excel Workbook for visualization and trend-analysis.

3.2.4 DATA ANALYSIS

Data analysis is the process of interpreting the data obtained to see trends that can help in making decisions about plant care. The main goal of analyzing the data is to identify trends in temperature, humidity, soil moisture, and light intensity. It is also important to detect anomalies such as insufficient watering or lack of irrigation in the plant environment to optimize plant care. Microsoft excel is used to create data visualization and analysis that provides features such as charts, conditional formatting and filtering to simplify interpretation.

3.3 PROJECT USABILITY FLOW CHART

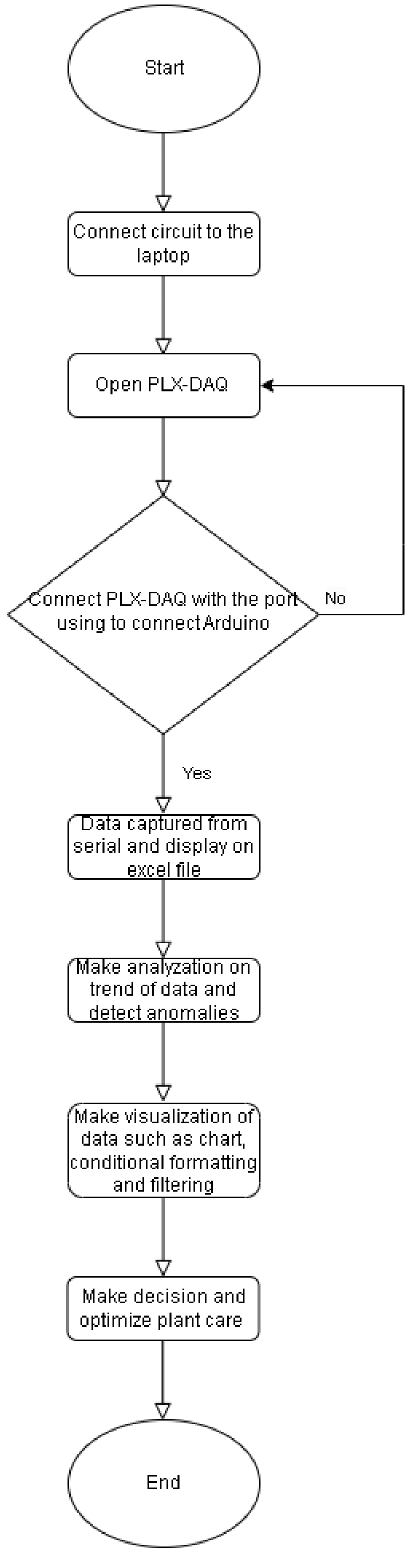

Figure 3.14 Project Flow Chart Usability

CHAPTER 4

FINDING AND ANALYSIS

4.1 RESULT & ANALYSIS

For this chapter represent the finding we get obtained from the implementation and testing environmental monitoring system. The system was created to collect data from three sensor which is DHT11 for temperature and humidity, soil moisture sensor, and the LDR sensor for light intensity. The data were collected streamed to a connected PLX-DAQ system and analysed to evaluate the system accuracy and performance.

The findings data are organized into section, starting with raw data from sensors, then followed by an analysis of trends, patterns, and anomalies. The comparisons with expected outcomes are also provided to assess the system reliability and practicality. Challenges that we face during data collection and system testing are discussed along with their potential impact for the result.

This chapter aims to we provide a comprehensive understanding of how the system perform under the real-world conditions and to interpret the significance of the collected data in relation to the project objectives

4.1.1 DATA SUMMARY OF SOIL MOISTURE SENSOR

Table 4.1 Data Summary Soil Moisture Sensor

Summary	**Values (%)**
Average	38.95
Max	46.04
Min	36.56

The data recorded from the Soil Moisture Sensor has been analysed by stating the average, maximum and minimum of the moisture percentage found in the soil to be able to monitor the health of the soil. The average data obtained was 38.95%, followed by the maximum data of 46.04% and the minimum data of 36.56%.

4.1.2 DATA SUMMARY OF DHT11

Temperature

Table 4.2 Data Summary Temperature (DHT11)

Summary	**Values °C**
Average	27.16
Max	27.60
Min	27.10

The temperature data recorded from the DHT11 Sensor has been analysed by stating the average, maximum and minimum of the temperature value found in the plant environmental to be able to monitor the consistent and moderate temperature and is suitable for most plant growth. The average data obtained was 27.16°C, followed by the maximum data of 27.60°C and the minimum data of 27.10°C.

Humidity

Table 4.3 Data Summary Humidity (DHT11)

Summary	**Values (%)**
Average	81.00
Max	81.00
Min	81.00

The humidity data recorded from the DHT11 Sensor has been analysed by stating the average, maximum and minimum of the humidity found in the plant's environment to be able to monitor the environment's humidity conditions. The average, maximum and minimum data obtained was same because not showing any changes which is 81.00%

4.1.3 DATA SUMMARY OF LDR SENSOR

Light Intensity

Table 4.4 Data Summary LDR Sensor

Summary	Values (*lx*)
Average	5.74
Max	7.02
Min	1.67

The lux data recorded from the LDR Sensor has been analysed by stating the average, maximum and minimum of the lux value found in the plant's environment to be able to monitor the environment's light intensity. The average data obtained was 5.74 *lx*, followed by the maximum data of 7.02 *lx* and the minimum data of 1.67 *lx*.

4.2 VOLTAGE READING

This voltage test is done to see the voltage received by each component or sensor used so that the reading received is stable when the project is underway. The test data was collected as shown in the table below.

Table 4.5 Voltage Reading of Sensors

Bil	Testing	Voltage Reading			Number Of Test	Status
		Pin	Normal	Measure		
1	Soil Moisture	VIN	5.0V	4.5V	1	succeeded
		GND	0.0V	0.0V	2	succeeded
					3	succeeded
		Pin	Normal	Measure		
2	LDR Module	VIN	5.0V	4.3V	1	succeeded
		GND	0.0V	0.0V	2	succeeded
					3	succeeded
		Pin	Normal	Measure		
3	DHT 11	VIN	5.0V	4.8V	1	succeeded
		GND	0.0V	0.0V	2	succeeded
					3	succeeded

4.3 SENSITIVITY SETTINGS

In this section, a sensitivity test is performed to identify the sensitivity of the sensor in order to launch the monitoring process.

4.3.1 LDR Sensor Sensitivity

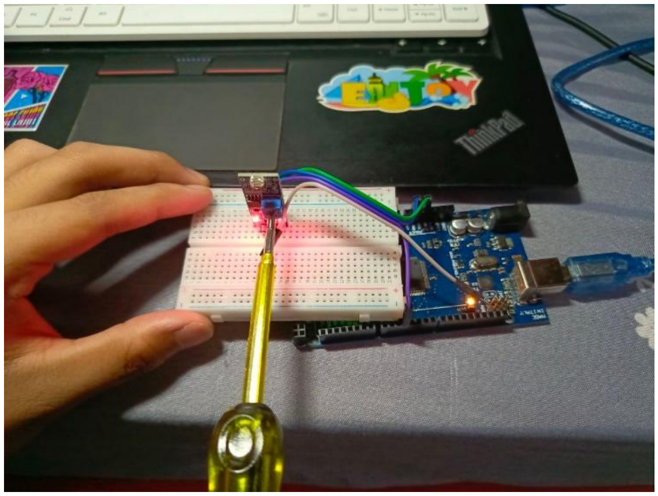

Figure 4.1 LDR Sensor Sensitivity Test

This sensitivity test is done to see the differentiate range on light intensity detected by LDR sensor. By adjust this sensitivity settings, user can measure and know the exact range of light level. Higher lux value indicates that the LDR sensor is less exposed to the light while low lux value indicates that the LDR sensor is exposed to light. These adjustments ensure the voltage receive by sensor remains stable. The measured data is presented in the table below.

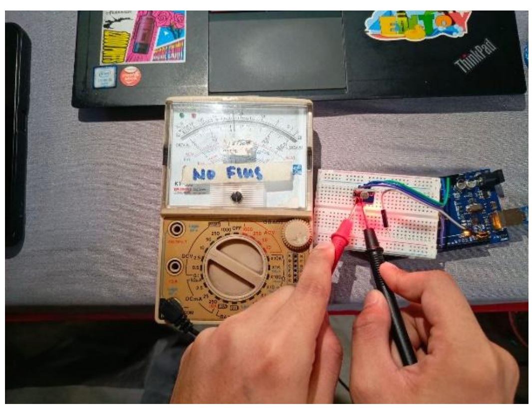

Figure 4.2 LDR Sensor Voltage Measuring Value

Table 4.6 Measured Lux Value from LDR Sensor

Lux Value	Conditions
0	Dark
4.26	Light

4.3.2 Soil Moisture Sensitivity

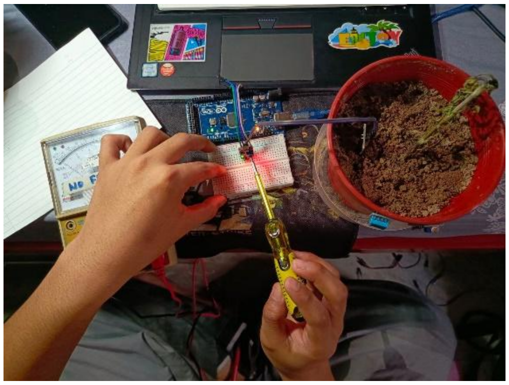

Figure 4.3 Soil Moisture Sensor Sensitivity Test

A sensitivity test was made on the soil moisture sensor before project monitoring was carried out. This is because it is to identify the sensitivity of the sensor to soil moisture. This sensitivity test is made by identifying the raw value for soil moisture by knowing the estimated raw value for dry soil, moist soil and wet soil. This is done so that the monitoring process can be done efficiently and the data obtained is appropriate to the condition of the land. In addition, it is to set the sensitivity of the sensor to the detection of soil moisture whether sensitive or less sensitive, adjusted by using an adjustable resistor that is included in the sensor module.

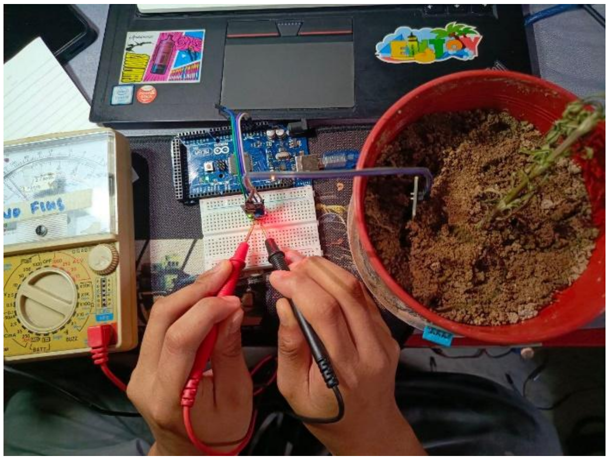

Figure 4.4 Soil Moisture Sensor Measuring Water Volumetric in Percentage

Table 4.7 Measured Soil Percentage from Soil Moisture Sensor

Range Value (%)	**Conditions**
0 - 30	Dry
31 - 80	Moist
81 - 100	Wet

A measured test was made on the soil moisture sensor to know the range value in percentage when the conditions is dry, moist and wet. This is to identify the value of volumetric water through soil moisture sensor. When the range value is around 0 to 30%. It's shown that the conditions of soil are dry. When the range value is around 31 to 80%, the conditions is moist. For range value 81 to 100% show that the condition of soil is wet. It will help users especially farmers to monitor out their plant ensuring the plants is in the good health care.

4.4 GRAPH CHART

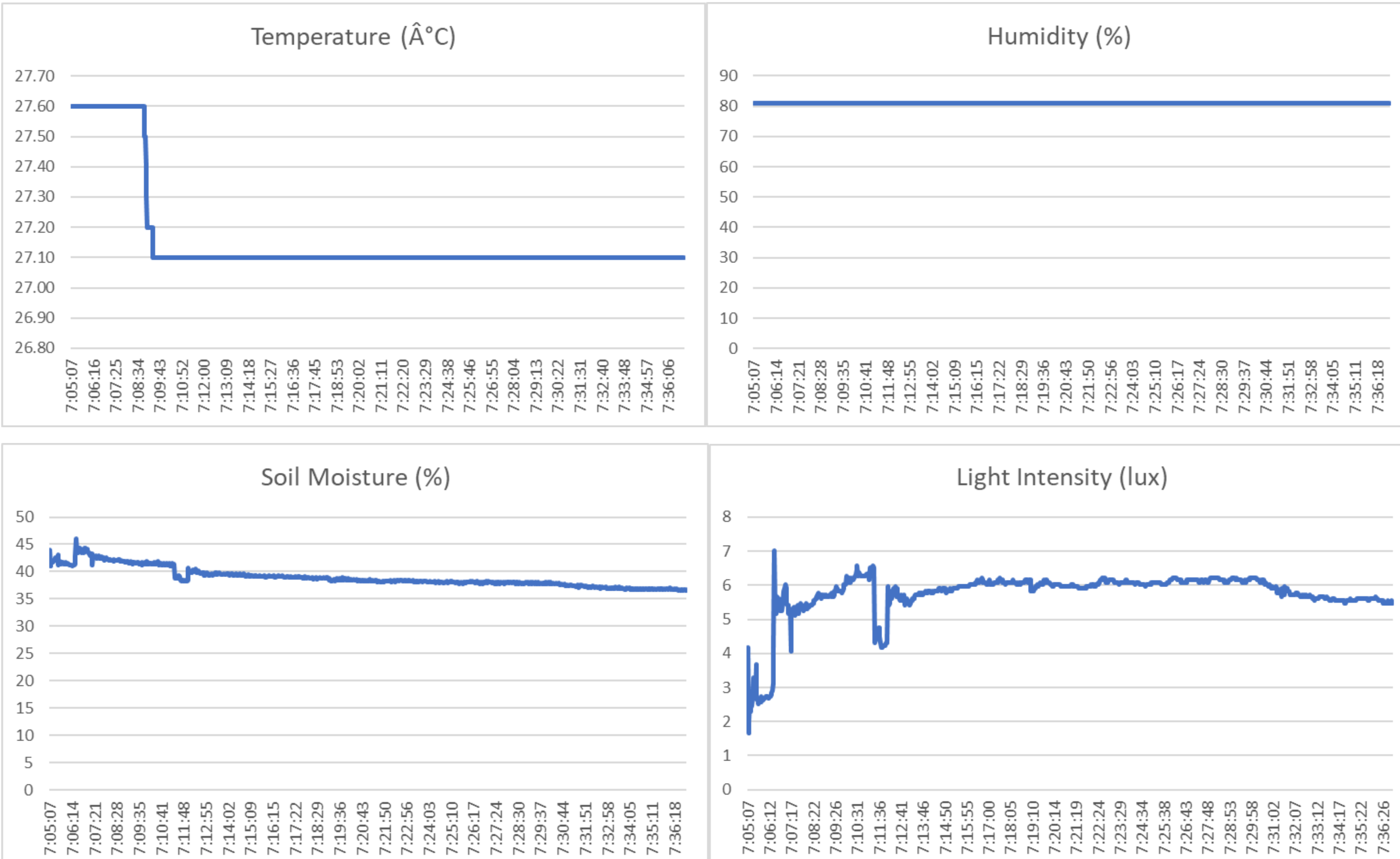

Figure 4.5 Graph Chart of Smart Plant Monitoring

The graph above illustrates the trends of environmental temperature, humidity, soil intensity and light intensity. The chart shows the entire data for the four parameters and has their respective patterns using three different sensors which is LDR, DHT11 and soil moisture sensor. You must be wondering why only use 3 sensors, how about humidity? Well, the humidity is senses by DHT11. DHT11 can measure humidity and temperature. In the first graph, show temperature using DHT 11 sensor. The temperature is dropping off from 27.60 to 27.10 is because the weather in the meantime is rainy. It doesn’t show much different on the graph. For the third graph which is soil moisture is measured by soil moisture sensor. The trends show the value of volumetric water in soils. It’s start dropping off when the time reach 7.08 am and above. For the last graph is using LDR sensor. The trends stable at 7.13 and 7.36 am. It’s because it the time, the sun is already up. The graph highlights environmental factor can affect the plant health.

4.5 CHALLENGES

These challenges provided valuable learning opportunities, enabling the team to identify areas for improvement and implement solutions to enhance the reliability and performance of the Smart Data Plan project. In the implementation of the Smart Data Plan project, several challenges were encountered, particularly in the technical aspects. These challenges impacted the efficiency and accuracy of the project. Below are the main challenges faced:

4.5.1 Data Collection Downtime

One of the challenges encountered during the project was a reduced data collection window, with data collected for less than an hour starting from 7:00 AM. This limited timeframe resulted in fewer data points, which made it difficult to analyse trends comprehensively and assess environmental changes over time. The short data collection period was attributed to technical issues that caused delays in initiating the sensors' operation. Addressing this issue required adjustments to sensor configurations to ensure extended and uninterrupted data acquisition in the future.

4.5.2 Weather Conditions

Adverse weather conditions, especially heavy rain, posed a considerable risk to the project. The components and laptops used in the project were not waterproof, increasing the likelihood of damage during outdoor operations. To mitigate this, protective measures such as waterproof covers were implemented, but the challenge remained a persistent obstacle in ensuring uninterrupted data collection.

4.5.3 Sensor Calibration Issues

Another challenge faced during the project was sensor calibration. Inconsistent sensor readings were observed at certain intervals, particularly with the soil moisture sensor and light intensity data. These discrepancies necessitated frequent recalibration of the sensors to ensure the accuracy of the collected data. This recalibration process consumed additional time and effort, highlighting the need for more robust and self-calibrating sensors in future implementations.

CHAPTER 5

RECOMMENDATION AND SOLUTION

5.1 INTRODUCTION

Our project smart plant monitoring system currently use DHT11, LDR, soil moisture sensor. By using these sensors, all the data must be capture in real-time monitoring time which means you can't monitor outside the radius of the project. After some discussion with our team members, we have suggested to add some improvements or recommendations in the future to upgrade the whole project into the next level.

5.2 RECOMMENDATION

5.2.1 UPGRADE SENSOR

- Using a specific pH sensor to capture the data more effectively.
- By considering using multiple types of moisture sensor to have a better soil hydration across different areas.

Figure 5.1 Image of pH sensor

5.2.2 DASHBOARD OR MOBILE APPLICATION

- Use dashboard or custom mobile app that can give you live monitoring data through just by your smartphone.
- Users can receive alerts by the notifications to adjust the watering time or other abnormal situations.

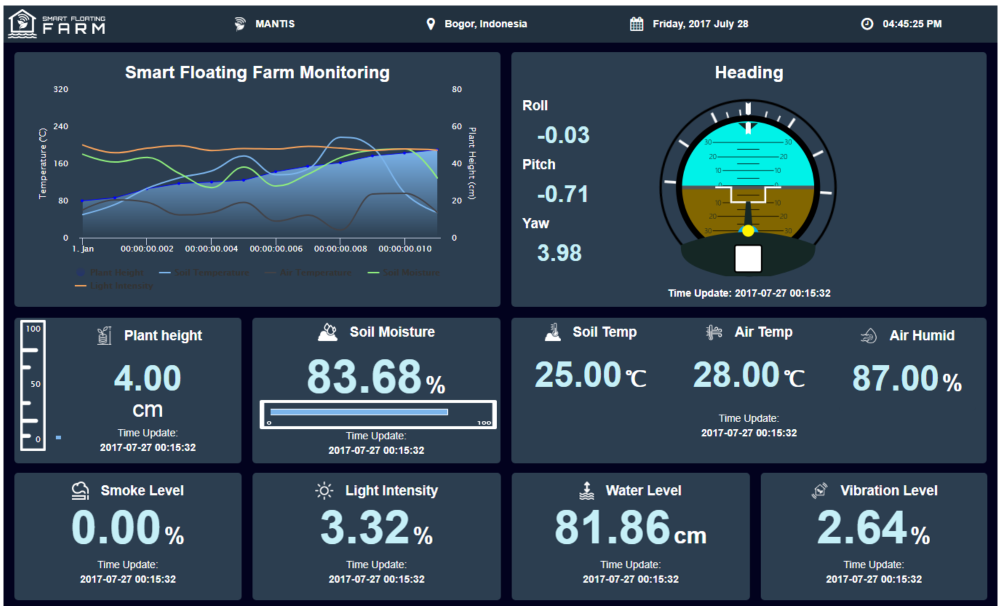

Figure 5.2 Example of using dashboard app

5.2.3 BACKUP AND SECURITY

- Using mobile app to add a function to make the whole system self-backup by itself and give more setting on how the sensor conditions like when the sensor needs to be changed or calibrated.

Figure 5.3 Image on how the data are linked through smartphone

5.3 SOLUTION

By using this recommendation, we're highly sure that the project can be improved in such an efficient way to collect the data with more reliable way. The additional sensor that we are suggested will gain more precise and comprehensive data collection. For the dashboard, will enhance the user on more accessible and convenience interface that might help user on monitoring the data in real time. Additionally, by integrating the backup systems and self-check system will ensure the system can continuously run without any hiccups.

5.4 CONCLUSION

To conclude this, this smart plant monitoring system has its potential to be improved more efficiency to collect the data. By using our implement idea which is using new dashboard and sensor will make the data that are collected more details. It's also having some potential on market demanding itself. The objective by making this project has already been accomplished as we can see the result at above. The objective is like below:

- To design a cost-effective system for monitoring environmental conditions essential for plant growth and health
- To develop an automatic monitoring system to saving time and more organized
- To provide a real time data logging light intensity, temperature, humidity and soil moisture level of plant to enable data-driven decision making

Table 5.1 Proof that this project is more worthwhile.

Feature	Other Projects	Your Project	Evidence of Difference
Cost-Effectiveness	Uses more expensive components like xiaomi smart plan 2 have price and RM 86.90	Uses affordable components like DHT11, LDR, and soil moisture sensors and price below RM30.	Component list and pricing show lower costs for your project without compromising performance.
Automation	Automation is limited to basic monitoring As an example, only one item can be monitored at a time.	Fully automated with monitoring and control of systems like irrigation or lighting.	Flow diagrams showing how full automation works in your system.
Real-Time Monitoring	Data is not recorded or accessible in real-time.	Provides real-time data logging for light intensity, temperature, humidity, and soil moisture.	Demo or screenshots showing real-time data accessible via apps or dashboards.

RUJUKAN

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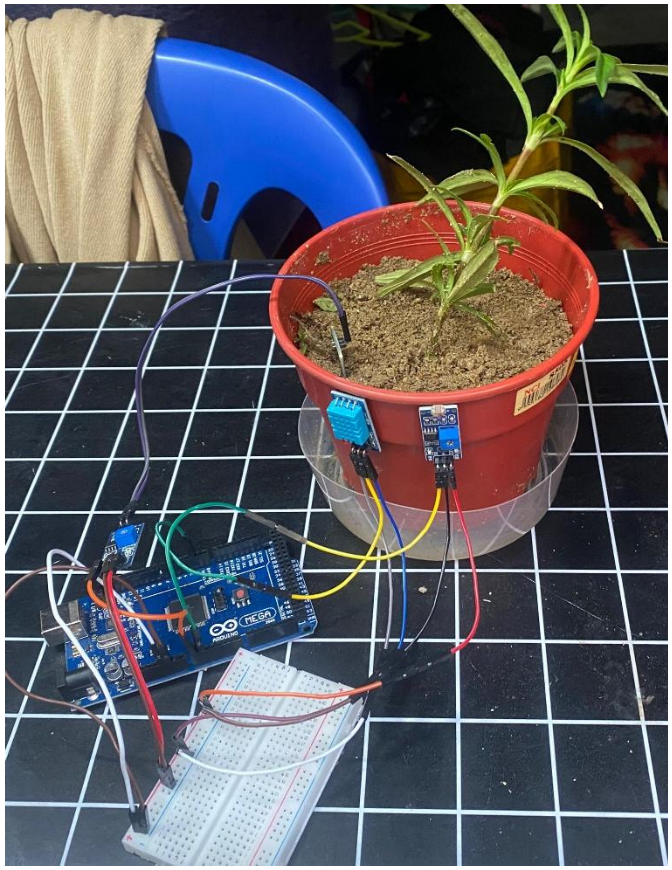
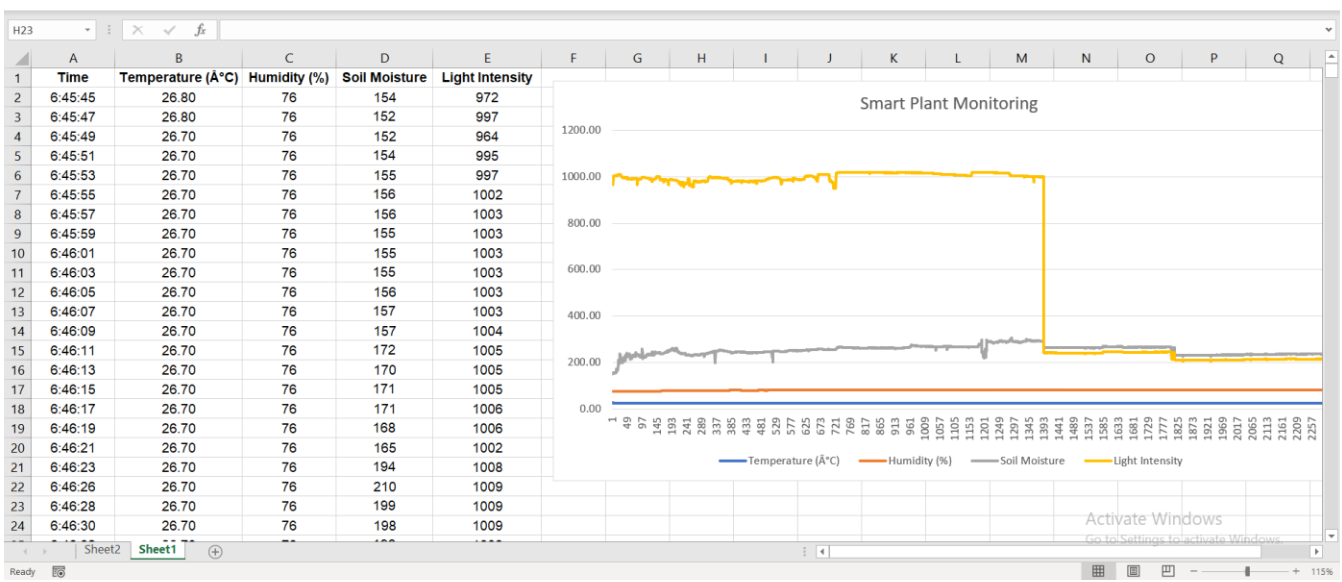


Figure 6.1 Actual Project Smart Plant Monitoring System



Time	Temperature (Â°C)	Humidity (%)	Soil Moisture	Light Intensity
6:45:45	26.80	76	154	972
6:45:47	26.80	76	152	997
6:45:49	26.70	76	152	964
6:45:51	26.70	76	154	995
6:45:53	26.70	76	155	997
6:45:55	26.70	76	156	1002
6:45:57	26.70	76	156	1003
6:45:59	26.70	76	155	1003
6:46:01	26.70	76	155	1003
6:46:03	26.70	76	155	1003
6:46:05	26.70	76	156	1003
6:46:07	26.70	76	157	1003
6:46:09	26.70	76	157	1004
6:46:11	26.70	76	172	1005
6:46:13	26.70	76	170	1005
6:46:15	26.70	76	171	1005
6:46:17	26.70	76	171	1006
6:46:19	26.70	76	168	1006
6:46:21	26.70	76	165	1002
6:46:23	26.70	76	194	1008
6:46:26	26.70	76	210	1009
6:46:28	26.70	76	199	1009
6:46:30	26.70	76	198	1009

Figure 6.2 Excel Data Interfaces

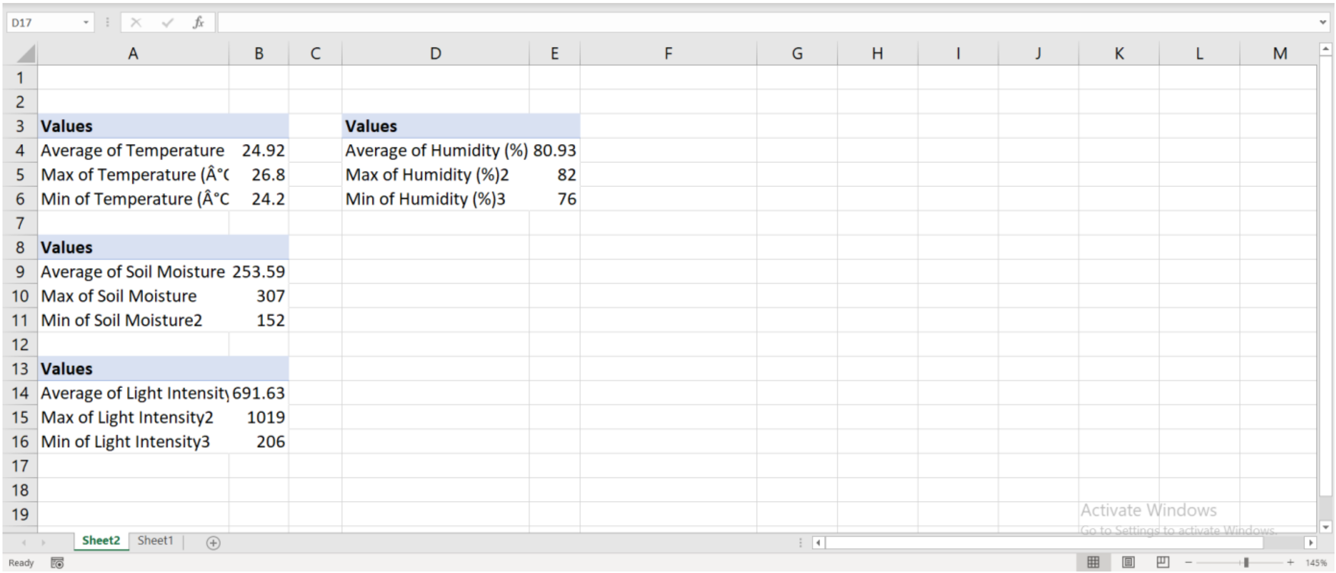


Figure 6.3 Excel Data Analyzation Using Pivot Table