

# AGROTECHNOLOGY SYSTEMS BASED ON INTERNET OF THINGS

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## ABSTRACT

The use of IoT can realize precision farming, which means through the use of sensors that are applied to several planting media or agricultural land that allows users to get detailed information about light levels at any given time. In this study we proposed an agrotechnology system using internet of things and mobile application development, which is called AGROTECHFARM Systems. It can help the productivity of crop planting. The research methodology consists of several stages such as: requirement analysis, systems design, and development. First stage was conducted by collecting system requirements data through interviews. In this stage, we analyze user and system requirement for AGROTECHFARM systems. Second stage we used UML to design AGROTECHFARM systems. Third stage is build and implementation AGROTECHFARM systems. The results of this study is implementation AGROTECHFARM systems in hydroponics, Indoor, and Outdoor planting. It can be used for urban agricultural community. Besides that, the impact of AGROTECHFARM systems is can help users to controlling plant maintenance. We proposed IOT sensors for support and monitoring the status of the planting growth.

**Keywords:** AGROTECHFARM Systems, IOT, Hydroponics, Indoor, Outdoor, Planting

## 1. INTRODUCTION

Indonesia is one of the horticultural countries that has great potential in agriculture. Broadly, the agricultural sector includes agriculture, plantations, fisheries, livestock and forestry. Indonesia is a country known for its diversity of tropical fruits and has great potential to develop the agricultural industry. Indonesia is called an agrarian country because the agricultural sector plays an important role in the economy and many of the population work in the agricultural sector. As the name implies, Indonesia has many abundant natural resources because Indonesia's geographical location is very good and supports the growth of plants. Indonesia is located in a tropical area that has high rainfall, thus making the soil and land conditions in Indonesia fertile and many various types of plants that can grow with good quality. According to [1], Internet of Things is a physical and virtual network of object that can collect data around it and communicate via the Internet [1]. The integration of Internet of Things into greenhouse has been implemented by [2]. Meanwhile, implementation research in [3] also proposes a smart agriculture that can support various types of IoT devices. Technological developments

make the current condition into the era of digitalization. The era of digitalization has made many industrial sectors begin to leave the traditional way, and begin to enter the automation function of business processes & activities of each industrial sector, such as the agricultural industry. The agricultural industry is an important industry to meet food needs. It can be said that the industry must implement new innovations in accordance with the development of information technology & the internet so that in the future the agricultural industry can create better results for the main human needs. According to [4], Indonesia has very wide agricultural land that have competitive advantage. Related to it, Indonesia has become an agricultural country that prioritizes the agricultural sector as a source of the nation's economy [5]. According to [6], the development of the agricultural sector in Indonesia is faced with various challenges and problems. Agricultural land in big cities is decreasing in big cities, because of urbanization and industrialization [7]. According to [8], the reduction in agricultural land in big cities will lead to several things. Several social and economic problems also threaten the Indonesian agricultural sector, especially in big cities [9]. Besides that, it is getting

worse with the low interest of youth in agriculture which causes low regeneration of farmers [10]. Related to [11], modernization process using technology is needed in agriculture. Internet of Things (IoT) can be used as a decision support system in controlling agricultural sensors and connecting them to cloud technology to support good plant growth [12]. In this study, it is important to design application for monitoring temperature, humidity, light, and CO<sub>2</sub> based on IoT. It consists of software and databases that store and manage the monitoring data that can be accessed from mobile application

## 2. RELATED WORKS

According to [13], Micro-climate is a set of climatic conditions measured in a localized area near the earth's surface. It is including temperature, light, wind speed, and humidity. Then it will provide meaningful indicators for habitat selection and other ecological activities. Besides that, related to [14], Micro-climate is discuss about habitat and urgent for organisms at the micro scale. Today, hydroponics is growing fast, while Hydroponics is a planting technique using planting media other than soil. It can use spumic, gravel, sand, coconut fiber or foam and utilizes water flow to provide plant nutritional needs [15]. The impact of this condition is planting does not require large tracts of land [16]. According to [17], IOT has been discussed and proposed for autonomous driving. Besides that, related to [18], implementation IOT for support deep learning has been discussed.

## 3. RESEARCH METHODOLOGY

We used interview and observation technique to collect systems requirement for construct the mobile IOT farming systems. We used UML to analysis and design the mobile IOT farming systems. Then, we used Axure RP9, Visual Studio, and Visual Paradigm to construct mobile application. We used sensors in the form of a microcontroller board equipped with several sensors according to analysis needs. We used NodeMCU V3 which is equipped with an ESP8266 Wifi module .Then, the microcontroller board will be connected to several sensors related to the needs of plant life, such as CO<sub>2</sub> sensors, temperature sensors, light sensors, and air humidity sensors. We will also add an OV7670 camera module to monitor the condition and development of the plant being analyzed. The circuit will be given a programming function with the

Arduino IDE software according to the needs of the researcher when it is assembled. The application will be connected to the database using the cloud feature, then connected to the mobile application and website application. The research methodology can be shown in four stages that can be explained in figure 1 below :

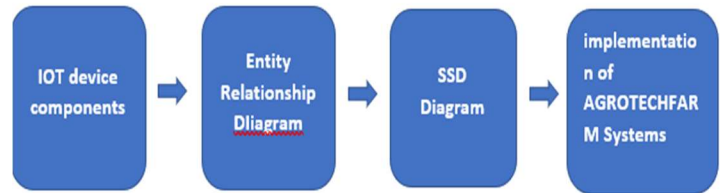


Figure 1. Research Methodology

## 4. RESULTS AND DISCUSSION

In this chapter consists of IOT device components, entity relationship diagram, SSD diagram, and implementation of AGROTECHFARM Systems.

### 4.1. IOT Device Components for AGROTECHFARM Systems

In this study, we used NodeMCU ESP 8266 functions as a microcontroller and is connected to the internet (WiFi). Then, we used the MQ 2 sensor is used to measure changes in gas pressure in an environment. The DHT 11 sensor is used to detect changes in temperature and humidity in the environment around this sensor. The BH 1750 sensor is used to measure changes in light levels in a room or environment. NodeMCU Base version 1.0 functions as a shield or shield for the microcontroller module and also becomes a connecting port between the sensor and the microcontroller. The F to F cable is used to connect the sensor with NodeMCU Base version 1.0 .Adapters are used to provide power from electrical switches to IoT devices.

### 4.2. Entity Relationship Diagram AGROTECHFARM Systems

We create Entity Relationship Diagram (ERD) for AGROTECHFARM Systems that can be shown in figure 2 below :

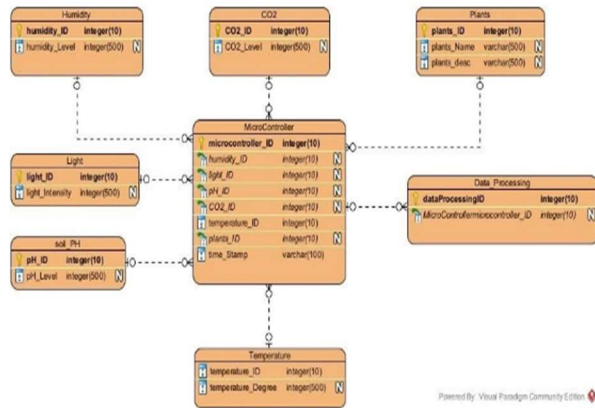


Figure 2. Entity Relationship Diagram

According to figure 1 above, there are eight entities such as humidity, CO2, plants, light, microcontroller, data processing, and temperature. It describes the relationship of the entities.

#### 4.3. SSD diagram for AGROTECHFARM Systems

In this study, we proposed SSD diagram which is able to describe and explained the flow and interaction in the AGROTECHFARM systems.

##### SSD add plants

SSD Add plants can be explained in figure 3 below. It is explained the interaction between actor and system.

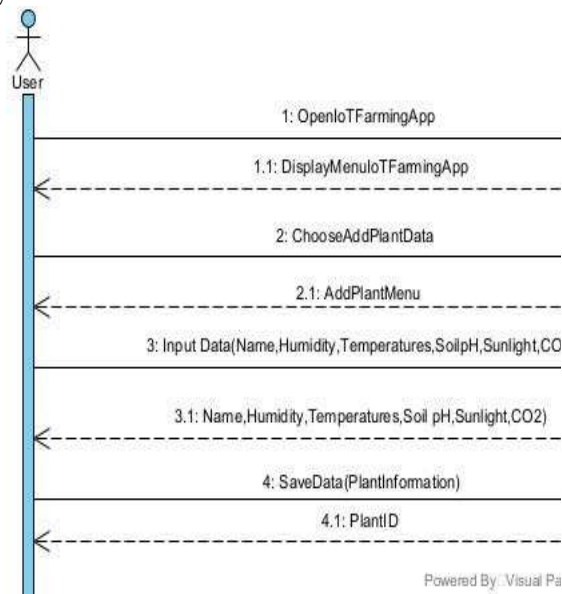


Figure 3. SSD Add Plants

According to figure 3 above, we can see SSD diagram for add plants. It describe and explained the activity of adding detailed plant information by users in the form of Name, humidity, temperature, soil pH, sunlight, CO2. This information will be used as a standard backlog. We can see the interaction between user and systems with more detail, such as open, display, choose, add plant menu, input data., and send data.

##### SSD View Plant Detail

The SSD diagram in figure 4 below illustrates the activity to view detailed information from the plant that has been inputted by the user. There are several plant details that can be seen by the user depending on the number of plant details entered by the user.

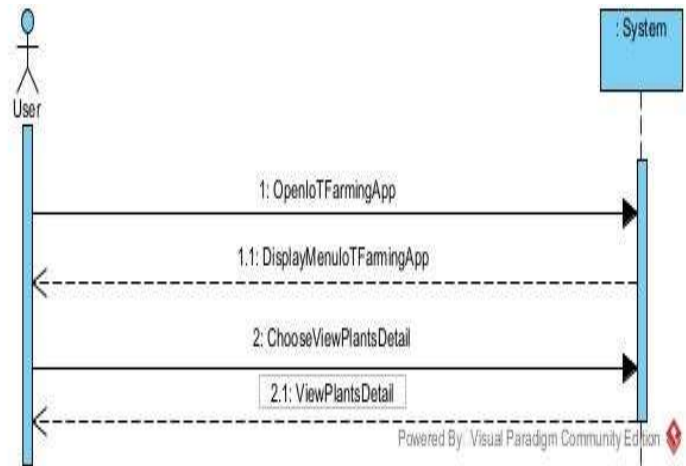


Figure 4. Ssd View Plant Detail

According to figure 4 above, we can see the interaction between user and systems such as open, display, choose, and view

##### SSD Delete Plant Detail

The SSD diagram in figure 5 below illustrates the activity to delete detailed information from the plant that has been inputted by the user, by selecting the plant details to be deleted.

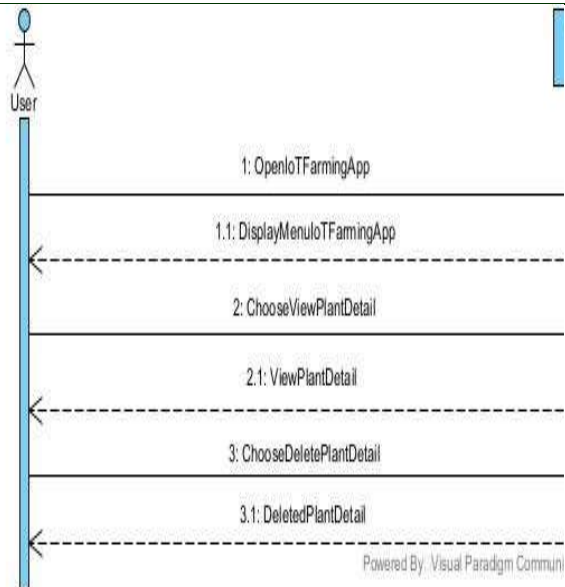


Figure 5. SSD Delete Plant Detail

**SSD View Measurement Plant**

Then, we create SSD for view measurement plant that can be explained in figure 6 below :

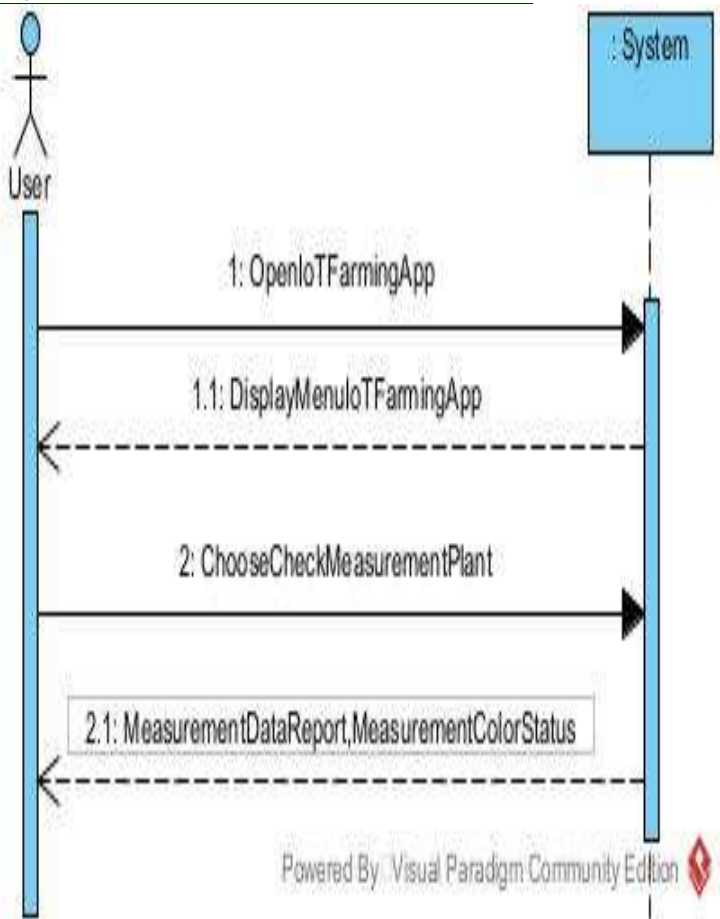


Figure 6. Ssd View Measurement Plant

The SSD diagram in figure 6 above illustrates the activity to view report data from the results of plant measurements using sensors. The data report will display the status in the form of color based on the measurement standards that have been determined previously. We can see in figure 6 above the states such as open, display, choose, and measurement data report.

**SSD Send the Result of Measurement Data**

The SSD diagram in figure 7 below illustrates the activity of the process of sending data from IoT farming sensors that are stored in a cloud database, then data processing is carried out from existing data variables to get measurement results.

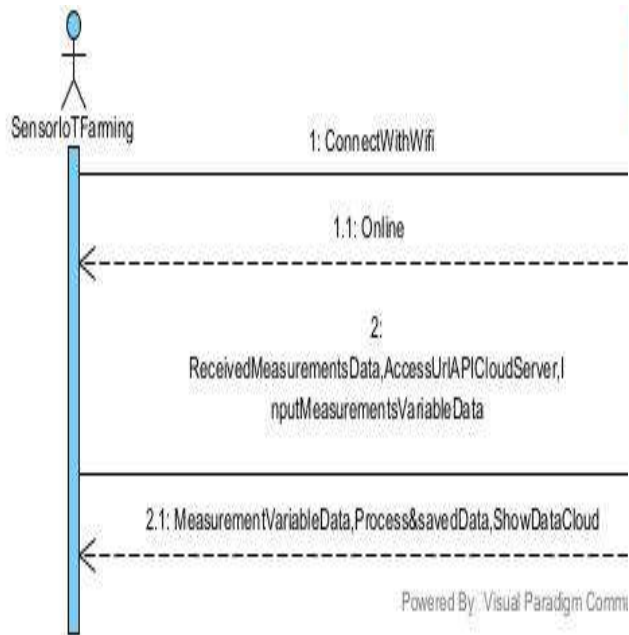


Figure 7. SSD Send The Result Of Measurement Data

According to figure 7 above, we can see the states in SSD send the results of measurement data. The states are connect wifi, online, receive measurement data access, and measurement variable data. The SSD shown the interaction between Sensor IOT Farming and systems.

#### 4.4. Implementation of AGROTECHFARM Systems

Implementation of AGROTECHFARM Systems consists of AGROTECHFARM systems menu, development stage, implementation hydroponic plant, implementation indoor plant, and implementation outdoor plant.

We create AGROTECHFARM systems that have menus or functionality such as : add plant data, view plants detail, and check measurement plants. Add plant data menus have capability to determine your standard measurements humidity, temperature, soil PH, sun light & CO2 for each plant have. View plants detail menu have capability to view and delete standard measurements data that have been set before here. Check measurement plants menu have capability to view measurements data of humidity, temperature, soil PH, sun light & CO2 plants and compare with the standards. In the application development stage, we use Android Studio software, because it already provides features that are quite complete & is devoted to making Android based applications. The design stage of development AGROTECHFARM can be shown in figure 8 below :

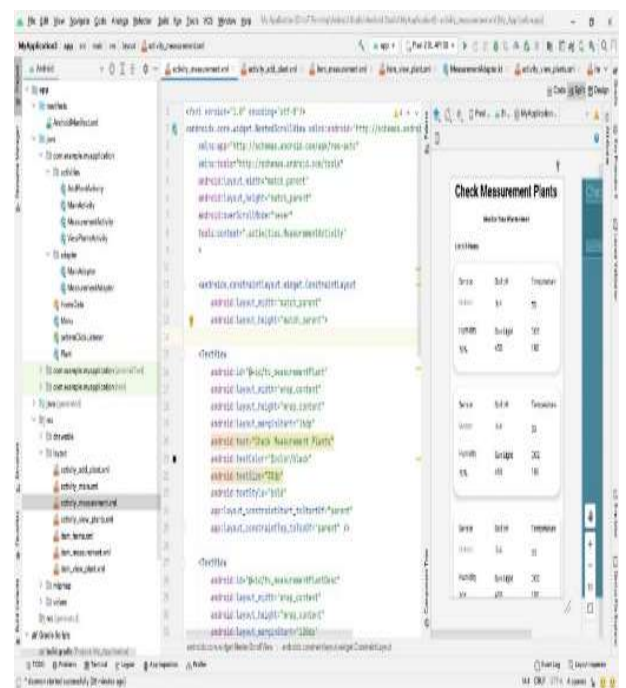


Figure 8. Agrotechfarm Design Stage

According to figure 8 above, the design stage can be initial user interface. There are 3 system features such as add plant, view plant & check measurement plant.

#### AGROTECHFARM Systems Menu



**Development stage for AGROTECHFARM Systems.**

We create script establishing Connection to Database that can be described in table 1 below :

At the development stage, the author creates a database on phpMyAdmin on the webserver and makes coding for the connection, the author uses the Visual Studio Code software. Software is very commonly used by programmers to make coding so the author also uses this software to make connection coding. In order to create agrotechnology systems based on analysis and system design before, we used PHP My admin and software visual code. Software is very commonly used by programmers to make coding so the author also uses this software to make connection coding. We carried out testing on the Node MCU microcontroller to find out whether the MCU Node that was connected to the humidity sensor could detect the level of moisture in the soil. Then, see also whether the data provided has been sent to the server or not. We used visual studio code in development stage that can be seen in figure 9 below :



Table 1. Scripting For Connection To Database

```
<?php

//Variabel database

$servername = "srv105.niagahost
er.com";

$username = "u1103320_user";
$password = "rm847tc3hrvk";
$dbname = "u1103320_DataSensor"
;

$koneksi = mysqli_connect($
servername, $username, $password, $
dbname); // menggunakan mysqli_conn
ect

if(mysqli_connect_errno()){
// mengecek apakah koneksi database
error

        echo 'Gagal melakuk
an koneksi ke Database (koneksi): '
        .mysqli_connect_error(); // pesan k
etika koneksi database error

    }
}
```

According to table 1 above, we define variable, connection, and try catch also.

Figure 9. Development Stage With Visual Studio Code

Then, we used Nodemcu Microcontroller Connection and Sending Data to Website using libraries in table 2 below :

Table 2. Libraries Used

#include <ESP8266WiFi.h>
#include "DHT.h"
#define DHTPIN D7
#define DHTTYPE DHT11
#include <Wire.h>
#include <BH1750.h>

After that, we create a method or functionality to reading analog sensors. In this method, we define variables and data types for support implementation. Table 3 below shown the method for reading analog sensors and also the description of the method.

Table 3. Method For Reading Analog Sensors

Method name	Description
Reading Analog Sensors	<pre>int kelembapan = dht.readHumidity();  int suhu = dht.readTemperature();  int CO2 = analogRead(A0); int cahaya = lightMeter.readLightLevel();  Serial.print(F("Humidity: ")); Serial.print(kelembapan); Serial.print("\n"); Serial.print(F(" Temperature: ")); Serial.print(suhu); Serial.print(F("°C ")); Serial.print("Gas Level: "); Serial.println(CO2*10); Serial.print("Light: "); Serial.print(cahaya);</pre>

```
Serial.println(" lx");
delay(2000);
Serial.print("connecting to ");
Serial.println(host);
```

Then, we create a method for send content, and method name is Send content. This method described description of temperature, light, humidity

Table 4 Below Shows The Method For Send Content

Method Name	Description
Send content	<pre>String url = "/write- data.php?CO2="; url += CO2*10; url +=String("&amp;suhu="); url += suhu; url +=String("&amp;cahaya="); url += cahaya;  url +=String("&amp;kelembapan="); url += kelembapan; Serial.print("Requesting URL: "); Serial.println(url);</pre>

The las step is we create a method for send to host address with port 80. Table 4 below shown the description of the method

Table 4. Method For Send To Host Address With Port 80.

Method Name	Description
Send to host address with port 80	<pre>WiFiClient client; const int httpPort = 80; if (!client.connect(host, httpPort)) {</pre>

	<pre>Serial.println("connection failed"); return;</pre>
--	---

mixed with 5 ml of nutrients A and B each. Then the flannel cloth is tucked in a plastic pot, and the plastic pot is inserted into a cardboard board with the appropriate hole size. In figure 11 below, we can see the kale seedlings are starting to grow .

### Implementation of Hydroponics Plant

In this study, we are doing testing and implementing hydroponic plant. The steps is The kale seeds are put into rockwool that has been moistened with water. Then the rokwoal is put into a water container that can be shown in figure 10 below :



Figure 10. Water Spinach Seed Planting

After that, Kale that has grown on the rokwoal is removed. Then, a water container filled with about 700 ml of water is mixed with 5 ml of nutrients A and B each. Then the flannel cloth is tucked in a plastic pot, and the plastic pot is inserted into a cardboard board with the appropriate hole size. Kale that has grown on the rokwoal is removed. Then, a water container filled with about 700 ml of water is



Figure 11. The kale seedlings are starting to grow

We assemble NodeMCU circuit with CO2 sensor that can be seen in figure 12 below :



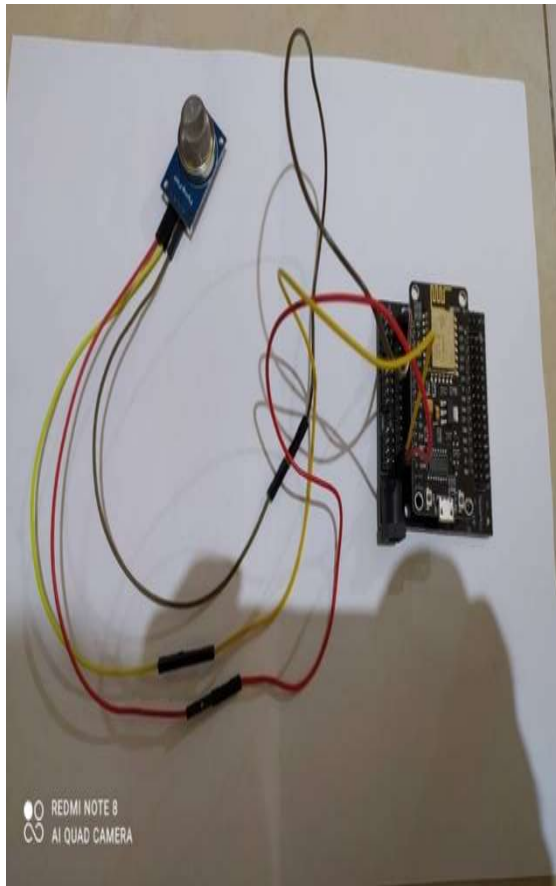


Figure 12a. Nodemcu Circuit With C02 Sensor

Suite:

1. Pin A0 on MQ2 to pin A0 on NodeMCU
2. GND pin on MQ2 to G pin on NodeMCU
3. VCC pin on MQ2 to VIN pin on NodeMCU
4. All male to female jumper cables are connected to female to female

The MQ2 Gas Sensor Module is used to detect gases that are harmful to plants such as H<sub>2</sub>, LPG, CH<sub>4</sub>, CO, Alcohol, Smoke or Propane. Due to its high sensitivity and fast response time, measurements can be made as soon as possible.

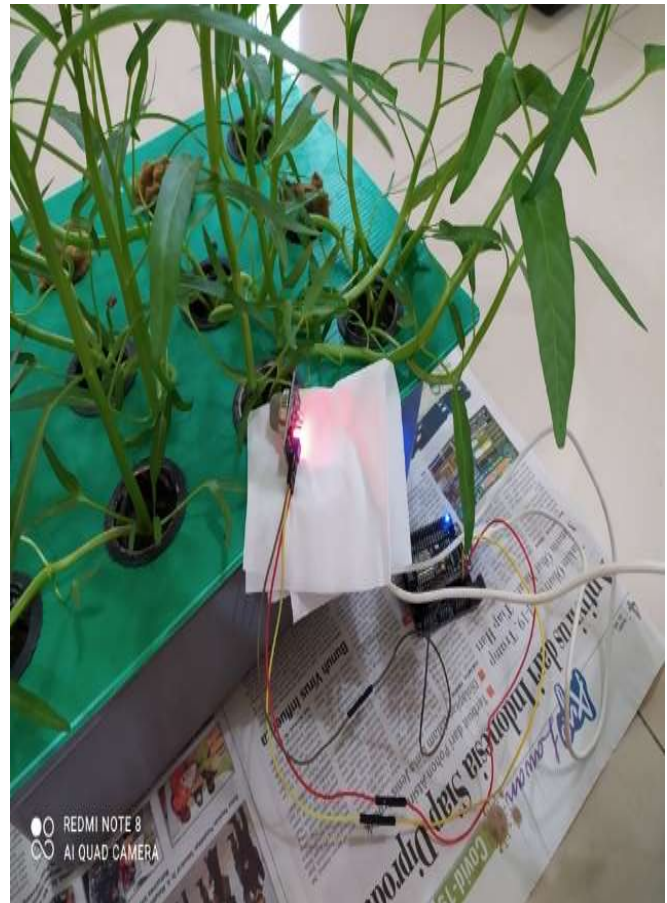


Figure 12b. Nodemcu Implemented With Hydroponic Kale

According to figure 12b above, we can see the implementation of NodeMCU for hydroponic kale.

### Implementation of Indoor Plant

In this study, we are doing testing and implementing Indoor plant. The first one is Inserting the soil media into the tray, after that watering the soil media evenly. Then enter the pakcoy plant seeds with a distance of  $\pm 1$  CM on the surface of the soil media



Figure 13. Indoor Plant Implementation

According to figure 13, it can shown the implementation of Indoor plant.

### Implementation of Outdoor Plant

In this study, we are doing testing and implementing Outdoor plant. The steps is Half of the soil media is put into the pot and then leveled after that the soil is sprayed with water evenly and then the rest of the soil media is also inserted into the pot after that the spinach seeds are sown evenly on the surface of the soil that can be explained in figure 14 below :

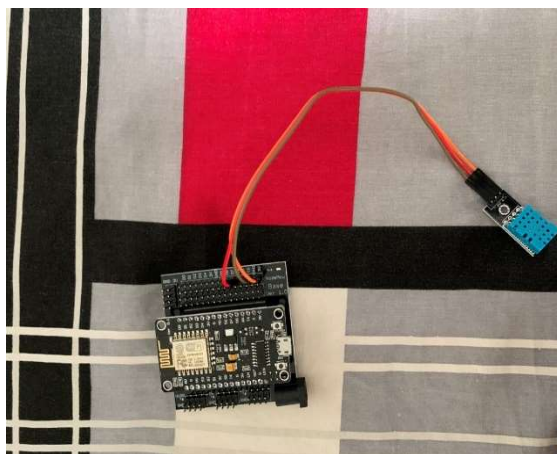


Figure 14. Outdoor Plant Implementation

The mechanism for arrange is On DHT 11 There are 3 Pins which work as follows: (1). The pin in the green cable serves as a cable to transfer data, (2). The pin on the Black Wire is the Ground Wire, and (3). The pin on the red cable is the 3 v . Power input cable

### 5. CONCLUSION

In this study, we proposed agrotechnology systems based on Internet of Things. These systems consists of several features which is supported processes in plant growth. It can support the productivity plant processes, users can find out the status of the plant and the room temperature to keep it stable. These conditions can be expanded and developed into a product that can be used for urban agricultural community. The process used in recording the development of plants that are being checked periodically will cause difficulties in finding files that accumulate and also the amount of paper used, recording plants also includes recording the progress of the status of plants that have been monitored, this will certainly take time because the number of areas that must also be thoroughly monitored and recorded. By using this IoT system, each user or user can easily check periodically using only a smartphone, data from information on the status of plant development can also be monitored through CCTV media provided by one of these features, the sensor will also automatically provide status to the server that will be sent directly to the user.

### ACKNOWLEDGMENT

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