Controlling And Monitoring Of Vegetables Growth With Smart Greenbox Automation System Using Machine Learning

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***Abstract*— Currently, agricultural technology is one of the technologies that help many people to solve their daily problems or activity. People on the city areas are farming in their house and they usually can't control their plants properly because of their busyness. However, the technology of Agricultural always developing in terms of creating ideal ways and condition for a crop. The presence of Internet of Things (IoT) technology has become a major break through for societal issues. IoT can makes people easier in controlling and monitoring their crops anywhere and anytime with remote. Greenbox is a tool which can contain several plants that we can monitor and control their growth. The data that will be displayed on the website is the data taken by the sensor on the greenbox device, which is stored in the firebase database, then the user will carry out commands according to the database. Sensors are used to determine the value of plant growth parameters. The expectation of this research is that the output of the system built can be a solution to problems that exist in the community so that the prototypes that are built can be perfected and marketed to the public.**

Keyword*— Greenbox, Internet of Things, Firebase

I. INTRODUCTION

The development of technology is intended can simplify human work and solve the problems effectively and efficiently. Technology in this world is always evolving and now we are entering The Industrial Revolution Era 4.0 where one of the pillars of industrial development is the Internet of Things (IoT). IoT is a technology that can help us in controlling and monitoring remotely with the help of the internet. This technology was really developed currently which makes it possible for this technology to become a daily food for the next few years [1].

In this era, many people are busy working outside the home all day and they need activities that can refresh their minds after working all day. But not everyone can do the regular activities because of their busyness. Therefore, we need a technology that can control and monitor remotely, namely IoT. Internet of things in recent times has been the driving power to the globe for its affordable and easily executable solutions [2].

Some people in urban areas have hobby like farming at this time. According to FAO (United Nations, Food and Agriculture Organization) we need to increase the productivity of agriculture by between 50 persent and 70 persent to be able to feed the world population in 2050 [3]. The IoT devices needed for controlling and monitoring can be installed in the greenhouse as well. The IoT device that has sensors and automation tools has connected to the internet (web server) so that the data taken can be uploaded to the database. In this way, the problem of plants at home can be resolved.

There has been much research and various attempts by apply new IoT technology to the agricultural areas. However, IoT for the agriculture should be considered differently against the same areas such as industrial, logistics [4]. There are several factors that influence the speed and quality of plant growth. These factors can be used as parameters or independent variables in this study which can later be analyzed to find which parameters have the most influence. Parameters in the form of light intensity, air humidity, and soil humidity. This research is expected to help people who are unable to monitor and control their plants any time.

II. BASIC CONCEPT

A. Greenbox

Greenbox is a small version of greenhouse which is more intended for people who want to cultivate plants that do not have large areas. Greenhouse is the tool that can help farming the urban population in the city. The greenhouse functions as a container for plants that are mostly green in order to grow optimally. The greenhouse is designed to recreate an environment wherein the temperature, humidity and light are monitored and adjusted to optimize the condittions of plant cultivation [5].

FIGURE **1**
Greenhouse

B. Internet Of Things

Basically, IoT implies the capacity to make everything around us beginning from (for example machine, devices, mobile telephones, and cars) even (Cities and Roads) are supposed to be associated with the Internet with a canny way of behaving and considering the presence of the sort of independence and protection [6]. Internet of Things (IoT) is a new era in the internet field, which can change every aspect of human life and has been widely applied in human life, such as the fields of communication, business, education, and others. According to Coordinator and support actions for global RFID related activities and standardization states the internet of things (IoT) as a global network connection infrastructure, which connects physical and virtual objects through the exploitation of data capture and communication technology. IoT utilizes a program that can generate an interaction between machines that are always connected automatically without any human intervention without distance limitations.

C. ESP-32

ESP 32 is a series of power-saving systems on a microcontroller chip with integrated Wi-fi and dual-mode bluetooth. This microcontroller already has a WiFi module on the chip. so, it is very useful for creating IoT application systems. The ESP 32 series uses the Tensilica Xtensa LX6 microprocessor in dual-core and single-core variants and includes an integrated antenna switch. ESP 32 was created and developed by Espressif Systems from China and produced by TSMC, and ESP 32 is also the successor of the ESP 8266 microcontroller [7].

FIGURE 2
ESP-32

D. Firebase

The Firebase platform for developing mobile and online applications offers the resources and tools required to create an effective application. You may use features like crashlytics, performance monitoring, test lab, real-time database, authentication, and many more with Firebase to raise the caliber of your app. Firebase Realtime database and Firebase Authentication is used in the application to store the ping data and secure our application. JSON formatted data is displayed by Firebase Realtime database. One benefit of using this Firebase tool is that the data is synchronized across all clients in real-time and is even accessible when the app is offline. It is a cloud-hosted database. On the other hand, Firebase Authentication offers strategies for user authentication and consequently offers tailored services. Users of the proposed application must authenticate themselves by entering their mobile number [8].

E. Website

A Website is an application that contains interactive media records, like text, pictures, sound, activity, and video on a site that utilizes the Hyper Text Transfer Protocol (HTTP) convention, then the Website will be changed over into Hyper Text Markup Language (HTML) which can be gotten to utilizing programming called a program [9]. In this study, the authors used some of the wesites include (1) HTML, programming language used to make site pages, show different data, and can likewise be utilized as connections to other website pages utilizing specific codes [10]. (2) Node JS, this is a Javascript implementation of server-side application framework. NodeJS's nature of event-driven, nonblocking I/O model suits well for real-time communication between client and server in a web application. The nonblocking nature of NodeJS is the basis for building web app capable of serving big data to the web. A NodeJS framework consists of server-side and client-side applications built on top of NodeJS into a fully capable web application [11]. (3) Cascading Style Sheet (CSS) that are utilized to set the style of components on website pages, for example, shading, text styles to be utilized, and others. What's more, CSS can likewise set responsive designs and formats, meaning it have some control over where the site will be opened. (4) JavaScript as programming language utilized for HTML and the web for servers, PCs, PCs, and others that can make the substance showed on internet browsers dynamic and intuitive and (5) Bootstrap that one sort of system for CSS, HTML, and JavaSript that will be utilized for web composition [10].

F. Machine Learning

Machine learning can be characterized as the use of PCs and numerical calculations embraced through discovering that comes from information and produces forecasts from here on out [12]. There are many methods in machine learning, for make a decision of the moisture of the soil, classfication threshold is one option that can used. Many binary classification algorithms produce a real-valued 'confidence score' between zero and unity as their raw output. To produce a final classification of a sample during inference, this real number needs to have a decision threshold applied, such that if the confidence score is smaller than the threshold, the classification is the negative class, and otherwise the classification is the positive class [13]. Besides that, the neural network (NN) algorithm is the most popular and is currently undergoing rapid development among ML techniques due to the vast amount of data that is currently available, the abundance of processing resources, and its sophisticated algorithm structure. The NN shows its great power in recognizing the underlying complicated patterns in the abovementioned tasks, most of which were once thought to be only possible for human beings [14].

G. QoS (Quality of Service)

QoS is a strategy to gauge how well an organization offers a decent support and an endeavor to characterize the qualities and properties of an assistance. The test boundaries that will be utilized to gauge the QoS esteem are postponement, throughput, and parcel misfortune [15].

1. Delay

Delay (Latency) is the time it takes for information to venture to every part of the separation from beginning to objective. A few things that can influence delay are distance, actual media, clog, or length of handling time [15]. the delay value can be calculated by the following equation.

$$\text{Delay} = \frac{\text{Time Span, s}}{\text{Packet}}$$

2. Throughput

Throughput is the successful information move rate estimated in bits each second (bps). Throughput is the absolute number of parcel appearances that have been seen at the objective during a specific time stretch isolated when span [15]. It can be determined utilizing the accompanying condition.

$$\textbf{Throughput :} \frac{\text{Packed received (kb)}}{\text{Time transmitted (s)}}$$

3. Packet Loss

Packet Lossis a boundary that depicts a condition that shows the all out number of lost bundles that happen because of crashes and blockage on the organization. The parcel misfortune esteem is a rate. The more noteworthy the level of parcel misfortune, the information got will be more regrettable [15]. It can be determined utilizing the accompanying condition.

$$\textbf{Packet loss} = \frac{\text{(Packet transmitted - Packet received)}}{\text{Packet transmitted}} \times 100\%$$

III. METHOD

A. System Design

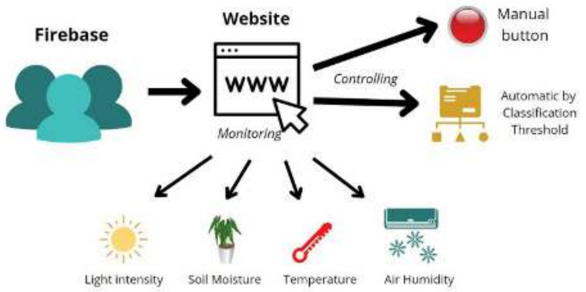


FIGURE 3
System Design

The system design in this study is to create a monitoring dashboard with a firebase realtime database and controlling using classification threshold model. The monitoring status sensor on the website also controls the mode for watering plant activity, and there are 2 watering modes, which are auto and manual. The monitoring procedure is carried out utilizing a website administered by admin on the plants, allowing for more cautious and concentrated monitoring in order to create plants with optimal development.

The admin must register on firebase and login to have access to the website. The website will show the state of the greenbox as well as the plants condition on data collected from IoT device sensors such as light intensity, temperature, air humidity and soil moisture. Then, the data collected from the IoT gadget will be saved in a data log.

B. Block Diagram

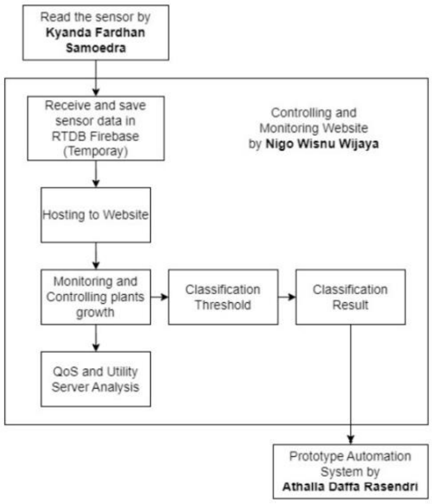
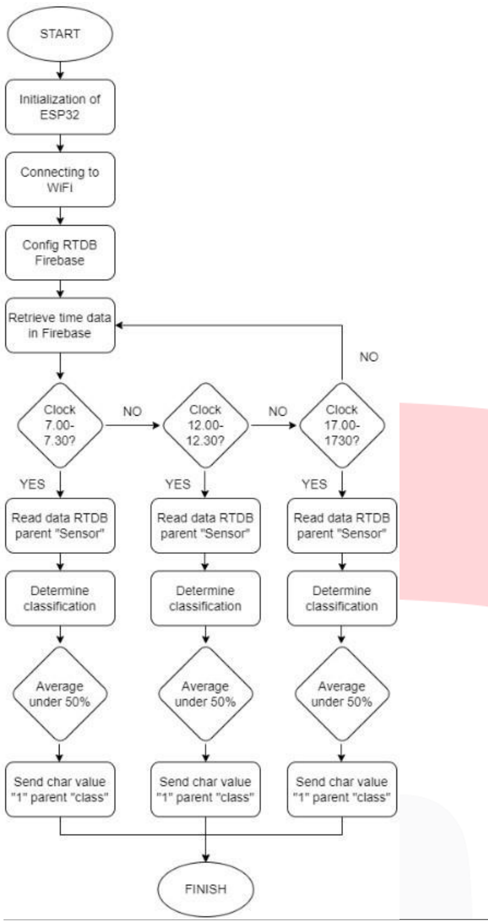


FIGURE 4
Block Diagram System

Figure 4 explains that the input for the entire work comes from the sensors that installed by Kyanda Fardhan Samoedra on the ESP-32. The data from sensor will received and saved in RTDB Firebase. Then, hosting to website on firebase and admin can login with account that has been created in firebase. The data sensor will be published in persentage number and graphic form. Monitoring and controlling can be accessed from the website are only for the User admin that registered at authentication section of firebase. The output of this system is automatic watering of the vegetable plant growth on greenbox automation system with classification model using classification threshold.

C. Firebase System Work Flow



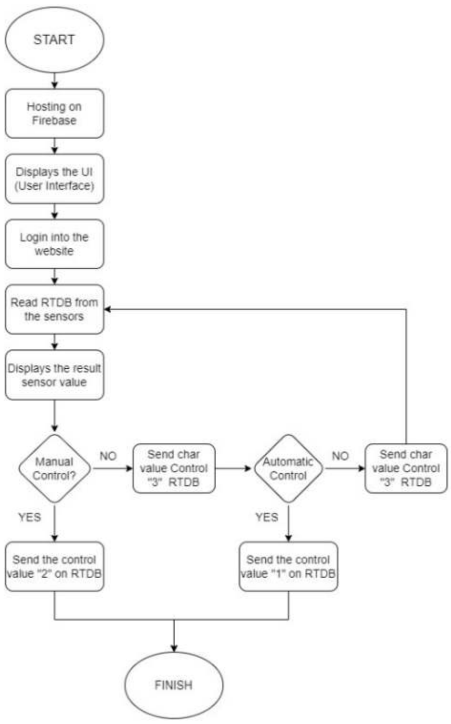


FIGURE 5
Firebase Flowchart

The figure 5 above is the firebase system work flow, where the author can monitor and control the growth of vegetables plant. The work flow start with hosting on firebase to displays the UI (User Interface), frontend created by nodeJS in VS- code with java language, the website is made simple and easily understood by the admin, and then login with the account that have been created in firebase authen-tication, after login into website the sensor will send the data and read by RTDB (RealTime DataBase).The website will displays the information about all sensors output data. Admin can choose manual or automatic for controlling their plant, if the admin choosing manual control, when the admin click that option, the green- box will watering directly by sending ”2” control value on RTDB, and if the adminchoosing automatic control, the condition will be checked by fuzzy logic classifica-tion threshold, if it true, greenbox will watering the plant by send ”1” control valueon RTDB, but if it false , it will read the sensor data on RTDB and looping again.

D. Classification Thershold Work Flow

FIGURE 6
Classification Thereshold Flowchart

Figure 6 is the flowchart of classfication threshold, where the automatic options can implemented. Start with initialization and declaration of pin and library of ESP32 microcontroller and already connected to wifi, config RTDB to firebase, then retrieve the time data in firebase with Clock parent. There will be 3 sessions. data capture time in one day, morning time at 7.00 until 7.30, afternoon at 12.00 until 12.30, and 17.00 until 17.30. The steps in each session will be the same, first reading the sensor data in Sensor parent with humidity, lux, soil moisture 1, soil moisture 2, and temperature child in RTDB, then the classification threshold will determine the condition and will show in website dashboard. If the soil moisture average is under 50%, it will watering the plants automatically with sending char value ”1” on Class parent. If the soil moisture average is above 50%, it will direct back to determine classification session with sending char value ”2” on Class parent.

E. Website Setup

Based on Figure 6 below, the admin has to hosting from firebase to open the website, and the author of the firebase is the only person that can get the hosting link, so the admin just login their account on the website that has be registered on firebase reffered on Figure 7.

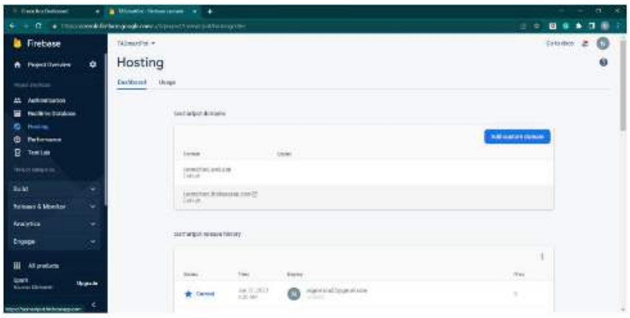


FIGURE 7
Website Hosting

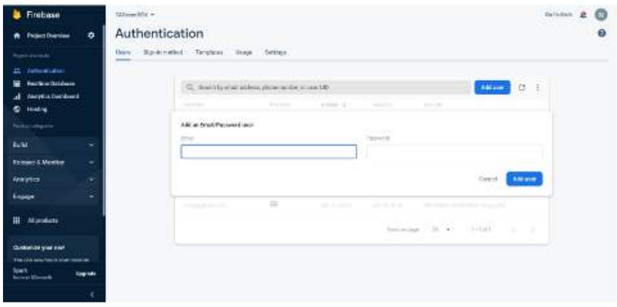


FIGURE 8
Register Account on Firebase

The following is the content of website that has been successful hosting using firebase in order to displays monitoring data and controlling the plant :

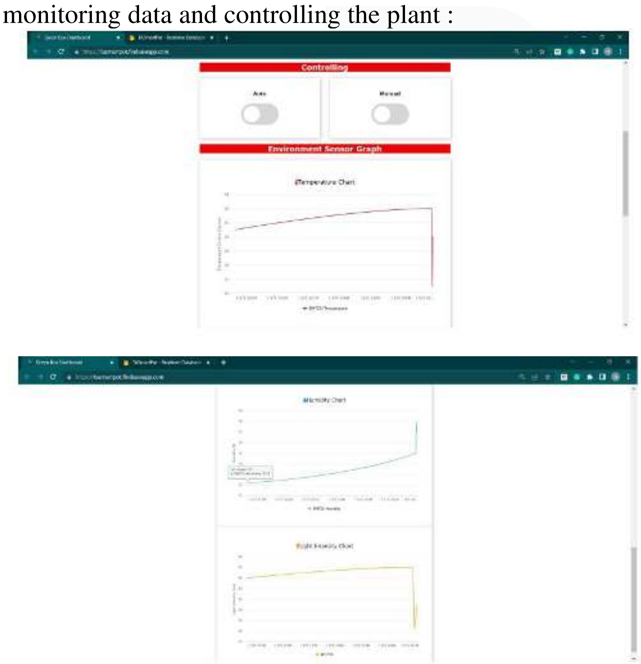


FIGURE 9
Website Design

After creating a firebase account, and then enter email and password. The website display will provide information about all sensor on the plants, such as temperature, air humidity, light intensity, and both of soil humidity. On the website, there are control options, it can be automatic or manual and also, it can be seen that the monitoring data can be shown in graphical form (Figure 9).

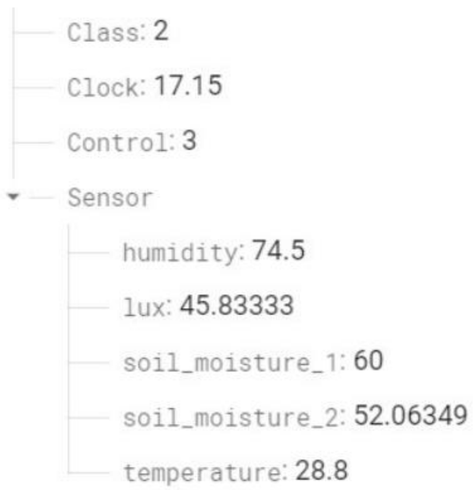


FIGURE 10
Firebase RTDB Variable

Figure 10 are several variable on firebase real-time database that will be used. There are 4 parent and 5 child, the parent variable as follows Class, Clock, Control, and Sensor. The child variable as follows humidity, lux, soil moisture 1, soil moisture 2, and temperature. Below is the firebase variable parameters that will be used :

TABLE 1
Firebase RTDB Variable Parameters

Variable Type	Variable	Value	Description
Parent	Class	"1"	Command to do watering to greenbox
		"2"	Command to not do watering greenbox
	Clock	7.00-7.30 12.00-12.30 17.00-17.30	Threshold parameter to indicate the length of time the sensor is working
	Control	"1"	Command to automatic controlling
		"2"	Command to do manual controlling
		"3"	Command to not do controlling, either auto or manual
	Sensor	All type of Sensor	-
Child	Humidity	Weather Condition	Dashboard Monitoring Information
	Lux	Lighting Condition	Dashboard Monitoring Information
	Soil Moisture 1	Optimal : 52.95 - 95.5 Not Optimal : 0 - 52.94	Threshold parameter for classification
	Soil Moisture 2	Optimal : 52.95 - 95.5 Not Optimal : 0 - 52.94	Threshold parameter for classification
	Temperature	Room Temperature	Dashboard Monitoring Information

F. Prediction Model

Data obtained from IoT device sensors stored in The database will be uploaded in the form of an Excel file which is the main data which will be used to create the dataset in this study. From that data obtained there will be several attributes, such as time and date, light intensity, temperature, air humidity, and soil moisture. The neural network algorithm will be used in this experiment. With this algorithm, will be obtained in the form of classifying attributes and parameters that most influence on watering plants.

G. Model Work Analysis

Confusion matrix will provide the results of the classification of training data and data test. The dataset will have 2 possibilities, optimal or not optimal. The accuracy score is used to tell about the algorithm's level of accuracy, with the outcome expressed as a percentage (%). Then, The QoS website analysis was carried out to measure the QoS of the internet network on the website process to databases. QoS measurements include delay, throughput, and packet loss. Below is the parameters and category that will be used:

TABLE 2
Delay Category by itu-t Rec. G.1010

Latency Category	Delay
Very Good	<150 ms
Good	150-300 ms
Fair	300-450 ms
Bad	>450 ms

TABLE 3
Packer Loss Category by ITU-T Rec. G.1010

Degradation Category	Packet Loss
Very Good	0%
Good	5-15%
Fair	15-25%
Bad	>25%

TABLE 4
Throughput Category by TIPHON

Throughput Category	Throughput
Very Good	>2.1 Mbps
Good	1200 Kbps-2.1 Mbps
Fair	700-1200 Kbps
Bad	338-700 Kbps
Very Bad	0-338 Kbps

IV. RESULT AND DISCUSSION

A. Website Functionality Test

This test aims to determine the condition of each feature that has been designed on the web by firebase. At this stage a system test will be carried out on the website, starting from the login page, control system (Auto and Manual), monitoring information such as 2 soil moisture, light intensity, temperature, and air humidity, and logout account.

TABLE 5
Website System Test

No.	SYSTEM TESTING	DESCRIPTION
1.	Hosting to the website	Successfully displays the website user interface
2.	User login	Successfully login to website with the account that has been created on Firebase
3.	Monitoring dashboard	Successfully displays the data from sensors
4.	Automatic Controlling option	Automatic control successfully works with classification threshold parameters
5.	Manual Controlling option	Manual control successfully works well, watering directly when the admin click the button
6.	Graphic form interface	Successfully displays data from sensors in graphic form
7.	User Logout	Successfully logout and back to the login page

Based on Table 5 above, the whole system and feature on website well implemented, and there is no problem when choosing controlling option, both of them can work properly. The display of sensor clearly legible and easy to understand.

B. Classification Test

This test will determine the condition of sensor on automatic controll test, based on figure 11 below the code shows there are 3 conditions the system will read value of sensor and process it with that 2 soil moisture will devide by 2 and the threshold are under 50% and above 50%. If average value of soil moisture sensor are under 50% it means the plant are needs more water the system will works with sending command value number 2 on firebase realtime database, and it will watering both of pots directly. If average value of soil moisture sensor are above 50% it means the plants are still well hydrated and the system will works with sending command value number 1 on firebase realtime database.

```
if(7.00 <= jam && jam <= 7.30)
{
  float sum_dat = (float)((HumTan1 + HumTan2)/2);
  Serial.print("Hasil Rata2 Soil Mositure:");Serial.println(sum_dat);
  if(sum_dat < 52.95)
  {
    int kelas = 1;
    Firebase.RTDB.setInt(&fbdo, F("/Class"), kelas) ? "ok" : fbdo.errorReason().c_str();
  }
  else
  {
    int kelas = 2;
    Firebase.RTDB.setInt(&fbdo, F("/Class"), kelas) ? "ok" : fbdo.errorReason().c_str();
  }
}
else if(12.00 <= jam && jam <= 12.30)
{
  float sum_dat = (float)((HumTan1 + HumTan2)/2);
  Serial.print("Hasil Rata2 Soil Mositure:");Serial.println(sum_dat);
  if(sum_dat < 52.95)
  {
    int kelas = 1;
    Firebase.RTDB.setInt(&fbdo, F("/Class"), kelas) ? "ok" : fbdo.errorReason().c_str();
  }
  else
  {
    int kelas = 2;
    Firebase.RTDB.setInt(&fbdo, F("/Class"), kelas) ? "ok" : fbdo.errorReason().c_str();
  }
}
else if(17.00 <= jam && jam <= 17.30)
{
  float sum_dat = (float)((HumTan1 + HumTan2)/2);
  Serial.print("Hasil Rata2 Soil Mositure:");Serial.println(sum_dat);
  if(sum_dat < 52.95)
  {
    int kelas = 1;
    Firebase.RTDB.setInt(&fbdo, F("/Class"), kelas) ? "ok" : fbdo.errorReason().c_str();
  }
  else
  {
    int kelas = 2;
    Firebase.RTDB.setInt(&fbdo, F("/Class"), kelas) ? "ok" : fbdo.errorReason().c_str();
  }
}
else
{
  Serial.println("Mode Idle");
  float sum_dat = (float)((HumTan1 + HumTan2)/2);
  Serial.print("Hasil Rata2 Soil Mositure:");Serial.println(sum_dat);
  if(sum_dat < 52.95)
  {
    int kelas = 1;
    Firebase.RTDB.setInt(&fbdo, F("/Class"), kelas) ? "ok" : fbdo.errorReason().c_str();
  }
  else
  {
    int kelas = 2;
    Firebase.RTDB.setInt(&fbdo, F("/Class"), kelas) ? "ok" : fbdo.errorReason().c_str();
  }
}
delay(1000);
```

FIGURE 11
Classification Codes

Figure 12 and Figure 13 shows the website chart display result of the test after it turn the automatic controll on for 1 day with 3 sessions, 7.00-7.30 in the morning, 12.00-12.30 and also 17.00-17.30 in the afternoon.

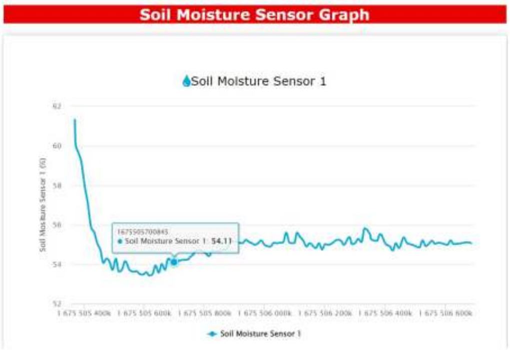


FIGURE 12
Soil Moisture 1 Chart

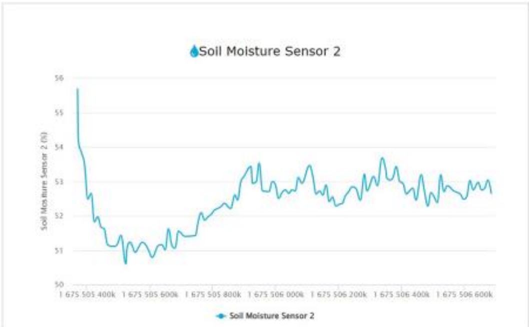


FIGURE 13
Soil Mositure 2 Chart

Based on 2 figure of soil moisture chart above after being tested for 1 day using classification threshold, automatic controlling, with 2 plants in greenbox, and placed on terrace of the author's house. The result is system detected lack of water on plants in greenbox at 7.00 in the morning, the data shows that soil moisture in the morning is less than the optimal threshold or under 50%, that means the moisture of the soil is quite good conditions, and on the other session, plants are well hydrated.

C. Neutral Network Method Test

Neural network is one of the methods supported in ESP32. The first stage for this analysis is normalization all the data with label encoder in Scikit-learn library, as shown as Figure 14 below the system detected 2582 data and the all sensor parameters will be omitted except soil moisture 1 and soil moisture 2. Class ”2” means optimal and class ”1” means non optimal.

	Date	Time	Temperature	Lux	Humidity(DHT_22)	Soil_moisture_1	Soil_moisture_2	Feature	Class
0	29/01/2023	07:03:21	28.6	45.00	76.3	48.18	60.76	54.470	2
1	29/01/2023	07:03:32	28.6	43.33	76.0	48.23	61.32	54.775	2
2	29/01/2023	07:03:44	28.6	43.33	76.6	48.18	60.78	54.480	2
3	29/01/2023	07:03:54	28.6	42.50	77.1	48.42	60.93	54.675	2
4	29/01/2023	07:04:05	28.6	41.67	76.8	48.38	61.20	54.790	2
...	...	...	...	...	...	...	...	...	...
2578	14/02/2023	03:41:22	29.0	141.67	64.8	0.00	0.00	0.000	1
2579	14/02/2023	03:41:40	28.9	135.83	64.9	0.00	0.00	0.000	1
2580	14/02/2023	03:41:57	29.0	140.00	64.8	0.00	0.00	0.000	1
2581	14/02/2023	03:42:08	29.0	135.83	64.8	0.00	0.00	0.000	1
2582	14/02/2023	03:42:22	29.0	130.00	64.7	0.00	0.00	0.000	1

FIGURE 14
Label Encoder

Figure 15 shows the evaluation result after traning and testing the data. Evaluation result displays the output of shape and sequential model.

```
Model: "sequential_34"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_71 (Dense)            (None, 32)                96

 dense_72 (Dense)            (None, 5)                 165

 dense_73 (Dense)            (None, 1)                 6

=================================================================
Total params: 267
Trainable params: 267
Non-trainable params: 0
_________________________________________________________________
```

FIGURE 15
Evaluation Result

```
from sklearn.metrics import confusion_matrix
confusion_matrix(y_test, y_hat)
```

```
array([[ 45,   0],
       [215,   0]], dtype=int64)
```

FIGURE 16
Confusion Matrix

Confusion matrix on figure 4.6 indicates the number of predictions for classification. The analysis of this matrix is to inform the accuracy score of the model prediction that has been trained. Figure 4.7 shows the accuracy score of this prediction model is 13,8% in the form of float data type. Accuracy value calculations can also be obtained from the confusion matrix shown in figure 4.6. The accuracy is quite poor due to the insufficient dataset.

```
accuracy_score(y_test, y_hat)
```

```
0.13846153846153847
```

FIGURE 17
Accuracy Score

D. The Quality of Service Measurements Result

This part will explain about the measurement of Quality of Service such as Throughput, Delay, and Packet Loss, measurement of QoS will be conducted to verify the network's quality from ESP32 to firebase and also firebase to ESP32. The Quality of Service testing was undertaken for 7 days and taken with parameter that has been determined in the previous chapter.

1. Delay Test

Based on Figure 18 below after being tested for 7 days using wireshark, the results of the delay test that has been carried out get an average value 37.42 ms with a maximum value of 56 ms on 1st day and a minimum value of 21 ms on 4th day. According to theITU-T Rec. G.1010 standardization, the result of delay on the network is very good because under 150 ms.

FIGURE 18
Delay Result

2. Throughput Test

Based on Figure 19, the result of the throughput test has been measured using wireshark software to get average results throughput of 3.64 Mbps. And for the highest value obtained on the 2nd day of 4.25 Mbps and the smallest value on day 4 of 3.25 Mbps. According to TIPHON standardization for throughput, throughput on the network very good because the value is above 2.1 Mbps.

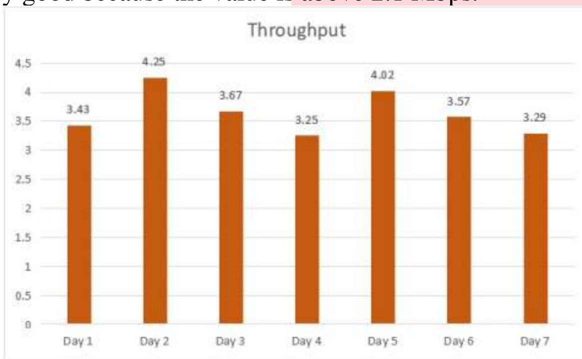


FIGURE 19
Throughput Result

3. Packet Loss Test

Reffering to Figure 20, the test results obtained in the image below, packet loss has an average value of 21.214%. For the highest value obtained by 27.6% on the 2nd day, while the smallest value was obtained on the 6th day of 12.5%. This matter making packet loss on this network classified as fair enough because it is less than 15-25% by ITU-T Rec. G.1010.

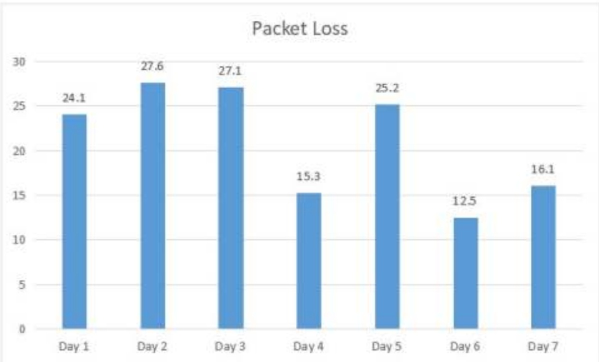


FIGURE 20
Packet Loss Test

V. CONCLUSIONS

A. Conclusion

These are the conclusions drawn from this thesis. The monitoring and controlling system on the vegetables plant is running well on the website, sensor data from ESP-32 microcontroller can be stored in the Firebase database and can be monitored and also controlled by accessing the website. Then, testing on the automatic controlling options just read and determined soil moisture for classification parameters and the testing on freshly watered soil and with moist soil are almost the same, and will be very different from the experiment on dry soil. For this system will be quite effective if the author puts the greenbox in sufficient lighting conditions, because in this experiment, light intensity is not included in the classification parameters. The neural network method has poor accuracy due to the insufficient dataset and the result of QoS test, the delay is categorized very good with an average value obtained 37.42 ms. Then Throughput is categorized as very good with an average value 3.64 Mbps, and the packet loss is categorized fair enough with average value 21.214%.

B. Suggestion

From the system that has been developed in this study, there are several deficiencies that can occur become material for further development. First, add more complex machine learning models with several parameters for more precise watering models of growth plants. And the last, add menu on website dashboard such as, select desired plant menu, so when the admin choosing a plant, the best growth pattern for that plant will appear.

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