Design and Implementation of Eco Green System for Plant Monitoring Based Internet of Things

Legowo Sulistijono and Junia Maulidya Nata
Politeknik Elektronika Negeri Surabaya, Indonesia

Keyword: Internet of Things, Singlehop Communication, Eco Green.

Abstract: Indonesia is an agrarian country where most of the population lives as farmers, but currently, farmers are still using conventional methods that are not able to increase their agricultural output. In addition, many problems occur in agriculture, such as changes in weather conditions, lack of labor, dry land, irregular irrigation processes, and so on. In the process of watering plants, special attention is needed, because if there is an excess of water or a lack of water, the quality of the harvest will be less than optimal. Thus, an Eco Green System was created with automatic watering and fertilization features. There is also monitoring to monitor the condition of agricultural land. Both from soil moisture and temperature in the land. This is a way to save time and energy. The application of a communication system with the Singlehop Communication method is an effective way of monitoring the automatic plant watering process because it uses calculations that have been adjusted to the level of soil demand. By using a capacitive soil moisture sensor V1.2 and a temperature sensor DHT 11, it will be able to read data on the land. To get real-time data, and Internet of Things system is needed to connect to the internet and communicate with each other. The results of the temporary test show that the error value between the sensor and measuring instrument is around 0-6%, while the communication system is running well and can read the humidity value at each node.

1 INTRODUCTION

Indonesia is an agricultural country that has extensive agricultural land, and diverse and abundant natural resources. In an agrarian country, agriculture has a very important role both in the fulfillment of basic needs, besides that agriculture plays a major role in boosting the social sector, economic sector, and trade.

In addition to the large natural potential that Indonesia has, there are other reasons, namely the agricultural sector is still the leader of the Indonesian economic sector and most of the population still works in the agricultural sector, but there are still various problems that make the Indonesian agricultural sector seem to be running in place and not experiencing rapid development such as other agricultural countries. Such as the agricultural system which still uses conventional systems, where the system has many weaknesses such as technological limitations, depending on the process and yields on the season, only involving family labor, limited availability of scarce fertilizers, and the most important thing is the process of watering and fertilizing which is still lacking. well scheduled.

In addition, current technological advances will also have a major impact, especially on the agricultural sector. By connecting automatic monitoring, watering, and fertilization system that is connected to the internet network, it is hoped that it can solve problems in the environment of the farmers and produce good quality products. In addition, it can also minimize crop failures caused by weather factors. By utilizing the internet of things for agricultural technology, this step is very appropriate to monitor and control crop conditions to produce better products and avoid crop failure (F. Tongke 2013), (Norakmar 2019). he internet of things makes observing or monitoring plants easier and more efficient to increase the productivity of crops and benefit the farmers. (D. D. Sreekantha and A. Kayva 2017).

2 SYSTEM OVERVIEW

Eco Green is one of the concepts of material management and production that is strived to always

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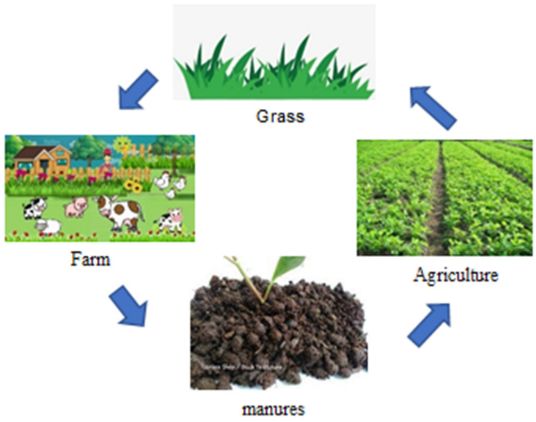


Figure 1: Basic overview of eco green.

be environmentally friendly which is suitable for farmers. Eco green is closely related to plants where plants are living things that need water and fertilizer for the development of their lives. This Eco Green concept can be applied in life by combining livestock and agriculture so that a good ecosystem occurs. In addition, the energy used is obtained from solar panels so that it will be more environmentally friendly.

In Figure 1 above, every farm must have waste, namely the results of the livestock manure, where the results of the waste can be used for agriculture as fertilizer which is commonly referred to as manure. So that when agriculture is given fertilizer, the plants planted will become fertile and will increase crop yields because one of the factors causing increased crop yields is fertilization. In addition, checking soil conditions is also very important for plant growth which must have optimal humidity between 60%-80% so that it is not too dry or wet (J. Ristaino 2010).

The agricultural land used is peanut farming land, this is because peanuts are one of the plants that can build a good eco-green because apart from the leaves being used for animal feed, the peanuts can also be used for the benefit of the farmers, besides that peanuts are also easy to use. planted and has many benefits for society.

This system will use Wireless Sensor Network (WSN) communication. WSN is a system where one node to another can make contact and exchange data. (Y. Nishikawa 2018), (M. Walid et al., 2019), (A. S. Editya 2017).

Based on Figure 2, there is a master note that controls all systems. When the master note asks for the monitoring value, the system will read the sensor data and send the data to the master node.

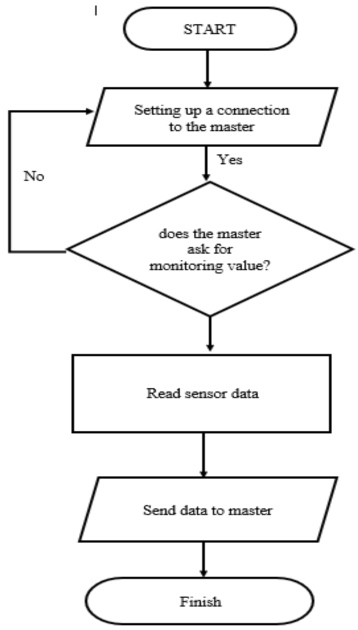


Figure 2: Flowchart of system monitoring.

3 EXPERIMENTAL RESULT

3.1 System Design

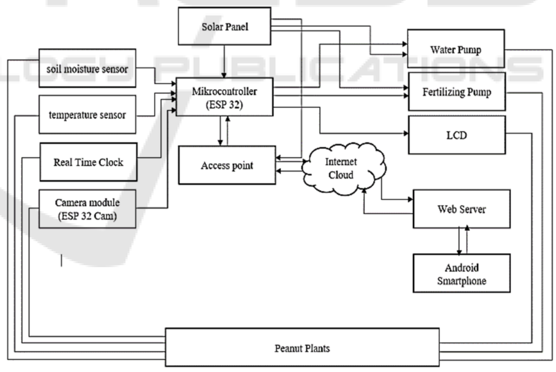


Figure 3: System diagram.

Based on the block diagram in Figure 3, there is a system that will be created, namely the Main System installed on the tool. The Main System consists of an ESP32 microcontroller as a microcontroller that functions to control all systems. Several inputs will be processed later, namely the Soil Moisture sensor which functions to detect moisture levels in the soil for the watering process and there is also a Real-Time Clock (RTC) which functions to set the timer in the fertilization process and there is an ESP32 Cam Camera Module which functions for monitoring plants. All of these inputs will be processed on the ESP 32 microcontroller which is commonly referred to as a server node.

The data that has been processed on the server node will be sent to the master-slave using the wifi access point contained in the ESP32 feature. Data from the node will be sent to the master-slave which also uses the ESP32 microcontroller. This master-slave serves as a central control for incoming data from all server nodes. Both node 1, node 2, node 3, and node 4 will all be processed on the master-slave. This master-slave also functions as the central control of all settings, both the watering process and the fertilization process. To be able to connect to android, this master-slave sends data to the web server using firebase.

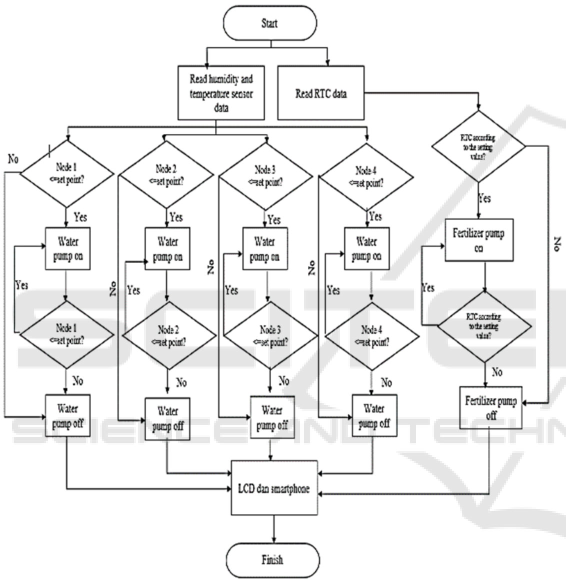


Figure 4: Flowchart system.

Based on the data in Figure 3 which describes the workings of the whole system, this system uses two pumps, namely for watering and for fertilizing. Fertilization is done by using liquid fertilizer. When the sensor reads soil moisture data, the data obtained will be processed whether the data is by the specified set points. The set point here is determined with a range of 1 to 100. When the soil moisture is more than 60% of the maximum range, the watering process will take place, so the water pump will turn on. The sensor will always work until when it exceeds the set point or is below 60% of the data, the watering will stop, this indicates that the soil is already moist and there is no need for watering, so the water pump will turn off. This condition will be the same between node 1 to node 4. For the way the fertilization process works, it can be set using the Real-Time Clock because the fertilization process is carried out routinely and simultaneously so it is only necessary to set the timer value on the RTC. When the RTC value matches the input, the fertilization process will take place and the fertilization pump will turn on so that fertilization is active. This can be adjusted to the conditions of the agricultural land used. When the delay in fertilization time is over, the pump will automatically shut down and the fertilization process is complete.

3.2 Singlehop Communication

Wireless Sensor Networks (WSN) are a very popular technology in this decade. WSN is a system where one node to another can make contact and exchange data. In addition, WSN is a cheap, fast, and quality data transmission technology without the cost and mess of cables. WSN can be used in many fields, including use in smart homes, tracking systems, agriculture, the military, the environment, and many more. One of the most important of these is the implementation in the environment (A. S. Editya 2017). The wireless sensor network has the following characteristics:

1. Limited manpower resources. WSN does not have a continuous power source. WSN power can be obtained with batteries and adapters, but it should be noted that WSN has a maximum limit of 3.3V. 14
2. The ability to survive in an environment that has conditions that tend to change such as temperature, rainfall, humidity, light intensity, and so on.
3. Ability to resolve errors on the node (decentralized management). This is necessary because the nodes used by WSN will be outside the scope of user control, so the ability to automatically resolve errors is vital.
4. Node mobility, the nodes used in the WSN can be placed anywhere as long as they are within the range of the WSN. Nodes are not related to the position, so they can be moved even when they are working.
5. Dynamic network topology, WSN does not have certain limitations or criteria in designing its topology. The topology can be designed according to the wishes and goals intended by the user.
6. Large-scale deployment, WSN can be used for monitoring a very large area and for various purposes.

In its development, wireless sensors have been developed with several network topologies such as:

1. Topologi jaringan Single Hop Star.
2. Topologi jaringan Multi Hop Mesh dan Grid.
3. Topologi jaringan Two Tier Hierarchical Cluster.

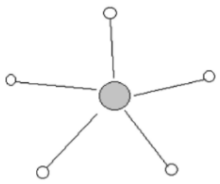


Figure 5: Single hop star topology.

Single hop star is a very simple WSN topology technology. In this topology, each node leads directly to the gateway or data collector. (M. Walid et al., 2019). Because this topology is centered on a minimal and simple network. This topology is very easy to implement. However, in this topological design, the biggest problem is the limitation on scalability problems. Nodes far from the Gateway will have poor connections. This topology is good for use on WSN networks that have fewer nodes and a small area (J. M. Nassar et al., 2018).

With the technology that is growing agriculture will also be able to see other sectors, namely the existence of a land management system in a modern way that can be used using modern systems and not using conventional methods. The soil management system in the form of a watering system and plant fertilization automatically uses a soil moisture sensor as a soil moisture detector, and a microcontroller as a program brain, while Android is used to receive soil moisture results based on soil pH that is already by plant needs, this tool is also equipped with a timer as a timer. clock and date on the tool for the periodic fertilization process, as for the relay as a water pump

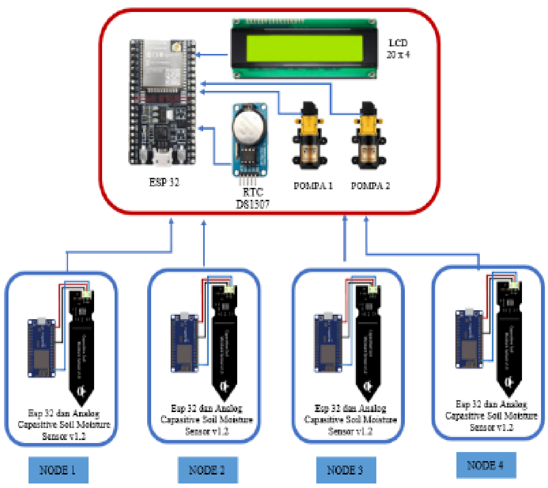


Figure 6: Node design.

controller, the internet as a data receiver from Arduino according to the program that has been set on Arduino whether the soil moisture is moist or wet according to reading from the soil moisture sensor in the form of the value on Android.

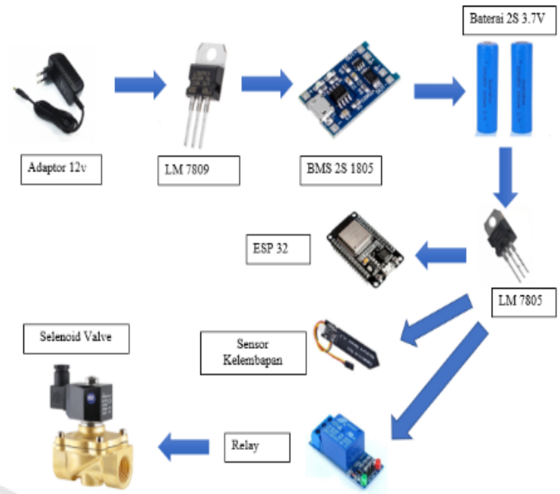


Figure 7: Master design.

In the picture above are the components contained in the master such as a 12V 5A power supply as the main source to activate other components such as pumps, RTC, and relays. Pump 1 acts as a tool to suck water and will flow it to the solenoid valve from each node that needs it. While pump 2 serves to drain liquid fertilizer in the fertilization process. ESP 32 master as the main microcontroller from the master which will receive data from other nodes. LCD 20 X 4 as a display of several values to be displayed such as pump on/off conditions and soil moisture content of each node. In the picture above are the components contained in the master such as the 12V 5A power supply as the main source to activate other components such as pumps, RTCs, and relays. Pump 1 acts as a tool to suck water and will flow it to the solenoid valve from each node that needs it. While pump 2 serves to drain liquid fertilizer in the fertilization process. ESP 32 master as the main microcontroller from the master which will receive data from other nodes. LCD 20 X 4 as a display of several values to be displayed such as the condition of the pump on/off and the soil moisture content of each node.

3.3 Internet of Things

From the overall design above that, each node is connected to the master and the master will be connected to the access point with the ESP32 Cam camera module where all data will be stored in the

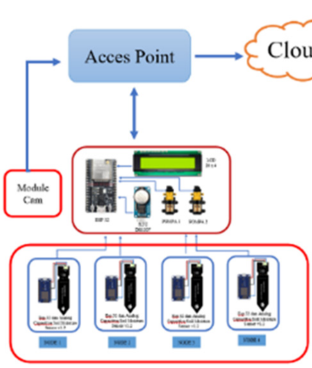


Figure 8: System design.

cloud and the data will be sent to android. So that monitoring can be done easily and efficiently on Android.

The ultrasonic sensor data acquisition software uses programming to convert the echo signal into digital data and send it to a personal computer via serial communication. The data that has been received by the personal computer will then be displayed or plotted using graphics in the software.*Web Server (Firebase)*

In this smartphone monitoring, data can be monitored such as the state of each node, besides that it is also programmed to be able to display camera time settings obtained from the camera module for fertilization which can be set on the smartphone. In addition, it can also display the camera view obtained from the camera module for fertilization that can be set on a smartphone. In addition, it can also display the camera view obtained from the camera module.

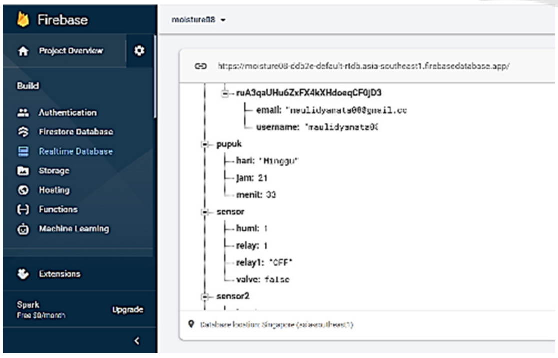


Figure 9: Firebase web server.

By using firebase as a web server, you will be able to monitor the condition of each node. This condition contains the level of soil moisture in each node. Data from the web server will also be monitored using a smartphone from the android studio software.*Aplikasi Monitoring*

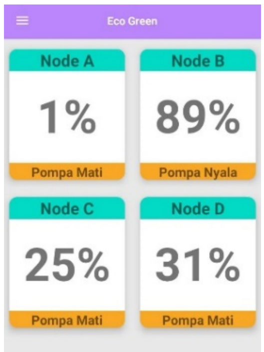


Figure 10: Monitoring application.

In this smartphone monitoring, data can be monitored such as the state of each node, besides that it is also programmed to be able to display camera time settings obtained from the camera module for fertilization which can be set on the smartphone. In addition, it can also display the camera view obtained from the camera module for fertilization that can be set on a smartphone. In addition, it can also display the camera view obtained from the camera module

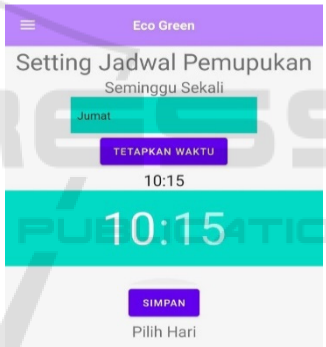


Figure 11: Fertilization application settings.

Figures 12: Sensor testing with analog measuring devices.

Figures 13: DHT11 Sensor Testing with the digital measuring instrument.

Table 1: Result from soil moisture test.

No.	Soil moisture value	ADC
1.	0.2	460
2.	1	438
3.	1.5	420
4.	3	372
5.	4.9	327
6.	5	313
7.	6	286
8.	6.5	272
9.	7	248
10.	0.2	460

Table 2: Digital measuring tool table list.

No.	Parameter	Sensor	Digital measuring tool	Error
1.	Humidity	79	84	5.95%
2.	Temperature	31.5	29.9	5.35%

Table 3: Pump test.

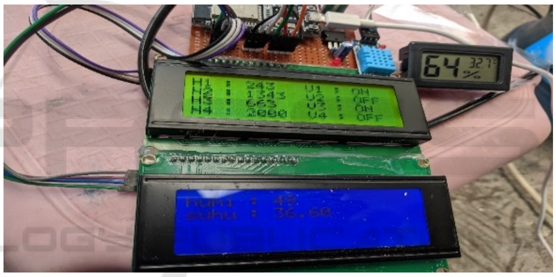
Node	Relay 1	Relay 2	Relay 3	Relay 4	watering relay	fertilization relay
1	Active	Not Active	Not Active	Not Active	Active	Not Active
2	Not Active	Active	Not Active	Not Active	Active	Not Active
3	Not Active	Not Active	Active	Not Active	Active	Not Active
4	Not Active	Not Active	Not Active	Active	Active	Not Active

This test is done by testing the watering and fertilizing pump. This test will be triggered from the relay which is for the watering pump. When one of the 4 relays in each node is active, the watering pump will be active and the fertilization pump will be deactivated. On the other hand, when the time setting schedule is appropriate, the fertilization pump will turn on with a trigger from the relay, and the fertilization pump will be active while the watering pump will not be active.

Table 4: Soil Test.

Watering Conditions					
Node	soil condition	Valve 1	Valve 2	Valve 3	Valve 4
Node 1	Dry	Active	Not Active	Not Active	Not Active
Node 2	Dry	Not Active	Active	Not Active	Not Active
Node 3	Dry	Not Active	Not Active	Active	Not Active
Node 4	Dry	Not Active	Not Active	Not Active	Active
Conditions during Fertilization					
Node	Dry	Active	Active	Active	Active

In this test, it is done with a relay, when the relay is active, the solenoid will also be active, so the way it works is almost the same as relay testing. When the relay is active, the solenoid is active and will turn on the pump. For the watering process using the input from the sensor value and for fertilization with a predetermined time setting value.



Figures 14: Whole system test.

Table 5: Watering System Test.

No.	Node	Humidity		Relay	Valve	Watering pump
1.	Node 1	72		Active	Active	Active
2.	Node 2	34		Not Active	Not Active	Not Aktif
3.	Node 3	69		Active	Active	Active
4.	Node 4	10		Not Active	Not Active	Not Aktif

From the overall test results, it is found that the value of each node will be different. As in the table above. When the value is below the specified set point, which is 60% of the humidity, then watering will be active in the node that detects less humidity. In this test, the active watering nodes are node 1 and node 3. So that the relay from node 3 and node 1 will activate the solenoid and the pump will drain the water.

Table 6: Fertilization System Testing.

No.	Node	Humidity	Relay	Valve	fertilization pump
1.	Node 1	42	Active	Active	Active
2.	Node 2	43	Active	Active	Active
3.	Node 3	40	Active	Active	Active
4.	Node 4	10	Active	Active	Active

In the results of the data above that the value of each node is different. Node 1 is 42, node 2 is 43, and node 3 is 40, while node 4 is 1. From these 4 nodes, automatic watering will be carried out. Which watering is based on input from a predetermined time setting? So that when the time is by the specified setting then fertilization will be active for 1 minute then it will automatically turn off the pump.

4 CONCLUSION

After carrying out the design and manufacture stage of the system which is then followed by the testing and analysis stage, it can be concluded that the soil moisture sensor works well according to how it works, this is evidenced by the error comparison value with measuring instruments that have a fairly small error, the more moist the soil quality then the value of the ADC that is read will be smaller, the drier the value of soil quality, the value of the ADC that will be read will be greater, the measurement results of this tool have an error range of 0-6% and the system can work well there are only a few errors due to the internet network.

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