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Soil Monitoring System Using LoRa-Based For Rice Plant Growth

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ABSTRACT

Farmers only use approximation, the application of this approximation can cause the quality of the soil in rice fields to be infertile. In this research, an agricultural land monitoring system was created using an agricultural land monitoring tool to make it easier for farmers to monitor the land to get good crop yields. The test results obtained are data collected on the land according to the parameters needed from rice plants. The research design was made in the form of a monitoring tool which will later display on the website to make it easier for farmers to check the land to be planted with rice remotely. This system also uses the Artificial Neural Network method which functions to predict soil conditions. The result of this system is to make it easier for farmers to get agricultural land that meets the criteria for quality rice plants.

INTRODUCTION

As an agricultural country, Indonesia has enormous potential in agriculture. This can be seen from the large number of Indonesian people who work in the agricultural sector. In February 2021, the Central Statistics Agency (BPS) obtained data on 38.78 million people or 29.59% of the total working Indonesian population (N. Mukhayat, P. W. Ciptadi, and R. H. Hardyanto, 2021). In terms of percentage, agriculture is one of the most dominant sectors in people's income in Indonesia because the majority of Indonesia's population works as farmers. But until now agricultural productivity in Indonesia is still far from expectations. One of the factors causing the lack of agricultural productivity is low human resources in cultivating agricultural land and its results (Sari, 2021).

The application of experience and estimation methods, causing farmers to be unable to improve soil quality can even cause the soil in rice fields to become infertile. Actually in the market there are tools used to determine the level of soil quality, namely soil pH sensors, moisture sensors and temperature sensors. But in terms of price, it is still too expensive for farmers. In addition, there is also a method of knowing the level of soil quality with soil samples and then examined in the laboratory. However, this method takes a long time, and also not all agricultural offices have their own soil quality testing laboratories (Bulkis, 2023) (Dillon & Barrett, 2017); (Saragih, 2019). The quality of the soil contained therein includes pH, temperature and humidity content. This problem can be solved with the existence of an Internet of Things (IoT)-based monitoring system that can make it easier to measure soil conditions. The development of technological advances today, this can be done by making a system of monitoring in real time the condition of agricultural land by utilizing sensors of soil pH, soil moisture and temperature (Setyawan et al., 2018).

Researchers (Setyawan et al., 2018); (Zhang et al., 2013); (Kodali & Sahu, 2016) created and designed a system that can monitor soil moisture, air humidity and temperature using the MQTT protocol in real time so that the tool is expected to make it easier for plant owners to supervise and care for their plants. This tool was created to make it easier for farmers to obtain information about the condition of agricultural land.

Researchers (PUJIARTI, 2018) monitored the quality of agricultural land in rice plants to obtain real-time data on changes in pH levels, temperature, air humidity, light identification and soil moisture using Arduino microcontrollers on sensor networks. Researchers (Mael, 2019) purpose of conducting this study is the most important part for plants, without fertile soil the plants will not grow well. Calculates the temperature, humidity, and pH of the soil used to grow all crops included in agriculture. Which is where the sensor used to measure temperature, humidity and DHT11 sensor connected to a microcontroller. And to measure soil pH levels using a soil pH sensor connected to a microcontroller then display using LCD or Android.

This study aims to monitor soil pH, soil moisture, air pressure, water pressure and temperature in order to make it easier for farmers to monitor the quality of agricultural land. The use of these tools can be done in real time and can be set monitoring time through a microcontroller. Therefore, farmers can monitor directly and scheduled how the condition of their agricultural land. Then the data obtained will be processed by Machine Learning to find out the pH value, soil moisture, air pressure, water pressure and temperature will be very useful to be able to determine the steps or handling of the soil.

METHOD

This section describes the design of the soil monitoring process in rice plants. The design and manufacture of the system to be described is the flow of making tools and materials to retrieve data and data processing with a microcontroller to produce soil classification output for rice plants.

A. Data Collection

To achieve the desired goal in making this monitoring system, the most important step is to collect data and information. The data collection method used in this study was to interview a student in agriculture to obtain primary data from a university of Brawijaya and also a farmer directly and consult the Supervisor. Literature studies are also carried out to collect data or sources related to the topics raised in a study. The literature study can be obtained from various sources, journals, documentation books, the internet and libraries.

B. System Design

The system design stage is the stage of identifying existing problems. System design aims to describe the system to be created, and understand the flow of the system to go to the implementation stage.

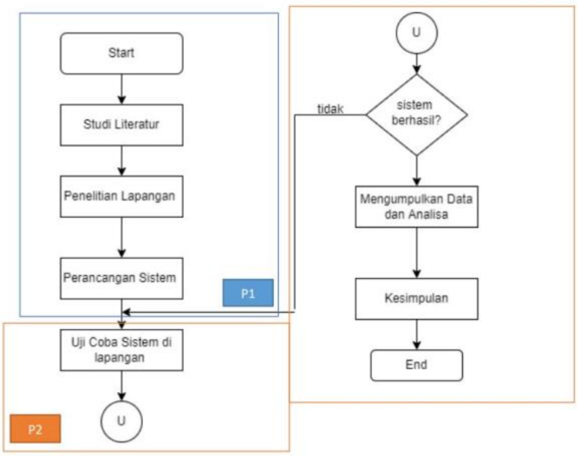

Figure 1. Implementation Stages Diagram

Figure 1 shows a research flow program that describes how the design of this system is made, starting from the field research stage, tool design, tool trials to the analysis stage of results and conclusions.

C. Block System Design Diagram

The working principle of the system, and the description of the tools made by the author can be seen in figure 2.

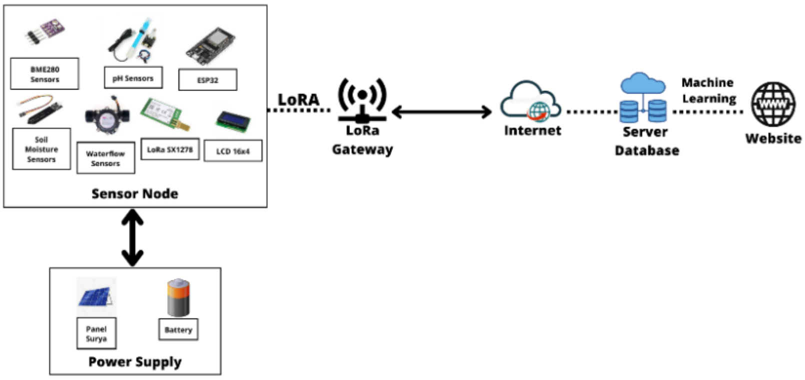

Figure 2. Block Diagram

Figure 1 Design workflow of agricultural land monitoring based on system diagram blocks, sensor nodes will take agricultural land condition measurement data. The data measurement results will be displayed via the LCD screen and the data received by ESP32 will be sent to the LoRa gateway. ESP32 output will be sent to LoRa gateway by using LoRa communication, LoRa node successfully sends data to LoRa gateway, if data is not successfully sent then data will be resent from the beginning. LoRa gateway will transmit the data it receives to servers and databases. data will be stored in the database, if the data is not stored it will be resent by the LoRa gateway to the database. The data stored in the database will be processed by supervised learning algorithms. Data stored in the database will be processed by supervised learning algorithms, data stored in the database will be processed by supervised learning algorithms.

D. System Flowchart

In this study, a workflow was created from the system created as shown in figure 2. Based on the flowchart, it is explained that the first step is a sensor node with a sensor reading the condition of agricultural land. The measurement results will be displayed on the LCD layer and the data processing that has been received by ESP32 will be carried out. ESP32 output will be sent and received to the LoRa gateway using LoRa communication. The LoRa node successfully sends data to the LoRa gateway, but if the data is not successfully sent, it will be re-sent from the beginning. LoRa gateway transmits data received from sensor nodes to servers and databases, after that the data will be stored in the database, if the data is not stored it will be resent by LoRa gateway to the database.data stored in the database will be processed by supervised learning algorithms, data that has been successfully processed 22 will be displayed to the website, so that users easily obtain land information.

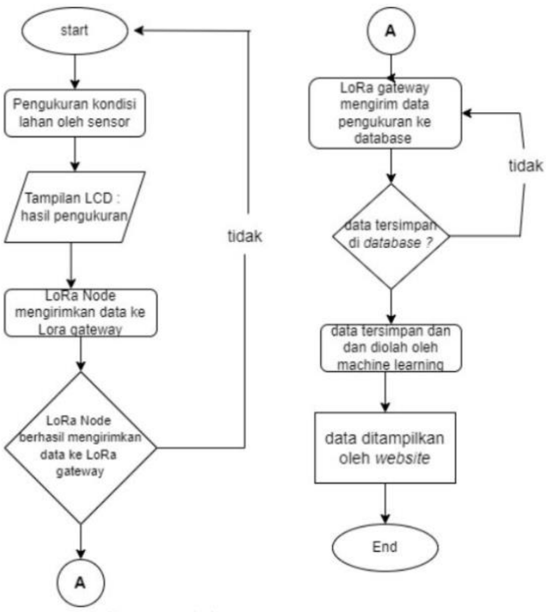

Figure 3. System Flowchart

E. Website Display Design

The appearance of the system website describes the form of the system interface created. The image is a website display that shows the display design on the monitoring system on rice plants.

Figure 4. Website Design Display

This initial page displays several features such as home, features, about and contact and a get started button. If farmers click on the button, they will automatically be directed to the dashboard page in Figure 4.

RESULTS AND DISCUSSION

This implementation will explain details about the Monitoring System of soil pH, soil moisture, air humidity, air pressure, water pressure and temperature in order to make it easier for farmers to monitor the quality of agricultural land. The use of these tools can be done in real time and can be set monitoring time through a microcontroller. The hardware used is a soil pH sensor, soil moisture sensor, waterflow sensor, ESP32, and LoRa EByte E32-900T20D. Therefore, farmers can monitor directly and scheduled how the condition of their agricultural land. Then the data obtained will be processed with the Artificial Neural Network method to find out the pH value, soil moisture, air humidity, air pressure, water pressure and temperature will be very useful to be able to determine the steps or handling of the soil.

A. Hardware Implementation

In the picture is the overall device that has been contained in the soil monitoring system, where the sensor will read data from the soil that has been laid, in this case the soil monitoring sensor is LoRa as a transmitter and as a receiver of data from the sensor to the database, BME280 sensor as a detector of temperature, air humidity and air pressure, pH sensor as a pH detector, Humadity sensor as a soil moisture detector, and Waterflow sensor as a water flow discharge detector, it can be seen that the yellow board under the component is a PCb which then all components are put together. in the process of reading soil monitoring data from sensors, namely realtime every data using a program carried out by Arduino IDE. It can be known that the data that has been read can be directly sent from the transmitter to the receiver which will then go directly into the database, and the data that has been detected will be processed by machine learning.

Figure 5. Tool Suite

B. Software Implementation

Software implementation is the display of input from sesnor nodes. The image displays the results of data that has been detected and displays the prediction results from data that has been processed by machine learning, on the dashboard display there are readings of humidity sensors, waterflow, soil moisture, air humidity, air pressure, soil pH and classification results.

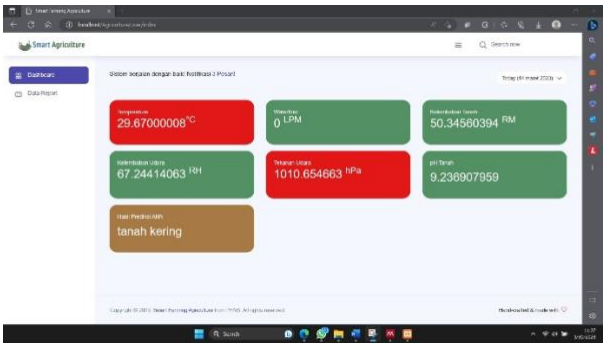

Figure 6. Website Display

C. System Testing

This test is a test that involves sensors to later see the results with the aim of checking so that they can be used properly. Sensor test results can be seen in the following table.

Table 1. BME280 Sensor Testing

No.	Hit	Temperature	Pressure	Humidity
1.	13.15	30.26	949.93	61.89
2.	13.30	30.15	949.92	61.93
3.	13.45	30.55	949,94	61.91

Table 1 shows the results of the BME280 Sensor which produces 3 parameters, namely temperature, air humidity, air pressure. This test is carried out every 15 minutes and has fairly stable results from these three parameters.

Table 2. Mositure Soil Sensor Testing

No.	Time	Soil Moisture (%)
1.	13.15	20.91
2.	13.30	20.22
3.	13.45	20.38

Table 2 produces a soil moisture value of 19-20% which means that the soil condition is dry soil and this test is carried out every 15 minutes.

Table 3. pH Sensor Testing

No.	Soil Conditions	pH Value
1.	Dry Soil	3.33
2.	Dry Soil	3.39
3.	Dry Soil	3.35

In table 3, data retrieval of each condition is carried out at intervals of 10 seconds to test the stability of sensor readings. The results of the soil pH sensor show that the soil pH results are read to produce a pH value of 3, where a pH value of 3 is interpreted as having soil with dry conditions.

CONCLUSION

This research resulted in a monitoring system of soil pH, soil moisture, air humidity, air pressure, water pressure, temperature in rice plants. This system is expected to make it easier for farmers to measure and monitor the condition of soil and rice crops and to make it easier for farmers to monitor the quality of their agricultural land. This monitoring system is assembled using various sensors added to ESP32, including soil pH sensors, BME280 sensors to identify air humidity, air pressure, and temperature, and also soil moisture sensors for soil moisture. In addition, LoRa can be used for projects such as controlling devices wirelessly with stable performance and connection. By using a soil monitoring system, it can be used to monitor soil pH, soil moisture, air humidity, air pressure, water pressure, and temperature so that soil condition monitoring can be done automatically and effectively because there is no need to check directly with manual tools. Therefore, farmers can monitor directly and scheduled how the condition of their agricultural land.

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