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Wireless Sensor Network Server for Smart Agriculture Optimatization

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Abstract: Server wireless sensor network (WSN) is a server that can retrieve data from wireless sensor network so that server can give service like normal server to be accessed by all client whenever and wherever. WSN Server to facilitate smart farming requires a server to serve all the needs of agricultural data so that the data can be processed and optimized for the needs of smart farming. wireless sensor network server serves as a server and can receive data from multiple sensors through WSN. Then in the save to the database in real time, then visualized into the form of the website and can be accessed via the Internet network.

Keyword: WSN server, IoT, Agriculture, Smart farming, Moisture sensor

1. Introduction

In agriculture, soil moisture has a major role in the process of the plant growth. This is because the pant needed water as a natural source for its's growth. The type of the paddy that can be known by the soil moisture in the farming area [1]. The moisture of the farm field can be known by checking it directly. The process to measure the moisture and the temperature of the farm field can be conducted by using thermometer and hygrometer. This process can consume a lot of time and effort to know the exact moisture of the farm field. The farmer need an easier way to know the condition of the farm, since the farmer usually has a huge area of farm field. One of the method to know the condition of the farm field is by putting a sensor in the farm field to monitor the condition from distance. One of the network that can receive data from the sensor on the farm field and transmit it wirelessly is wireless sensor network.

Wireless sensor network server (WSN) is a server that can retrieve data from wireless sensor network so that server can give service like normal server to be accessed by all client whenever and wherever. WSN Server to facilitate smart farming requires a server to serve all the needs of agricultural data so that the data can be processed and optimized for the needs of smart farming. Wireless sensor network server serves as a server and can receive data from multiple sensors through WSN. Then in the save to the database in real time, then visualized into the form of the website and can be accessed via the Internet network.

Wireless sensor network (WSN) is a network system that connect sensors and equipped with communication devices to receive information or data from devices to WSN server. WSN usually used to monitored agricultural or plantation environment. WSN can even use to monitor disaster event. Wireless sensor network is widely used in agricultural domain for efficient farming management. The application of the network system for agricultural environment monitoring was successfully developed in this research[2].

Optimum soil moisture for rice cultivation with System of Rice Intensification (SRI) is very important with the aim to increase rice production and water productivity. Soil moisture is classified into three levels based on the water retention curve, wet, slightly wet (medium) and dry. Soil moisture at the wet level for the initial and vegetative phases is very important for plants, especially the rooting areas in providing sufficient water for root, stem and leaf growth[3].

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One of the monitoring system in agricultural is to used WSN to monitored the environment from distance. This system can be manifested by designing a WSN server. This WSN server used to collect data from sensors trough WSN and stored in the database server. This data can be seen remotely by web.

2. Methodology

The methodology that used in this research is network development life cycle can be seen in Figure 1. Figure 1 shows the phase of the methodology used in this research. The methodology consists of analysis, design, simulation prototyping, implementation, monitoring and management. The description of each phase are explain as follow[4]

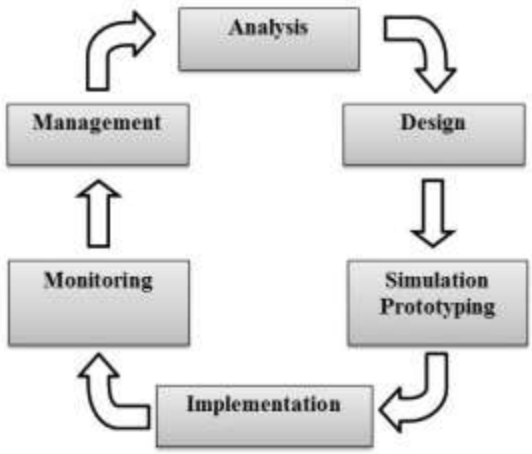

Figure 1. Network development life cycle

2.1. Analysis

The problem in this research were analyzed and to measure the requirement needed. The problem was the connectivity between the database and the microcontroller were unavailable. The WSN for smart farming optimization can be used to monitor the farm from the distance and able to store the data into the database.

2.2. Design

The network topology design was created. By creating the design of the network topology and the interconnection between the database and the sensor the system can provide reliable data from the farm. The design created were include the network topology, the data access design and cabling.

2.3. Simulation

After the analysis and the design phase, the next phase is to simulate using cisco packet tracer to test the readiness of the system for implementation

2.4. Implementation

In the implementation phase everything that has been done were implemented. The implementation phase will determine the result weather a failure or a success. The implementation phase was divide as follow:

1. The sensor process while activated produced the output as data to send to the database
2. Wireless router as communication media from sensors
3. The server computer will receive the data through WSN to store into the database and can be viewed via website

2.5. Monitoring

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The monitoring phase is to see the reliability condition of the system, the flow of the transmitted packet in the network and the stability of the connection.

2.6. Management

The management phase is to manage the network so the WSN communication among all devices can be maintain.

3. Result

The condition of the farm field can be known by visiting the farm directly and measure the moisture using a measuring device such as hygrometer. This activity takes time and to know the moisture of the farm field. To ease the process to know the condition of the farm field, the WSN were needed so the condition of the farm field can be seen remotely. By implementing the WSN in the farm field the farmer can be able to measure the moisture of their farm field.

3.1. Analysis

The research uses sensors to measure the moisture of the farm field and an Internet of Things (IoT) module to transfer the data from the sensors to the WSN server.

3.1.1. Moisture sensor and Architecture of Sensor Node

The sensor used is to measure the soil moisture which is YL 69. The voltage that the sensor output changes accordingly to the water content in the soil. The voltage increase when the soil is wet and the voltage decrease when the soil is dry. The sensor works at 5v voltage with 10 bits of digital data which means can produce a digital value from 0 to 1023[5].

Currently, in agricultural applications, the use of SoCs are very rare. However, the advent of SoC has a lot of potential for the agriculture and farming domain. Firstly, the use of SoCs based sensor nodes instead of current day embedded multi-chip sensor nodes will increase the computation power, and decrease the energy consumption. Also, the size of the nodes will be less and thereby, portability of the overall system increases. Compared to multiple silicon dies in SiP, SoC is single die based, and thus, SoCs result in lesser size, but, higher cost[6]

In figure 2, it can be explained that on the placement of ports connected to each part of the system, this electrical design is made using Fritzing software.

- NodeMCU-ESP8266 to process moisture moisture sensor data (YL 69).
- Moisture soil moisture sensor (YL 69) when executed process will get the output of data will be sent to NodeMCU-ESP8266.
- On board for placement of ports connected to each component.
- Jumper cable to connect all components to be connected

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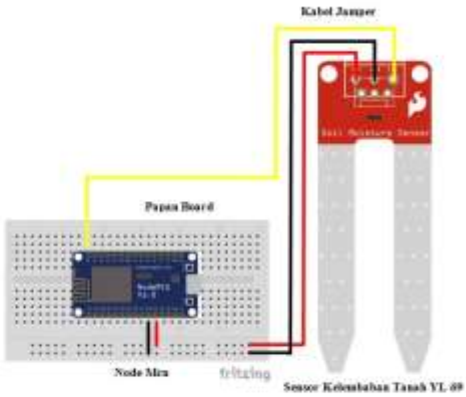

Figure 2. Arcitecture of Sensor Node

3.1.2. IoT platform

The IoT platform used is Node MCU esp8266 from Arduino. The microcontroller can be programmed using C/C++ programming language. The microcontroller has 12 general purpose input/output pin than can be used as input or output of the microcontroller. The microcontroller has 128KB memory and 4MB rom to store the program.

3.2. Design

3.2.1. Topology design

The network topology used in this research can be seen in Figure as follow:

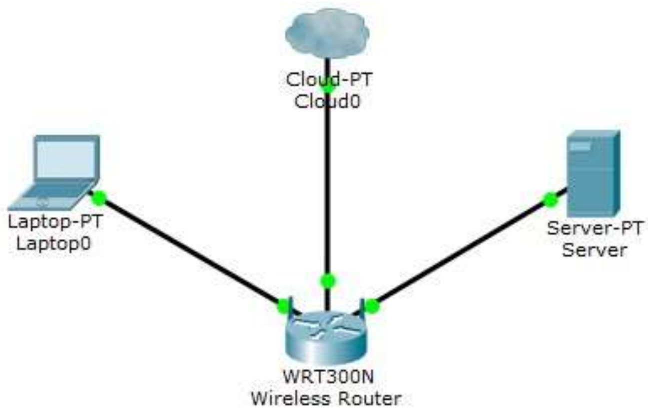

Figure 3. Topology design

The network topology used in this research are based on the client server topology. This topology uses one computer server, one wireless router, one laptop and an internet connection. This device was used so the system can be controlled remotely and the data can be viewed via web.

3.2.2. WSN design

The design of the WSN can be seen in Figure .

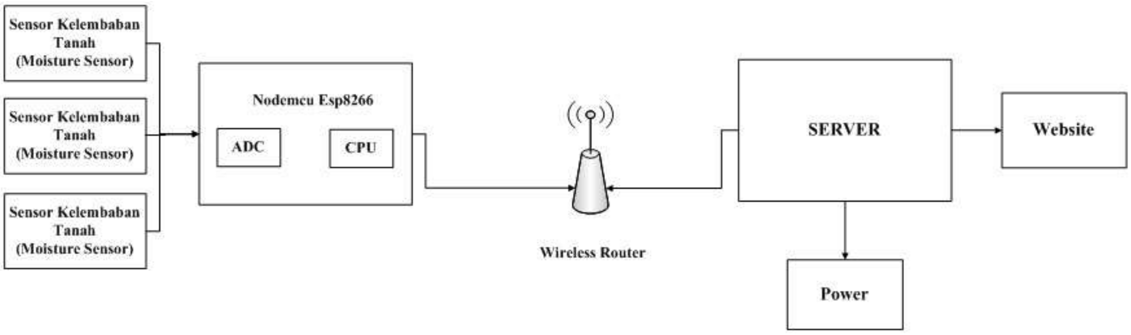

Figure 4. WSN design

Figure shows the design of the WSN. The sensors on the farm field sent its data trough a microcontroller to the server via a wireless connection. The data from the server can be seen remotely by accessing a website that provide the data from the farm field. The data from the server can be accessed through an internet connection.

3.2.3. Model design

In this research the overall WSN model created as minimum as possible to optimize the performance of the system. The model can be seen in Figure as follow:

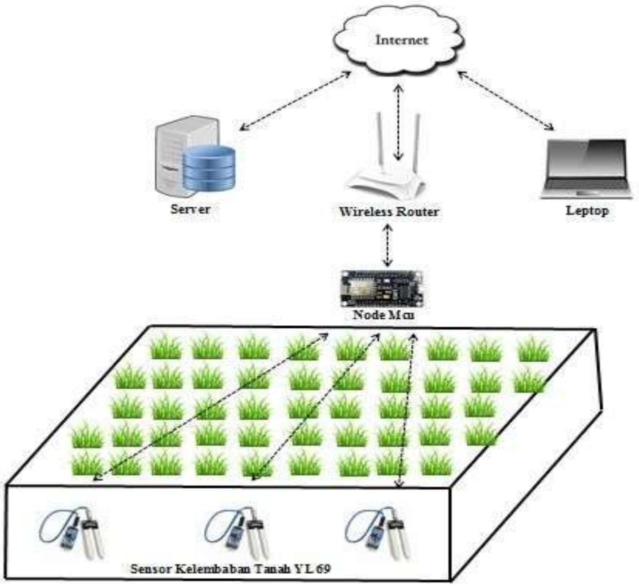

Figure 5. Model design

Figure shows the position of the sensor were spread in the model. The model of the farming field where using acrylic has 60 cm length, 90 cm wide and 20 cm high.

3.3. Simulation

The simulation of the system conducted by testing the client server network. The server received the data from the sensor trough wireless router and stored to the database. The router used as the communication media between the sensors and the server. The data stored from the moisture measurement process by the sensor can be seen through laptop.

3.4. Implementation

Shown the measurement of each sensors at the different condition. The condition set with normal, low moisture and high moisture. The data shows that the system able to read the moisture level of the farm field successfully. The high reading of the sensor indicate that the soil has a high moisture and the low reading of the sensor indicate that the soil has a low moisture. The implementation of the model can be seen in Figure 6 below

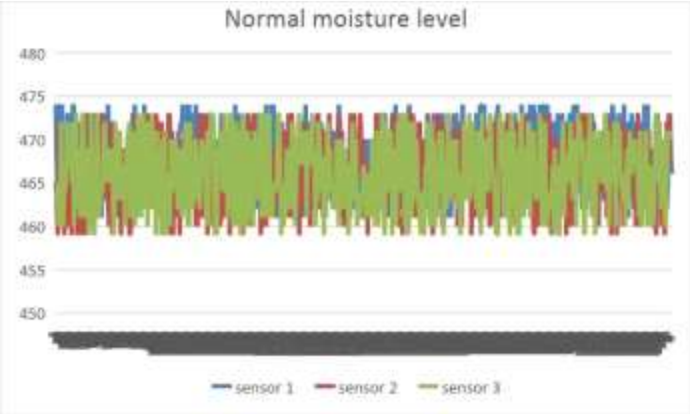

Figure 6a. Normal moisture level

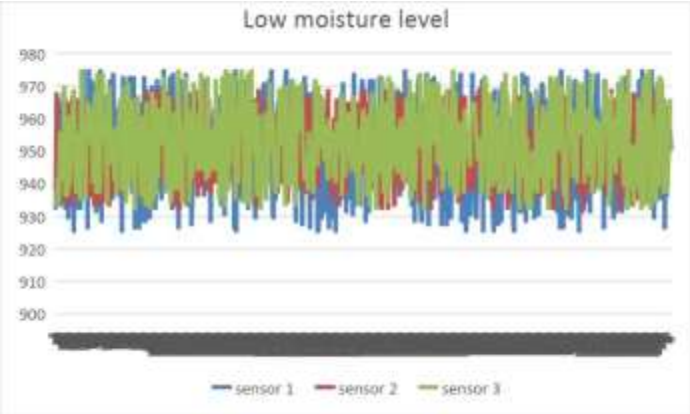

Figure 6b. Low moisture level

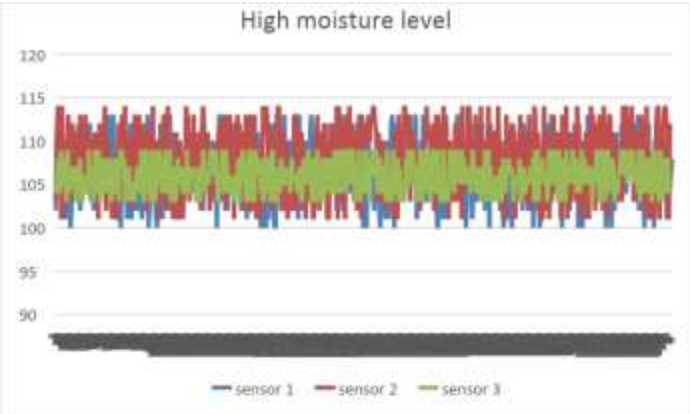

Figure 6c. High moisture level

Figure 6. Sensors reading

Figure 6 shows the measurement of each sensors at the different condition. The condition set with normal, low moisture and high moisture. The data acquisition process takes time every 5 minutes for two days. The data shows that the system able to read the moisture level of the farm field successfully. Figure 6a shows the reading at the normal moisture field, the data reading shows an average reading at 466.53 that indicate the soil is in normal moisture level. Figure 6b shows the reading at the low moisture field, the data reading shows an average reading at 951.35 that indicate the soil is in low moisture level. Figure 6c shows the reading at high moisture field, the data reading shows an average reading at 106.79 that indicate the soil is in high moisture level.

3.5. Monitoring

The monitoring phase is to monitor the connection among the IoT platform, the server and the client. The connectivity shown in Figure .

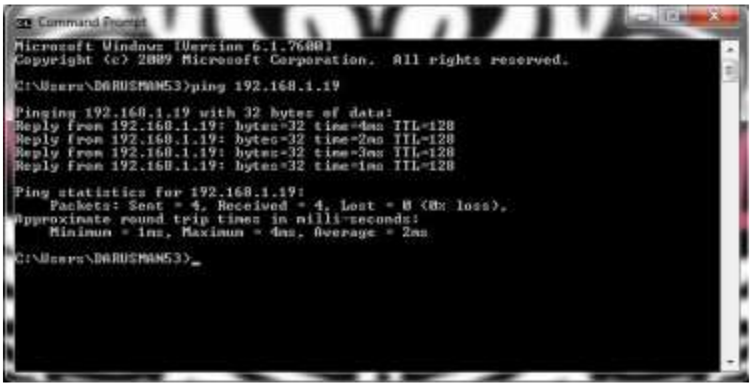

Figure 7. Connectivity monitoring

Figure shows the connectivity of the WSN system. The connection test was conducted by using a ping command to the IoT platform trough the server from the client PC. the monitoring process of the connection shows a stable connection and able to transmit data from the IoT platform to the client

3.5.1.Management

The configuration of the dynamic IP in the browser conducted to test the website user interface. The testing of the dynamic IP configuration shown in figure 6.

Figure 8. Client user interface

4. Conclusion

The WSN server model for smart farming optimization are using moisture sensors and an IoT platform to send the data from the sensors to the server. The sensor data can be access in the website trough an internet connection. The server role as a data storage to store the data from the moisture sensor that spread across the farm field. the data in the server can be accessed remotely and provide a real time data from the farm field.

The sensor data from the farm field shows a promising reading. The sensor can acknowledge the moisture level of the soil in the farm field. the average normal moisture level of the soil is 466, the average high moisture level of the soil is 954 and the average low moisture level of the soil is 105.

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