Designing smart greenhouse systems using SCADA based on IoT

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Abstract. The purpose of this study is to design a smart green home system to help the process of vegetable growth in urban areas by utilizing SCADA and IoT technology. This system can help planting vegetables in urban areas with natural conditions that are not possible and limited land. Using the hydroponic planting method will certainly be very appropriate because it does not need soil as its growing medium. The system that we designed can control and monitor parameters that affect the development of vegetables such as temperature, humidity, nutrition, water level, light, and water use in real time.

1. Introduction

The increasing lifestyle of people in urban areas and eating patterns that are classified as instant can make public health in urban areas less attention. The emergence of health problems may be due to unhealthy eating patterns and mostly consume foods that are instant and practical. This is where the need for a healthy lifestyle and self-awareness to maintain a balanced food intake [1,2].

With the start of a healthy lifestyle awareness in the community and awareness of healthy foods such as vegetables, it will increase the consumption needs of vegetables in the community so that the supply must always be maintained and always stay fresh [3]. Therefore, the supply must be balanced with a large and fast vegetable production. However, on the other hand it is almost impossible to plant vegetables in urban areas because in addition to natural conditions and land is an obstacle [4]. Therefore we need an artificial ecosystem that can resemble the real nature.

With artificial ecosystem technology, growing vegetables can now be applied on limited land such as in urban areas, so that it becomes more efficient. Green house technology can bridge the needs of vegetables in urban areas through a hydroponic planting system that does not require planting media such as soil and without pesticides. This hydroponic system will produce healthy vegetable products without chemicals such as pesticides and no seasonality in the planting process, so that people in urban areas will be able to get fresh vegetables for consumption every day [5-7]. Utilization of green houses in urban areas will be very efficient because it is not fixated on certain ecosystems. The availability of fresh and healthy vegetables on the market will continue to be maintained. To maintain the quality and the quality of the greenhouse production of this hydroponic system in its production requires precise data, is controlled quickly, and can be monitored directly so that the production process can produce good products. This requires a system that can control and monitor data directly on the green house [8].
The need for a SCADA (Supervisory Control And Data Acquisition) system in the application of green houses in urban areas with hydroponic planting is a major factor. We propose a system in such a way as to provide the needs for healthy, fresh, quality vegetables in urban areas and always maintain their availability on the market. Based on the aforementioned explanation, this study describes the design of a smart greenhouse system to be able to produce products with good performance, control the system, acquire data, and monitor the development data of vegetables grown on the greenhouse system.

2. Methods
The design of the smart greenhouse system is carried out with several stages and several preparation processes, so that the system can be structured and made easier in the design process [9]. The initial stages of the design method are divided into 3 parts, namely RTU greenhouse A and B databases, data communication systems, and monitoring parameters for plant development of smart greenhouse systems.

In 2 units of greenhouse RTU, they communicate with SCADA CIMON with Modbus RTU RS-485 communication media which only uses 2 wire cables, namely A and B. In principle, the data communication system to these 2 RTU units communicates in sequence, starting from slaveID 1 then slaveID 2, where in this communication process each address variable sends or receives data sequentially starting from the 40001-40045 address. By using Team Viewer software, it is possible to communicate data with the smart greenhouse system remotely using a computer/laptop and can also communicate this data using a mobile phone.

![Diagram block and prototype of Smart Green House.](image)

The design of smart greenhouse system framework as illustrated in Figure 1 is divided into 2 parts, namely 2 pieces of greenhouse room and the placement of supporting equipment such as storage tanks, 2 tanks, 4 tanks of nutrition, pipes, wiring, PSU, and Control Board.
This greenhouse automation system uses the SCADA system, combined with an IoT-based control system. Some components that work automatically based on parameter data that will be inputted to SCADA, communicating with arduino nano as a controller are SCADA CIMON, Arduino nano microcontroller, RS485 module, DHT11 sensor, water flow sensor, ultrasonic sensor, LDR sensor, fan, pump, and lamp. SCADA software systems and hardware elements in Figure 2 illustrate functions to control processes locally, monitor, process real-time data, interact with devices such as sensors, valves, pumps, motors, and others through human-machine interface software, and record real-time data into log files.

3. Results and discussion

The system created is then tested based on a predetermined program. Data measured are in the form of temperature and humidity, light, water level, and water usage. The data obtained is as follows.

From Figure 3 it can be explained that in 2 pieces of greenhouse A and B, obtained information on temperature, humidity, fan speed, and harvest time of each plant planted on this smart greenhouse system. There is a humidity parameter where the set point is not reached within 31 minutes, causing the fan speed to reach 100% from the start of the program start until the program stops. The humidity system
in green house B is only able to reach 76%, which means that the fan humidity system is unable to reach the set humidity point of 80% according to the set point for 31 minutes.

The intensity of the light in the greenhouse room reaches 150 Lux maximal from the 12v LED after being calibrated using LUX meters. The LDR sensor set points outside the green house can work as desired. When the set point of light conditions at an intensity level of less than 80% on the LDR sensor readings that are located outside the green house, then the lights will turn on, otherwise the lights will go out.

![Graph of water level and water usage in greenhouse A.](image)

**Figure 4.** Graph of water level and water usage in greenhouse A.

Referring to the water level graph information with an ultrasonic sensor, it is found that the reading is not stable due to the low quality of the ultrasonic sensor used (Figure 4). We set the water level to 15cm, tank volume A 10.2 liter and Tank B 11.7 liter. 1.5 liter difference was found due to the unstable ultrasonic sensor reading.

4. Conclusion

Based on the results of the test equipment and data sampling acquired by SCADA, it can be concluded as follows:

- Greenhouse prototype that has been designed according to the needs of green spinach and mustard plants;
- The growth conditions parameters of the two types of plants work as expected; found an ultrasonic sensor reading that has not been stable;
- The temperature and humidity system is not maximal because it only uses a fan.

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