Journal of Artificial Intelligence and Engineering Applications

Website: https://ioinformatic.org/

15th October 2025. Vol. 5. No. 1; e-ISSN: 2808-4519

Automated Fertilizer Spraying System for Purple Eggplant Plants Based on IoT at STMIK KAPUTAMA

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Abstract

The purple eggplant plant (Solanum melongena L) is a high-value vegetable crop that requires proper fertilization to support optimal growth. However, the manual fertilization methods currently in use are often inefficient and inaccurate, leading to fertilizer waste and suboptimal harvest yields. This study developed an automatic fertilizer spraying system based on the Internet of Things (IoT) using a NodeMCU ESP8266 microcontroller and soil moisture sensors to monitor soil conditions in real-time. The system is equipped with an RTC module and the Blynk app to automatically adjust fertilizer application based on soil moisture levels between 50% and 60%. Test results demonstrate that the system can efficiently activate the pump when moisture drops below the minimum threshold and deactivate it when moisture reaches the maximum threshold. Implementing this system improves fertilizer efficiency compared to manual methods and facilitates remote control, thereby supporting increased productivity and the development of purple eggplant farming.

Keywords: *Purple Eggplant Plant, Blynk, IoT, Soil Moisture, System.*

1. Introduction

Agriculture is an important sector that plays a role in meeting the world's food needs. In addition to providing food for a growing population, this sector is also a source of livelihood for millions of people in various countries. One type of plant that is in high demand by farmers is the purple eggplant (Solanum melongena L). The purple eggplant is one type of vegetable that can be harvested more than once. However, the cultivation of this crop faces various challenges, one of which is fertilization, which must be done at the right time and efficiently to ensure optimal plant growth. Proper maintenance and the application of appropriate fertilizers are crucial for supporting plant growth and achieving maximum harvest yields. Therefore, a more precise and efficient fertilization method is needed to address these issues.
To achieve optimal results, soil moisture levels in eggplant plants must be consistently maintained, ideally between 50-60%. This is because soil moisture acts as a medium for transporting nutrients and other compounds from the soil to the plants, as well as maintaining and regulating plant temperature. Additionally, fertilizer application and soil moisture are crucial in supporting plant growth. Sufficient soil moisture allows the applied fertilizer to dissolve properly, enabling nutrients from the fertilizer to be absorbed optimally by the plant roots. Conversely, if soil moisture is low, fertilizer dissolves poorly, and nutrient absorption becomes ineffective, potentially hindering plant growth and crop yield.
In today's digital age, Internet of Things (IoT) technology offers innovative solutions to enhance efficiency and effectiveness in agriculture. By utilizing sensors and connected devices, farmers can monitor plant conditions in real-time, including nutrient needs and soil moisture levels.

2. Research Methodology

2.1 Research Methodology

This research focuses on developing a system that utilizes Internet of Things (IoT) technology to automate the process of spraying fertilizer on purple eggplant plants. The system is designed to monitor plant and environmental conditions in real-time through sensors connected to an IoT-based microcontroller, enabling fertilizer spraying to be performed automatically and on time without requiring manual intervention. By utilizing soil moisture sensors and other environmental parameters, data is transmitted via the internet to the Blynk application, enabling users to control and manage the spraying process remotely. The objective of this system is to enhance fertilizer usage efficiency, maintain the health of purple eggplant plants, and simplify agricultural management within the STMIK Kaputama environment.

2.2. System Requirements Analysis

The analysis of system requirements for IoT-based automatic fertilization covers both hardware and software.

Table.1 : system requirements for IoT-based

Hardware	Software
NodeMCU Esp8266	Arduino IDE
DS3231 RTC	Blynk
YL-96 Soil Sensor	Fritzing
LM2596 Stepdown	
I2C LCD	
Relay Module	
12V Adapter	
Smartphone	

2.3. Block Diagram System

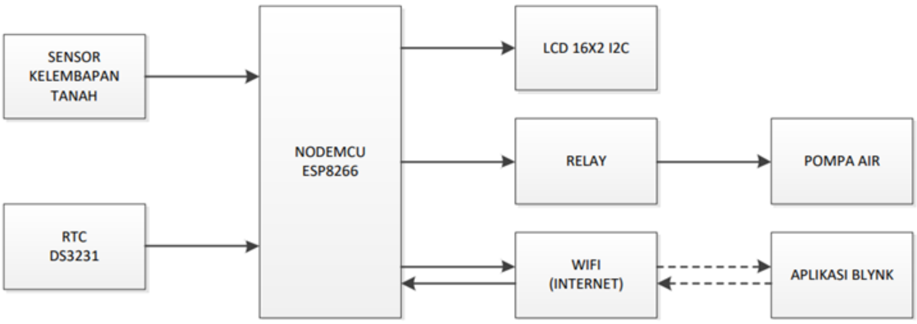

Fig. 1: System Block Diagram

The system block diagram in Figure III.1 shows the system block diagram of an Internet of Things (IoT)-based automatic fertilizer spraying system for purple eggplant plants. This system uses a soil moisture sensor that continuously measures soil moisture levels and sends the data to the NodeMCU ESP8266 as the control center. Additionally, the DS3231 RTC module is connected to the NodeMCU to provide accurate time and date information as the basis for scheduling fertilizer spraying. The NodeMCU then processes data from the sensors and RTC, controlling a relay that activates or deactivates the water pump according to predefined conditions. Information about soil moisture levels and system status is displayed in real-time on a 16x2 I2C LCD for easy local monitoring. Additionally, the NodeMCU is connected to a WiFi network to communicate with the Blynk app via the internet, enabling users to monitor and control the fertilizer spraying system remotely via a smartphone. The integration of these components creates an efficient, adaptive, and easily controllable and scalable fertilizer automation system.

2.4 Overall Tool Set

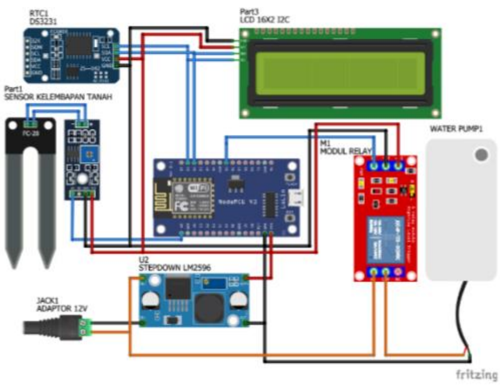

Fig. 2: Overall set of Tools

2.5 Circuit Flowchart

The design of the device begins with the creation of a flowchart to facilitate the planning and development of programs on the microcontroller. The flowchart in this study is designed to provide a clear picture of the system's working flow, thus facilitating understanding of how the device works. In this study, the diagram includes a control system for automatic fertilizer spraying that involves reading soil moisture sensor data, data processing by the microcontroller, real-time scheduling using the RTC module, and pump control via relays based on predetermined humidity and time conditions. This flowchart also explains how data is periodically sent to a mobile application via a WiFi network for remote monitoring and control, increasing the efficiency and ease of use of the system. The flowchart of the device's working system can be seen in Figure III.3 below:

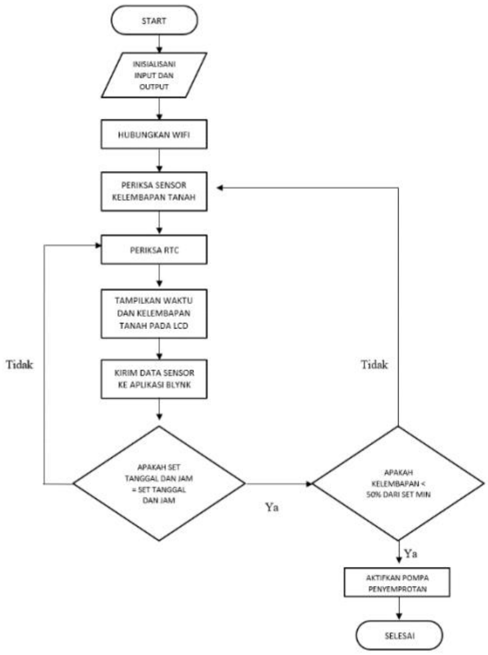

Fig. 3: Tool Work Flowchart

3. Results and Discussion

3.1 Discussion

This research has successfully developed an automated fertilizer spraying system that utilizes Internet of Things (IoT) technology to directly maintain soil moisture. This system is configured to automatically activate fertilizer spraying when the soil moisture level drops below the minimum limit of 50%, and stop the spraying process when the humidity reaches the maximum limit of 60%. Furthermore, the date and time of fertilization can be flexibly set through the Blynk application, making it easy for users to adjust the fertilization schedule according to their needs.

3.2 Test Results

The testing phase is a crucial step taken to ensure that the software and hardware in this automatic fertilizer spraying system are functioning properly and according to expectations. During this phase, every component is thoroughly tested, from the YL-69 Soil sensor and the relay module to the overall system integration, to ensure optimal performance.

3.3 Software Testing

The developed software was tested to ensure the performance and accuracy of this IoT-based automatic fertilizer spraying system. The test was conducted by monitoring the system's response to soil moisture sensor readings and time signals from the RTC module, as well as the effectiveness of pump activation and shutdown based on programmed parameters. The test results showed that the system can read soil moisture data in real-time with soil moisture levels capable of determining when the pump should be activated or turned off. The system successfully activated the pump automatically when soil moisture fell below the minimum threshold of %, and turned off the pump when the humidity reached the maximum limit of 60%. Setting the date and time of fertilization through the Blynk application also worked well, allowing flexible scheduling and real-time remote control. Moisture data, pump status, and spraying time can be monitored directly through the application display, increasing the ease of monitoring and control for users. The test results can be seen in Figure III.1.

Fig. 4 : Blynk Display

3.4 Hardware Testing

Hardware testing was conducted to ensure all components functioned as designed. The soil moisture sensor was tested for accuracy and validity when installed in the growing medium. Test results showed that the sensor was able to detect changes in soil moisture content with a fast and stable response.

The DS3231 RTC module was tested to provide the correct time and date as a basis for setting the spraying schedule. This testing demonstrated that the RTC module could operate precisely and synchronize with real-time.

The NodeMCU ESP8266 successfully communicated with the sensor and RTC module simultaneously, controlling the output of the relay to activate the water pump. The relay and pump were tested under real-time conditions, with the pump being turned on and off according to signals from the microcontroller based on sensor data and the specified time.

Furthermore, WiFi connectivity and the Blynk application were tested to ensure that sensor data could be sent to the application in real time, allowing users to perform remote settings and monitoring without any issues.

Overall, the hardware testing results demonstrated that all components operated well and were synergistically integrated to effectively support the automated fertilizer spraying system. Below shows the entire device circuit, showing how all the components are connected to each other.

Fig. 5: Overall Tool Suite

3.5 Sensor Testing

Sensor testing can be performed manually using the Arduino IDE. Soil moisture levels can also be monitored via a 16x2 I2C LCD. The serial monitor and LCD provide information on soil moisture levels, minimum humidity levels, maximum humidity levels, the set date and time, and pump status.The information displayed on the LCD can be seen in Figure III.3

Fig. 6 : Display on LCD

Information :
1. HUMID shows soil moisture data
2. Min is the minimum soil moisture that has been set through Blynk app.
3. Max is the maximum soil moisture that has been set through blynk app.
4. The clock display displays the spraying time and date that has been set.
5. The set display displays the spraying time and date.

4. Conclusion and Suggestions

4.1 Conclusion

Test results showed that the system was able to work accurately and efficiently in monitoring soil moisture and automatically regulating fertilizer spraying.
1. This research successfully designed an Internet of Things (IoT)-based automatic fertilization system for purple eggplant plants using a NodeMCU ESP8266 microcontroller and a soil moisture sensor. This system allows for real-time monitoring of soil conditions and automatic fertilizer spraying settings based on soil moisture levels.
2. The designed system can regulate fertilizer application in real time and accurately based on soil moisture, with moisture parameters ranging from 50% to 60%. The spray pump automatically activates when soil moisture falls below the minimum level and stops when it reaches the maximum level, ensuring more efficient and effective fertilizer application.

4.2 Recommendations

The following are some suggestions to consider for the development of an IoT-based automatic fertilizer spraying system for further research.
1. Sensor Calibration and Quality Improvement: It is recommended to perform routine calibration on soil moisture sensors and use sensors with higher quality so that the data produced is more accurate and reliable in controlling fertilizer spraying.
2. Additional Sensors: To improve the accuracy and effectiveness of spraying, it is recommended to add additional sensors, such as soil pH, air temperature, or humidity sensors, to provide more comprehensive control over plant conditions.

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