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# NodeMCU-enabled intelligent fertigation system for efficient water and nutrient management

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**ABSTRACT**

Fertigation is a methodology that encompasses the direct application of fertilizers via irrigation water systems, thereby augmenting the delivery of nutrients to plants and reducing the wastage of valuable nutrients, consequently enhancing both crop yield and quality. Specific injection tools are used to introduce nutrient solutions into the irrigation water (Shukla et al., 2018). This technique is particularly beneficial for farmers managing a large quantity of plants, as it streamlines the process by ensuring a consistent supply of water and fertilizers to the crops. Most farmers cannot be present in their fields around the clock and this method demands continuous monitoring of fertilizer and water levels. As a result, this project aims to showcase how the Smart Fertigation system project will address the challenges faced by farmers who adopt this method. This project promotes a monitoring mechanism that tracks water and fertilizer levels and monitors moisture and ambient temperature around the plants, thereby providing farmers with comprehensive insights.



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## Introduction

The agricultural industry is essential for the economic advancement of developing nations (Nya et al., 2010). Farmers depend on technology to boost their crop yield and earnings. Therefore, the integration and application of new technology play a crucial role in the advancement of agriculture (Piya et al., 2012). The use of fertigation technology has shown to be successful and productive in growing leafy vegetables and fruits. In the realm of precision agriculture, IoT can be utilized to observe environmental conditions and crop development instantly, providing a useful method for organizing and managing sustainable farming practices (Na et al., 2020).

This research discusses how IoT is applied in agriculture, focusing on monitoring the Smart Fertigation System for automatic fertilization. Multiple parts collaborate to regulate the distribution of water and nutrients and meticulously track environmental factors for effective plant growth. The system aims to oversee and enhance the irrigation and fertilization process to prevent water and fertilizer wastage and aid employers in minimizing labor (Pibars et al., 2022). Unlike other platforms, it is connected to the Internet of Things for distant supervision and can be managed via the Blynk mobile app. Through the use of a smartphone, individuals can virtually control the automatic fertigation system by receiving notifications and adjusting settings. The easy-to-use interface allows for remote monitoring and live control of various parameters like ambient temperature, soil moisture level, and water level of fertilizers.

This system utilizes a PIC control system. Functions on 240 volts of alternating current electricity and manages the allocation of 5 volts for the NodeMCU circuit. Users can benefit from this NodeMCU control system by programming schedules for irrigation and fertilization to improve the quality of crops. This system aims to assist farmers in controlling the automated fertilization of their crops and enhance agricultural productivity in Malaysia.

## Method

In this research, we develop an IoT-based monitoring system integrated with a mobile platform. This system aimed to streamline and make interactions between farmers and their plants more efficient. The system uses a smartphone to control irrigation and monitor fertilizer through the Blynk app using the NodeMCU system circuit (Robin Blynk 2.0 | IOT Smart Plant Monitoring System | Smart Irrigation | Nodemcu Smart Irrigation ESP8266). This system aims to help farmers save time, reduce labor, and save water and fertilizer.

Smart Fertigation System comprises a mobile-based system, automatic fertigation system, and communication network. The main focus is on mobile-based systems where current data is collected to display parameters such as water level status, soil moisture, and the overall operation of the automated fertigation system. this system allows users to access mobile phones to set fertigation schedules and monitor their crops.

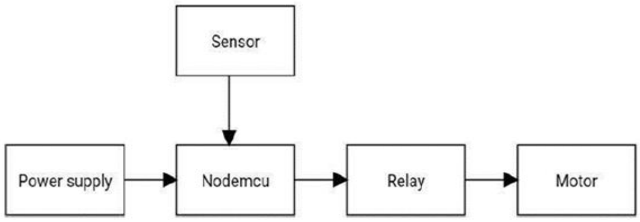


**Figure 1 <Block Diagram of Smart Fertigation System>**

Figure 1 shows a block diagram of the Smart Fertigation System. A sensor will detect some input which then sends a signal to a Nodemcu device. The Nodemcu device controls a relay that activates or deactivates a motor based on the input from the sensor.

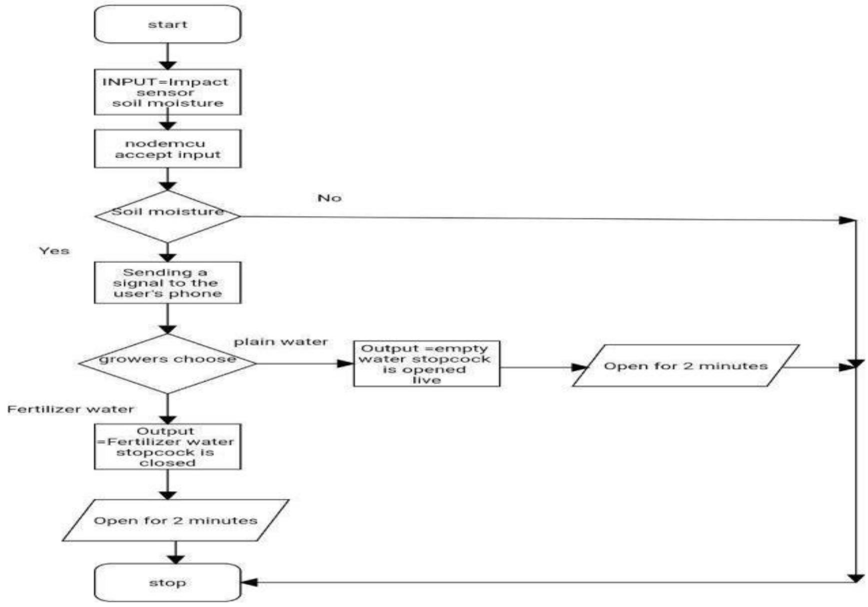


**Figure 2 <Flow Chart of Smart Fertigation System**

Figure 2 shows a flowchart of the outline process for an automated irrigation system. The system uses a soil moisture sensor that transmits a notification to the user's phone. The system automatically controls watering by checking soil moisture and alerting users when irrigation is required. It also provides options for plain or fertilized water, opening the appropriate valve for a set duration. This helps optimize water usage and plant nutrition based on real-time soil conditions. Next, the user selects either plain water or water with fertilizer, deciding which stopcock to open.

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## System Development

### Hardware Requirements

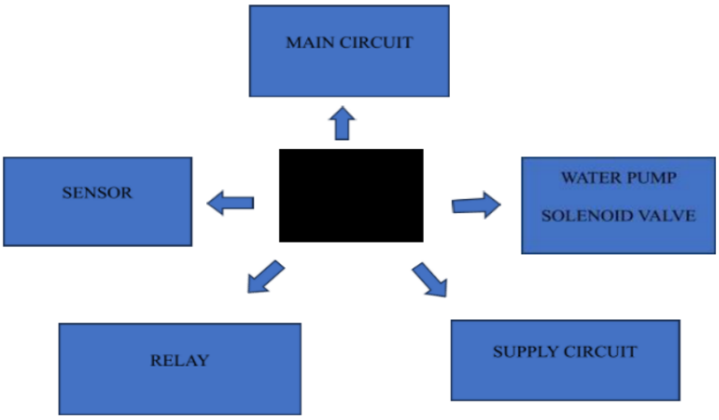


**Figure 3 <Smart Fertigation System Circuits>**

Figure 3 shows the hardware circuit involved in the Smart Fertigation System. The flow of operation seems to be: The sensor detects a condition (e.g., low moisture levels) and sends a signal to the Main Circuit, which then activates the relay to turn on the water pump or open the solenoid valve, allowing water to flow to the desired location. The Supply Circuit provides power to all the components. After the development of the PIC system, the project is analyzed to measure its effectiveness and ensure that the project objectives are achieved. Throughout the analysis stage, the strengths and weaknesses of the PIC system are identified. From this project, there is a difference between using a circuit in simulation and on a PCB board when performing operations in software. Proteus software is used to design the circuit and design the PCB board.

### Software Requirements

During this stage, our focus is on establishing connections and integrating all equipment to ensure that they are functioning correctly. In addition to that setup, all equipment will be implemented in this phase. We use Arduino IDE to code the firmware for the device. We also create the interface for monitoring and control through the use of Blynk.

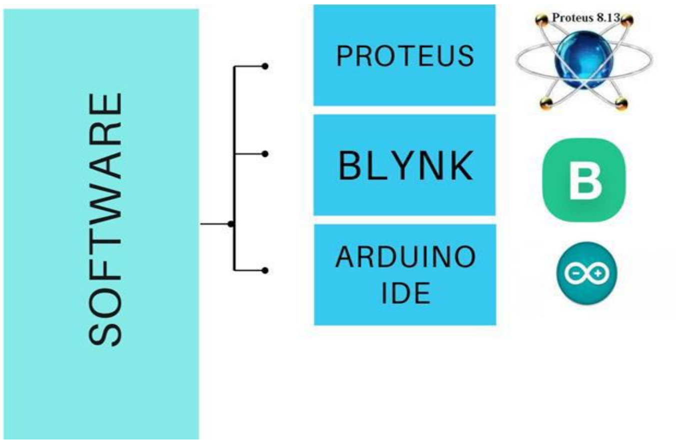


**Figure 4 <Software used in Smart Fertigation System>**

The Proteus software integrates with the Arduino IDE and Blynk platform as shown in Figure 4 allowing users to develop firmware using Arduino, simulate and test the circuits in Proteus, and potentially interface with Blynk for remote monitoring or control capabilities. Segmenting code into functions allows a programmer to create modular pieces of code that perform a defined task and then return to the area of code from which the function was "called". The typical case for creating a function is when one needs to perform the same action multiple times in a program. For programmers accustomed to using BASIC, functions in Arduino provide (and extend) the utility of using subroutines (GOSUB in BASIC).

### Blynk Application Configuration

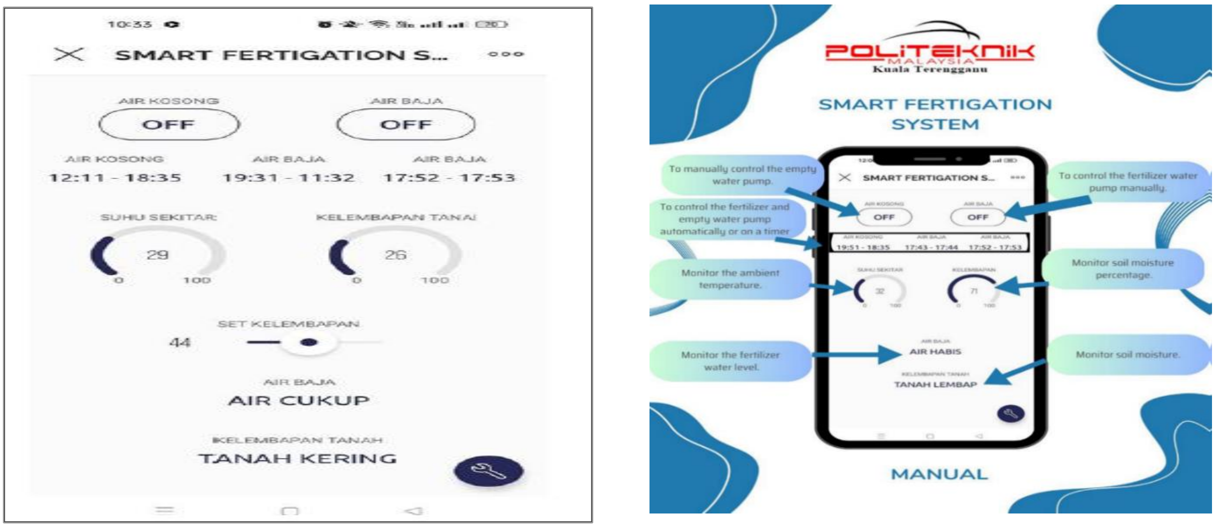


**Figure 5 <BLYNK Mobile and Web-based System>**

Figure 5 shows a BLYNK mobile and web-based system that appears in a smart fertigation system The interface displays various settings and parameters related to irrigation and humidity control. Here's an overview of the information shown: 1) switch button on/off air kosong and air baja: these refer to controlling the plain and fertilizer water pump manually; 2) timer: set schedules to provide automated control and monitoring for irrigation and fertilization needs; 3) kelembapan tanah: indicators of soil moisture levels; 4) suhu sekitar: indicators of ambient temperature level; 5) humidity meter: a slider allows monitoring and setting of the desired soil humidity and ambient temperature level; 6) air baja: this section monitors the fertilizer water level (sufficient water); 7) kelembapan tanah: indicator and monitor soil moisture as desired.

## Results and Discussions

"Smart Fertigation System" was inspired by previous observations of existing products. Therefore, the Smart Fertigation System has been upgraded by using a smartphone to control the watering of trees and monitor fertilizers using the NODE MCU system circuit.

### Creating a Prototype

**Figure 6 <The Smart Fertigation System Prototype>**

Figure 6 is an illustration of a prototype for a Smart Fertigation System. This system uses automated irrigation where plain and fertilizer water are given to the plant in the form of a solution and channeled to the roots through a drip irrigation system. It consists of various elements like electronic circuits, tubing, containers, and sensors that work together to monitor and control the watering or nutrient delivery process for plants. The main components are sensors, water reservoirs, pumps, solenoid valves, tubing/dripper lines, and controllers/timers that operate the solenoid valves according to a programmed schedule.

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Table 1 <Configuration of the Prototype>

| Main Components | Action | Explanation |
|---|---|---|
| Sensor Soil Moisture > 50% | Water Pumps OFF<br>Solenoid Valve CLOSE | Motor/Solenoid Valve in standby mode. |
| Sensor Soil Moisture < 50% | Water Pumps ON<br>Solenoid Valve OPEN | A motor/solenoid valve will allow water to flow to the plant. When the humidity level reaches 55% as desired, the motor/solenoid valve will stop the water irrigation |
| Blynk Mobile Apps | The interface displays parameters related to real-time data monitoring of water flow status, water/ nutrient delivery, and environmental temperature. | This system allows users to monitor and control various aspects of crop fertigation through a mobile application interface which means GSM will send messages to users via Blynk mobile. |

**Working Principles**

***Data Collection***

The sensor will monitor soil moisture and ambient temperature levels. The system will also show the temperature around the plant to control the plant from extreme temperatures. Users can use this system automatically by setting the timer and pressing the ON-OFF button on the Blynk mobile display.


**Figure 7< The Monitor Sensor >**

***Making Decisions***

The control unit will process the data of the soil moisture sensor to detect when to start irrigation and how much plain and fertilizer water will be used.

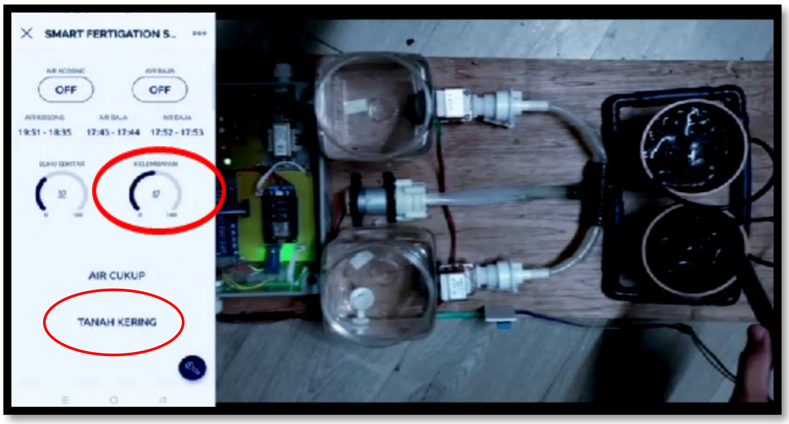


**Figure 8 < The Control Unit >**

As shown in the picture above, the sensor detects the condition of dry soil and soil moisture temperature of 47. Blynk display will be shown "**TANAH KERING**".

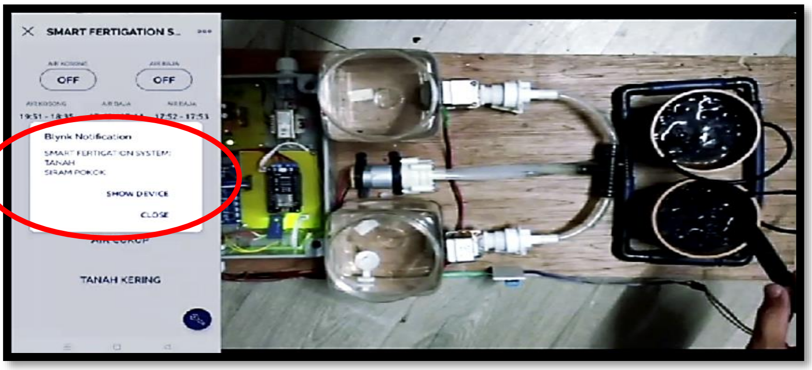


**Figure 9 <The Sensor Detects the Condition of Dry Soil and Soil Moisture Temperature>**

Then the user will get a Blynk notification such As "Smart Fertigation System: Tanah Siram Pokok”. This notification is important to inform the user of the current state of the plants while watering their plants.

***Irrigation and Fertilization***

By controlling the open/close solenoid valve, it can control the delivery time and amount of empty water and fertilizer water to meet the plant's nutrient needs according to a programmed schedule set by timer or by clicking the button ON-OFF on the Blynk display. This system allows efficient automatic irrigation and fertilizing to avoid over/under irrigation/fertilizing. The solenoid valve can control irrigation and fertilization well without waste.


**Figure 9 < Open/Close Solenoid Valve >**

As we can see in the picture above, the ON button is active to allow the irrigation of water to the plants and at the same time, the sensor will stop the solenoid valve when the soil moisture gets enough water.


**Figure 9 < The Desired Humidity Level >**

When reaching the desired humidity level, the solenoid valve will stop and the display on Blynk will show "AIR CUKUP" "TANAH LEMBAP". After irrigation, sensors will continue to monitor soil conditions and provide continuous feedback to the control unit to adjust future irrigation and fertigation cycles.

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For potential Enhancements, we can add additional sensors for light and sensors to control water pressure to further optimize growing conditions. Besides the collection and analysis of data over time can improve system efficiency and crop yield.

## Conclusion

This system is created to automate and enhance irrigation and fertilization activities. Users can check the plant's current condition and adjust settings using control and monitoring features to oversee soil conditions, irrigation schedules, soil moisture levels, and ambient temperature in fertigation systems. Various water conditions and schedules are employed to maximize plant growth and water efficiency. This system optimizes the use of water and fertilizer without any waste. Drip irrigation directly delivers water and nutrients to the roots to support the growth of plants. The system can work automatically using sensor feedback or manually with the Blynk mobile app.

## References

Nya, E. J., Okorie, N. U., & Eka, M. J. (2010). An economic analysis of Talinum triangulare (Jacq.) production/farming in Southern Nigeria. Trends in Agricultural Economics, 3(2), 79-93.

Na, L., Wang, X., Zhang, Y., Hu, X., & Ruan, J.. (2020). Fertigation management for sustainable precision agriculture based on Internet of Things. Journal of Cleaner Production, 277, 124119.

Piya, S., Kiminami, A., & Yagi, H. (2012). Comparing the technical efficiency of rice farms in urban and rural areas: a case study from Nepal. Trends in agricultural Economics, 5(2), 48-60.

Pibars, S., Gaballah, M., Mansour, H., & Khalil, S. (2022). "IoT Application in Agriculture: Monitoring Smart Fertigation Systems for Automated Fertilization." *Journal of Agricultural Engineering and Technology*, 15(3), 112–125.

Robin Blynk 2.0 | IOT Smart Plant Monitoring System | Smart Irrigation | NodeMCU Smart Irrigation ESP8266 from url: https://www.youtube.com/watch?v=dsWIgPRP8Ok&t=98

Shukla M., Sadhu, A. C., Chinchmalatpure, A. R., Prasad, I., Kumar, S., & Camus, D. (2018). Fertigation-Modern Technique of Fertilizer Application. Indian Farmer, 5(9), 1062-1071.