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IoT-based Plant Watering System

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Abstract

This work presents an IoT-based plant watering system using the Internet of Things (IoT) via the Nodemcu ESP32. The objectives are to design an automatic plant watering system with an ESP32 microcontroller and appropriate sensors, such as a soil moisture sensor and a humidity sensor, and integrate the Internet of Things (IoT) into the plant watering system so that the plant can grow optimally. Also, to evaluate the proposed system's effectiveness based on the plant's conditions on the eggplant. The scope of the study is focused on developing a prototype of an IoT-based intelligent plant watering system that detects the soil moisture level of plants on a small scale to automate the water supply and automatic liquid fertilizer. In this work, it requires Blynk application software on the smartphone and hardware implementation that can detect the condition of the plant by using the dht-11 sensor, pH sensor, and moisture level sensor. The findings of this paper are based on the experiments that were done, which show optimal conditions for plants. The Internet of Things (IoT)-based watering system continuously analyzes and reacts to a range of environmental aspects. At various times, the actions of the system are displayed. The second two experiments were between smart irrigation and normal irrigation. After 5 weeks, the results showed that smart irrigation surpassed normal irrigation. The conclusion of this paper is based on the objectives that all three objectives have already achieved.

1. Introduction

In Malaysia, many of people enjoy gardening as a hobby or pleasure as it is a wonderful opportunity for them to relax and take in the outdoors while also establishing a lovely and lively environment. Malaysia is a tropical nation with a warm, moist atmosphere that is perfect for growing a wide variety of plants including flowers, vegetables, fruits, herbs, and plants [1]. In Malaysia, gardening may be a fulfilling activity because it encourages creativity. A popular Malaysian small-scale gardening method.

The growth of the 21st century is significantly influenced by the Internet of Things (IoT) which is a network of all Internet-connected devices that can share data. It offers a platform for connecting these devices and allowing users to manage them using big data technologies, which can improve performance and reduce the need for human interaction in many areas of daily life. With the introduction of opensource Nodemcu ESP32 boards and moisture sensors, it is now possible to build gadgets that can both monitor the moisture of the soil and irrigate fields or landscapes as needed [2]. This work also uses three input sensors, to measure, monitor and track soil moisture, the Blynk platform's IoT is connected to mobile devices and tested on eggplant.

Eggplant is a summer vegetable that grows well in warm to hot temperatures. Therefore, it is the ideal condition throughout the year for eggplant farming in Malaysia. The most well-known regions for eggplant production in Malaysia, according to statistics from the Malaysian Ministry of Agriculture, are Pahang (331 ha), Johor (200 ha), Sarawak (188 ha), and Terengganu (132 ha). In Malaysia's producing areas, 1,540 hectares of eggplant were grown in 2015, producing an estimated 25,950 metric tons of produce worth RM51.8 million [3].

According to the search results, eggplants require soil moisture between 41% and 80% [4]. Eggplants root to about 2 feet deep and should not be subject to water stress, as stress during the bloom can cause substantial reduction in fruit set [5]. Therefore, it is recommended to keep adequate moisture in the deeper soil layers even when plants are small. When the soil moisture is below 50%, eggplants need to be watered [6]. It is important to note that irregular watering, either under or over, can cause tough, leathery fruit or root rot in eggplants.

The ideal range of temperatures for growth is between 21 and 30 °C, with a maximum of 35 °C and a low of 18 °C. 24-32 °C is the ideal soil temperature for seed germination [7]. Young plants are at risk of frost. Meanwhile, a soil pH between 5.5 and 7.5 is best [5].

2. Materials and Methods

All the sensors' connections are combined in this circuit diagram. Fig. 1 shows the schematic diagram of the system. Fig. 2 shows the process flowchart for an automatic mode of the system.

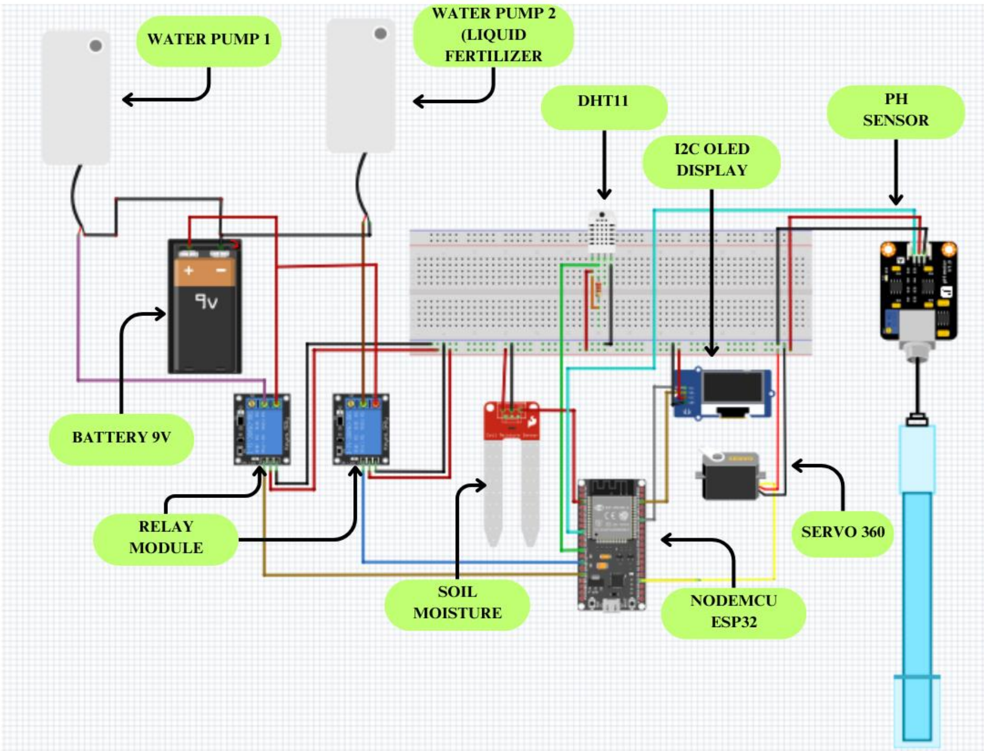

Fig. 1 *Circuit diagram of IoT based watering system*

3. Results and Discussion

3.1 Prototype Setup

The automatic watering plant system consists of NodeMCU ESP32, soil moisture sensor, temperature sensor, and pH sensor. The hardware and software are developed using IoT Blynk platform. The soil moisture sensor and temperature sensor are used as input to measure soil moisture levels and weather temperature, which are then fed into the NodeMCU ESP32 controller to water the plant automatically. Meanwhile, for pH sensor is then connected to the system to monitor the soil's acidity or alkalinity. It additionally involves turning on the water pump once every two weeks to automatically fertilize the plant using liquid fertilizer. Blynk application will send a notification to the user for monitoring purposes. Fig. 3 indicates the prototype of the system using PVC board and plastic materials.

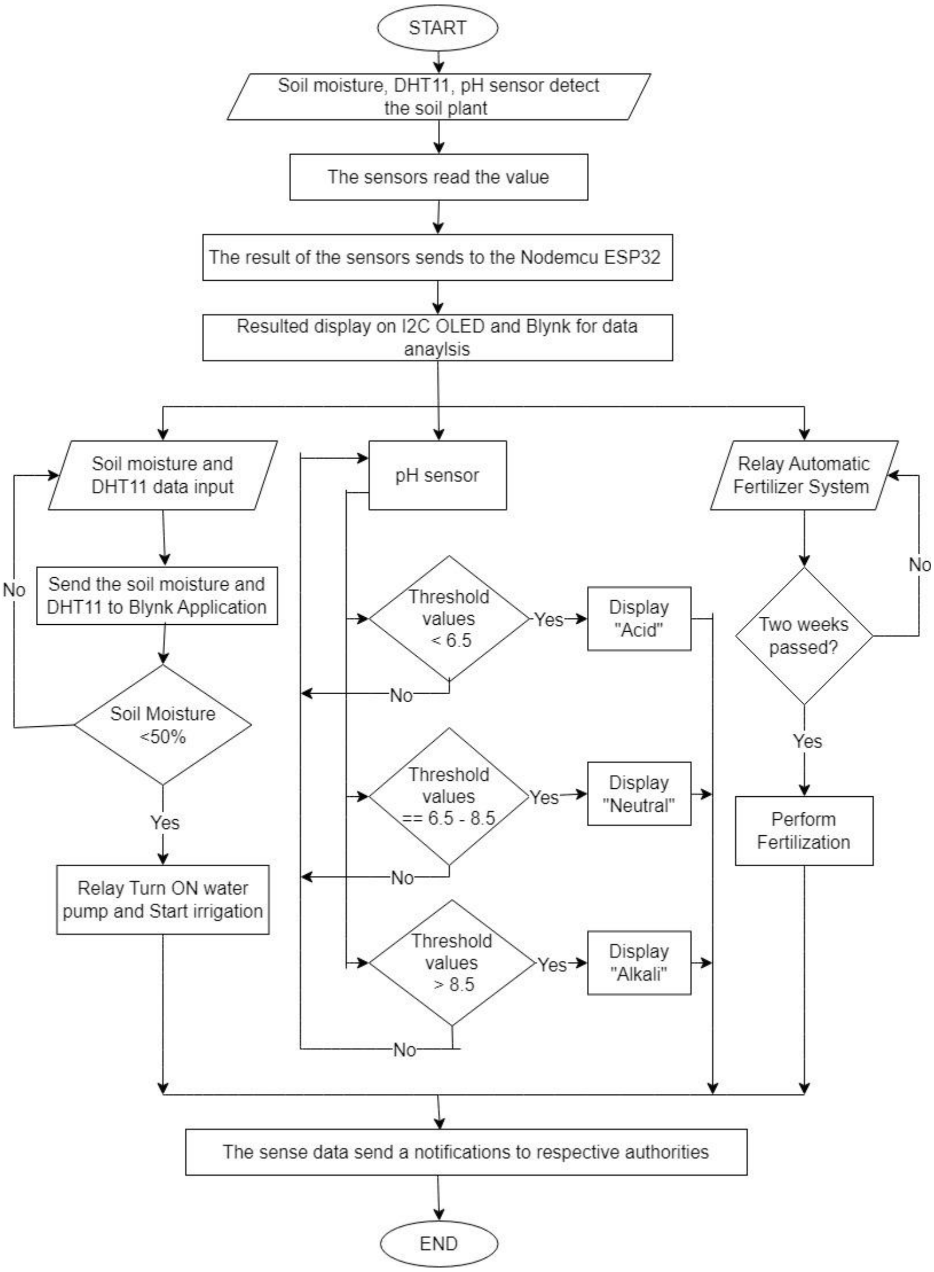

Fig. 2 *Process flowchart of IoT based watering system*

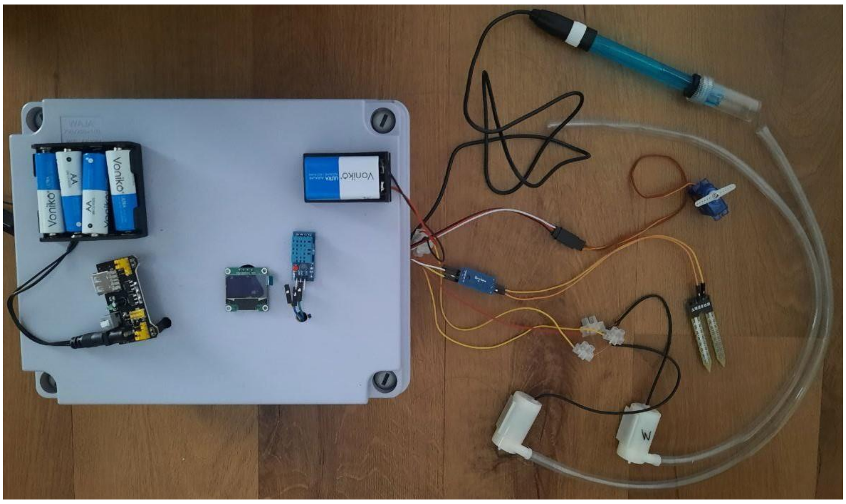

Fig. 3 *Prototype of IoT based Watering system*

3.2 Blynk System

The Blynk platform or domain will be used to construct the IoT application. This IoT application will be designed and developed to monitor and control the sensor temperature, humidity, pH and soil moisture level. The Wi-Fi module is utilized to connect the device and the application. Fig. 4 and Fig. 5 illustrate a layout of the mobile IoT application for a soil monitoring system. The profile was created in the Blynk application by using a mobile phone. There are 3-gauge meters for the humidity, pH and soil moisture level. Also, have a labeled valu for the temperature. The humidity meter reading varies from 0 to 100, soil moisture reading is in the range 0 – 100 % and pH reading is from 0 – 15 pH. The temperature meter reading varies from 0°C to 100°C. It is helpful and easy for the user to monitor the surrounding parameter.

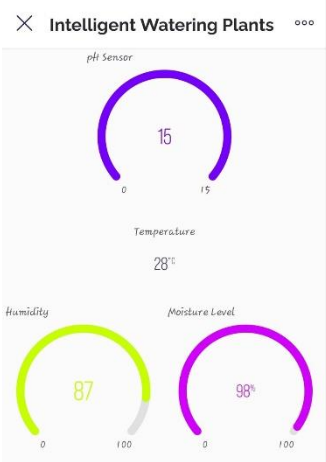

Fig. 4 *Blynk profile of the system*

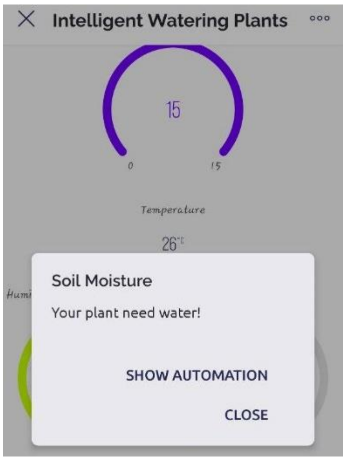

Fig. 5 *Notification that detect the soil moisture*

3.3 Data of Results

Table 1 shows the result of the Automatic Watering Plant system that contains the soil moisture, temperature, humidity and water pump status using Blynk App. The reading of soil moisture in the app will be in the range of 0 to 100. The app shows the water pump state, indicating whether it is on or off, to make interpretation easier for users. With the help of this integrated system, users can easily monitor and manage critical environmental parameters for the best possible care for their plants.

Table 1: The result automatic watering plant

Time	Input			Output
	Soil Moisture (%)	Temperature (°C)	Humidity (%)	Water Pump
8 AM	75	29	78	OFF
12 PM	45	31	73	ON
4 PM	50	30	74	ON
8 PM	98	28	80	OFF

Fig. 6 shows graph of soil moisture, temperature, and humidity changes daily, providing a comprehensive view of the plant environment. It helps caretakers make informed decisions about irrigation, temperature control, and environmental adjustments. The continuous monitoring ensures optimal conditions for plants, promoting a proactive approach to maintaining a healthy ecosystem. This visual representation helps caretakers discern patterns and correlations, enabling more effective management of the plant's health.

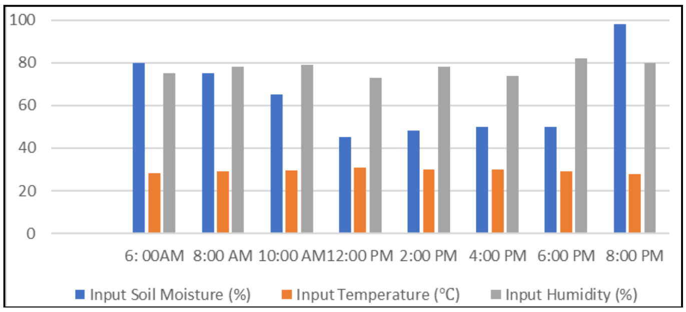

Fig. 6 *Sample data of monitoring the Blynk Application*

3.4 Comparison

The plant system's results from tests have been collected in terms of observations on plant growth using two different planting methods: manual watering and automatic watering. When using automatic watering planting techniques, plants grow more quickly than when using manual methods. This is because the automated systems can adjust to the surrounding environment, maximizing water utilization and fostering plant health. On the other hand, manual watering provides a greater understanding of each plant's specific needs and allows carers to have a hands-on, natural connection with plants. This allows carers to adjust watering schedules according to quick observations. Fig. 7 shows the comparison of plants week 1 until week 5.

WEEK 1 **WEEK 3** **WEEK 5**

Fig. 7 *The comparison of plants week 1 until week 5*

4. Conclusion

In conclusion, the development of a smart irrigation and fertilization solution has advanced greatly with the integration of an automatic liquid fertilizer supply system and an automatic plant watering system. The system that has been put into place effectively makes use of temperature, pH level and soil moisture sensors to keep an eye on and control environmental factors that are important to plant growth. By constantly controlling a water pump by soil moisture levels, the automatic watering plant part ensures that plants receive the ideal amount of moisture. When the moisture level drops below 185 degrees, the system sets a threshold that triggers the water pump. Users can see real-time information about this process on both the I2C OLED display and the Blynk application.

In addition, an automatic liquid fertilizer supply to the capabilities adds another level of system functionality. Liquid fertilizer may now be efficiently and instantly applied to plants by use of a fertilizer pump relay that is managed by the Node MCU. Plant health and growth are enhanced by scheduling methods that make sure fertilizer is applied at periods that refer to the plants' nutritional needs. The Blynk application functions as a central center for fertilization and watering process monitoring. Users gain from an easy-to-use interface that offers notifications and real-time updates, enabling them to make knowledgeable decisions about the management of their plants.

Essentially, this combined system shows how smart technologies may improve agricultural operations by providing a thorough and intelligent approach to plant care. In addition to making plant maintenance easier for users, automated fertilization and watering enable more effective and long-lasting plant growth. Based on the system that has been completed, certain improvements should be made to enhance the system's consistency in future works as follows.

- Add a Color Sensor to analyze leaf color for plant health and nutrient status monitoring.
- Use Bluetooth module for all users, especially those without Wi-Fi facilities.
- Use of a PCB board for circuit space saving and better organization of components.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nurul;* ***data collection:*** *Nurul;* ***analysis and interpretation of results:*** *Nurul;* ***draft manuscript preparation:*** *Nurul and Rosli. All authors reviewed the results and approved the final version of the manuscript.*

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