SMART FERTIGATION SYSTEM USING NODEMCU ESP8266

Dr.V S Sandeep Kumar Reddy, Mr.S.Midhun ,Mr V.Likhith,Mr .Dileep, Mr.M.Rajesh, Mr.Tanshiq

Department of ElectricalEngineering,Assistant Professor,ANITSVisakhapatnam, India
Department of Electrical Engineering, B.tech final year,ANITS Visakhapatnam,India
Department of Electrical Engineering, B.tech final year,ANITS Visakhapatnam,India
Department of Electrical Engineering, B.tech final year,ANITS Visakhapatnam,India
Department of Electrical Engineering, B.tech final year,ANITS Visakhapatnam,India
Department of Electrical Engineering, B.tech final year,ANITS Visakhapatnam,India

Abstract

This paper introduces an Automated Fertigation System, which is designed and implemented using the NodeMCU microcontroller. The system incorporates an automatic mixing mechanism controlled by the NodeMCU, facilitating the precise blending of fertilizers with water based on soil moisture levels detected by a sensor. This project is classified into two main parts. The first part focuses on maintaining the optimal moisture level in the soil. A soil moisture sensor is utilized to detect the moisture content in the soil. The sensor's output is then transmitted to the NodeMCU ESP8266 microcontroller, which determines whether additional water needs to be pumped. The second part involves designing a control system for the mixing and delivery of fertilizers. Utilizing the built-in Wi-Fi capabilities of the NodeMCU ESP8266, the project facilitates wireless communication with the Ubidots application, enabling real-time monitoring and storage of moisture sensor data. This showcases the capabilities of IoT technology in agriculture. When the smart fertigation system is implemented, it enhances water and fertilizer utilization efficiencies, resulting in savings of labor, capital, time, and energy, while also increasing production and productivity.

1. Introduction

Farmers rely on the accessibility of essential nutrients and water to ensure the high productivity of their crops. These two fundamental aspects are essential for the development of plants, and without them, crops will not thrive. However, simply providing plants with water and nutrients is not enough to guarantee their optimal growth. Farmers need to ensure that the plants are receiving the correct balance of nutrients and water to achieve optimal plant life and optimal water usage. A technique thatfarmers can employ to achieve this balance is fertigation. It is a method where receive precise amounts of water and nutrients at specific stages of their growth. Fertigation involves feeding crops with water that has been mixed with a soluble nutrient solution, using an automatic fertigation system. By utilizing this technique, farmers can guarantee that their crops are receiving the right amount of nutrients and water with perfect timing, which leads to better crop yields and higherquality produce [1][3].

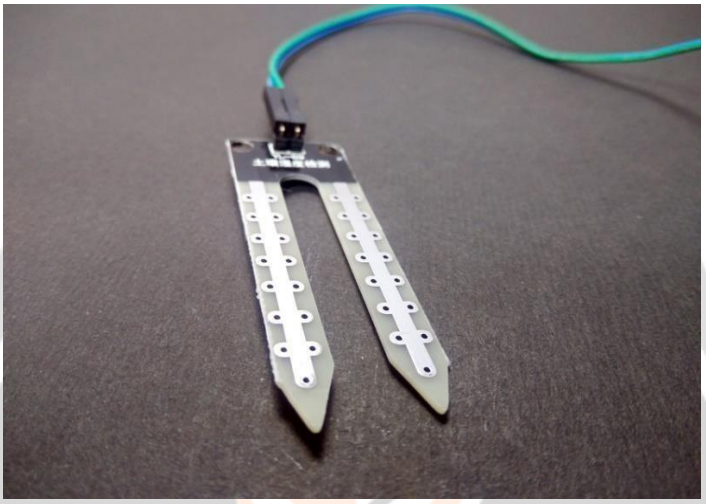
The key to successful fertigation is maintaining the correct balance between nutrients and water. Too much of either element can be harmful to the plants, and leads to stunted growth or even death. Farmers need to carefully monitor the nutrient levels in the water, and adjust the system as necessary to guarantee that the plants are receiving the correct amount of each element [2]. Farmers can contribute to the health, strength, and productivity of their plants by making sure they are receiving the right nutrition for their crops.

This system typically involves the use of specialized equipment, such as pumps, valves, and sensors, controlled by a central unit or microcontroller. The microcontroller regulates the timing and quantity of fertilizer and water delivery based on preset parameters or real-time feedback from sensors measuring soil moisture, and other relevant factors. This exact control makes it possible for the targeted and efficient provision of nutrients to crops at every stage of development [1]. The efficiency of fertilizer mixtures on plants is often assessed through the quantity of water present in the soil. Pumping excess water in irrigation poses several problems. Firstly, it leads to water wastage, depleting precious water resources. Additionally, it can cause soil erosion by saturating the ground, leading to the loss of fertile topsoil [4]. Over-irrigation also increases the risk of waterlogging, depriving plant roots of oxygen and potentially causing root rot. Too much water can remove vital nutrients from the soil, leading to nutrient leaching and reducing soil fertility. To achieve this, an automated fertigation system is considered a potential solution

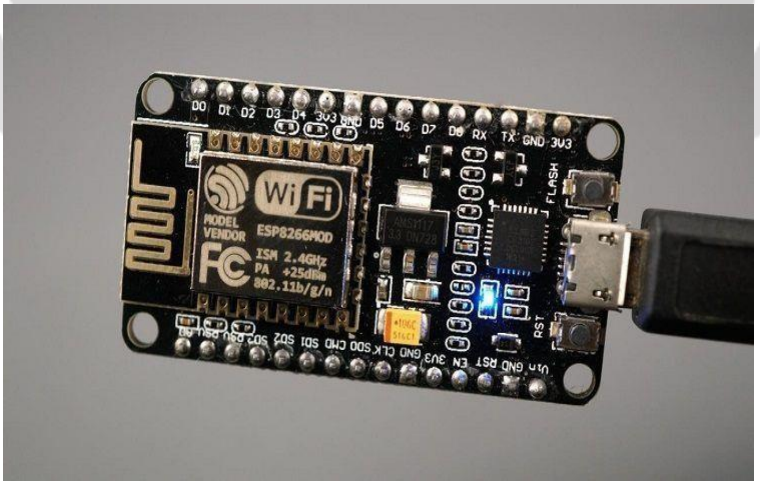
2. Components:

The fertigation system comprises several essential components designed to automate the nutrientdelivery process and ensure optimal plant growth. Key components include a 4-channel relay, motor, solenoid valves, moisture sensor, and NodeMCU microcontroller. Each component has a significant part in the system's functionality, from controlling the delivery of water and nutrients to monitoring soilmoisture levels.

Moisture sensor: The moisture sensor measures the moisture content of the ground. The sensor helpsin maintaining the ideal soil moisture content for the growth of plants. This sensor provides voltage output based on the soil's conductivity, which varies with moisture levels [5][6]. It provides feedback tothe NodeMCU microcontroller, which then determines whether additional water is required for irrigation.



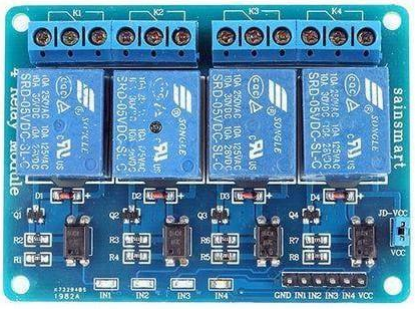
NodeMCU ESP8266: The NodeMCU ESP8266 microcontroller serves as the brain of the fertigation system. It receives data from the moisture sensor, processes it, and controls the operation of the motor and solenoid valves through the relay. The integrated Wi-Fi feature establish wireless connectivity with the Ubidots application [8]. This allows for seamless communication, enabling real-time monitoring and storage of data collected from the moisture sensor.



Motor: The motor is responsible for driving the mechanism that mixes the fertilizer and water. It is controlled by the relay and operates based on signals received from the NodeMCU microcontroller.

Solenoid valves: Solenoid valve is an electromechanical devices that regulate the flow of liquids or gases. [7] In the fertigation system, solenoid valves are used to regulate the flow of water and fertilizer mixture to the irrigation system. They are controlled by the relay and activated based on the moisture sensor readings.

4-channel relay: A relay is an electromechanical switch that is used to manage the flow of electricityto other devices. In this fertigation system, the 4-channel relay is used to manage various operations such as turning the motor on or off and opening or closing the solenoid valves.



3. Methodology Hardware Integration:

Begin by setting up all the necessary components for the fertigation system, including the NodeMCU, 4-channel relay, motor, solenoid valves, and moisture sensor. Connect the components together according to the system design. Ensure proper wiring and connections to allow for seamless communication and operation. The system that we are using for our plant fertigation process is expertly controlled by a node mcu [esp8266], which is a small and powerful microcontroller. This system is made up of two containers, one holding water and the other fertilizer. A 4-channel relay controls the solenoid valves that are attached to the containers. A moisture sensor is also included, and it measures the amount of moisture in the plant soil.

The system operates based on soil moisture levels found by the moisture sensor. When it detects that the plant soil is not moist enough, the system activates the motor and initiates the fertigation process. The motor in the system helps to mix the water and fertilizer in the containers, and the relay controls the flow of the liquid to the plants. When the moisture sensor detects that the soil is lacking in moisture, it automatically turns on the motor and the fertigation process begins. This ensures that theplants receive the correct quantity of water and nutrients at the right time, without any manual intervention.

The use of the node mcu [esp8266] microcontroller provides several benefits to this system. It allowsus to remotely monitor the moisture levels of the plants, and adjust the irrigation process accordingly.This means that we can ensure that our plants are always receiving the ideal amount of water and fertilizer, without any wastage or manual intervention.

Programming and Wireless Communication Setup:

Develop the firmware for the NodeMCU using suitable programming language. Here in our project we used c++ . Write code to control the operation of the motor, relay, and solenoid valves based on input from the moisture sensor. Configure the NodeMCU's Wi-Fi capabilities to establish communication with the Ubidots application. Set up the necessary protocols and credentials for data transmission.

To successfully implement our project, we needed to develop the firmware for the NodeMCU. This involved using a suitable programming language, and in our case, we opted for c++. With this language, we were able to write code that would control the operation of the motor, relay, and solenoid valves based on input from the moisture sensor.

In addition, the code now includes a timing function that allows the fertigation process to happen ona regular basis. This indicates that, based on the particular needs of the plants, the fertilizer and watermixture is applied at regular intervals. By doing this, the plants are better equipped to grow and develop because they can absorb the nutrients more effectively and efficiently.

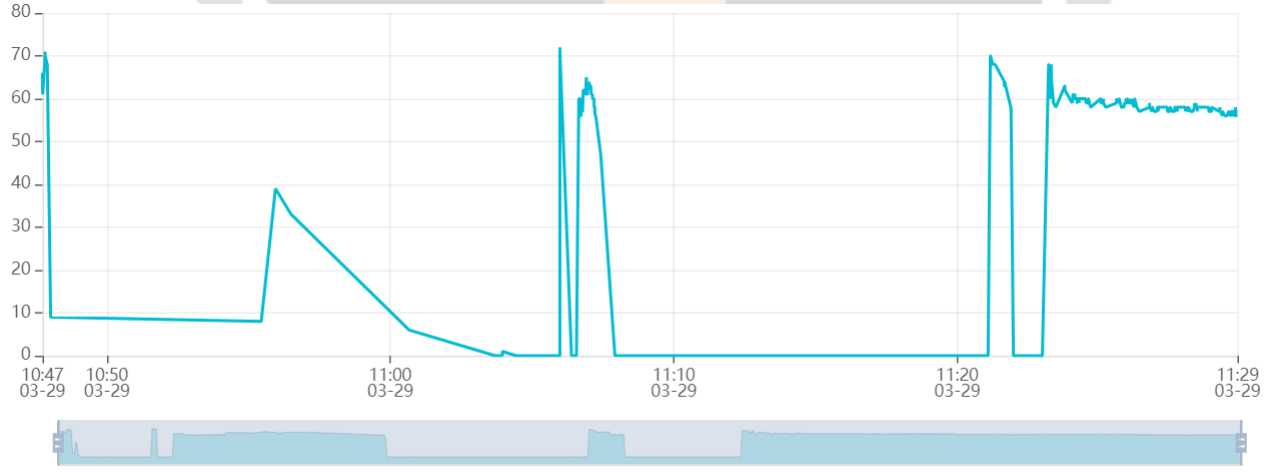
Furthermore, the timing function also helps to conserve water and fertilizer by ensuring that they are not wasted or overused. This is particularly important for farmers and gardeners who need to be mindful of their resource usage and costs. With fertigation and a well-planned timing function, they can achieve the best possible results while minimizing their environmental impact and expenses.

One of the critical aspects of our project was establishing communication between the NodeMCUand the Ubidots application. To achieve this, we had to configure the Wi-Fi capabilities of the NodeMCU. This allowed us to connect to the internet and establish a reliable and secure connection with the Ubidots application.

Once we had established connectivity, we needed to set up the necessary protocols and credentialsfor data transmission. This involved creating a unique identifier for our device, which would allow usto identify and authenticate our Untitled 7 NodeMCU with the Ubidots application. We also had to set up the appropriate communication protocols, which ensured that our data transmissions were secure.

4. Results and discussions

The machine immediately enters auto mode when it is powered on. The sensor for soil moisture initially gathers information from the soil. The results are then communicated to the NodeMCU. The NodeMCU compares the received values with predefined thresholds. If the values deviate significantly, indicating a need for fertigation, the system activates the fertigation process. Additionally, a timing function implemented in the code ensures that fertigation occurs periodically. Once fertigation is completed, the measured data is sent to the Ubidots application for monitoring and analysis.



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5. Conclusions and future scope

The conventional techniques for fertilizing and irrigating crops are expensive and frequently imprecise, which results in lower yields and fertilizer losses. Furthermore, over time, these methods might have a negative impact on the condition of the soil. In order to overcome these obstacles and enhance the precision and efficiency of the fertilization and irrigation procedures, an automated fertigation system has been suggested. This technique conserves water, lowers energy use, saves money and time, and avoids over fertilization. Furthermore, it is simple to program to adjust to different climates. The parts needed for this system are all easily found and reasonably priced in the neighborhood market. This paper proposes the use of this concept as a substitute for conventional farming practices. The system can be expanded to cover larger areas by dividing the land into smaller sectors.

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