

From Sensors to Smartphones: Evaluating the Blynk IoT Smart Plant Monitoring System for Modern Gardening

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Abstract

In our technologically advanced era, where automation permeates every aspect of our lives, even plants have been transformed into smart entities. This article explores the integration of various technical components to imbue plants with self-maintenance capabilities, eliminating the need for human intervention. The system discussed herein regulates moisture levels and temperature within plants, ensuring optimal growing conditions. It incorporates alerts to notify users of deviations from preset parameters and activates a water pump for irrigation when necessary. To improve security and surveillance, the device also has motion detection capabilities. Key components include an ESP8266 Node MCU board, DHT11 temperature and humidity sensor, soil moisture sensor, PIR motion sensor, 18650 battery, relay module, and water pump. The system's functionality is accessible and controllable via the Blynk Application, providing users with a user-friendly graphical interface for seamless interaction. The primary element of this idea is an agricultural system powered by water that eliminates the need for soil. This hydroponic automated system provides water and nutrients to the crops in response to input from sensors, including temperature and humidity monitors and electrical routes for physical occurrences.

Keywords: Node MCU, ESP8266, plant monitor, Blynk IoT, soil moisture, water pump

INTRODUCTION

Most Indians rely on agriculture, which is the foundation of our nation. Water scarcity is the primary problem facing agriculture. Water is squandered because the available resources are not used effectively. For the most part, agricultural practices still struggle with proper irrigation. A poor water

supply can have an impact on crops as well as the soil. To solve this issue, a workable monitoring or controlling system can be quite helpful. Worldwide, agriculture has a significant impact on the growth of agricultural nations. Agriculture-related issues have traditionally stood in the way of the country's advancement. This issue can be resolved by implementing smart agriculture and updating the current conventional farming practices. Therefore, the project's goal is to use Node MCU and IoT technologies to construct a hydroponic system. This project's main feature is a water-driven agricultural system that will do away with the requirement for soil. The crops in this hydroponic automated system are supplied with water and nutrients based on input from sensors such as humidity and temperature measurements and electrical pathways for physical phenomena.

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AIM

An Internet of Things (IoT)-based smart plant monitoring system uses data analytics, connectivity, and sensors to help users manage plant care more efficiently. The technology can track plant health, keep an eye on a variety of environmental factors, and even automate certain parts of plant maintenance.

Objective

1. *Optimizing plant health*: The primary aim is to enhance plant health and growth by providing real-time monitoring and actionable insights into environmental conditions.
2. *Remote monitoring*: Enable users to remotely monitor their plants' health and environmental conditions from anywhere using a mobile app or a web interface.
3. *Data collection and analysis*: Gather information on a range of environmental factors, including nutrient levels, light intensity, temperature, humidity, and soil moisture. Analyze this data to gain insights into plant requirements and growth patterns.
4. *Automation and control*: Implement automation to regulate environmental conditions based on preset thresholds or user-defined preferences. One such example would be to water the plants automatically when the soil moisture content falls below a predetermined level.
5. *Alerts and notifications*: Provide timely alerts and notifications to users about any deviations from optimal environmental conditions or potential issues such as pest infestations or diseases.
6. *Energy efficiency*: Design the system to be energy-efficient, utilizing low-power sensors and devices to minimize energy consumption and prolong battery life.
7. *Scalability and flexibility*: Ensure that the system is scalable to accommodate varying plant types and sizes, as well as flexible enough to adapt to different environments and user preferences.
8. *Integration and compatibility*: Ensure compatibility with existing smart home ecosystems and IoT platforms to facilitate seamless integration with other smart devices and services.
9. *User experience*: Prioritize user experience by designing an intuitive interface for easy setup, configuration, and interaction with the system.
10. *Research and development*: Encourage ongoing research and development to improve the system's functionality, accuracy, and efficiency based on feedback from users and advancements in technology.

Problem Statement

Consistent attention to a variety of elements, including soil moisture, temperature, humidity, sun exposure, and more, is necessary for proper plant care and monitoring. This can be a difficult undertaking for people who are not experienced in horticulture, farmers, or busy people. Manual monitoring takes a lot of time and is prone to human error, which can result in less-than-ideal plant development or, in extreme situations, plant death. Furthermore, watering plants too much or too little might waste resources and damage the ecosystem. Ineffective plant care and irrigation can have major financial effects for larger companies. An automated system is therefore required to guarantee that plants receive the best care possible while reducing resource waste.

OBSTACLES AND THINGS TO THINK ABOUT

- *Sensor accuracy*: For efficient monitoring, it is essential that the sensors deliver precise and trustworthy data.
- *Network connectivity*: Remote control and real-time data transfer require reliable internet access.
- *Power supply*: If the system is to be used in an outside or remote area, it needs a dependable power source.
- *Environmental factors*: It is important to shield sensors and microcontrollers from elements such as precipitation, high temperatures, and physical harm.

Background

Plant maintenance, whether in backyard gardens, farm fields, or urban green areas, is more crucial than ever in a time when environmental awareness and sustainable practices are becoming more

popular. Conventional plant care techniques mostly rely on manual observation and intervention, which can result in inefficiencies and a delay in addressing problems related to the health of the plants. Insufficient maintenance can lead to decreased plant health, higher water use, and even crop failure, which can affect both individual health and larger agricultural results.

LITERATURE SURVEY

The fundamental and important concepts surrounding the IoT and its future possibilities are discussed by Kolhe et al. They looked at the necessity of IoT for many applications in daily life and provided a brief overview of the technology. IoT makes a substantial contribution to innovative farming techniques. Thus, they use an automatic watering system to demonstrate IOT. An automatic irrigation system keeps track of and regulates the soil's estimated moisture content. The microcontroller utilized to create the control unit is an Arduino UNO. Three sensors—temperature, moisture, and humidity—are used by the system to approximate the soil's moisture content, temperature, and humidity. This number helps the system determine how much water to utilize, avoiding over- or under-irrigation [1].

Using a variety of sensors, Pawar et al. proposed a system that would record every detail about the temperature and soil. IoT enables remote sensing and control of items via network infrastructure. The end product decreases human intervention while increasing accuracy, economic benefits, and efficiency. In addition to discussing important and fundamental concepts about the IoT and its possible uses, they also looked at how essential the technology is to many aspects of daily life and gave an overview of the field. IoT makes a substantial contribution to innovative farming practices. They used an automated watering system to illustrate IoT. An automatic irrigation system keeps track of and regulates the soil's estimated moisture content [2].

R. Suresh et al. (2014) discussed the use of an automatic microcontroller-based rain gun irrigation system in [3], which only irrigates when there is a high demand for water, hence conserving a significant amount of water. These solutions alter the way field resource management is done. They created the Android software stack, which consists of an operating system, middleware, and essential apps for devices. The Java programming language can be used to start creating applications on the Android platform with the help of the Android SDK's tools and APIs. As they meet so many of our demands, mobile phones have practically taken over as a necessary component of our lives. This program uses a mobile phone's GPRS functionality to solve irrigation control system problems.

Srishti Rawal suggested an automated irrigation system that monitors and maintains the proper soil moisture content through automated watering. The ATMEGA328P microcontroller, which is part of the Arduino Uno platform, is used to create the control unit. Soil moisture sensors were utilized in the setup to precisely measure the soil's moisture content. By assisting the system in using the appropriate amount of water, this number helps to avoid over- or under-irrigation. Using IOT, farmers can be updated on the state of their sprinklers. A farmer can use the GSM-GPRS SIM900A modem to obtain data from the sensors, which is updated on a webpage regularly, and use that data to determine whether the water sprinklers are on or off at any particular time. Additionally, a Thing talk channel receives the sensor values, which are then used to create graphs for analysis [4].

The work that Karuppusamy has presented is intended to regulate specific applications that are situated far from the control station. For the operations, the design makes use of the Blynk server and the internet. The electrical equipment is kept close to a sensor-based monitoring station that transmits the application system's status [5]. In Jayam's project, IoT is used to send different sensor information to the cloud via NodeMCU. The cloud receives the sensor value. ThingSpeak is used to monitor and control sensor data. The Blynk app can be used to examine and control the system. When the moisture content of the soil falls below a certain threshold, a DC motor tap is utilized to provide water to the plant. The system was deployed in the field and produced the intended outcomes. IoT was successfully

used to automate the motor pump [6]. According to Shibani et al. [7], the two primary goals are to use sensors and the IoT to monitor the needs of the plants and to assess the data gathered by Blynk to categorize the plants as healthy or unwell. Data is collected via sensors and then sent to the Blynk application. Only when the moisture content drops below a certain level does the automatic water controller turn on. They compare the results of support vector machines, random forests, and logistic regression for classification [7]. The system that Nehra et al. proposed is based on an algorithm that considers sensed data in addition to the parameters that were already specified. The complete system has been developed and implemented on a pilot basis. It wirelessly gathers sensor node data via the cloud using web services, and using an information visualization and decision support system that is accessible via the online and mobile platforms, it delivers real-time insights based on sensor analysis. The investigation showed distinct disparities in the short- and long-term effects of the monitored and unmonitored environments on plant health. The graphs aid in the visualization of the variations in the environment at specific periods of time [8]. This technology can be combined with other technologies in the future to forecast rainfall, regulate pH levels, and protect the massive amounts of data that sensors gather and store on the cloud. This would increase the system's long-term sustainability and increase its level of autonomy from human intervention.

Using sensor technology and a Raspberry Pi, Ramalingam's proposed IoT technology monitors temperature, humidity, and the amount of CO₂ generated during industrial processes. Every procedure will have its own system for tracking and managing data. The gadget was installed via a mobile application for the BLYNK native server, which can display real-time updates on the degree of environmental pollution in remote areas or industries. The idea of IOT facilitates knowledge access from far-off places. The primary goal of the implementation effort was to create a real-time, fully machine-controlled management system that takes advantage of IoT [9].

To monitor plant conditions, Absar et al. presented an intelligent system built on the IoT that remotely gives users data on temperature, humidity, and soil moisture intensity [10].

By utilizing Node MCU, Kumar et al. sought to automate plant monitoring and watering systems. Sensors are employed to track the crop's environmental conditions, and the crop's outputs are downloaded to the cloud and displayed on an Android-based mobile application [11].

Ahmad et al. aim to apply artificial intelligence applications to automate smart gardening and plant monitoring to decrease human labor and improve system performance with minimal user interaction. Three plant input factors—temperature, humidity, and soil moisture—are controlled and tracked via smartphone apps and the IoT. Data from the sensors is communicated to the mobile application using Node-MCU ESP32 via Blynk and ThingSpeak [12].

Rajput et al. invented a computerized farming device that can save farmers' strength, money, and time. The early irrigation methods required several labor-intensive manual steps. The automated farming technique has reduced the amount of human intervention [13]. Aziz et al.'s paper examined the virtues and cons of a number of irrigation systems, with a particular focus on how the type of microcontroller and sensors used affects design complexity and cost [14].

Block Diagram

A block diagram of the proposed system is shown in Figure 1.

EXPLANATION

The suggested system's block diagram is shown in Figure 1. Every sensor is linked to the Node MCU, and the power supply is connected to the DC pump and relay module. Here, the power supply serves as the battery. Viewing the output is possible using the Blynk app. This software is used to monitor and manage our hardware project as well as display the parameters on the web dashboard of the Blynk app.

The circuit diagram is displayed in Figure 2 below. Below is an explanation of the circuit connections. We use D3, D2, D5, and A0 in the node MCU in addition to VCC and GND pins. The DTH11 sensor is made up of three pins: supply and ground are connected to VCC and GND, respectively, while the data pin is attached to the MCU's D3 pin. The remaining two pins of the soil moisture sensor are linked to ground and supply, respectively. LED negative is grounded, and LED positive is linked to D2. The supply and ground pins of the relay module are linked to VCC and GND, respectively, while the data pin is connected to D5. A DC motor depends on the battery is attached to the relay module. DC motor depends on the battery and relay to function. The user software stored in flash memory is activated and the outputs are displayed when we supply 5V or 9V power to the Node MCU. We solve the issues related to soil moisture based on the information that is shown, and we then enhance soil moisture by providing the right amount of water to the plant via a motor. Subsequently, we naturally increase plant growth and decrease water waste.

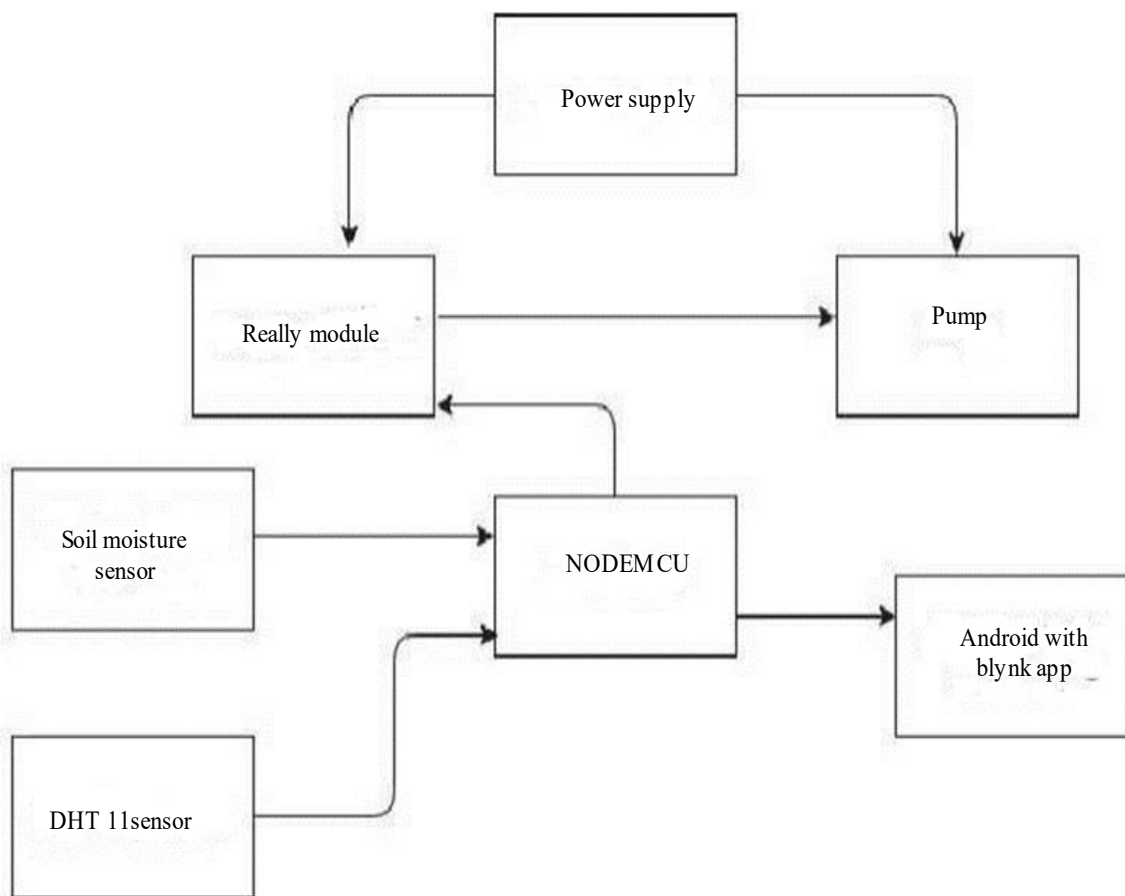


Figure 1. Block diagram Blynk IoT based smart plant monitoring system.

Section of Control

The Arduino board receives information from the sensors. The ATMEGA328P microcontroller, which is part of the Arduino board, is in charge of turning on and off the motor that water sprinklers can be mounted to. Arduino sensor values are sent to the GSM-GPRS SIM900A modem. This modem accepts a SIM card with a 3G data pack, which gives the system access to IOT functions. IOT section values are subsequently communicated via the modem.

The SIM900A GSM modem is a plug-and-play, quad band GSM modem with great flexibility that may be easily integrated with RS232 applications. Among the functions it supports are voice, SMS, Data/Fax, GPRS, and an integrated TCP/IP stack. Its features include voice, SMS, Data/Fax, GPRS,

and an established TCP/IP stack. The GSM modem's rx and tx are linked to the Arduino's tx and rx pins, respectively.

WORKING PRINCIPLE

The IoT makes it possible to create a smart plant monitoring system. Numerous parameters, including soil moisture, air temperature, and humidity, are used to track plant growth. NodeMCU may be used to retrieve all sensor readings. It is analogous to the digital pin in the NodeMCU. A resistive soil moisture sensor is connected to the NodeMCU's analog pin in our experiment. The NodeMCU's integrated Wi-Fi module allows sensor data to be sent to cloud services. Blynk IOT is the platform used by the cloud server. A connection between the NodeMCU and the Blynk IOT server will be made using the Blynk Template.

Users can compare various sensor data sets, plot the data, and carry out other operations on it using Blynk IOT. They can also analyze and process the data according to their needs. Moreover, the mobile Arduino IOT cloud application receives the sensor data.

The NodeMCU interfaces with the Arduino IOT cloud mobile program using the Auth token generated by the Arduino IOT cloud-based application. The user can monitor the various sensor readings in real-time from anywhere in the world. The user can switch the water pumping motor system. This was also achieved by giving the right syntax code and header file specifications for the various sensors on the NodeMCU. Once a program has been loaded into the NodeMCU and it is connected to any Wi-Fi, the data quantities are instantly sent to the cloud mobile applications for Blynk IOT and Arduino IOT. If the user has an internet connection, he can view this data right away.

Hardware Description

Node-MCU ESP8266

Development board configurations are accessible for the open-source firmware Node-MCU. The standard prototyping equipment consists of a circuit board that functions as a dual in-line package and combines a USB controller with a small surface-mounted board carrying the MCU and antenna.

Soil Moisture Sensor

Soil moisture instruments determine the volumetric amount of water subsequently by using another characteristic of the soil, such as the resistance to electricity, dielectric value, or relationship to neutrons, as a proxy for water present. This is because removing, drying, and weighing a sample is required for the direct gravimeter measurement of free-soil moisture. Soil moisture meters determine the amount of water per unit volume subsequently by using another characteristic of the soil, such as the resistance to electricity, dielectric value, or association with neutrons, which is a proxy for water present. Free soil moisture measurement requires eliminating, drying, and considering a sample.

DHT11 Temperature Sensor

This entry-level, affordable digital temperature and humidity sensor is DHT11. It uses a capacitive humidity sensor and thermistor to measure the ambient air quality before sending a digital signal on the data pin (analogue input pins are not needed). Time is critical to capturing data, despite its ease of use.

Relay Module

A relay is a motorized device that opens or closes a switch's contacts by use of the flow of electricity. The single-channel relay device is much more than just a basic relay; it has components that help with switching and connection in addition to indicators that show whether the relay is working and whether the module is powered.

Water Pump

This little, inexpensive submersible pump runs on DC 5V and is noiseless. It has an extremely low current consumption range of 300mA to 1A maximum, and it can hold up to 150 liters per hour. Water

is drained through the pump's input and discharged through the output utilizing the water suction way of operation. Water is drained through the pump's input and discharged through the output utilizing the water suction way of operation.

Software Description

Arduino IDE

The Arduino Integrated Development Environment (IDE), also referred to as the Arduino Software (IDE), consists of multiple menus, a message section, a text console, a toolbar with buttons for frequently performed activities, and a text editor for writing code. It communicates to the Arduino and Genuino hardware to upload applications and interact with it.

BLYNK App

The open source Blynk software for Android makes it simple to create IoT applications in only five minutes. It is compatible with ESP8266, ESP32, Arduino, Raspberry Pi, and more. These micro-controllers can be managed via the internet by using a smartphone. BLE and Bluetooth are also supported. Blynk is an IoT platform made to store, display, and visualize sensor data in addition to enabling remote hardware control.

It is made up of three primary parts

1. *Blynk software*: This iOS and Android software lets users use different widgets to build unique interfaces for their projects.
2. *The Blynk*: Server manages all communication between the smartphone and hardware. Either locally or in the cloud, it can be hosted.
3. *Blynk libraries*: These handle all incoming and outgoing commands and allow communication with the server.

ARCHITECTURE OF THE SYSTEM

In order to enable smooth communication and data sharing, hardware and software components are integrated into the system architecture. This is how it usually operates:

- *Data collection*: Sensors gather information from the surrounding environment, including temperature, light levels, and soil moisture.
- *Data transmission*: Using Wi-Fi or other connection protocols, the microcontroller processes the sensor data and sends it to the Blynk server.
- *Data visualization and alerts*: A user-friendly interface presents the data in the Blynk app. Different parameters have thresholds that users can set to get notifications if any values exceed the intended range.
- *Automation*: Automated activities, such as turning on irrigation systems or modifying grow lights to ensure ideal growing conditions for plants, can be initiated based on the sensor data. A flow chart of the system is shown in Figure 3.

Prototype Assembly and Working

- The three sensors' input modules (moisture, DHT22) begin to function when the power supply is turned on, as shown in Figure 2.
- Sensors that are turned on will read information gathered from the surrounding terrain and soil.
- A power source will turn on or off corresponding to the readings that the sensors determine.
- The motor turns on if the moisture level falls below the threshold.
- The motor and drinking water supply will both shut down if the water content level is too high.
- The sensor's ultrasonic sound will also have identified a low water level in the reservoir.
- All of the sensor data is sent to the ThingSpeak cloud server using an ESP8266 Wi-Fi module, and then it is stored in an online database (Firebase) using a dummy server.
- The information received by the WI-FI module will be graphed by Thing Speak.
- After that, the Android app will display all of the information.
- An Android app makes it simple for the user to manually operate the motor.

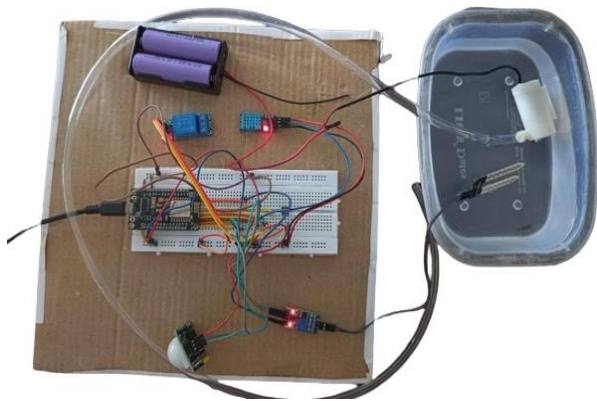


Figure 2. Prototype of the proposed system.

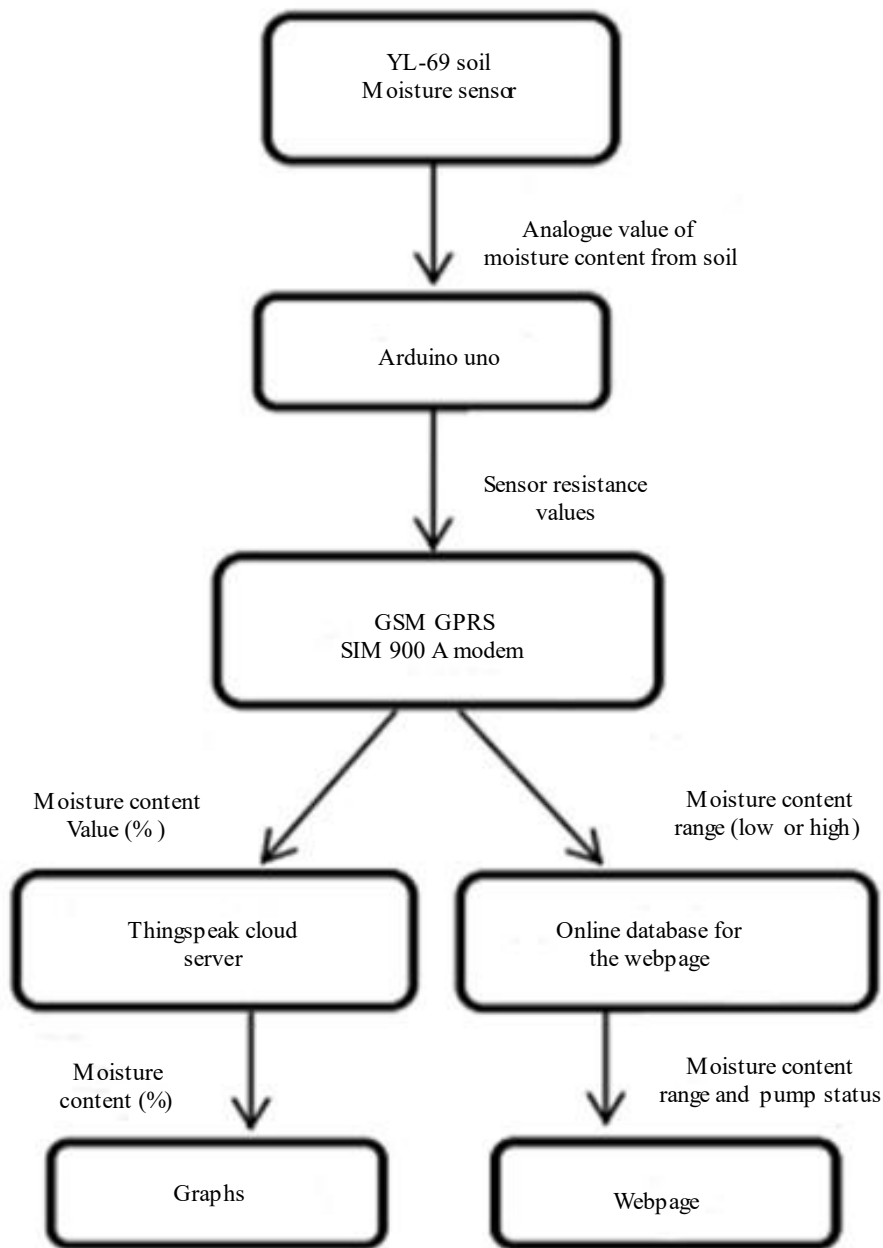


Figure 3. Flow chart of the system.

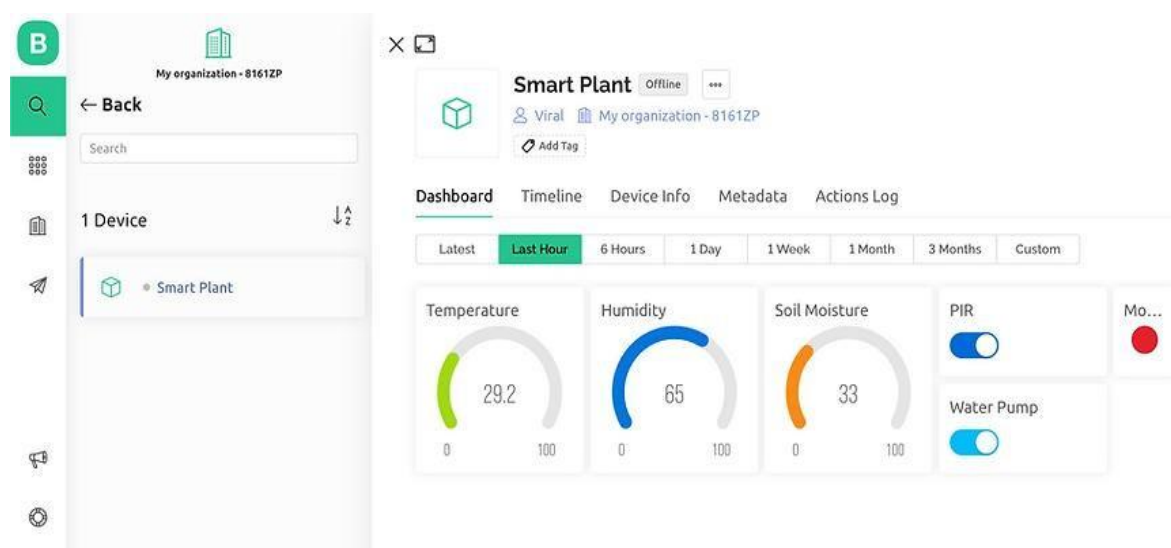


Figure 4. Result window.

RESULTS

Output window is shown in Figure 4.

CONCLUSION

In conclusion, the incorporation of DHT11 temperature and humidity sensors alongside soil moisture sensors into a smart plant monitoring system yields manifold benefits for plant care optimization. This integration furnishes plant owners with precise, up-to-the-minute environmental data essential for fostering robust plant growth and vitality.

Moreover, the potential of the smart plant monitoring system extends beyond mere sensor integration. Through the addition of features such as data logging, notifications, and remote access, users gain invaluable tools for comprehensive plant management. Historical data analysis empowers users with insights into long-term trends, facilitating informed decision-making. Timely notifications serve as a proactive measure, alerting users to critical events and enabling prompt intervention. Meanwhile, remote access offers unparalleled convenience and peace of mind, affording plant owners the ability to oversee and adjust plant conditions remotely, regardless of their location.

In essence, the amalgamation of DHT11 temperature and humidity sensors and soil moisture sensors within a smart plant monitoring framework marks a paradigm shift in plant care methodologies. By harnessing the capabilities of this technology, plant owners can cultivate optimal growing environments, resulting in healthier, more vibrant plants poised for sustained growth and flourishing.

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