An approach for modern gardening through monitoring and maintenance of plant health

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ABSTRACT

The study explores the use of internet of things (IoT) devices in agriculture to improve sustainable practices and environmental concerns. It uses the ESP8266 microcontroller and the Blynk platform to create a revolutionary plant health monitoring and automated care system. The system is designed to handle continuous monitoring and plant maintenance in various environmental conditions. Sensors measuring light, temperature, humidity, and soil moisture are strategically placed to receive real-time data. The ESP8266 microcontroller analyzes this information and links it to the Blynk cloud for accessibility via mobile or web applications. The system is effective in monitoring ideal growing conditions, such as soil moisture and weather conditions. Automated care elements like irrigation and supplemental lighting have been shown to improve plant growth and health. The study contributes to smart farming by offering an affordable and easy way to automate and monitor plant health, demonstrating how IoT technologies can enhance agricultural practices, conserve resources, and enable remote management of plant ecosystems.

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1. INTRODUCTION

Various important parameters like temperature, humidity, and light intensity affect plant growth [1]. The research is aimed at coming up with a way of assessing plant health and underlines the importance of technological advancements such as the development of smart modules that can be used by farmers to increase crop yields throughout the year [2]. It has been observed that using silicon technology could replace expensive lab-based plant health monitoring systems in favor of many inexpensive ones without losing their accuracy [3].

Moreover, it is emphasized that achieving net-zero carbon emissions from agriculture by 2050 will require developing technologies that increase productivity but still reduce resource use and energy consumption [4]. The scientific framework for managing and controlling pest infestations and pathogen interventions is related to plant health. It can considerably help in the efficient management of farms and forests when used on a wider scale, directly affecting the caliber of the food we consume and the cattle we rear [5].

An efficient and reasonably priced wireless security system that uses Global System for Mobile Communication (GSM) and ZigBee modems to track and control unwelcome events such as burglary and the emergence of hazardous circumstances in residences, neighborhoods, or cities is proposed. The particle swarm optimization (PSO) technique is used to improve the network by utilizing cluster nodes that include ZigBee modems and switching customized to each user's requirements [6]. Dealing with large changes in the geographical and climatic conditions that can cause disasters is a difficult task. It is crucial to keep an eye on these changes and take quick action to protect lives. Sensor nodes, regional control centers, and a central control room make up the system's three main parts [7].

Discharge sensors are used to control gate openings up to predetermined limits while data from the sensor nodes is gathered for monitoring [8]. According to the conditions that are being observed, all decisions are taken through the central control room, which also issues orders to various local control rooms. A hooter is accessible at the local control room for issuing notifications in the event of criticality or discrepancies that reach danger limits [9].

This research serves as an illustration of internet of things (IoT) applications in the creation of monitoring devices with real-time tracking of the population and the sending of alarm messages to users' mobile phones when the population exceeds specified criteria. Rural residents can monitor their numbers when they approach critical levels by putting in place intelligent IoT-based monitoring devices [8], [10].

2. LITERATURE REVIEW

The suggested approach provides the potential to detect plant diseases in their early stages, minimizing losses and, to some extent, reducing reliance on experts [11]. Growing environmental pollution is a significant problem for our generation, with diminishing oxygen levels caused by deteriorating plant health being a major worry. To solve this problem, sustainable development must be achieved [12]. The life-course approach has the potential to increase crop yield by better recognizing how interactions between plants and their environment affect plant and crop health. This includes a thorough analysis of analytical tools and how they can be used to monitor plant growth [13].

Green plants are essential to the health of our environment and the foundation of ecosystems' long-term viability. As a result, encouraging the growth of healthy plants is crucial, and early identification of plant illnesses can help with their treatment [14]. A nation's economy has historically been heavily reliant on agriculture, but as urbanization and population growth accelerate, arable land is becoming less and less available [15]. Methods of vertical farming are becoming more popular in the current urbanization and Industry 5.0 era. By using less space and lowering carbon and greenhouse gas emissions, these strategies encourage sustainability. When not in use, the green internet of things (G-IoT) switches to a dormant mode to save energy, which helps to improve environmental sustainability [16].

To improve IoT for urban terrace gardening in the authors' community, a unique smart IoT-based system is being launched that uses microcontrollers, sensors such as soil moisture and light detectors, and the Bolt-IoT cloud [17]. The production of high-quality crops to meet the rising demand for food presents a twin challenge for modern farmers. Application of fertilizers and nutritional improvements are necessary to increase crop yields [18]. The block diagram of plant health monitoring system in Figure 1 is described as follows for this study: The user interface for monitoring and managing the plant care system is a smartphone or laptop. We can access real-time sensor data using the Blynk app that has been downloaded to our device and give instructions to the system [19].

Our laptop or smartphone and the plant care system are connected by the Blynk app. To visualize sensor data (such as soil moisture, temperature, and light levels) and manage the system's actuators, we can build a graphical user interface (GUI) with widgets [20]. The brain of our plant care system is the ESP8266 microcontroller. It is in charge of gathering information from the sensors, processing that information, and managing the actuators. The microcontroller can communicate with the Blynk app because it is linked to our Wi-Fi network [21]. To collect important environmental data, this project employs a variety of sensors. It determines when the plant needs watering by keeping an eye on the soil's moisture level, enables us to guarantee ideal growing circumstances by measuring the temperature in the area around the plant, and finds out if the plant is getting enough light by detecting the light levels. According to the microcontroller's instructions, the actuators are machines that perform actions. When the soil moisture drops below a certain level, automatic watering of the plant is provided [22].

To maintain an ideal microclimate for the plant, control the airflow and humidity. When the plant does not receive enough light from the sun to grow, provide additional lighting [23]. All system parts, including the microprocessor, sensors, actuators, and any additional peripherals, are powered by a dedicated power supply. The ESP8266 microcontroller continuously gathers data from the sensors while it is in use. Our Wi-Fi network is used to transmit this data to the Blynk app. Through the Blynk app on our smartphone or laptop, we can monitor the sensor data and remotely operate the actuators. For instance, we can use the app to activate the water pump to irrigate the plant if the soil moisture sensor detects that the soil is dry. Similar to that, we can change the fan speed or turn on LED lights as necessary to produce the ideal conditions for plant growth. This networked system makes it possible to monitor the circumstances of the plant in real-time and respond appropriately, encouraging healthy growth and effective resource use in our automated plant care project [24].

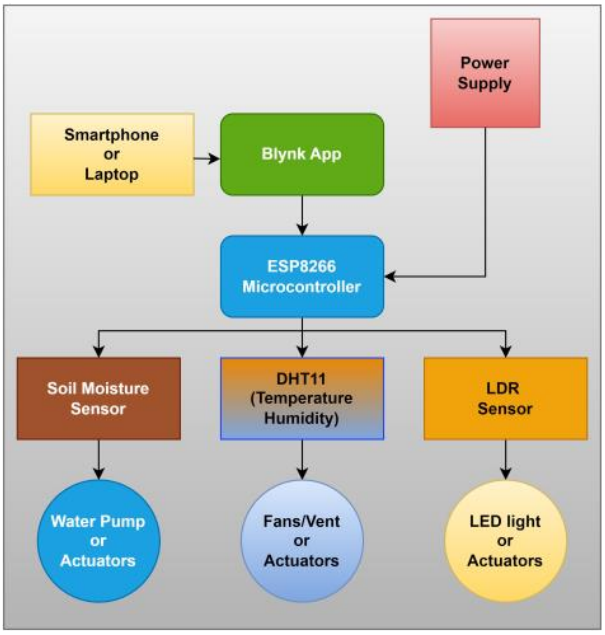

Figure 1. Block diagram of intruder detection node

3. HARDWARE DEVELOPMENT

The hardware interfacing for plant health monitoring is represented in Figure 2. Three pins are normally present on the soil moisture sensor VCC for power, GND for ground, and SIG for signal. Connect the 3.3 V output on the ESP8266 board to the VCC (power) pin of the soil moisture sensor. The sensor receives power from this. A ground (GND) pin on the ESP8266 board should be connected to the GND (ground) pin of the soil moisture sensor. A common ground connection is made as a result.

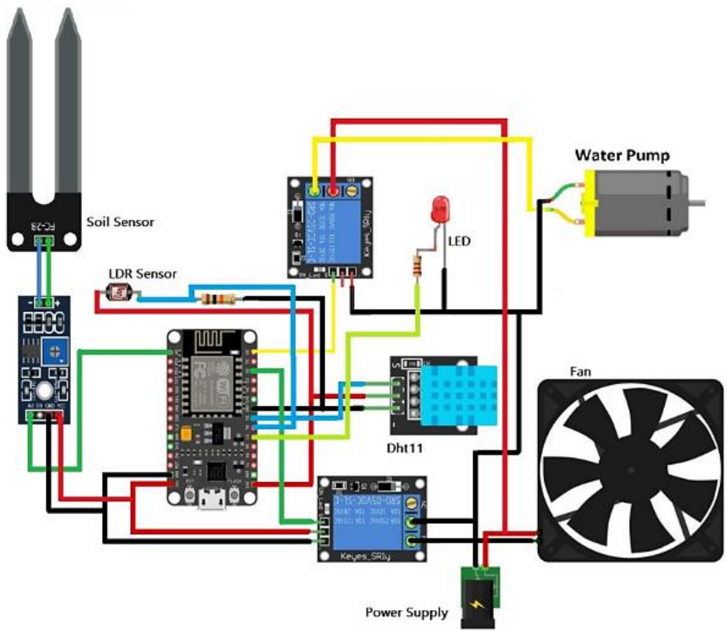

Figure 2. Connection diagram of plant health monitoring

- The ESP8266, such as A2, should be connected to the SIG (signal) pin of the soil moisture sensor. The soil moisture sensor reads soil moisture and displays it on the Blank app via ESP8266.
- The DHT11 sensor has three pins which power pin is connected to voltage and ground is connected to the ground and the data pin of the DHT11 sensor is connected to D5.
- The LDR sensor has three pins, which power pin is connected to the voltage, and ground is connected to ground and the data pin of the LDR sensor is connected to D6.
- The signal pins of the fan and motor pump are connected to esp8266 with the help of a relay. The motor pump is attached to D0 and fan is attached to D2 pin of ESP8266 with the help of the relay and lead data pin attached to pin no D7 of ESP8266. The hardware component that has been proposed in the present study is represented in Figure 3.

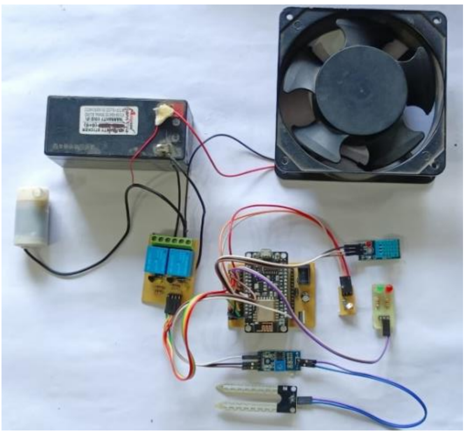

Figure 3. Hardware of plant health monitoring

4. IMPLEMENTATION OF THE SYSTEM

The system starts with an initialization stage where all hardware parts are powered on and initialized, including the ESP8266 microcontroller, sensors, actuators, and the Blynk app. The connected sensors, which comprise the temperature sensor, light sensor, and soil moisture sensor, continuously feed data to the microcontroller.

The soil moisture sensor gauges the soil's moisture content, the temperature sensor keeps track of the surrounding temperature, and the light sensor measures the brightness of the light. The sensor data is processed by the microcontroller to ensure precision and dependability [25]. To remove noise or incorrect readings, it could undertake calibration and filtering. The processed data is momentarily stored for analysis before being sent to the Blynk app for remote access. The ESP8266 microcontroller maintains a Wi-Fi connection with the Blynk cloud platform. To connect to the microcontroller, an encryption token is employed by Blynk application installed in the laptop or Smartphone. Soil moisture sensors, temperature sensors, light levels are often sent to Blynk app. Designed for both PC and Smartphone use, Blynk App allows users to monitor plant care systems and view real-time sensor data. This software has a user-friendly interface with visual representations of the sensors through widgets such as gauges and graphs. Users can set thresholds and if the values exceed this range, they will receive alerts or warnings.

The system on its own uses sensor data to control care activities within it. For instance, when soil moisture is below a threshold value set by a user, the microcontroller can turn on the pump to start the watering process. There are also situations where there is not enough light for plant development, so the microcontroller makes LED turn on lights. Temperature and humidity readings can be used by the microcontroller to modify fans or ventilation systems. Information concerning the working of the system is immediate on Blynk app as shown in Figure 4. In case a critical threshold is reached, an alert is created calling for user intervention. The system loops to Blynk app while collecting and processing data. It ensures that surrounding environmental conditions are held in place for optimal plant health. To ensure safe operating of a system shutdown protocols are applied. Regular maintenance practices such as hardware inspection and sensor calibration provide accurate information gathered through sensors. This algorithm depicts the main contents of our automatic plant monitoring and care system, focusing on data processing, gathering and user involvement through the Blynk app. The smartness of this system lies in being able to adjust to its surroundings while providing an easy way of keeping the overall health of a plant [26].

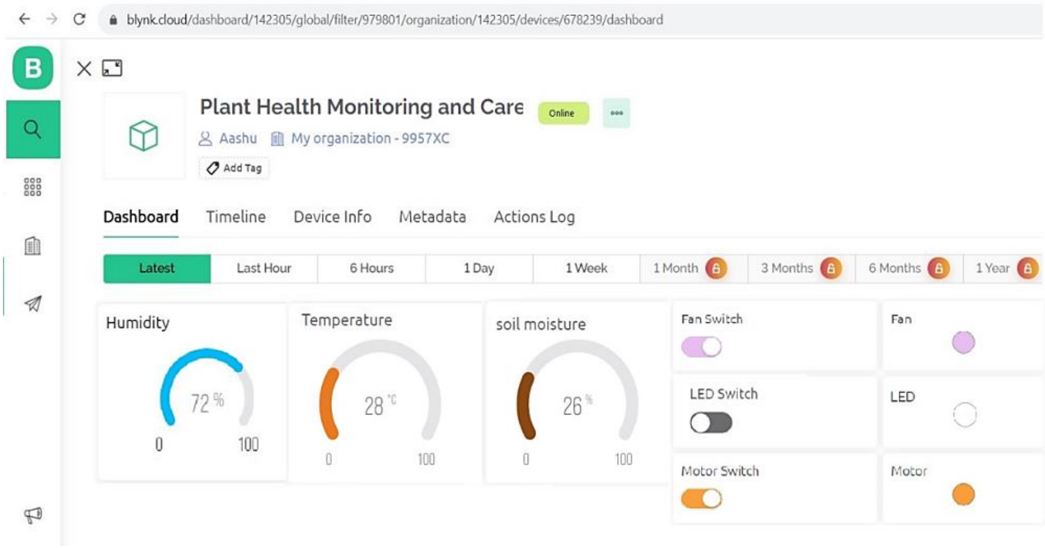

Figure 4. Blynk cloud dashboard

5. CONCLUSION

There has been a great revolution in precision farming and smart agriculture, achieved by creating and implementing an auto care system plus a plant health monitoring system that utilizes ESP8266 microcontroller with the Blynk platform. Based on the findings of this study, it can be concluded that IoT technology is effective and feasible for enhancing remote management of plants. Through these sensors, there is a continuous checking of environmental conditions surrounding the plant like light quantity, humidity, soil moisture, and temperature. This information is easily processed to the Blynk app operates as an intuitive user interface for data presentation or visualization and also remote control from far distances. Such a level of accessibility allows users to understand how they need to deal with their plants regardless of where they are located geographically.

Among the automatic care characteristics include temperature and humidity regulation using fans, light modulation as well as and automatic plant watering that is dependent on the soil moisture levels, which are very effective in enhancing the healthiness and vibrancy of plants. This is facilitated by the rapid response of this system toward changing external aspects, which ensures that the plant’s needs are met effectively and efficiently. Also, this research strengthens the broader aims of conserving resources and agricultural sustainability. The system continues with waste reduction; improvement in resource utilization efficiency, and reduced physical effort thus carrying out ecologically conscious farming principles. In addition to this, it can also be scaled up or down to serve various needs starting from huge amounts of agricultural enterprises to small-scale gardens at home. This paper analyzes an automated plant healthcare tracking system along with a care system that automates everything on a farm in a way that is cost-effective and practical. It depicts how IoT technology has changed remote management issues as well as made environmental monitoring possible for better plant maintenance. As technology evolves, we envisage more uses and improvements of this system. Eventually, it will help speed up the development of more environmentally sustainable and efficient agricultural practices in a world where change is constant.

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