Internet of Things Based Smart Plant Monitoring System

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Abstract: The Internet of Things is the process of connecting any physical objects embedded with sensors, electronics, software, and network connectively, enabling devices to exchange data and be monitored remotely. IoT can address water scarcity in agriculture by using sensors to measure soil temperature and moisture content along with humidity, which will help optimize the usage of water and minimize waste. IoT systems help improve farming efficiency because real-time data is provided, and processes like irrigation can be automated. Technology minimizes interference between human intervention, improves accuracy, and its economic benefits have resulted in its being an important apparatus in modern agricultural practices and other crucial applications.

1 INTRODUCTION

Plants play a crucial role in the food chain and the ecological cycle, requiring careful monitoring to ensure optimal growth and health. Automation and IoT technology are making plant monitoring systems smarter by providing real-time data on soil moisture and environmental conditions. IoT-based solutions enable intelligent decision-making for resource management, such as water use in plantations. Soil moisture, humidity, and temperature sensors placed near plant roots can detect conditions favourable for growth. The collected data is transmitted to a web server (cloud) for analysis, enabling smarter, more reliable planting practices.

Application of IoT in agriculture has several benefits and addresses serious issues like water scarcity. In areas characterized by low levels of rainfall, the realization of the efficient use of water resources through the application of IoT improves crop irrigation in real-time. IoT devices, for instance, are Arduino IDE and NodeMCU, which often process sensor data. The technologies offer cost-effective means of solution in home and large-scale farming. Further research is still being conducted in order to evaluate the adverse impacts of IoT systems on human health and the environment.

2 LITERATURE SURVEY

Caroline El Fiorenza (2018) et.al., have designed a smart e-agriculture monitoring based on Arduino using IoT (Fiorenza et al., 2018). The production of crops varies from place to place, where each crop has certain condition for its production. The lack of information about the crop, leads to failure in production. This proposed system includes the monitoring platform for agricultural ecosystem using smart technology. According to its methodology, the crops are being monitored with the help of Arduino boards and GSM technology where in the Arduino boards behave as a microcontroller. The purpose of this system is to supply water when the farm is dry during absence of human, it will also monitor the humidity, salinity of the soil, soil moisture and temperature also. This work consists of Arduino Nano with Node MCU sensors like soil moisture and

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Dht11, along with Solenoid valves, relays. With the help of internet, the control of the system is handled and the sensors used in the project stores the parameters in timely manner.

Prachi Kamble (2020) et.al., focuses on the IoT Based Plant Monitoring System for the parameters such as humidity sensor, moisture sensor, temperature sensors placed in root zone of plant (Kamble et al., 2020). The module includes a gateway unit (ESP8266) that handles the sensor information and transmit data to a android application. This application is developed to measure approximate values of temperature sensor, humidity sensor and moisture sensor that was programmed into a micro-controller to control quantity of water.

Monirul Islam Pavel (2019) et.al have proposed an IoT enable device which sends environment data in real-time to the database along with image of plant leaf to classify diseases using image processing and multiclass support vector machine (Pavel et al., 2020). The proposed model describes the image processing has been implemented to detect and classify the affected plant disease. In this process, the work is divided into four parts, which are image acquisition and preprocessing, segmentation of affected region, feature extraction, classification using multi-class support vector machine algorithm. The data obtained from the Arduino are stored in a string format. This data is then transferred as string to Raspberry Pi 3. Further, the data is split and again stored in array format. During this process, a Uniform Resource Locator (URL) is created with data server's IP address with corresponding database column name of each sensor and thus the values of sensor are obtained.

3 PROBLEM STATEMENT

A smart plant monitoring system leveraging Internet of Things (IoT) technology aims to address the challenges associated with traditional plant care methods by providing real-time monitoring and automated management functionalities. The problem statement for a smart plant monitoring system involves designing a solution to efficiently monitor and manage the health of plants in various environments. Busy lifestyles or travel can result in inconsistent plant care, leading to poor growth or plant loss.

Figure 1: NodeMCU ESP8266 Wi-Fi Module.

4 METHODOLOGY

The purpose of an IoT-based smart plant monitoring system is to enhance plant care by leveraging interconnected devices to collect real-time data on environmental conditions such as soil moisture, temperature, and light levels. The goal is to enhance plant growth, minimize resource wastage, and improve overall agricultural or horticultural practices through smart plant monitoring. This system aims to provide automated and efficient monitoring, that enables user to remotely track plant health, receive timely alerts, and optimize resource usage for better growth and sustainability. This system aims to provide real-time monitoring and analysis of crucial environmental variables such as soil moisture, temperature, humidity, light intensity, and nutrient levels, ensuring optimal growing conditions for plants. This system enables remote monitoring and control of plant health parameters from anywhere, at any time, through a smartphone or computer interface. The goal is to empower individuals, farmers, and horticulturists with actionable insights and automated responses to ensure the well-being and productivity of plants, leading to improved crop yields, resource conservation, and sustainable agricultural practices (Ashton, 2009), 7], (Chen et al., 2013).

5 SYSTEM CONSTRUCTION

The system of IOT based smart Plant monitoring system is composed of NodeMCU ESP8266 Wi-Fi Module is as shown in Fig.1. The module facilitates to monitor parameters, such as moisture, humidity and temperature.

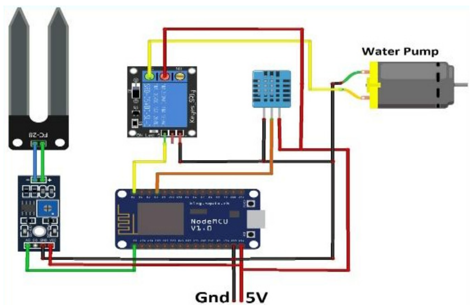

Figure 2: System Construction of Smart Plant Monitoring System.

5.1 Hardware Components

5.1.1 NodeMCU ESP8266 Wi-Fi Module

The ESP-12E module shown in Fig. 2, is an upgrade form of ESP-12, it adds six GPIOs and supports UART with a 110-460800 bps transfer rate. It has a micro-USB port, 15-pin headers for power, SPI, UART, and GPIO, plus flash and reset buttons. NodeMCU is an open-source IoT board with Lua, based on the ESP8266 Wi-Fi & SoC (Zhang et al., 2014).

5.1.2 DHT11 Temperature and Humidity Sensor

The device DHT11, shown in Fig.3, provides temperature and relative humidity measurements with excellent long-term stability due to its calibration and digital output. It supports reliable signal transmission over long distances while maintaining minimal power usage.

Figure 3: DHT11 temperature and humidity Sensor.

5.1.3 Jumper Wires

These wires shown in Fig.4, are used to connect components on the breadboard to the header pins placed on Node-MCU. Jumper wires are used to create temporary electrical connections between components on a breadboard.

Figure 4: Jumper Wires.

5.1.4 Soil Moisture Sensor

Soil moisture meter shown in Fig.5, along with the humidity sensor monitors the water level in the lawn's root zone, ensuring precise irrigation. These controllers, like evapotranspiration (ET) controllers, help to reduce water usage.

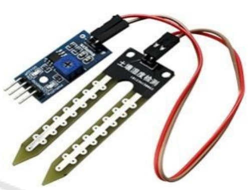

Figure 5: Soil Moisture Sensor.

It also maintains the turfgrass quality, where the appearance of the grass is intensified (Chaparro et al., 2019).

5.1.5 Relay (5V)

The 5V relay, shown in Fig.6, operates with a coil voltage of DC 5V and has a rated load capacity of 7A at 250V. It features a single-pole, double-throw (SPDT) contact configuration, allowing it to switch between two different outputs. The design includes five pins, with the increased capacity to handle up to 7A, making it suitable for various switching applications.

Figure 6: 5V Relay.

5.1.6 Passive Infrared (PIR) Motion Sensor

This PIR sensor shown in Fig.7, detects motion by sensing infrared radiation from objects like humans or animals. It passively identifies changes in infrared energy when something moves within its range, triggering responses such as activating lights or alarms. PIR sensors are energy-efficient and widely used in security systems and home automation. Their reliability makes them ideal for covering large areas (Motlagh et al., 2021), (Tubaishat and Madria, 2022).

Figure 7: PIR Motion sensor.

5.2 Software Components

Blynk, Fig.8, is a platform that enables developers to build IoT applications for controlling and monitoring connected devices using a simple drag-and-drop interface mechanism.

Figure 8: BlynkApp.

Users can design their own mobile app interfaces by selecting from a wide range of widgets such as buttons, sliders, graphs, and displays. These interfaces are then linked to physical hardware devices like microcontrollers. The Arduino Integrated Development Environment (IDE), Fig.9, is an open-source software application that provides a platform for writing, compiling, and uploading code to Arduino-compatible microcontroller boards. It offers a user-friendly interface, and a set of tools designed to simplify the process of programming Arduino-based projects. Key features of the Arduino IDE include Code Editor, Compilation and upload, Serial monitor.

Figure 9: Arduino IDE.

6 WORKED CARRIED OUT

The circuit connections of IOT Based Smart Plant Monitoring System using the hardware components are as shown in Fig.10. The Fig.11, shows the Blynk software connection used to display the values of temperature, humidity & Soil moisture. The Fig.12 indicates the Blynk connection when PIR Motion sensor is in ON state. Fig.13 shows the Blynk notifications through mobile. The Blynk App display for Temperature, Humidity and Soil moisture with PIR sensor in ON state is shown in Fig. 14.

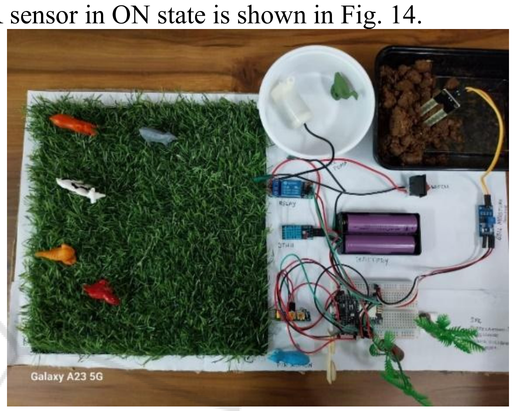

Figure: 10 Circuit Connection.

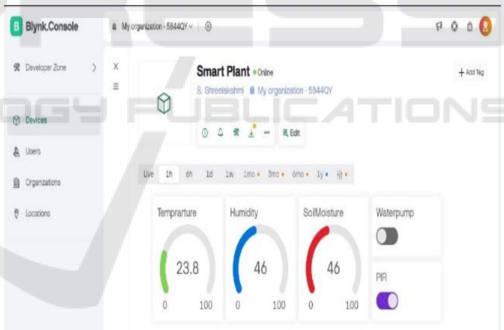

Figure 11: Blynk Software Display.

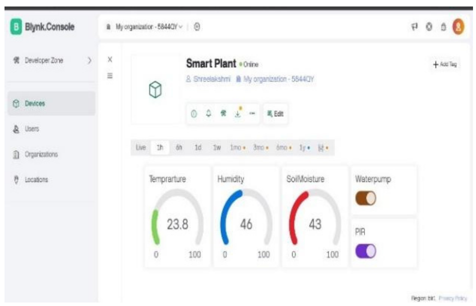

Figure 12: Blynk connection display for PIR motion sensor in ON state.

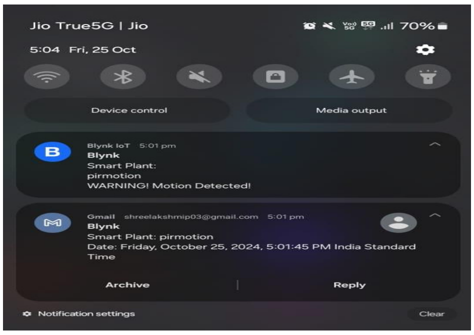

Figure 13: Blynk Notification through mobile.

Figure 14: Blynk App display for Temperature, Humidity and Soil moisture with PIR sensor in ON state.

7 RESULTS

The IoT-based Smart Plant Monitoring System has yielded promising results in revolutionizing the way we care for our plants. By integrating sensors, wireless communication, and data analytics, this system provides real-time monitoring of crucial plant parameters such as soil moisture, temperature, light intensity, and humidity. The continuous data collection and analysis enable precise adjustments to watering schedules, environmental conditions, and nutrient levels, optimizing plant growth and health. Moreover, the system offers remote access through mobile applications or web interfaces, empowering users to monitor their plants from anywhere at any time. IoT-based Smart Plant Monitoring Systems hold great potential in promoting sustainable agriculture practices and enhancing green spaces in both urban and rural settings.

8 CONCLUSIONS

By connecting various soil parameters to the cloud and enabling remote control via a mobile application, the Internet of Things-based Smart Garden system has been proven to function satisfactorily. The system is designed to monitor sensor data, including moisture, humidity, temperature, as well as to actuate other parameters based on requirements. For instance, if the tank's water level drops to a minimum, the motor switch will automatically turn on until the tank's water level reaches its maximum value. This system can be installed anywhere because of its low initial cost and ease of installation. The advancement of sensor technology allows the system to be upgraded to the next level, allowing users to make the most economical use of their investment. This approach reduces labor costs and makes effective use of the available water resources, which increases revenue. The system's feedback will help the gardening process be implemented more effectively.

REFERENCES

M. Mancuso and F. Bustaffa (2006), “A Wireless Sensors Network for Monitoring Environmental Variables in a Tomato Greenhouse”, IEEE International Workshop on Factory Communication Systems.

Teemu Ahonen, Reino Virrankoski and Mohammed Elmusrati , (2008), “Greenhouse Monitoring with Wireless Sensor Network”. University of Vaasa, IEEE/ASME.

Caroline El Fiorenza, Sushmita Sharma, Soumya Ranjan, Shashank, (2018) “Smart e-Agriculture Monitoring Based on Arduino Using IoT”, International Journal of Scientific Development and Research, IJSDR.

Prachi Kamble, Sudhanshu Bhagat, Sohail Shaikh, Ronak Sahu, Chavan, Prajakt Zodge, (2020) “IoT Based Plant.Monitoring System”, International Journal of Interdisciplinary Innovative Research & Development (IJIIRD), ISSN: 2456-236

Monirul Islam Pavel, Sadman Sakib Hasan, Syed Mohammad Kamruzzaman and Saifur Rahman Sabuj , (2019), “An IoT Based Plant Health Monitoring System Implementing Image Processing”, IEEE 4th International Conference on Computer and Communication Systems, Singapore.

Kevin Ashton, (2009), “That Internet of Things thing”, RFID Journal.

Nikkila, R., Seilonen, I., Koskinen, K., (2010)‘‘Software Architecture for Farm Management Information Systems in Precision Agriculture.’’ Comput. Electron. Agric.

Chen, Joy Iong Zong, Yuan-Chen Chen, and Shien-Dou Chung, (2013), “Implementation of a Greenhouse Crop Remote Monitoring System with IOT Technology, TANET.

Zhang, Xiang Wen, Ran Chen, and Chun Wang, (2014), “Design for Smart Monitoring and Control System of Wind Power Plants.” Advanced Materials Research.

D. Chaparro, MerceVall-llossera, M. Piles, A. Camps, C. R¨udiger and R. Riera-Tatch, (2019), "Predicting the Extent of Wildfires using Remotely Sensed Soil Moisture and Temperature Trends", IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing.

N. H. Motlagh et al., (2021), "Monitoring social distancing in smart spaces using infrastructure-based sensors" Proc. IEEE World Forum Internet Things (WF-IoT).

Malik Tubaishat, Sanjay Kumar Madria, (2022) "Sensor networks: An Overview", IEEE Potentials 05/2013.PV systems," Simulation Modelling Practice and Theory.