Smart Irrigation and Plant Monitoring System

Balaji S[1], Pradnesh S[2], Krish Kumar Gupta[3]
UG Scholar [1]
[1,2,3]Dept of CSE, Velammal Engineering College

Abstract: In today's digital era, the Internet of Things (IoT) has revolutionized agriculture by enabling smart irrigation and crop monitoring, addressing the inefficiencies of traditional methods that often lead to water wastage and soil degradation. This project develops a Smart Irrigation and Plant Monitoring System that integrates sensors to measure temperature, humidity, and soil moisture levels, ensuring an optimal water supply for crops. By continuously analyzing real-time data, the system enhances crop yield, conserves water, and maintains soil health while minimizing human intervention. The automation of irrigation improves efficiency, sustainability, and precision farming. Additionally, IoT enables remote access and control, allowing farmers to monitor and manage their fields effortlessly. This cost-effective and scalable solution promotes sustainable agricultural practices, ultimately benefiting both farmers and the environment.

Keyword: Smart Irrigation, Plant Monitoring, Internet of Things (IoT), Precision Farming, Soil Moisture Monitoring, Automated Irrigation System, Real-time Data Analysis, Agricultural Sustainability, Water Conservation, Remote Monitoring

INTRODUCTION

The **Internet of Things (IoT)** concept was first introduced in 1982 with a modified Coke machine, the first internet-connected appliance. While companies explored IoT from 1982 to 1999, the term was officially coined in 1999 by **Kevin Ashton** during his work at Procter & Gamble, gaining mass recognition only after 2011 and reaching the market in 2014. IoT enables devices to communicate and exchange data using **RFID, wireless technology, and sensors**, allowing efficient automation in various industries, including **agriculture**. Since plants play a crucial role in maintaining the **ecological balance and food chain**, proper monitoring of their growth and health is essential. The **Smart Irrigation and Plant Monitoring System** leverages **IoT technology** to automate irrigation based on **real-time environmental data**, utilizing **Arduino NodeMCU ESP8266, Temperature and Humidity Sensors, Soil Moisture Sensors, and 5V Relays**. By analyzing **soil moisture levels and weather conditions**, the system ensures optimal **water supply, preventing overwatering or underwatering**, thereby improving **crop yield, conserving water, and enhancing soil health**. This **automated, sustainable, and efficient** solution reduces human intervention, making **modern agriculture smarter and more resource-efficient**.

PROBLEM STATEMENT

Water scarcity is a major challenge in agriculture, often leading to inefficient water usage and wastage. To address this issue, the Smart Irrigation and Plant Monitoring System leverages IoT technology to automate the irrigation process. By utilizing sensors to measure temperature, humidity, soil moisture, and light intensity, the system enables real-time monitoring and data-driven decision-making. Based on the sensor readings, irrigation is optimized to ensure efficient water usage, reducing waste while maintaining optimal soil conditions for plant growth. This smart approach enhances agricultural productivity, conserves water, and promotes sustainable farming practices.

EXISTING SYSTEM

The **Smart Irrigation and Plant Monitoring System** integrates both **hardware and software** to optimize agricultural water management. The system consists of an **open-source Arduino-based embedded system** equipped with **moisture sensors** to monitor soil conditions and automate irrigation as needed. A **PHP-based web interface** enables remote access and control, while a **GSM-SMS module** facilitates real-time alerts on key parameters such as **soil moisture levels, temperature, humidity, electricity status,**

and motor conditions. The system utilizes **GSM-GPRS SIM900A** to update sensor data on a webpage, allowing farmers to monitor and manage irrigation remotely. By leveraging **IoT and mobile communication**, this system ensures efficient water usage, minimizes wastage, and enhances agricultural productivity, making smart farming more accessible and sustainable.

DISADVANTAGES

the **Smart Irrigation and Plant Monitoring System** has some limitations. The system relies on **internet connectivity and GSM networks**, which may be unstable or unavailable in remote agricultural areas, affecting real-time monitoring and control. Additionally, **initial setup costs** for sensors, microcontrollers, and communication modules can be high, making it less affordable for small-scale farmers. Sensor accuracy can also be influenced by **environmental factors** such as soil type and weather conditions, leading to potential discrepancies in irrigation decisions. Furthermore, the system requires **regular maintenance and calibration** to ensure optimal performance, which may add to operational costs and complexity.

LITERATURE REVIEW

Several studies have explored the implementation of **smart irrigation systems** using IoT, GSM, AI, and cloud-based technologies to optimize water management in agriculture. **Patel et al. (2018)** developed an **IoT-enabled irrigation system** that monitors **soil moisture, temperature, and humidity** using **Arduino, GSM, and cloud storage**, allowing remote access and real-time decision-making. Their study demonstrated **water conservation and improved crop yield** but faced challenges in **sensor calibration and network dependency**. Similarly, **Sharma et al. (2019)** proposed a **GSM-SMS-based irrigation system** with a **wireless sensor network (WSN)** to send real-time alerts about **soil conditions, motor status, and power supply failures**. While effective in reducing manual intervention, it suffered from **network instability and high initial costs**. Advancements in **machine learning and AI** have enabled predictive irrigation models, as seen in **Gupta et al. (2021)**, where an **AI-driven system** analyzed past weather data and soil conditions to determine optimal irrigation schedules. However, its **high computational requirements and technical complexity** made it less accessible for small-scale farmers. Additionally, **cloud-based and mobile monitoring systems**, such as those developed by **Kumar & Singh (2020)**, provided farmers with **real-time sensor data access via mobile applications**, improving ease of use and flexibility. Despite these advancements, challenges such as **data security, connectivity issues, and affordability** remain, emphasizing the need for **cost-effective, AI-driven, and energy-efficient solutions** for wider adoption in agriculture.

PROPOSED SYSTEM

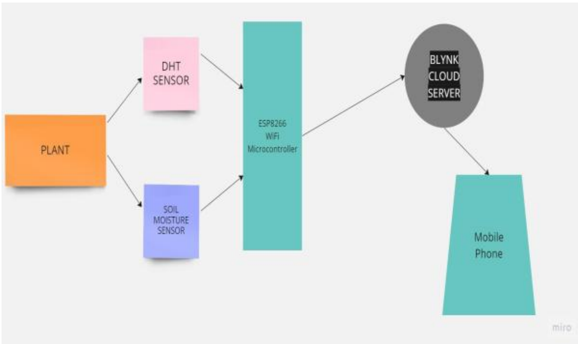
The **irrigation process** can be easily automated using **Arduino and NodeMCU** integrated with **temperature, humidity, and moisture sensors**, allowing real-time monitoring of environmental conditions. A **relay module** is used to **control the flow of water**, acting as an **automatic switch** for efficient water supply management. Additionally, a **web-based interface** enables users to **check the current status of the agricultural field** remotely through a browser, enhancing convenience and precision in farm management.

ADVANTAGES

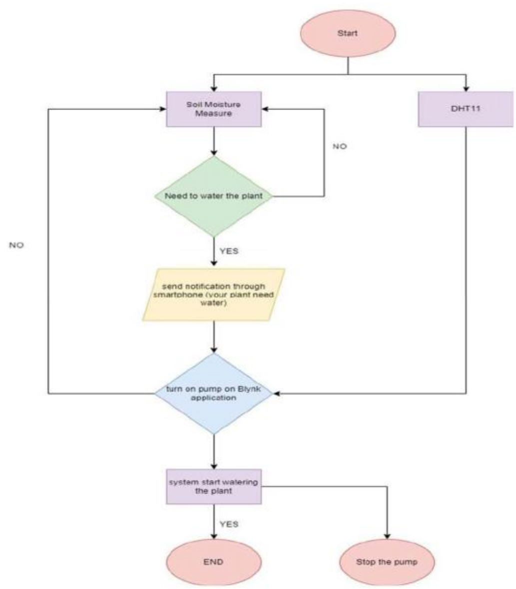
Proper irrigation can be efficiently carried out through **remote monitoring of fields**, ensuring optimal water usage and preventing wastage. This helps in **overcoming the issue of improper water usage**, leading to better resource management. The **integration of technology in agriculture** plays a crucial role in **increasing crop production** while also **reducing manpower efforts**, making farming more efficient and sustainable.

IMPLEMENTATION AND RESULT

BLOCK DIAGRAM:



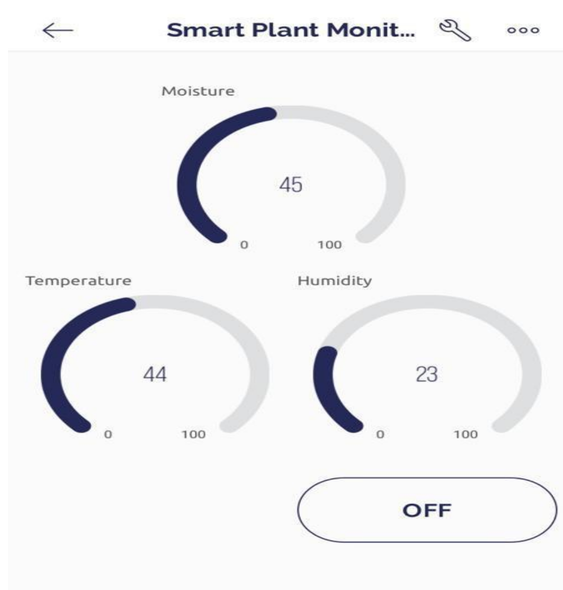
FLOW CHART:



METHODOLOGY

The proposed Plant Monitoring System utilizes NodeMCU as a microcontroller, which includes an inbuilt ESP8266 WiFi module to connect the system to the Blynk app via WiFi. The system's functionality is programmed using Arduino IDE, an environment that integrates code with hardware. A soil moisture sensor continuously detects the moisture level in the soil and displays real-time data on a Virtual LCD widget in the Blynk app. If the soil moisture drops below the required level, the user can switch ON the water supply.

OUTPUT



CONCLUSION

The implementation of the **Smart Garden system** using the **Internet of Things (IoT)** has been successfully verified, allowing different soil parameters to be connected to the cloud and controlled remotely via a **mobile application**. The system not only **monitors sensor data** such as **moisture, humidity, and temperature** but also **automates necessary actions** based on real-time conditions.

FUTURE WORK

The performance of the system can be further enhanced by using **high-end microcontrollers** with improved **operating speed, memory capacity, and instruction cycle period**. Additionally, the number of **sensor channels** can be increased by incorporating **advanced controller versions**, allowing for broader monitoring capabilities.

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