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Smart Irrigation System using Node MCU

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Abstract - Water conservation and efficient irrigation are critical challenges in modern agriculture. This project presents a **Smart Irrigation System** using **Node MCU (ESP8266)**, which automates irrigation based on real-time soil moisture levels, weather conditions, and user preferences. The system integrates **soil moisture sensors, temperature and humidity sensors (DHT11/DHT22), and a water pump**, all controlled through the **Node MCU microcontroller**.

The Node MCU connects to a cloud-based IoT platform, enabling remote monitoring and control via a smartphone or web application. When the soil moisture drops below a predefined threshold, the system automatically activates the water pump, ensuring optimal water usage. Additionally, real-time weather data can be incorporated to prevent unnecessary irrigation during rainy conditions.

This smart irrigation system enhances **water efficiency, reduces manual intervention, and supports sustainable farming practices**. It is cost-effective, easy to implement, and suitable for both agricultural and home gardening applications.

KEYWORDS

- **Smart Irrigation**
- **Node MCU (ESP8266)**
- **IoT (Internet of Things)**
- **Soil Moisture Sensor**
- **Automated Irrigation**
- **Water Conservation**

1.INTRODUCTION

Water is one of the most vital resources for agriculture, and its efficient use is essential for sustainable farming. Traditional irrigation methods often lead to **water wastage**, **over-irrigation**, or **under-irrigation**, which can negatively impact crop yield and soil health. With the advancement of **Internet of Things (IoT)** technology, smart irrigation systems have emerged as an effective solution to optimize water usage while reducing human intervention.

This project focuses on developing a **Smart Irrigation System** using **NodeMCU (ESP8266)**, a low-cost microcontroller with Wi-Fi capabilities. The system integrates **soil moisture sensors, temperature and humidity sensors, and a water pump**, all controlled via the NodeMCU. The real-time data collected from the sensors is processed to determine the soil's moisture level, and the system

automatically irrigates the field when necessary.

Furthermore, the system is **IoT-enabled**, allowing users to monitor and control irrigation remotely through a smartphone or web application. It can also integrate **weather forecasts** to optimize watering schedules, preventing unnecessary irrigation during rainy conditions. By automating the irrigation process, this system helps in **conserving water, reducing labor costs, and enhancing crop productivity**.

This smart irrigation system is designed to be **cost-effective, scalable, and suitable for various applications**, including home gardens, greenhouses, and large-scale farming. By leveraging IoT and automation, the system promotes **precision agriculture**, ensuring that crops receive the right amount of water at the right time.

2.SYSTEM STUDY

2.1 EXISTING SYSTEM

Traditional irrigation methods, such as **manual watering, sprinkler systems, and drip irrigation**, are widely used in agriculture. However, these systems often suffer from inefficiencies that lead to **water wastage, higher labor costs, and reduced crop productivity**. Some common drawbacks of the existing irrigation systems include:

1. **Manual Irrigation** – Farmers or gardeners manually water the crops, which is time-consuming and inefficient. It often results in **over-irrigation or under-irrigation**, affecting plant growth and soil quality.
2. **Timer-Based Irrigation** – Some irrigation systems use **timers** to control watering schedules. However, these systems do not consider **real-time soil moisture levels, weather conditions, or crop requirements**, leading to unnecessary water usage.
3. **Conventional Drip Irrigation** – While drip irrigation improves water efficiency compared to manual watering, it still lacks **automation and real-time monitoring**. Farmers must manually turn the system on/off, and it does not adjust based on environmental conditions.
4. **Weather-Dependent Challenges** – Existing systems do not integrate **weather forecasting** or **real-time environmental data**, leading to irrigation even during rain, resulting in excess water usage and potential crop damage.
5. **Lack of Remote Monitoring** – Most traditional irrigation systems do not provide **remote control or monitoring**. Farmers must be physically present to manage irrigation schedules, making it difficult to optimize water usage efficiently.

2.2 DRAWBACKS

While the **Smart Irrigation System using NodeMCU** offers significant advantages in terms of water conservation, automation, and efficiency, it also has some **limitations** that need to be considered:

1. **Dependence on Internet Connectivity** – Since the system is

IoT-based, it requires a **stable internet connection** for real-time monitoring and remote control. In rural or remote areas with poor internet coverage, the system may not function effectively.

2. **Initial Setup Cost** – Although the system is cost-effective in the long run, the **initial investment** in **sensors, microcontrollers, and IoT infrastructure** may be relatively high for small-scale farmers.
3. **Sensor Accuracy and Maintenance** – Soil moisture sensors, temperature sensors, and other components may experience **calibration drift, wear and tear, or inaccurate readings** over time. Regular **maintenance and recalibration** are required for optimal performance.
4. **Power Supply Dependency** – The system requires a **continuous power supply** for the Node MCU and water pump. In areas with frequent power cuts, additional **battery backup or solar panels** may be needed to ensure uninterrupted operation.

2.3 PROPSED SYSTEM

- Automated Irrigation
  - Uses soil moisture sensors to detect water levels in the soil.
  - The system automatically activates the water pump when moisture falls below a threshold and stops when the soil is adequately watered.
- Node MCU (ESP8266) as the Core Controller
  - The Node MCU microcontroller processes sensor data and controls the irrigation system.
  - It connects to the internet, enabling real-time data transmission and remote monitoring.
- IoT-Based Monitoring & Control
  - The system is integrated with a mobile app or web dashboard to allow farmers to monitor soil conditions and control irrigation remotely.

2.4 ADVANTAGES

The **Smart Irrigation System using NodeMCU** offers several benefits, making it a highly efficient and sustainable solution for modern agriculture. Here are its key advantages:

1. Water Conservation

✅ Uses **soil moisture sensors** to supply water only when needed, reducing water wastage.

✅ Prevents **over-irrigation and under-irrigation**, ensuring optimal soil moisture levels.

2. Automated and Efficient Irrigation

✅ Eliminates the need for manual watering, reducing human effort.

✅ Ensures **consistent and precise watering** based on real-time data.

3. IoT-Based Remote Monitoring & Control

✅ Farmers can **monitor and control irrigation remotely** using a mobile app or web interface.

✅ Provides real-time data on **soil moisture, temperature, and humidity** for better decision-making.

3.METHODOLOGY

The Smart Irrigation System using Node MCU follows a structured methodology to ensure efficient, automated, and IoT-enabled irrigation. The system is designed to monitor soil conditions, process data, and control irrigation automatically. Below is a step-by-step breakdown of the methodology:

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1. System Design and Components Selection

The system consists of:

- Node MCU (ESP8266) – Acts as the main controller for processing data and connecting to the internet.
- Soil Moisture Sensor – Detects soil moisture levels and determines when irrigation is needed.
- DHT11/DHT22 Sensor – Measures temperature and humidity to optimize irrigation.
- Water Pump & Relay Module – Controls water flow based on sensor readings.
- Cloud/IoT Platform – Stores sensor data and enables remote monitoring.
- Mobile/Web Application – Allows users to view real-time data and manually control irrigation if needed.

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2. Data Collection using Sensors

- The soil moisture sensor continuously monitors moisture levels in the soil.
- The DHT11/DHT22 sensor collects temperature and humidity data.
- Additional weather data can be fetched from an online API to consider external conditions.

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3. Data Processing and Decision-Making

- The Node MCU reads sensor data and compares it with predefined threshold values.
- If the soil moisture level is below the threshold, the system activates the water pump via the relay module.
- If moisture is above the threshold, the system keeps the pump off to prevent overwatering.
- Weather conditions are analyzed to avoid unnecessary irrigation during rainy periods.

4.ALGORITHM AND IMPLEMENTATION

4.1 LOGISTIC REGRESSION

Logistic Regression is a supervised machine learning algorithm used for binary classification problems. In the Smart Irrigation System using Node MCU, it can be used to predict whether irrigation is required (1) or not (0) based on environmental factors like:

- Soil Moisture Level
- Temperature
- Humidity
- Weather Conditions (Rain Probability, Cloud Cover, etc.)

This predictive model helps in making intelligent irrigation decisions rather than relying on fixed threshold values.

irrigation is needed, reducing water wastage, and preventing over-irrigation.

4.2 SUPPORT VECTOR MACHINE (SVM)

Support Vector Machine (SVM) is a **supervised machine learning algorithm** used for **classification and regression tasks**. In the **Smart Irrigation System using Node MCU**, SVM can be used to **classify whether irrigation is needed or not** based on environmental parameters such as:

- **Soil Moisture Level**
- **Temperature**
- **Humidity**
- **Weather Conditions (Rain Probability, Cloud Cover, etc.)**
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By applying SVM, the system can **predict irrigation needs** more accurately compared to simple threshold-based approaches.

5. CONCLUSION

The Smart Irrigation System using NodeMCU is an efficient, automated, and IoT-enabled solution that optimizes water usage and enhances agricultural productivity. By integrating sensors, real-time data processing, and cloud-based control, this system ensures precise irrigation based on soil moisture, weather conditions, and environmental factors.

The implementation of machine learning techniques like Logistic Regression and SVM further improves the system by making intelligent predictions about when

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