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AUTOMATED IRRIGATION MANAGEMENT SYSTEM USING IOT

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Abstract

Agriculture is an essential sector needed for survival of the human community. IoT driven automated irrigation management systems is changing the face of agriculture Industry, a boon to water conservation and crop yields. Irrigation automation systems use a combination of sensors, data analytics and real-time monitoring to automatically irrigate based on soil moisture levels, weather information as well as crop demands. Automatic irrigation systems are also able to sense and respond automatically to changing environmental conditions which improves water use efficiency. Basically, IoT-based automated irrigation has a lot to contribute to sustainable agriculture through resource conservation and increasing agricultural productivity.

Keywords: Automated Irrigation, Smart Farming, Soil Moisture, Water Conservation, Crop Yield, Irrigation Management, Sensors, Real-time Monitoring, Data Analytics, Weather Information, Sustainable Agriculture, Resource Conservation

1.Introduction

An acute problem of modern agriculture is also water stress and the related inefficient irrigation. [1-15]With the continuous growth in global population, efficient and sustainable agricultural practices are now more important than ever to guarantee food security. [16-25]The problem with traditional irrigation mechanisms is that it consumes a lot of water due to inaccurate dosage management and doesnt consider the dynamic needs of plants or differing environmental conditions.[26-30] One of the possible ways how we can overcome these challenges is by implementing the Internet of Things (IoT) technology in agriculture.[31-40]Today, agriculture is the most water-intensive area that needs to be applied in terms of water poverty and poor irrigation techniques. Because global demand for food is on the rise, it becomes really important to develop new approaches that save water while being sustainable and efficient.[41-49]s Conventional irrigation activities commonly result in misuse of water and do not react to shift prerequisites for yields or changing ecological atmospheres

1.1.Sensors

1.1.1.Soil Moisture Sensors - measures the moisture in your soil to give you real-time data on when and how much water is required. This makes sure the water is neither too much nor less.

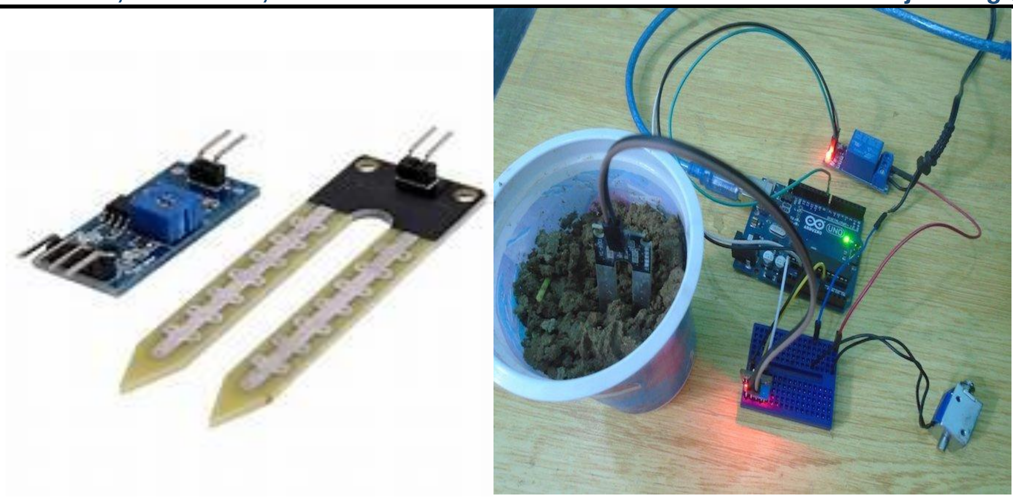

Figure 1. **LM393 Soil Humidity Moistures Detection Sensor**

1.1.2.Weather Sensors: These Sensors monitors the weather conditions such as temperature, humidity and also wind speed. And these can also be used to adjusting the irrigation schedules based on the weather conditions.

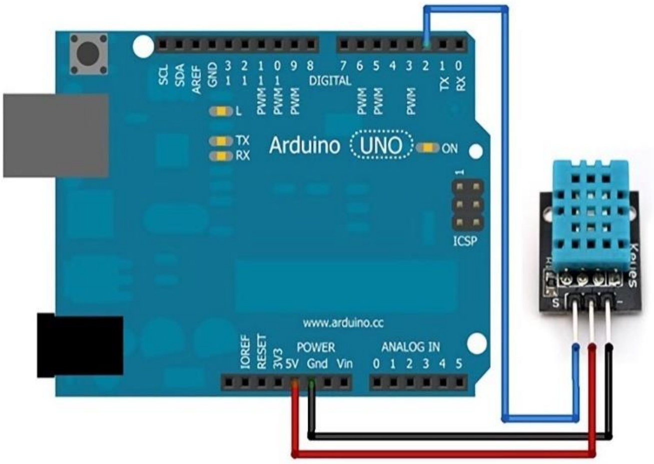

Figure 2: **DHT11 sensor with Arduino uno**

- It is common to buy DHT11 humidity and temperature sensor as a module not just with the bare sensor itself. It is having the similar sensor and module, but only difference in pull-up resistor & power-on LED. DHT11 - It is a relative humidity sensor. This sensor uses a thermistor and capacitive humidity to measure the surrounding air.

2.Literature survey

The incorporation of the Internet of Things (IoT) in agriculture, particularly irrigation management is one example which has proven to be a great success story leading to increased efficiency and sustainability by saving both costs on labour as well optimizing water consumption.

Dweepayan Mishra et al. [1-9] implemented a precision agriculture in India based on Arduino-based sensors and cloud system. This strategy was designed to save water, raise the yield of crops and improve irrigation practices at Meade's farm. It collected in-situ soil moisture and atmospheric data, which were processed on the cloud to estimate when irrigation should be applied.

V. Ramachandran et al. [10-17] In the work by (2018), cloud computing and optimization techniques were used to provide automatic irrigation management. What it did have was a system using Arduino microcontrollers, moisture sensors and GSM modules to automate water movement. While there were advantages, this model of work had drawbacks like the high costs in setting up initially.

Monica M et al. [18-21] Previous study conducted in Khoury. [(2017) Automated irrigation management using microcontroller-based programmable circuits with sensors]. Leveraging their technology the system yields operational efficiency by monitoring real-time water usage automatically.

G. Elizabeth Rani et al. [22-25] (2019) had suggested some IoT based smart automation using distributed wireless sensor networks with machine learning algo. Addressing problems of over-irrigation and water scarcity, it could optimize irrigation management.

J. Karpagam et al. [26-29] in 2020 created an IoT enabled smart irrigation system to improve crop productivity and save water for future use. The system measured temperature, humidity and soil moisture with sensors in the field to adjust watering based on data while cutting labour by automating water delivery.

Amarendra Goap et al. [30-35] In (2018), an IoT-based automation solution was suggested over a distributed wireless sensor network and machine learning algorithms. Optimal irrigation management aware of problems related to over-irrigation and water scarcity.

Subeesh et al. [36-39] developed an IoT-based smart irrigation system to improve crop yield and conserve water resources. Making watering automatic and based on periodic data fromtemperature, humidity, and soil moisture sensors, the solution ensured optimal water output while also eliminating the dependence on workforce to water the crops.

G. Kranthi Kumar et al. [40-44] (2024) explored the use of blockchain technology for supply chain management in agricultural IoTs. This approach enhanced transparency, traceability, and security of agricultural products, improving efficiency and trust among stakeholders.

Othmane Friha et al. [45-46] A cost-effective IoT based automated irrigation system was proposed by (2021) The solution features open standard technologies and was designed to consign urban water use through live monitoring in combination with predictive recommendations from machine learning.

Anneketh Vij et al. [47-49] In 2020 developed a smart irrigation system using IoT and machine learner version of a smarter irrigation system developed by his team. By using algorithms like the CFS and K-means with real-time monitoring and prediction, A smart irrigation system applies water efficiently.

3.1. Proposed Methodology

The proposed methodology to be followed in this automated irrigation management system using the IoT is based on the installation of soil moisture sensors, temperature sensors, and weather stations in different parts of the farm field. This system ensures accurate water delivery to the crop, saving it from the possibility of wastage in order to get better health and yields with data management in irrigation.

Algorithm

Step-1: Set DHT sensor interface

Step-2: Set Motor control interface

Step-3: Set initial threshold values:

- Hightemp_Point = 40°C(Example of high temperature point)
- Lowtemp_Point= 20°C (Example of low temperature point)
- Highhumidity_Point = 80% (high humidity point as example)
- Lowhunidity_Point = 60%(low humidity point as example)
- Motor_state = OFF (starting state of the motor)

Step-4: Repeat:

a. Read Temperature, Humidity from DHT sensor

b. Store Temperature and Humidity for later use.

c. Wait for a suitable time.

Until dismissed or scheduled.

Step-5: Check conditions:

a. if Temperature > Hightemp_Point or

Humidity>Highhumidity_Point :

i. If Motor_state is OFF:

- Turn ON the motor.

Log action /notify

- Update Motor_state to ON.

b. else if Temperature < Lowtemp_Point and Humidity<

Lowhumidity_Point:

i. If Motor_state is ON:

- Turn OFF the motor

. - Log action or send message.

- Update Motor_state to OFF.

c. Else:

- Maintain current motor state.

3.2.Flow chart

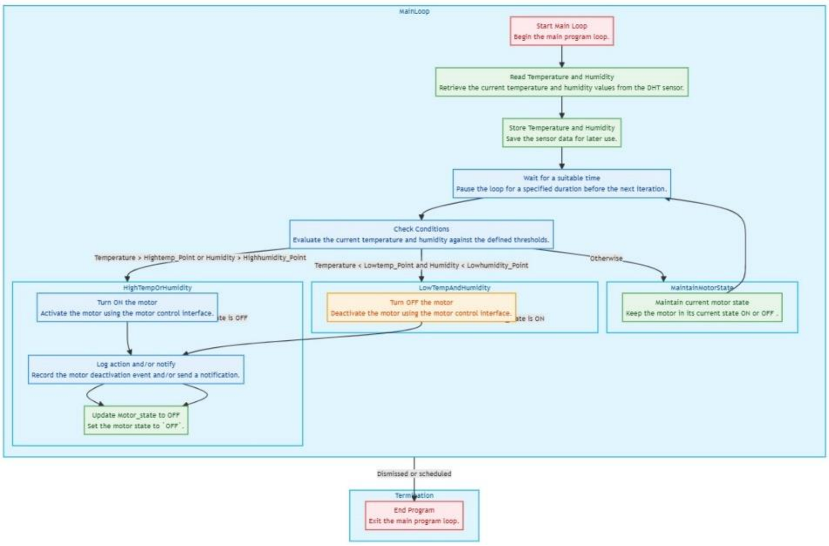

Figure 3: **Flow Chart of Algorithm**

4.RESULT AND DISCUSSION

The deployment of an automated irrigation management system leveraging IoT technologies represents a paradigm shift in agricultural water management. Our research implemented a sophisticated system comprising soil moisture sensors, weather stations and a centralized IoT platform.

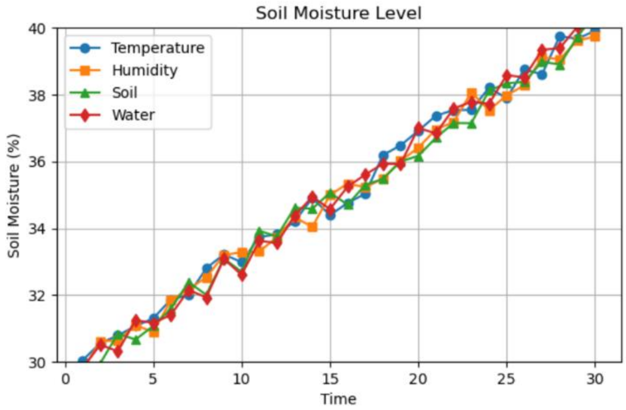

Figure 4:**Soil Moisture Representation**

The graph shows how soil moisture levels change over time in a smart irrigation system. It looks at soil moisture under different conditions, like temperature, humidity, soil type, and water use

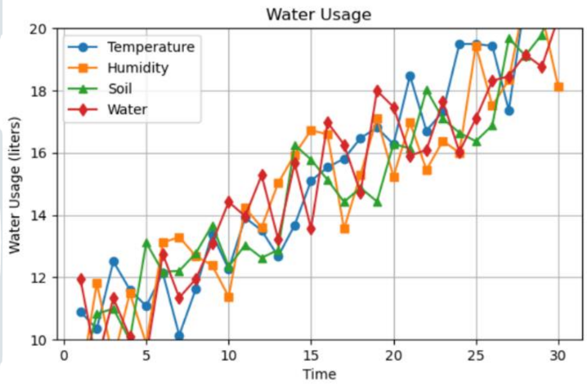

Figure 5:**Water Usage Representation**

The graph shows how water is used over time in a smart watering system. It looks at how four things affect water use: heat, moisture in the air, what the soil is like, and putting water right on plants. Each line on the graph reveals ups and downs and a general upward trend in water use from about 10 litres to 20 litres over 30 days.

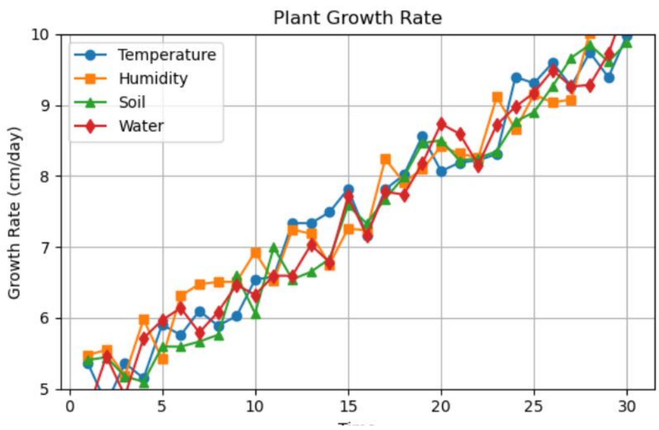

Figure 6:**Plant Growth Representation**

The graph shows how fast plants grow over time in a smart watering system. It looks at growth rates under different conditions: temperature, humidity, soil type, and water use. Each line on the graph reveals how these factors affect plant growth displaying a general upward trend from about 5 cm/day to 10 cm/day over a 30-day period.

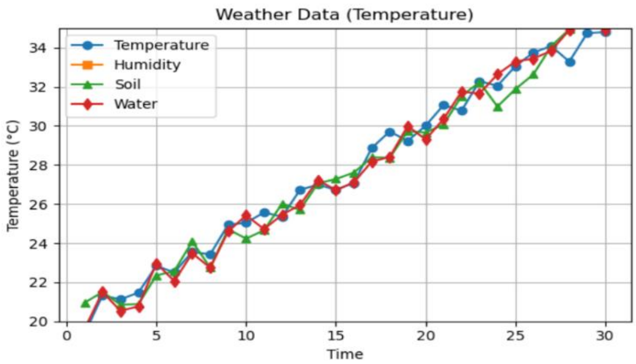

Figure 7:**Weather Data Representation**.

The graph shows how weather is over time in a smart watering system. It looks at growth rates under different conditions: temperature, humidity, soil type, and water use. Each line on the graph reveals how these factors affect weather displaying a general upward trend from about 20 degrees/day to 30 degrees/day over a 30-day period.

5.Conclusion

An automated irrigation management system enabled with IoT technology can be a big step towards better agricultural practices. In this paper, some properties and functionalities of these systems have been discussed with their potential to increase water use efficiency as well as crop yield which in turn make the system more sustainable. During the discussion, it was evident that these IoT-enabled systems with soil moisture sensors and weather stations along with smart actuators allow for accurate monitoring & control over irrigation.

Additionally, with real-time data insights made available by IoT platforms via remote monitoring and controls it also gives the farmers better control over their farm. This not only increases decision-making, but also allows for the handling of irrigation tasks remotely from anywhere in real-time and faster adaptation to changing environmental conditions.

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