Application of IOT and Machine Learning in Smart Agriculture System

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Abstract— **Agriculture is the most crucial and vital occupation in India since it balances both the human population's need for food and the supply of essential raw materials for numerous industries. The development of creative farming methods is gradually increasing crop output, increasing its profitability and lowering irrigation waste. The suggested model is a smart irrigation system that uses machine learning to estimate how much water a crop would need. The three most important variables to consider when estimating the amount of water needed in each agricultural crop are moisture, temperature, and humidity. This system consists of sensors for temperature, humidity, and moisture that are placed in an agricultural field and relay data via a microprocessor to a cloud-based IoT device.**

To effectively forecast outcomes, the decision tree method, a powerful machine learning technique, is applied to data collected from the field. Farmers receive a mail alert with the findings of the decision tree algorithm, which aids in making decisions on water supply in advance.

***Index Terms*-- Irrigation System, IoT, Soil Moisture, Temperature, Humidity, Decision Tree Algorithm, Mail alert.**

I. INTRODUCTION

The Internet of Things (IoT) is a cutting-edge technology that allows you to monitor and manage devices from anywhere in the world. It can link machines and living beings. The Internet of Things is leaving a lasting impression on numerous industries. Today, the IoT's adaptive nature has changed and can be used by regular users. IoT has produced a number of approaches that have improved man's quality of life, including smart cities, e-health, and automation. These approaches should be applied to essential requirements like food, which can be fulfilled by agricultural fields, rather than only man's comforts. According to the World Bank, if the population trend continues at its current rate, more than 50% of the world's food must be produced before 2050.

However, such a large agricultural production would not be supported by the current climate changes. Therefore, field-based sensors, drones, modern tractors, and hydroponic farming may enable farmers in the future to produce more crops at very low costs. As a result, exquisite farming is becoming increasingly necessary. Farming uses a huge portion of the water that is withdrawn. Therefore, there should be more conversations and measures taken in the farming area. Profitability in agriculture is, in fact, a key component of the arrangement.

India is a country renowned for its agriculture. Its water system requirements should be considered in relation to increasing yields. For crops to grow well, a good irrigation system must be used at the appropriate intervals. The industry where there is a great demand for labour is agriculture. Teenagers' lack of interest in agriculture and their limited awareness of opportunities were the main causes of the fall in work force. Therefore, in order to ensure that the harvests are being developed properly, farmers who devote their time to cultivating crops in vast areas needed to spend their entire day outside.

The knowledge that future water scarcity will cause significant disruption was a major motivator for the work outlined in this paper. In India, agriculture is a major industry, and the fields there need a lot of water. The only use of more than 80% of water resources is for agriculture. The water supplies may completely diminish as a result of this ongoing trend. This was taken into account when a model to control water usage was proposed. Implementing smart technologies in agricultural techniques must be prioritised for increased land productivity.

These issues can be resolved by properly analysing the agricultural setting and extracting data to provide irrigation scheduling and regulating based on ML algorithms and detected real time data, as well as advice for efficient ways of producing crops. The irrigation system is fully automated with the aid of this method, and it also delivers farmers real-time information and irrigation schedules based on the crop utilising machine learning over data about the lands and crops that will aid farmers in making informed decisions.

A. Precipitation

All water that falls from the atmosphere as rain, dew, or snow is referred to as precipitation. One of the most crucial elements that influences a place's vegetation is rain. Rice, tea, and coffee are grown in regions with abundant and evenly distributed rainfall, while sorghum and millet are grown in regions with less of it.

B. Temperature

The ideal temperature range for most crops, which would result in maximum output, is between 15 and 40 degrees Celsius. The distance from the equator has a significant impact on a location's temperature. Crop growth and productivity are closely tied to temperature.

C. Humidity

One of the most significant elements affecting crop production is humidity. The term "humidity" describes the amount of water that is present as vapours. In actuality, only a small number of crops can thrive in relative humidity levels of 75% and beyond; most crops require relative humidity levels of between 45 and 60 percent. The likelihood of infections and pests is also increased by humidity.

II. EXISTING METHODS

There is generally no automated irrigation technique in use around the globe. However, research on automating the watering procedure has been conducted. The basic irrigation strategy used in the majority of studies is as follows: To start, information is gathered from a number of sensors to establish the temperature of the surroundings and the moisture content of the soil.

They are fastened to a breadboard that is connected to an Arduino board using wires. The board sends data to the Arduino IDE. The computer language used executes instructions that extract data and reflect it, deciding whether to turn the water pump "On" or "Not" based on the input.

III. PROPOSED IRRIGATION MODEL

The project's proposal is to use Arduino to create a smart irrigation monitoring system. The focus will be on variables like soil moisture and temperature. This system will take the place of traditional farming practises. We will create a system that will enable a farmer to monitor the condition of his fields from anywhere in the globe, including at home. For the agricultural fields, it suggests a system of automatic watering. Automation currently plays a significant role in human life. In addition to comfort, it also saves time, energy, and resources. The automation and control equipment used by enterprises today is expensive and unsuitable for use in an agricultural field.

Therefore, it also creates low-cost smart irrigation technology here that Indian farmers can use. The fundamental brain of the entire system is Arduino. To maximise the utilisation of irrigation water for agricultural crops, an automated irrigation system was created. We can automatically control appliances thanks to automation. The automatic operation of the water motor was one of the paper's goals.

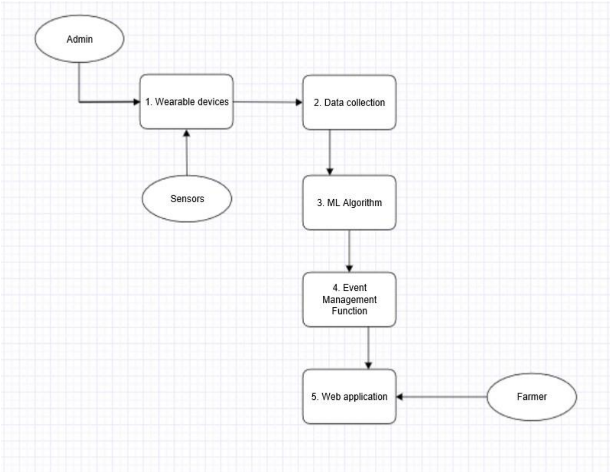

Fig 1. Data flow diagram

A. Data Collection

The system periodically collects the appropriate air temperature, humidity, and soil moisture data from the

physical environment for the watering decision during the data gathering stage, which is carried out for both options. These data are time-stamped and gathered into a database after being acquired. Additionally, during the data collecting phase, the system's automatic or manual irrigation times are noted in the database. The decision-making system can therefore determine when to irrigate using this information.

IV. IMPLEMENTATION

We use the Hardware device like, Submersible DC motor, DTH11 sensor, Soil Moisture Sensor Module, NodeMcu ESP8266, Relay module.

NodeMcuEsp8266: This Internet of Things device is open-source. It is a 32-bit microcontroller that enables data transmission and reception for Wi-Fi-enabled devices. It is a cheap semiconductor with integrated TCP/IP networking software. This board contains 17 GPIO pins. It is equipped with a Tensilica L 106 RISC CPU, which is extremely energy-efficient. ADCs, power amplifiers, and certain power management modules are all compatible with it. 4 KB of RAM are available.

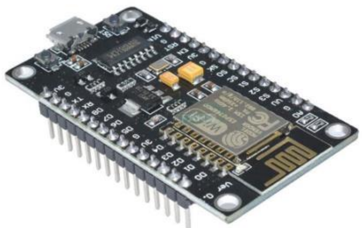

Fig 2. NodeMCU

Soil Moisture Sensor Module: A soil moisture sensor measures how much water is present in the soil. It primarily consists of two conducting probes. The moisture content is calculated using the variation in resistance between those probes. Resistance is inversely correlated with the amount of soil moisture. The data it transmits is analogue.

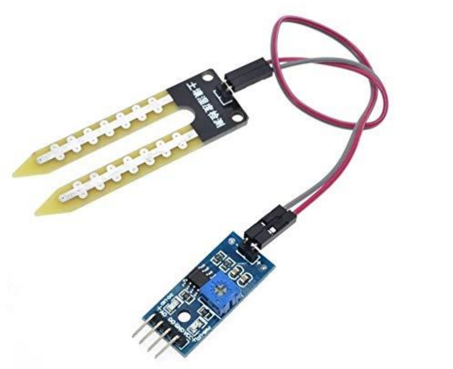

Fig 3. Soil moisture sensor

After feeding this information into ADC, the value will range from 0 to 1023. Therefore, the value lowers if there is no water in the soil. There will be a number, 1023. Therefore, we require a map from (0,1023) to (1,100), which may be accomplished using the map function.

A submersible DC motor is one that can be submerged entirely. It is hermetically sealed to keep water from getting into the motor. Rotational energy is transformed into kinetic energy, which is then transformed into pressure energy, which pushes water to the surface. The output of the water will be connected to this engine through a tube, which will be immersed in water.

Fig 4. Submersible pump

DTH11 sensor: This versatile sensor measures the humidity and temperature of the surrounding air. It is constructed of temperature and humidity-detecting thermistors. With humidity acting as the dielectric material in between, a capacitor can be used to detect humidity by changing the capacitance in response to variations in humidity. We are aware of how thermistors work. Temperature-dependent fluctuations in the resistance value are observed. We can get the 3-5 volts it requires from the NodeMcu.

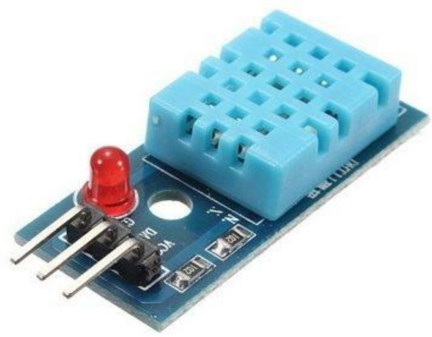

Fig 5. DTH11 sensor

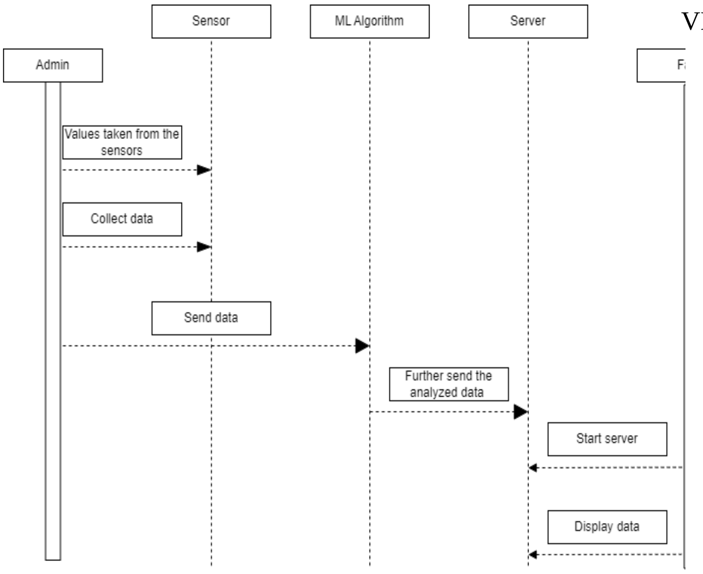

Fig 6. Sequence diagram

V. Tests and Results

The Arduino ATmega328 is used to implement this project. Jumper cables are used to connect sensors to the Arduino platform. The credit card-sized microcontroller Arduino monitors and manages the entire system. For automatic water supply, simple DC motors are employed. 5 volt batteries are used to supply power. Using the Arduino operating system, sensor values are presented in a monitor. Java coding is used to provide connection establishment. Based on the soil values here, the motor automatically turns on and off. Using Arduino OS, the sensor values are analysed and shown in the system monitor. On the basis of readings, the motor will turn ON.

VI. CONCLUSION

In this study, we suggest a smart irrigation model based Internet of Things system that gradually learns how to irrigate a plant without any initial pre-prepared data. We put a prototype application into operation as proof of concept. After a few hand irrigations, this application adjusts itself to the irrigation-related conditions. We created tests for manual and automatic irrigations when various ML algorithms were applied in order to assess its performance. The outcomes demonstrate that the model performs quite well when making irrigation decisions.

In upcoming study, we'll test the proposed model's effectiveness using prolonged irrigation on a larger number of plants.

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