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Cloud Based Irrigation System with IoT and Machine Learning

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ABSTRACT- There is a growing demand for electrical energy requirements in India. Nowadays, people tend to maintain home gardens, Terrace farms, and Mini farms. This Maintenance growth has been possible because of a timely and adequate supply of water. The irrigation depends on the groundwater availability, but as per the census of 2017, the groundwater levels have dropped down by 61% from 2007. Therefore, water usage with effective power consumption is of at most importance. Despite their desire to maintain, people take a step back, owing to time constraints, their busy lives, and the unavailability of a person to look after farms. Hence, the Internet of Things (IoT) and Machine Learning (ML) based smart irrigation system with Cloud integration is employed to address the farms. The system forecasts using SVM and reports graphically, the irrigation requirement of the field using several environmental parameters along with weather forecasting that assists the growth of the crops with the effective use of water and power conserving initiatives is presented in this paper.

KEYWORDS: Internet of Things, Machine Learning, Cloud, Terrace farms, SVM, Decision Tree

I. INTRODUCTION

According to a recent UNESCO World Water Assessment Program (WWAP) estimate, the world's population will expand by 33% by 2050, tripling the demand for food and water. This will have major ramifications for the entire world, particularly poor countries. Smart agriculture is one of the most important new applications of the omnipresent Internet of Things (IoT) technology. Smart Agriculture Techniques have lately piqued the interest of farmers and academics alike to fulfil rising food demand.

Smart Agriculture Systems (SAS) are driven by several key factors, which include the adoption of IoT technologies for remote, unmanned monitoring of the agriculture fields and taking corrective actions to make the environment most conducive for crop growth.

On the software side, the current rise in AI, ML, and Big Data technologies enables not only the management of massive amounts of data generated by hardware modules but also the use of this data as input to innovative, ML-based predictors, which may provide the farmer with better-informed judgments. They can swiftly assess the most recent data patterns and present the farmer with a variety of insights. These advantages include increased agricultural output, the conservation of scarce resources such as water for irrigation, and the reduction of the usage of hazardous chemicals such as those found in water usage, fertilizers, pesticides, and herbicides.

Such a level of control over agriculture not previously possible gives the farmer greater flexibility and insight to plan his activities, such as determining what crops will result in optimum yield under existing and predicted climatic conditions. It keeps him well informed about his current and projected use of permissible fertilizer, water, and pesticides use. It also helps him regulate the usage of tightly managed resources such as water for irrigation purposes.

II. LITERATURE SURVEY

Jitcha Shivangi [1] developed a simulated system to predict weather conditions of the Indian subcontinent using Machine learning. Data for training was collected from data.gov.in, ncdc.noaa.gov and UCI machine learning data repository. The system utilized a linear regression algorithm for data training.

Zaheer Ullah Khan [2] utilized different information digging methods for the expectation of climate determination including diverse groupings like K-Nearest, Neighbour Decision Trees. Among the order algorithms, the decision tree has accomplished promising outcomes contrasted with different calculations.

Radhika [3] presented a paper on support vector machines for climate forecast. Time arrangement information of every day greatest temperature at an area was dissected to anticipate the most extreme temperature of the following data at that area dependent on the day by day most extreme temperatures for a range of past n days alluded to as requested. Non straight relapse technique was utilized to prepare the SVM for this application.

Rao [5] presented a system for monitoring weather based on IoT. The system measured various parameters such as values, light intensity, and CO level.

Kumar and Jasuja [4] designed a new system based on IoT by using Raspberry Pi Card. The system aimed to evaluate air quality by measuring its paraments, such as temperature, monoxide and dioxide carbon and air pressure and humidity.

III. COMPONENTS USED IN THE PROJECT

A. ESP8266

The ESP8266 is a WIFI module with an IP/TCP protocol stack that is a complete or self-contained system on a chip (SOC). Through your WIFI connection, the ESP8266 provides you access to any microcontroller.

One of the most key features of the ESP8266 is its ability to host any application or offload all WIFI networking activities. It is extremely sturdy and can perform reliably even in the harshest industrial conditions. This is solely due to its wide operating temperature range. It also has a low-power architecture and a 32-bit Tensilica CPU. The ESP8266 Module has a lot of processing and storage power onboard, which makes it easy to interface with sensors and other applications. It features a high on-chip integration level. The on-chip integration requires extraordinarily little external reference on the circuitry.

For Bluetooth and VoIP application coexistence interfaces, the ESP8266 uses APSD. It also has a self-calibrated radio frequency (RF) that allows it to work in any operating state without the need for radio frequency parts.

B. DHT Sensor

The DHT11 is a low-cost digital sensor for measuring temperature and humidity. This sensor may be simply interfaced with any microcontroller, such as Arduino or ESP8266, to measure humidity and temperature in real time.

DHT11 humidity and temperature sensor is offered as a sensor and a module. The pull-up resistor and power-on LED distinguish this sensor from the module. DHT11 is a relative humidity sensor. This sensor employs a thermistor and a capacitive humidity sensor to measure the surrounding air.

C. Soil Moisture Sensor

One type of sensor used to measure the volumetric content of water in soil is the soil moisture sensor. As the straight gravimetric dimension of soil moisture must be eliminated, drying and sample weighing are required. These sensors estimate the volumetric water content indirectly, using soil rules like as dielectric constant, electrical resistance, otherwise interaction with neutrons, and moisture content replacement.

D. Single Channel Relay

A 5v relay is a type of automatic switch that is widely used in an automatic control circuit to control a high current with a low-current signal. The relay signal's input voltage varies from 0 to 5V.

E. OLED Display

OLED is an acronym that stands for Organic Light Emitting Diode. Because solid-state OLEDs are easier to manufacture, they are replacing CRTs or LED displays. They are light emitting thin-film organic semiconductor devices. It employs a thin layer of organic material placed between two electrodes, anode, and cathode.

F. ACS712 Current Sensor

A voltage drop occurs when current flows through a conductor. Ohm's law describes the relationship between current and voltage. An increase in the quantity of current above the device's demand causes overload and can destroy the equipment.

Current measurement is required for the proper operation of equipment. Voltage measurement It is a passive task that can be completed without influencing the system. In contrast, measuring current is an intrusive activity that cannot be observed directly as voltage.

IV. MAJOR MECHANISMS USED IN THE PROJECT

A. Internet of Things

The Internet of things (IoT) is a network that connects any object to the internet via an exchange protocol to send monitoring, administration, tracking, and identifying information amongst different smart devices. Over the last few years, it has become the subject of study in a variety of applications, allowing for the connection of a plethora of network-embedded devices used in daily life to the internet. IoT is also seen as revolutionary since it adds functionality to current network systems, allowing them to deliver solutions to time-critical applications in a variety of industries such as healthcare, manufacturing, logistics, military retail, and so on.

B. Cyber-Physical Systems

A Cyber-Physical System (CPS) is a system that efficiently integrates cyber and physical aspects. A perfect CPS would have a computing system, networking tools, and physical components like sensors. Controllers monitor the physical characteristics of a smart grid by connecting the sensors via a communications network; this allows them to keep track of the overall status of the smart grid and its operating conditions; the sensors communicate all necessary data to the controllers for action.

C. Cloud Computing

Cloud computing provides data storage and processing capabilities for applications and services via the internet. Cloud computing pools resources to avoid the need for specific physical systems and can enable higher levels of automation.

D. Infrastructure as a service (IaaS)

The most fundamental type of cloud computing services. IaaS allows you to rent IT infrastructure servers and virtual machines (VMs), storage, networks, and operating systems on a pay-as-you-go basis from a cloud provider.

E. Platform as a service (PaaS)

Cloud computing services that provide an on-demand environment for designing, testing, delivering, and maintaining software applications are referred to as platform as a service. PaaS is intended to make it easier for developers to construct web or mobile apps without having to worry about setting up or managing the underlying infrastructure of servers, storage, networks, and databases.

F. Software as a service (SaaS)

Software as a service (SaaS) is a technique of distributing software applications over the Internet on-demand and often through a subscription. Cloud providers host and maintain the software application and supporting infrastructure, as well as any maintenance, such as software upgrades and security patching, via SaaS. Users access the application over the Internet, typically through a web browser on their phone, tablet, or PC.

G. Machine Learning

Machine learning is a branch of research concerned with understanding and developing methods that 'learn,' that is, methods that use data to improve performance on a set of tasks. It is regarded as a component of artificial intelligence.

H. Support Vector Machine (SVM)

Support Vector Machines are supervised learning models with related learning algorithms that analyse data for classification and regression analysis in machine learning. The straight line required to match the data is referred to as a hyperplane in Support Vector Regression.
A support vector machine algorithm's goal is to find a hyperplane in an n-dimensional space that clearly classifies the input points. Support Vectors are the data points nearest to the hyperplane on either side of the hyperplane. These affect the position and direction of the hyperplane and so aid in the construction of the SVM.
Support Vector Regression (SVR) is a supervised learning approach for predicting discrete values. Support Vector Regression operates on the same principles as SVMs. SVR's primary concept is to identify the optimum fit line. The best fit line in SVR is the hyperplane with the greatest number of points.
Unlike other Regression models, which seek to minimise the difference between the true and projected values, the SVR seeks to fit the best line within a given range. The distance between the hyperplane and the boundary line is the threshold value. The fit time complexity of SVR is more than quadratic with the number of samples, making it difficult to scale to datasets with more than a few tens of thousands of samples.
Linear SVR or SGD Regressor is used for large datasets. Linear SVR is faster than SVR but just considers the linear kernel. Because the cost function skips sample whose prediction is close to their target, the model built by Support Vector Regression is only dependent on a fraction of the training data. Because the cost function for developing the model is unconcerned about training points that are beyond the margin, the model built by support-vector classification is solely dependent on a portion of the training data.

V. ARCHITECTURE OR DEPLOYMENT MODELS FOR IOT IN AGRICULTURE IRRIGATION SYSTEM

A remote monitoring system based on the Internet of Things uses a number of approaches for a variety of applications, resulting in a wide range of design and deployment patterns. When it comes to IoT architecture, there is no such thing as a one-size-fits-all solution. A three- or four-layer design is used to consolidate the Internet of Things architecture.
Three-Layer and Four-Layer Architectures
The common architecture is the three-layer architecture represented in Figure 1, comprising the physical, network and application layers

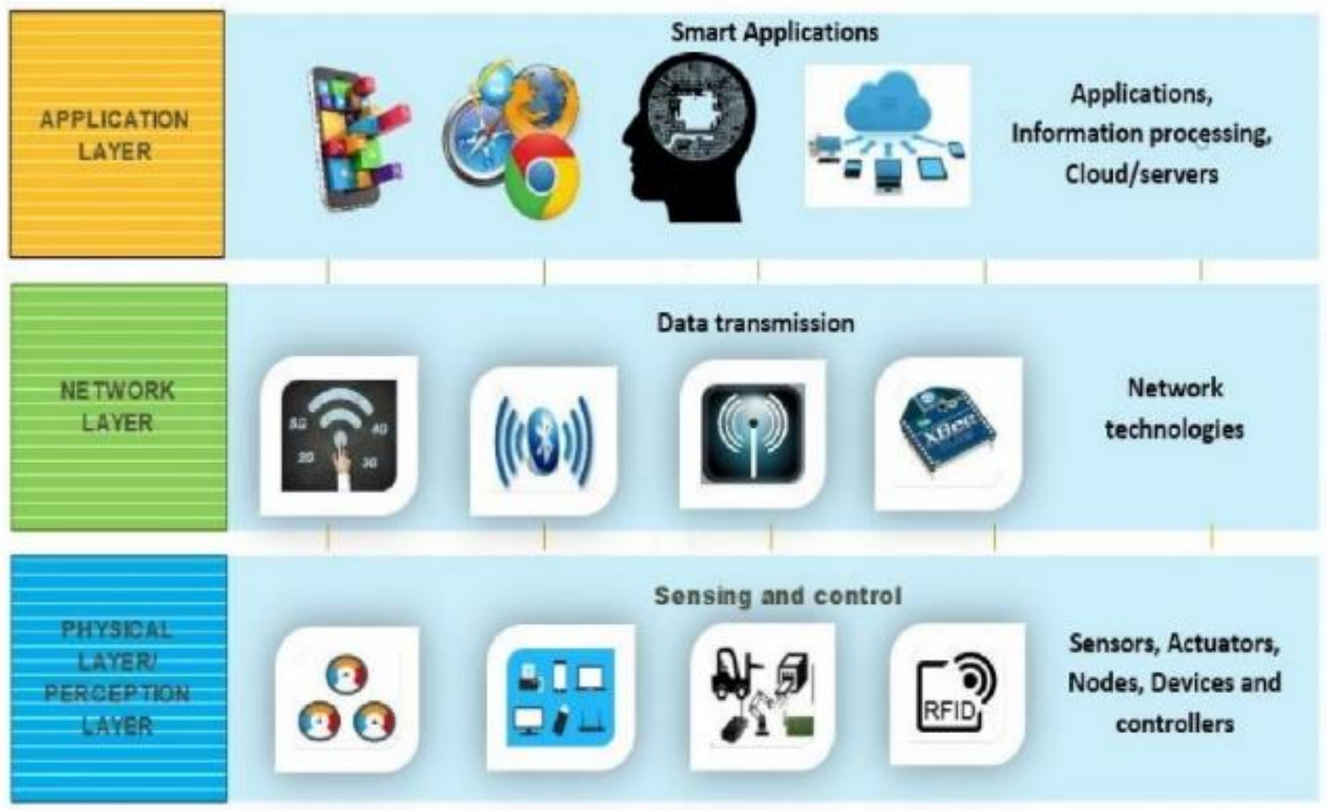

Figure. 1: Three Layer Architecture

The sensors and actuators are coupled to the sensor and actuator layer (physical layer), which allows sensing to acquire information from the environment and control the actuators.

In an IoT application, the network layer (data management layer) connects other devices, servers, and things. Because it combines several functions, such as data aggregation and pre-processing, this layer is sometimes referred to as the communication layer. The application layer provides end users with application-driven services or functions.

The service layer is added to the three-layer architecture in the four-layer design shown in Figure 2, and the service layer classifies the data for the application layer. Applications such as visualisation, security, storage, communication services, and analytics are used to classify the data. The service layer oversees creating and managing the services required by applications. It serves as a middleware for the application and network layers, and it oversees maintaining the services registry for service discovery, API, and service composition.

Figure. 2: Four-layer Architecture

VI. Working of the System

We employed a four-layer design for this project and flow of working is depicted in Figure 3. A website application is a software programme that performs specified functions using web-based technology. Web applications are hosted on remote web servers, which also store data from multiple linked machines. To work properly, a web app needs three things: a web server to receive client requests, an application server to execute the tasks requested, and a database to store the data. The frontend of the Web App used in this project is HTML, CSS, and JavaScript, and the server-side programming language PHP is used to manage HTTP requests from the user interface or the microcontroller ESP8266, and all data is saved in a SQL database.

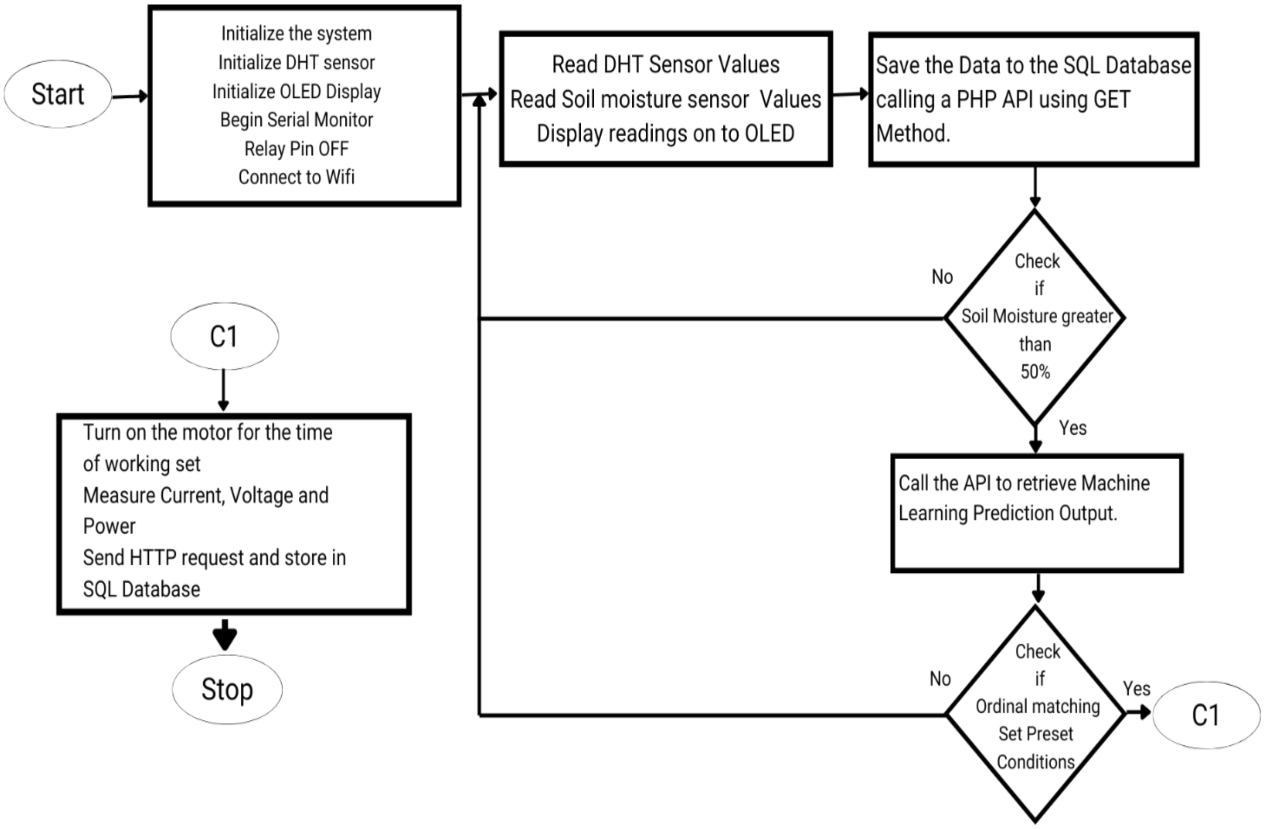

Figure. 3: Flow Diagram of Project

When the system is turned on for the first time. The Microcontroller is turned on, and the system is initialised, which includes the commencement of the serial monitor, which allows us to evaluate the system via a USB cable. After that, the DHT sensor is activated, the OLED display is set up, and the screen is cleared. The relay is turned on and off. The motor is linked in a typically open state according to the circuit. Finally, we link the system to the internet via WIFI.

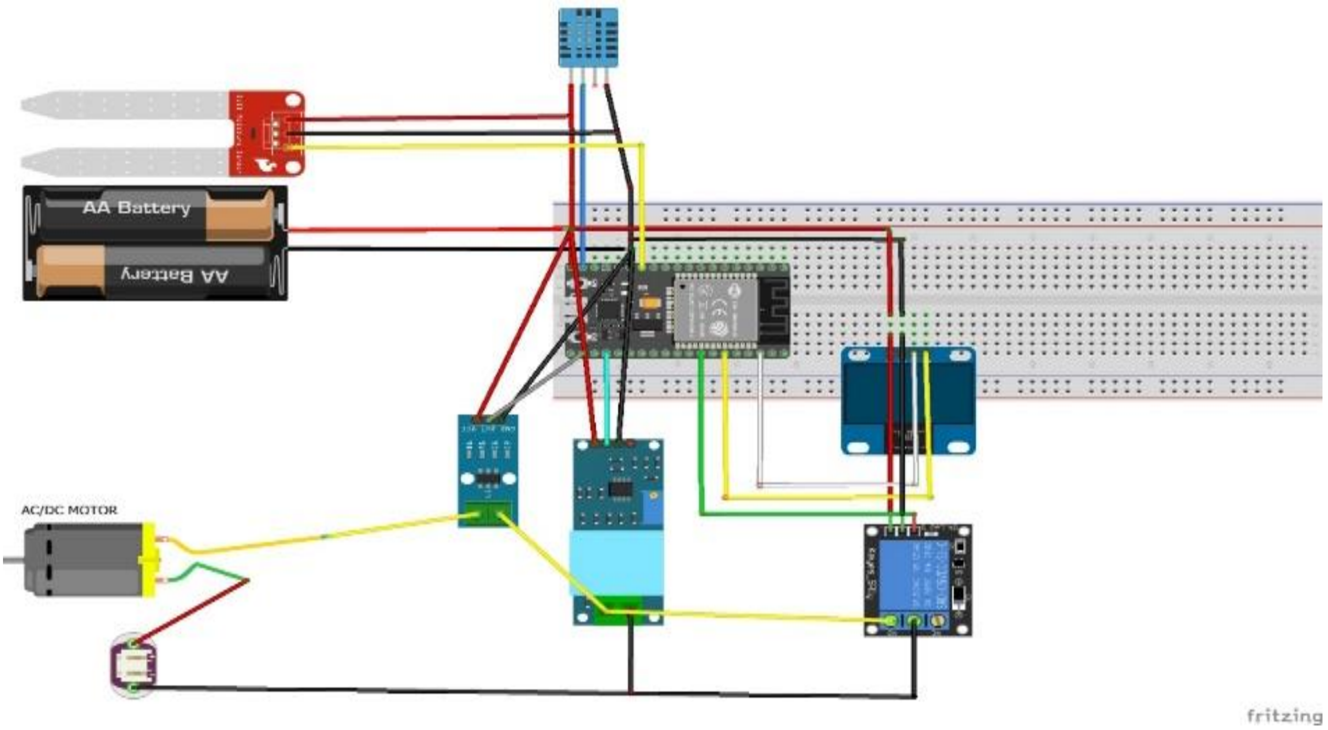

Figure. 4: Circuit Diagram

We come to read the DHT sensor and moisture sensor values and display temperature, humidity, and moisture value on the OLED display after connecting the system to WIFI. The data is then collected via the GET method and stored in a SQL database after calling an API. The next stage is to determine whether the moisture content in the soil is greater than 50% or not. If the moisture content is greater than 50%, we use an API to acquire the Machine Learning Prediction Output. The output, which includes the ordinal and the weather state, is then saved in a variable. Then, depending on the ordinal value that is matched against set predefined values, a function is ran that switch on the motor. The parameters such as current, voltage, and power are also measured and stored into the SQL Database and the circuit of the project is represented in Figure 4.

VII. RESULTS

The Support Vector Machine and Decision tree algorithms are used as learning algorithms in this project which gives outputs relating to weather condition, by taking the historical data related to the climate of a particular region. Support Vector algorithm is used to deliver the accurate weather description with an accuracy of 99% from our historical data and its implementation code is in [6]. Whereas the classification and regression tree (CART) or decision tree algorithm gives us binary output which relates to the rainfall with an accuracy of 97% from our historical data which is classified by decision tree. These algorithms drive the IOT system from the cloud server depending on the output that they produce.

VIII. CONCLUSION AND FUTURE SCOPE

The real time weather prediction system presented in this thesis has been developed around low cost IoT board and sensors. The temperature, moisture and humidity are the three important parameters that are monitored and uploaded on the cloud. The system has been deployed in an outdoor environment and values of the parameters have been recorded in a Database. A Support Vector Regression (SVR) model has been used in the cloud that is trained with pre-recorded values of parameters and used to predict the weather parameters in real time environment. Then the system analyses and predicts whether it will rain or not. The result of the model is also compared with the other works available in literature and the proposed system is slightly better in terms of accuracy. Further, the system can be modified to be used at commercial level and have many applications in smart homes, buildings, sports, hospitals etc.

As future work, we are paving the way towards scaling up our system by deploying our solution in several farms in the region, allowing our BDAP (Big Data Analytics Platform) to collect big real-time data about water-table usage in the region. Thus, appropriate irrigation strategies can be derived and analyzed. Besides, we plan further experimentation to enhance solar energy production and storage. We will also integrate LoRa wireless sensors/actuators network and develop a machine learning system that predicts soil moisture, energy production, and energy consumption within a few days. The machine learning algorithm can adapt to different crop requirements in moisture levels and improve crop yield. Secondly, we can add renewable power source such as solar panel so that where no electricity can reach the IoT system can work. Also, in case if the Wi-Fi aspect of the project does not work, we could use a backup system such as SMS feature can alert on your mobile about the system.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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