Weather Analyser and Soil Moisture Detection for Smart Irrigation

A COURSE PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report titled "**Weather Analyser and Soil Moisture Detection for Smart Irrigation**" is the bonafide work of **ANIK SAU (RA2011029010027)** and **ARNAV JHA (RA2011029010026)** who carried out the project work under my supervision.

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ABSTRACT

The scarcity of clean water resources around the globe has generated a need for their optimum utilization. Internet of Things (IoT) solutions, based on the application specific sensors' data acquisition and intelligent processing, are bridging the gaps between the cyber and physical worlds.

IOT based Weather Forecasting System and Soil Moisture Analyser for farmers aims to ensure higher productivity of crops using optimum water-resource utilization in the precision farming and lower the risk of weather hazards. This paper presents an open-source technology based smart system to predict the irrigation requirements of a field using the sensing of ground parameter like soil moisture, soil temperature, and environmental conditions along with the weather forecast data from the Internet. The intelligence of the proposed system is based on a smart algorithm, which considers sensed data along with the weather forecast parameters like precipitation, air temperature, humidity, and UV for the near future.

The complete system has been developed and deployed on a pilot scale, where the sensor node data is wirelessly collected using webservices and a web-based information visualization and decision support system provides the real-time information insights based on the analysis of sensors data and weather forecast data. The paper describes the system and discusses in detail the information processing results of three weeks data based on the proposed algorithm.

Keywords: Internet of Things (IoT), sensors, prediction algorithm, Irrigation Management, Precision agriculture.

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1.INTRODUCTION

In India, where 60-70% economy depends on agriculture, there is a great need to modernize the conventional agricultural practices for the better productivity. Due to unplanned use of water the ground water level is decreasing day by day, lack of rains and scarcity of land water also results in decrement in volume of water on earth.

Weather forecasting has been a standout amongst the most experimentally and technologically troublesome issues over the world in the most recent century. Environmental change has been looking for a great deal of consideration since a long time because of the sudden changes that happen. There are several limitations in better execution of weather forecasting thus it ends up hard predicting weather here and now with effectiveness.
The objective of the system includes conserve energy and water resources, handles the system manually and automatically, detects the level of water. Due to the climatic changes and lack of precision; agriculture has resulted in poor yield as compared to population growth.

This paper presents an intelligent system that predicts soil moisture based on the information collected from the sensors deployed at the field and the weather forecast information available on the Internet. The field data has been collected through a self-designed sensor node. The server-side software has been developed with node side connectivity along with information visualization and decision support features.

A novel algorithm has been developed for soil-moisture prediction, which is based on Machine Learning techniques applied on the sensor node data and the weather forecast data. The algorithm shows improved accuracy and less error. The proposed approach could help in making effective irrigation decisions with optimum water usage. It exhibits a classifier approach utilizing Naive Bayes and Chi Square strategy for weather forecasting. In this system, state of weather is classified in some attribute like as Outlook, Temperature, Humidity, and Wind. Using those attributes, the system will predict the class label as Weather Forecasting (Good/Bad). In the system two basic functions namely classification (training) and prediction (testing) will be performed.

2. LITERATURE SURVEY

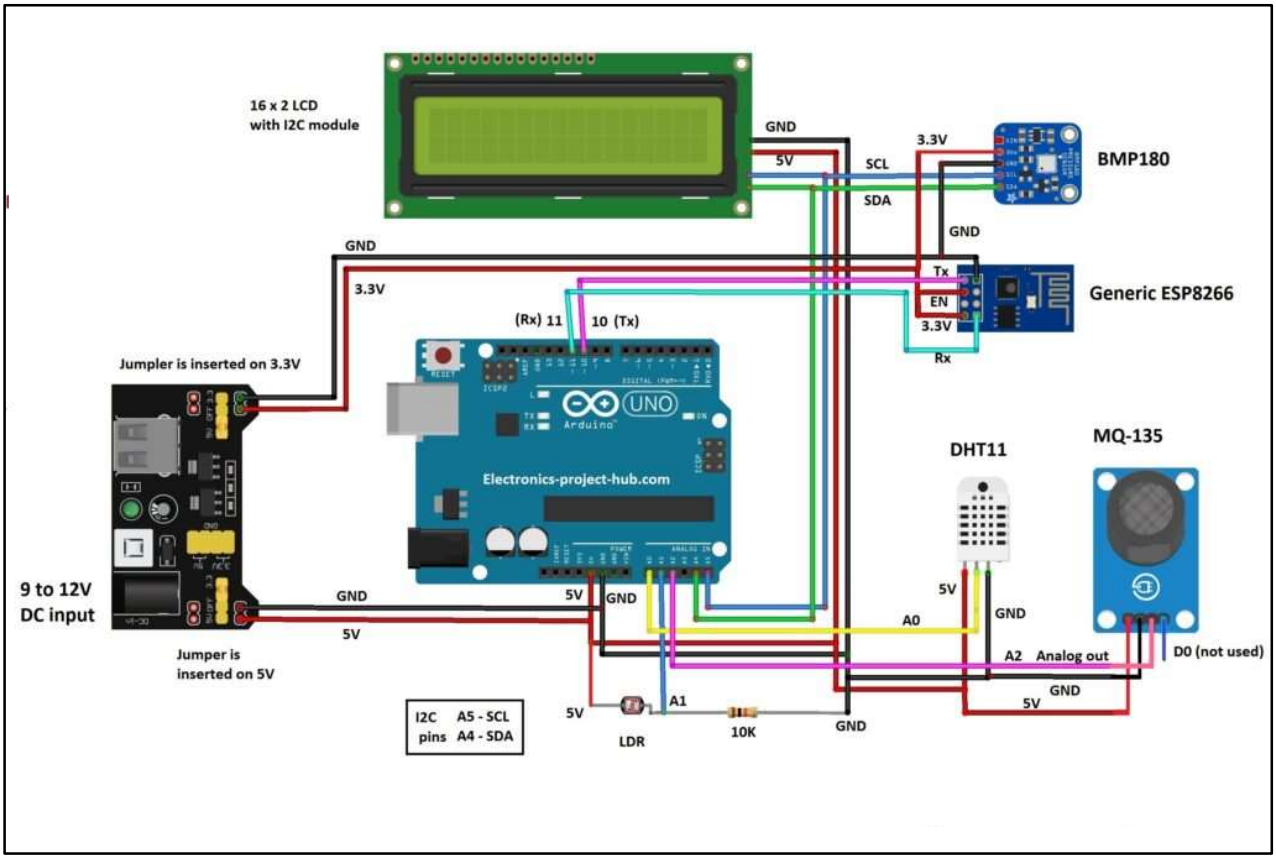
The following table acknowledges the Papers studied and the inferences obtained.

Sl. No.	Paper Name	Month & Year of Publication	Authors	Inference
1	IoT-based data logger for weather monitoring using Arduino-based Wireless Sensor Networks with remote graphical and application alerts	January, 2021	Jamal Mabrouki, Mourade Azrour, Driss Dhiba, Yousef Farhaoui, Souad El Hajjaji	This Journal provides insights on automatic weather monitoring system that allows having dynamic and real-time climate data of a given area, which is the backbone of this project. With the provided statistical data, we sensed the need for monitoring and prediction of soil texture and moisture index along with the changes within the climate parameters.
2	Weather Radar and Rain-Gauge Data Fusion for Quantitative Precipitation Estimation: Two Case Studies	March, 2020	Fabrizio Cuccoli, Luca Facheris, Andrea Antonini, Samantha Melani, Luca Baldini	An early warning of severe rainfall through a timely and accurate estimation is crucial for reducing the hydrological risk. Moreover, the rain-gauge networks are often not able to detect rainfall due to their limited sampling capability.

3	Automatic Weather Monitoring Analysis for Renewable Energy System	July, 2020	U. Ramani, R. Nithya, S. Sathieshkumar, T. Santhoshkumar	After analysing the paper, we inferred about the sustainable availability of a weather monitoring systems for our farmers without the hassle of complex processing units.
4	IoT Based Air Quality and Weather Monitoring System with Android Application	February, 2022	Ashfaqul Haq, Sayed Sahriar Hasan, Md. Zillur Rahman, Dipesh Das, Ata Ullah	In today's world, weather and climate conditions have become unpredictable, which can lead to the destruction of agricultural productivity. There is an urgent need for a real-time local weather station that can keep farmers informed of current weather conditions and to quantify harmful substances in air particles.
5	Weather Monitoring System AIoT Based for Oil Palm Plantation Using Recurrent Neural Network Algorithm	November, 2021	Prasetyo Mimboro, Ford Lumban Gaol, Harco Lesie Hendric Spits Warnars, Banefano Soewito	The purpose of this research is to develop an IoT device with an artificial neural network algorithm embedded in the device to predict weather conditions in real-time. This delineates the description of the IoT system using the Recurrent Neural Network (RNN) algorithm and provides with the real time statistics for a particular crop type.

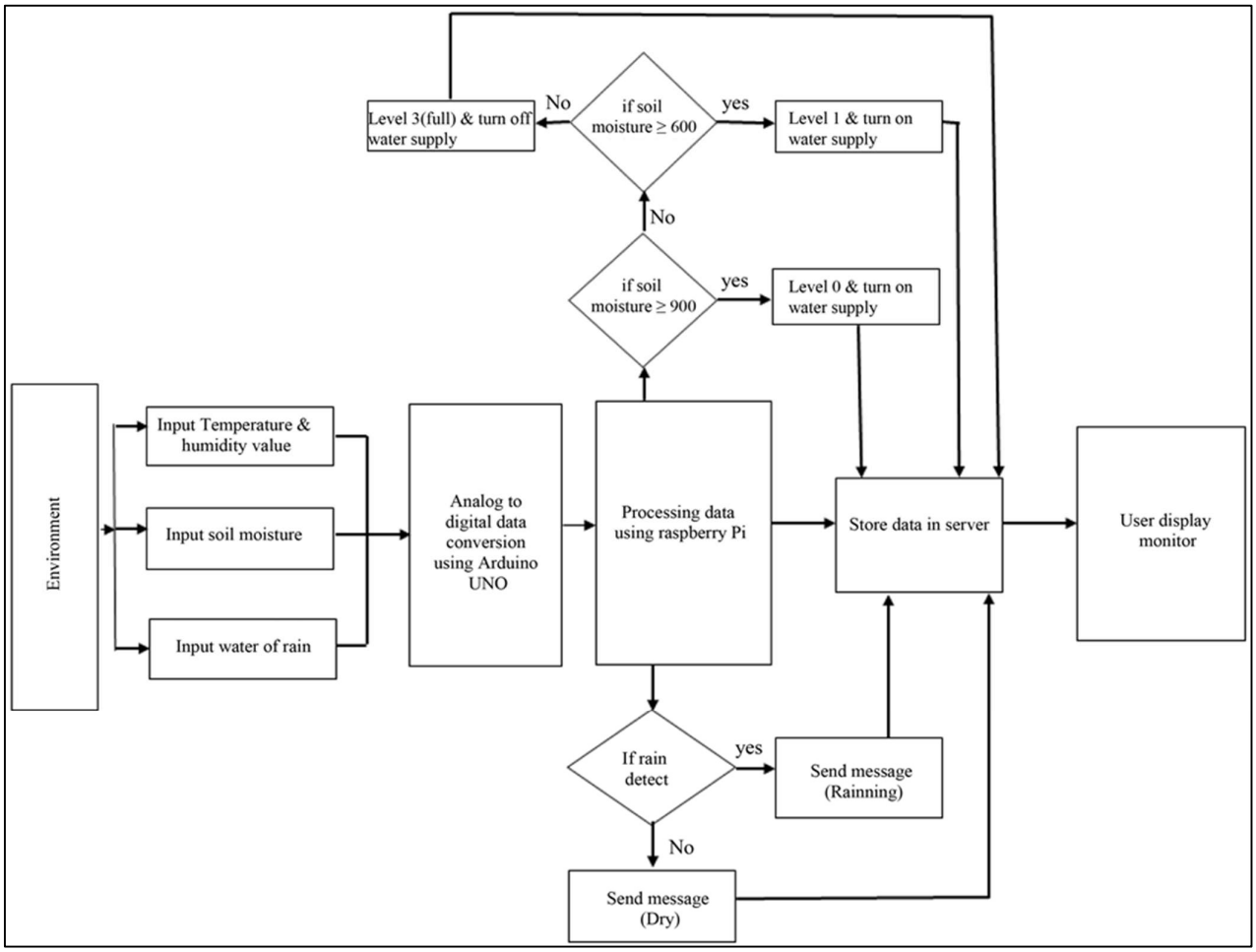
3. INNOVATIVE IDEA

All the above-mentioned Papers refer either towards monitoring the weather and inferencing the physical parameters from the collected data. Our aim is to infuse the above-mentioned technology in order to generate a ranking matrix or a notational grid, which simplifies the weather data for the regional farmers. Moreover, with the help of Integrated Forecasting System (IFS) and the data assimilation through satellites systems, Soil Moisture and Ocean Salinity (SMOS) data can be procured to notify the farmers regarding the soil moisture and air temperature forecast in the short range at regional scale.

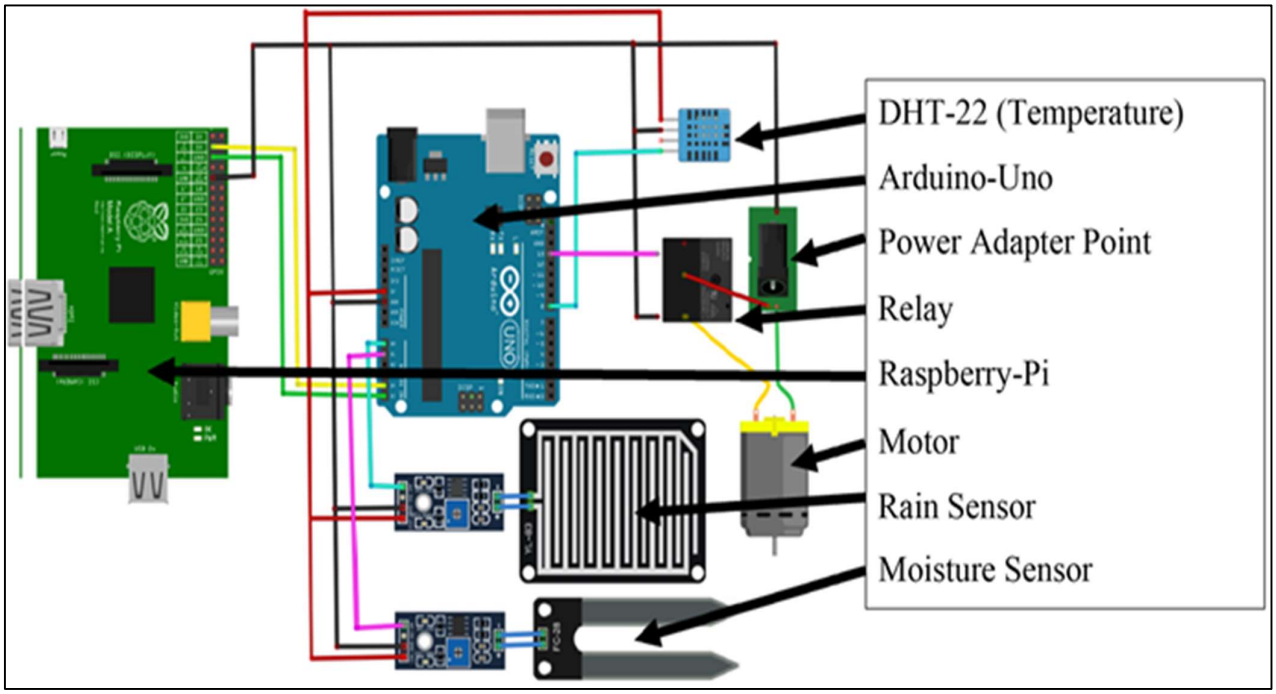


4. ARCHITECTURE

Irrigation can be automated by using sensors, microcontroller, Wi-Fi module, android application. The low-cost soil moisture sensor continuously monitors the field. The sensors are connected to Arduino board. The sensor data obtained are transmitted through wireless transmission and are reached to the user so that he can control irrigation. The mobile application can be designed in such a way to analyse the data received and to check with the threshold values of moisture, humidity and temperature. If soil moisture is less than the threshold value the motor is switched ON and if the soil moisture exceeds the threshold value the motor is switched OFF. The user can schedule the irrigation at a specified threshold value of soil moisture. The system guides to maintain the threshold value based on the predicted pattern of soil moisture and precipitation information. Once the enough water is delivered, the pump stops doing its work. Power supply has a task to power the complete system and the recommended voltage should respect the input supply range for the microcontroller, that is, from 7V to 12V.



4.1 System Design



4.2 Hardware Setup

Tools

Following is a list of different tools of proposed project.

1) Raspberry Pi 3B

2) Arduino UNO

3) Temperature & Humidity sensor (DHT-22)

4) Soil moisture sensor

5) Raid detector sensor

6) Motor

7) Router

Software Requirements

1) IDLE (python 2.6.)

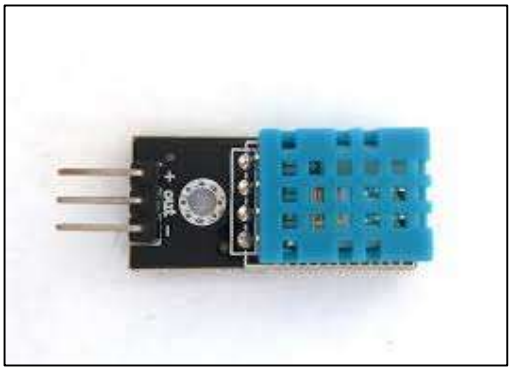
2) Sqlite3

5. WORKING

5.1 SENSORS

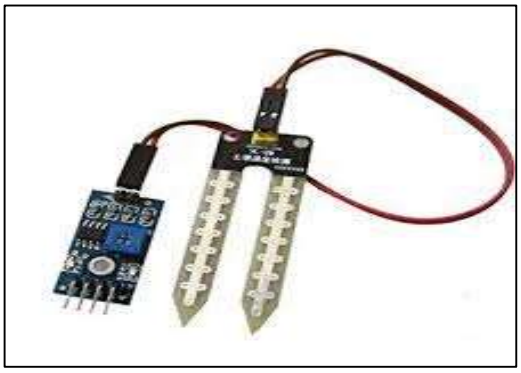
DHT11

1. The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy.
2. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz .i.e. it gives one reading for every second.
3. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA.



FC-28

1. FC-28 soil moisture sensor is a soil hygrometric transducer that can read the amount of moisture present in the soil surrounding it.
2. The module uses the two probes to pass current through the soil, and then it reads that resistance to get the moisture level.



BMP 180

1. This precision sensor from Bosch is the best low-cost sensing solution for measuring barometric pressure and temperature.
2. The sensor is soldered onto a PCB with a 3.3V regulator, I2C level shifter and pull-up resistors on the I2C pins.

5.2 ALGORITHMS

In this work, data classification is performed using two data mining technique: Chi square test and Naive Bays Statistics. The data which have to be classified is called training dataset, is fixed. By using this data with testing data, Weather Forecast will be possible. The algorithm of chi square and naïve bays finds relationships between the values of the predictors and the values of the target. The model learns from the training set and that knowledge is used as test data to predict in the scorings.

- **Chi Square Algorithm**

Chi Square Algorithm is a predictive technique used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories. The Equation is as follows:

$$\chi^2 = \sum(O_i - E_i)^2/E_i,$$

where O_i = observed value (actual value) and E_i = expected value.

In our project we use chi square statistic to determine the best attribute of weather forecast.

- **Naïve Bayes Algorithm**

Naïve Bayes Algorithm is a classification technique based on Bayes Theorem. Naïve Bayes is easy to build and very much useful for large datasets. By using the Naïve Bayes equation, we can find the future probability. The Equation is as follows:

where, (c|x) is future probability of class (c, target), P(c) is the prior probability of the class, P(x|c) is the likelihood which is the probability of predictor given class, P(x) is the prior probability of predictor.

The condition of predicting weather of our project is as follows:

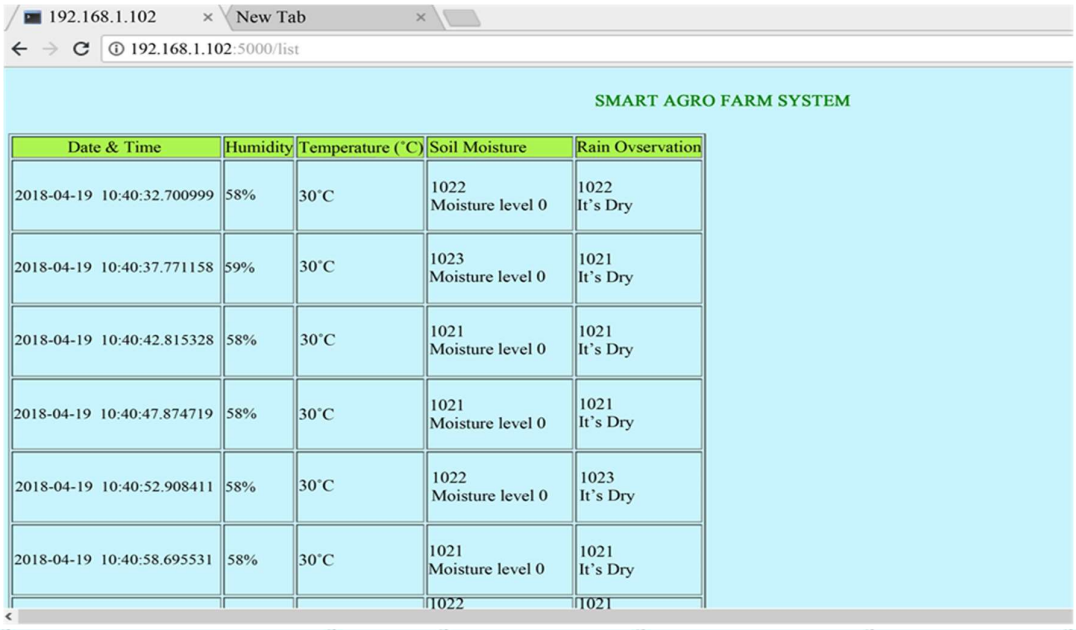
Class:

C1: Weather Forecasting = ‘Good’,

C2: Weather Forecasting = ‘Bad’.

6. OUTPUT AND RESULTS

In this result, local server shown a smart agriculture farm weather monitoring system in 10 second time interval. It showed four parameters, humidity, temperature, soil moisture, rain detection.



Date & Time	Humidity	Temperature (°C)	Soil Moisture	Rain Ovservation
2018-04-19 10:40:32.700999	58%	30°C	1022 Moisture level 0	1022 It's Dry
2018-04-19 10:40:37.771158	59%	30°C	1023 Moisture level 0	1021 It's Dry
2018-04-19 10:40:42.815328	58%	30°C	1021 Moisture level 0	1021 It's Dry
2018-04-19 10:40:47.874719	58%	30°C	1021 Moisture level 0	1021 It's Dry
2018-04-19 10:40:52.908411	58%	30°C	1022 Moisture level 0	1023 It's Dry
2018-04-19 10:40:58.695531	58%	30°C	1021 Moisture level 0	1021 It's Dry
			1022	1021

2018-05-13 18:09:54.885827	60%	30°C	1003 Moisture level 0	247 It's Rainning
2018-05-13 18:10:04.957241	60%	30°C	1008 Moisture level 0	483 It's Rainning
2018-05-13 18:10:15.616399	60%	30°C	1001 Moisture level 0	505 It's Rainning
2018-05-13 18:10:25.687110	60%	30°C	999 Moisture level 1	424 It's Rainning
2018-05-13 18:10:35.754428	60%	31°C	988 Moisture level 1	234 It's Rainning
2018-05-13 18:10:45.832260	60%	31°C	347 Moisture level is Full	181 It's Dry
2018-05-13 18:10:55.916154	60%	31°C	310 Moisture level is Full	242 It's Rainning
2018-05-13 18:11:06.006169	60%	30°C	320 Moisture level is Full	226 It's Rainning

CONCLUSION

The soil moisture is a critical parameter for developing a smart irrigation system. The soil moisture is affected by a number of environ- mental variables, e.g., air temperature, air humidity, UV, soil temperature, etc. With advancement in technologies, the weather forecasting accuracy has improved significantly and the weather fore- casted data can be used for prediction of changes in the soil moisture. This paper proposes an IoT based smart irrigation architecture along with a hybrid machine learning based approach to predict the soil moisture. The proposed algorithm uses sensors' data of recent past and the weather forecasted data for prediction of soil moisture of upcoming days. The predicted value of the soil moisture is better in terms of their accuracy and error rate. Further, the prediction approach is integrated into a standalone system prototype. The system prototype is cost effective, as it is based on the open standard technologies. The auto mode makes it a smart system and it can be further customized for application specific scenarios. In future, we are planning to conduct a water saving analysis based on proposed algorithm with multiple nodes along with minimizing the system cost.

FUTURE SCOPE

The machine learning requires a mass data so our recorded meteorological data helps a lot in improving the performance. The future work is to incorporate more attribute of weather condition to predict and to work with other classification algorithms. The region or area wise prediction can be done for giving more accurate farming suggestions of which crop can be grown by analysing the data based on the soil and weather conditions.

This paper can further be industrialized with camera feeds for checking the discoloration of leaves or plants and accordingly send the results to control the disease from anywhere. The field area can be protected from the trespassers by the deployment of AI and surveillance.

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