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Multidisciplinary Real-Time Model for Smart Agriculture using Internet of Things

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Abstract-

IoT is a network or a web of physical objects that contain an embedded technology for sensing and interacting with surroundings. It plays a prominent role in almost every sector, like retail, education, manufacturing, safety, and security. One of the best applications is in the field of agriculture, which the authors will propose in this research work. It will help in optimizing the production by analyzing and monitoring various data produced by the sensors. Here IoT will run parallel with other technology like Cloud, Big data, data analytics, and wireless sensor network. The combination of these technologies will result in precision farming. It will lead to the most significant contribution to the agriculture IoT market during the time of forecasting. The model will help us to analyze the information related to weather conditions like temperature, humidity, rain, and many more. Based on this information farmer will take action accordingly. Some time due to climate change and lack of information available may all result in reduced productivity. The authors propose a real-time model that will enhance the productivity level, cost, and efficiency.

1. Introduction

IoT is an emerging technology that seems like a blessing for the 21st century. It interconnects all the objects inside a system. The authors have explained how IoT linked with other technologies like Machine Learning, Cloud Computing, and Big Data. All these technologies play a significant role in designing the IoT based model. Cloud helps to store data and other useful information generated by sensors like temperature, humidity, pH, etc. Big data and Machine Learning used in the context of IoT to improve data storage efficiency. Due to an increase in the number of connected devices and data consumption, the role of other technologies like big data

and machine learning, are being used with IoT to overcome from this problem. They overlap with IoT to provide better network performance, improves data storage efficiency, provide data processing for a broad set of data, and high-level system security. One can't imagine a single automated system without the help of IoT. The application of IoT is vast enough in almost every field. Some of its use in various sectors like the retail sector, agriculture sector, health and monitoring sector, defense sector, education sector, etc. shows its diversified nature in the current world. In this paper, the authors show how IoT and its devices are useful in the agriculture sector to ease the agricultural system of a society or a country.

1.1. Overview and Motivation

In this paper, the authors have proposed a multidisciplinary real-time model for smart agriculture. Through this model, the farmer has ease of information access related to agriculture. The model is bright, as everything in this model will be automated. The farmers and vendors will get all the necessary information related to their crops. Through this model, farmers will monitor the temperature, humidity, moisture level, pH value, and water level through various sensors like a rain sensor, temperature sensor, water level sensor, soil moisture, and humidity sensor. Based on this information, one can quickly know the number of fertilizers, water usage, and a fixed time to plant and cultivate the crops. This information generated by various sensors sends from the base station to the cloud, which will store data, and accordingly, the data will reach the farmer through an android application. It will be a real-time monitoring system, which will give the status of the farm on developing an android based application.

Agriculture plays a vital role in any country; in a country like India, agriculture is one of the largest sources of economy. The government of India is working well in the field of agriculture by providing useful information through television channels like Krishi Vigyan on door darshan and many other valuable advertisements. When technology has slightly improved, they have taken some other initiatives like solving their queries online through instant messaging, but these are only static improvement.

1.2. Objective

The main objective is to design a multidisciplinary model for smart agriculture-based systems with the help of technologies like IoT, sensors, big data, cloud computing, etc. Through this model, the farmer will get every relevant information related to agriculture. The work is completely a real-time system which tells the exact status of the farm. The usage of new

technology will increase the production level and will keep agriculture cost low.

1.3. Scope

The scope of the proposed work completed within agriculture. Through this research work, by sensing the pH value, one can quickly know the amount of fertilizer and which fertilizers to use. The model is such that one can easily access the information within or outside the field. These all are possible by making an application which could help people in the rural and urban area both.

2. Related Work

In this digital era, IoT plays a significant role in every organization as well as country development, and agriculture is one of the fields in which most of the things automated through IoT devices. The main reason is to deploy the IoT sensing devices in the agriculture field to get accurate data of weather as well as the health of plants so that according to the weather, we can fulfill the requirements. Some multiple things that have already done in the agriculture field with the help of IoT devices.

IoT is used in agriculture here. It will help the farmer to get all the information through an application. This project uses various technologies like cloud computing, big data, sensors, etc. The paper aimed to increase production. The author has explained how IoT uses the cloud to store information generated by the sensors. [1]

The information generated by sensors like humidity, temperature, moisture, water level, etc. will be stored at the cloud, making a cost-effective way of farming.

The use of new technologies to enhance crop productivity shown in [2]. The use of new technologies will be helpful to process and analyze the data. To store information related to soil, the authors are using the Blynk app. The information it will save will be its humidity, moisture, etc. Its uses are shown in [3]. The overlapping of IoT with other technologies in [4] shows how big data, mobile computing, sensors, cloud computing used for a different purpose. They are used for pre-processing and analyzing data. This will reduce the computation cost and will make the model efficient. Connection to the internet is a significant issue in IoT. The association of IoT devices through the internet is here a wireless connection that is based on some standards, norms, and protocols shown in [5]. The model includes different modules used that are Sensor Module, App Module, Cloud Module, Big data and Analysis Module, etc. The Usage and working of the various modules are explained in [6, 7]. These are the module which makes the project complete. Here sensor module manages the entire task related to sensors. The app module provides ease of information access to farmers. Cloud module is used for data storage

and big data analysis module used for data analysis. IoT devices constitute of various components and interfaces. The interfaces are for sensors, connected to the internet, memory storage, and audio/video. These are explained in [8, 9]. The usage of other technologies with IoT like Cloud Computing, Big Data, Communication Protocols, and other useful embedded system is shown in [10, 11]. The challenges in technology implementation during the phase of developing IoT system are shown in [12, 13]. The components and modules like Arduino Uno, Sensors, Wifi modules, battery, etc. with full circuit diagram and the working principle is shown in [14].

3. Proposed Model

Multidisciplinary Real-Time Model for Smart Agriculture based on Weather forecasting, using IoT is a smart farming based work which helps the farmer or agriculture industry to automate the farming system using IoT. So that based on the captured data through a weather station, we can provide the optimal solution to the farmer to take care of their crops and plants. This proposed work also provides the visual data related to weather like temperature, humidity, and air quality index as well as the entire statistic related to the plants like soil moisture, water level, etc. In this work, the author proposed an algorithm so that we can capture data related to weather as well as agriculture using IoT sensing devices and show the data on ThinkSpeak cloud for further analysis.

Figure 1 consists of different modules that help us to fetch the data from sensors and send them to the ThinkSpeak to analyze further.

i) Wi-Fi Module
ii) DHT-11 Sensor
a) Temperature
b) Humidity
iii) Rain Sensor
iv) Soil Moisture Sensor

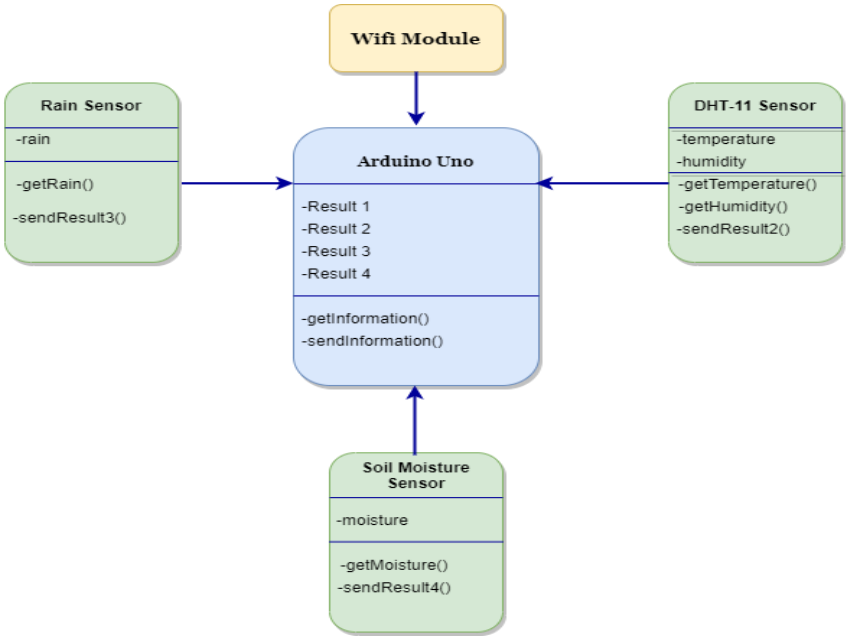

Figure 1. Shows the connection of IoT Components

Figure 1 represents the connections of different IoT components (Rain sensor, DHT-11 sensor, and Soil Moisture Sensor) with the embedded device and collectively gathering and sending data to the cloud in real-time by ESP8266 wifi module. Data collected through various sensors can be send to Arduino by calling getRain(), getHumidity() and getMoisture() from their respective sensors. The data collected in real-time will be shown to serial-monitor as Result 1, Result 2, Result 3, Result 4 by calling sendResult1(), sendResult2() and sendResult3(). The resultant data will be substituted or added to the cloud by send Information() and to fetch data from the cloud getInformation() function will be utilized.

3.1. Proposed Algorithm

Weather Forecasting:

1. Procedure Weather_forecasting (dht_data, rain_data)
2. System Initialization
3. Setup ThinkSpeak cloud to get data
   i) Initialize apiKey = “”
   ii) Initialize ssid and password
4. Let dht_temp = t, dht_humidity = h and rain_sensor = r
5. Read the value from sensor through Arduino

6. Call getTemperature() and getHumidity()
7. Store temperature in t and humidity in h
8. Get rain sensor data through getRain()
9. Send results of sensors sendResult1(), sendResult2() and sendResult3() to Arduino Uno
10. Arduino getInformation() and sendInformation() to ThinkSpeak Cloud

Smart Agriculture:

1. Procedure Agriculture (getTemp, getHumidity, getRain, moisture, motor)

2. System Initialization
3. Setup ThinkSpeak cloud to get data

iii) Initialize apiKey = “”

iv) Initialize ssid and password

4. Let moisture = m and getRain data from Weather forecasting module
5. Read the value from sensor through Arduino that is getMoisture()
6. If Moisture < = defined value

Then: Water_Motor = High

Else:

Water_Motor = Low

7. If Rain_Water_Level >= defined level

Then: Servo motor = rotate (90 deg)

Else:

Servo motor = set (0 deg)

8. Send the moisture data sendResult4() to ThinkSpeak Cloud
9. Store temperature, humidity, rain and moisture data into .csv file
10. Get Result in graph form

4. Simulation and Result Analysis

Human evolution begins when they understand the importance of resources and how to utilize it. The critical factor in human development is the cultivation of plants by various

tools and technology, which is termed as Agriculture. A major trend in technology is IoT, which benefits society in multiple ways and also helps in building a smart agriculture system. Proposed model includes Temperature, humidity, rain, water level, Air quality and soil moisture sensor along with ESP8266 Wi-Fi module and all of it are connected with Arduino Uno which collects physical quantities like temperature, humidity, level of water, quality of air in ppm and moisture level inside soil and sends this information to database located at cloud on which some machine learning algorithm are applied to forecast weather according to which all the necessity of crop are satisfied. The data collected from sensors in real-time are sending to Android application on which user can manage and monitor these data from anywhere. User can also watch real time analytics of sensor data.

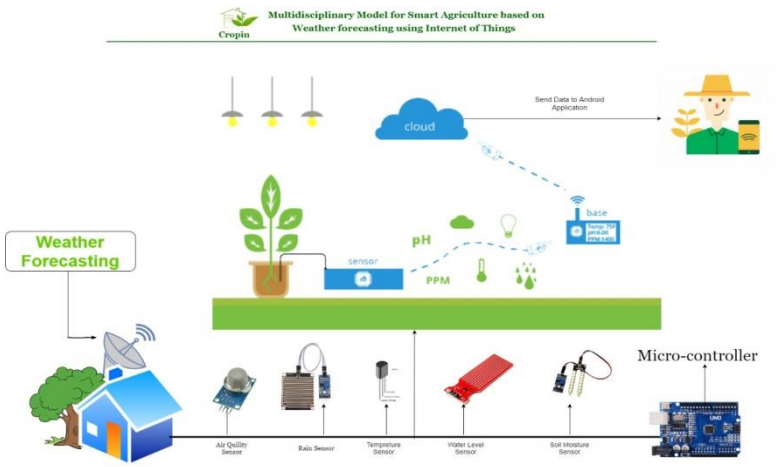

Figure 2. Shows the working process of model

After getting data from IoT sensing devices and by using Wi-Fi module we send the data to ThinkSpeak cloud which shows by the different graphs.

Figure 3. Shows the different result

After setup ThinkSpeak cloud the final step involves gathering of various sensors data and sending all these data to ThinkSpeak cloud by the help of the ESP8266 module and this platform provides real-time analytics of these sensor data as shown in Field chart 1, Field chart 2 and Field chart 3. Field chart 1 shows the fluctuation of Moisture data obtained from the Moisture sensor in real-time and measured for 1 hour. Field chart 2 shows the change in Humidity data obtained from Humidity and Temperature sensor in real-time measured for 1 hour. Field chart 3 shows the change in Temperature data provided by Humidity and Temperature sensor in real-time measured for 1 hour. The data obtained during this interval will be utilized to forecast the weather and fulfill the requirements as necessary.

4. Conclusion and Future Direction

In this paper, the authors proposed a model named a multidisciplinary approach for smart agriculture based on the weather using IoT devices. Through this module, the farmer will get all information related to agriculture, like compared to crops and plants. It will provide ease of access information to farmers. The farmers will accordingly manage their crops by knowing the weather and climatic condition through the website or mobile application. The information generated by the app will be temperature, moisture, humidity, water level, etc. This will help them to make their production effective and increase their production.

Smart farming is an emerging concept which refers to managing agricultural farms to increase the quantity and quality products while

optimizing the human labor required. This Smart Agriculture model will help to track the progress of crops and plants. In the future, we can add more sensors according to our needs, like motion sensors for monitoring the movement of animals. The authors can also add some other technologies to train our model effectively.

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