An Automated Optimize Utilization of Water and Crop Monitoring in Agriculture Using IoT

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Abstract. AI Solution for Farmers is an agricultural based project, created to help farmers and to help them in increasing their productivity. Since the technologies are running the world, why agriculture must be deprived of it. Agriculture is one of the most important areas that have major impacts on the economy and society of a country. Technological developments serve as tools to share knowledge and practices of agricultural products and make more satisfactory lives for farmers, traders, policymakers, and the overall society. It is evident that knowledge has become a crucial component in production, society, food security, health, poverty, and other millennium development goals. The use of technology may provide a better approach to solve the problems arising from sowing the seed to harvest the crop. The new technologies like Machine Learning and Data Science may be great help to have an eye on the deciding factors to the growth of crop.

Keywords: IoT, Sensors, Raspberry-PI, Microcontroller, Wi-Fi.

1. Introduction

An intelligent system to utilize internet of things (IoT) to monitor a plurality of crops in an agriculture field and further enables a farmer to manage the crops and the agriculture field in real-time is provided substantially, as shown in and/or described in connection with at least one of the figures, as set forth more completely in the claims.

The intelligent system comprises a plurality of sensor units, a wireless unit, a server unit, a database, a computing device, a software application, a water motor and water management unit, a buzzer unit, a CCTV camera, an unmanned-aircraft vehicle system (UAVs), and a pesticides control unit and crop quality unit [1]. The plurality of sensor units are configured with the crops to periodically detect a plurality of parameters pertaining to the crops and the agriculture field. The plurality of parameters include but not limited to temperature and humidity around the agriculture field, an obstacle in the agriculture field, soil condition and a plurality of predefined vibrations frequencies.

In an aspect, the plurality of sensor units comprises a DHT temperature and humidity sensor, an ultrasonic sensor, a soil moisture and humidity sensor, and a fence sensor [2]. The DHT temperature and humidity sensor detects the temperature and humidity around the agriculture field. The ultrasonic sensor detects the obstacle in the agriculture field to provide security to the agriculture field and further detects the water level in a tank placed in the agriculture field.

The soil moisture and humidity sensor detects the soil condition. The soil moisture and humidity sensor is configured with a water motor and water management unit to initiate a command to supply water. The fence sensor detects a plurality of predefined vibrations frequencies generated by the movement of an animal or a human, cutting, climbing or lifting around a fence of the agricultural field to protect the agricultural field and further transmits a notification signal to the computing device of the farmer [3].

The wireless unit is configured with the sensor units to transmit the detected data to a remotely placed server unit via a communication network. The server unit is configured with a database to store the detected data. The computing device connected to the server unit to receive the detected data from the server unit [4]. The software application is integrated with the computing device to provide a plurality of indicators pertaining to crops and weather forecast to manage the agriculture.

The buzzer unit is configured with the fence sensor to generate an audio signal on detection of the vibrations to alert the farmer. The CCTV camera and an unmanned-aircraft vehicle system (UAVs) for continuously monitoring the agriculture field and transmitting the monitored to the computing device of the farmer via the server unit. The pesticides control unit and crop quality unit provides a predefined ratio of pesticides to prevent the crops from insects. The software application [5] provides the detected data in an analog form and enables the farmer to check the quality of their corps.

In an aspect, the water motor and water management unit automatically supplies water to the soil on receiving a wireless command from the computing device of the farmer. The ultrasonic sensor monitors and controls the water level in a water for pouring the water onto the soil when required [6].

2. Literature Review

This monitoring systems can be classified according to the environment that is used for, such as industrial, home, office, agriculture and others environment. In literature system, this smart agriculture monitoring system project will be discussed among the previous research of a project [7]. Selected publications will be a guide for reference in this literature review. The table below shows the developed system's critical review. These projects have successfully come on board because they target a specific location only. This smart agriculture monitoring system is inexpensive and efficient project. It is better than the hazardous traditional methods.

Table 1. Critical Survey on Development System

S. No.	Functionality	[1]	[2]	[3]	[4]	[5]
1.	User Friendly	Yes	Yes	Yes	Yes	Yes
2.	Low Cost	Yes	Yes	No	No	No
3.	Application [Mobility]	Yes	Yes	WSN	WSN	Sensor
4.	Power	Yes	LOW	Low	Low	Low

5.	Employ	Home Control	Agriculture Industry	Agriculture Industry	Agriculture Industry	Agriculture Industry
6.	User Interface	Yes	-	Yes	Yes	Yes
7.	Security	Yes	-	Yes	Yes	-
8.	Load Limit [web server]	Yes	Yes	Yes	Yes	No
9.	Simplicity	Yes	-	No	No	Yes
10.	Flexibility	Yes	Yes	Yes	Yes	Yes
11.	Community	Yes	Yes	Yes	Yes	No
12.	Freedom	Yes	Yes	Yes	Yes	Yes
13	Easy installation & Upgrade	Yes	Yes	No	Yes	Yes
14	Display control	Yes	-	Yes	Yes	Yes
15	Configure Website	Yes	Yes	Yes	Yes	No

3. Proposed Methodology

Recent time farmers have used irrigation technique in which the farmer manually switch the on and off the water-pump according to the need. Besides indicating power points, the ballasts do not indicate on the load, thereby farmers cannot know the power point is low [8, 9]. If they switch OFF any motor, the sudden slowdown of armature circuit. They may have to travel too far to plug and unplug the unit from electricity. They may be experiencing the heat, rain and at night too. Upon reaching the farm, they found out that there is no power and they sighed in disappointment.

3.1 Working of Proposed Model

- Our model is responsible for obtaining data regarding the location, time and weather conditions (most prominently rain) and automate the working of irrigation system according to the moisture content of the soil at required intervals in a day.
- The model facilitates agility while working with varied soil types, crop variants in different weather conditions and seasons [10].
- All of this is done while keeping in mind its feasibility to farmers even in the remote areas.
- Our smart controller enables users to control and monitor their home's irrigation through mobile smartphone. Thee data collected by sensors is sent to the database created on the cloud for further processing and future weather condition prediction purposes.

In the app farmer have to login to register with the authorized login [11]. The authentication location has to submit with their relative field of strength. The login has to commit with the authorized token. The authentication token is sent to the own relative id to the relative society to the end of submission.

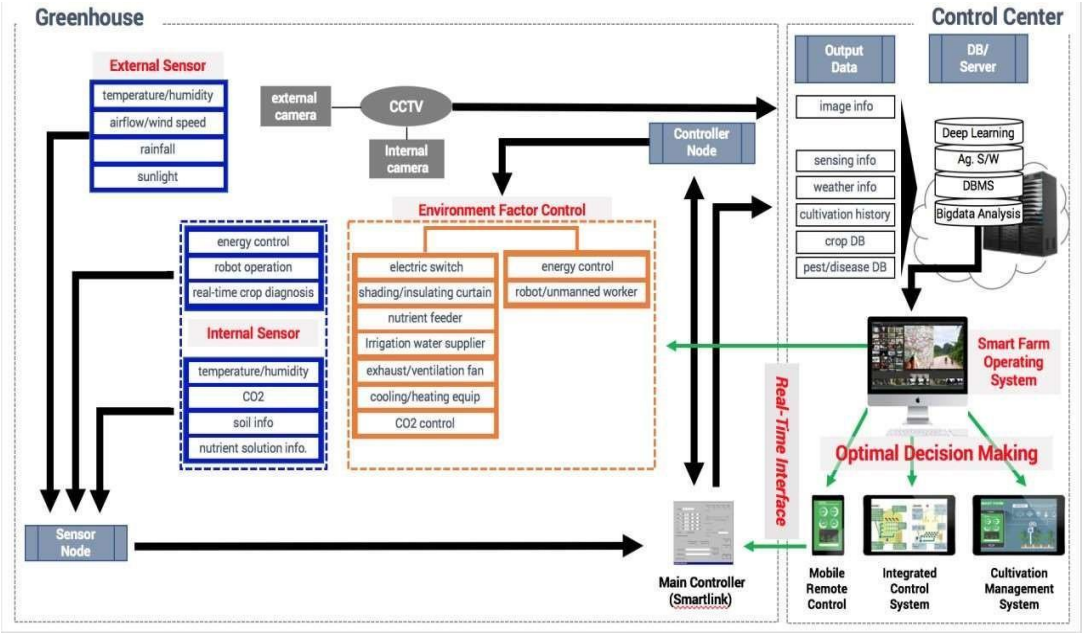

Figure 1. ERD diagram of sprint backlog

Smart farm operating system is a software consists of mainly three components mobile remote control, integrated control system and cultivation management system. This smart system is based on machine learning, by the help of which one can find suitable crop, environment for cultivation with the help of some information based on images, weather and cultivation history stored in the database. Basically System's main controller interacts with the three major nodes: sensor node, controller node and the mobile remote controller [12] .Here external sensor node senses all the external environmental activities such as temperature, humidity, wind speed, rainfall and sunlight. Another major sensor is internal sensor node which detects the inside information of soil such as humidity, temperature, nutrient information, CO2 content of soil, this whole data coming from external and internal sensor node then sent to the main sensor node which makes the right information out towards the main controller. Main controller then instructs the environment controller (EC node) node based on the data it is gaining from the sensor node, EC node automatically turn electric switches (motor, electricity, etc.) on/off, EC node also perform other activities which totally replaces the manual interaction such as shading/insulating curtain, irrigation water supply, exhaust/ventilation fan [13], temperature control (heating/cooling), CO2 control and these all activities are monitored in CCTV camera.

4. Experiments & Results

An experiment for the smart irrigation system was made on an ornamental plant grown in a greenhouse. Plant requires 1200mm of water per day and its soil temperature should be not less than 50°C. In the Arduino program, using variables moisture and temperature, they were set to 300 and 450 respectively. This method is an effective way of saving water, inexpensive and efficient.

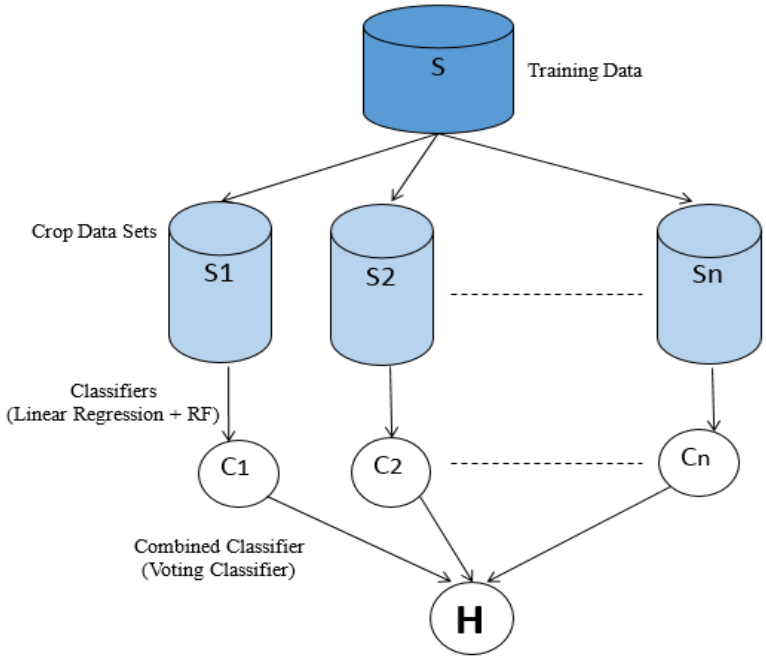

Figure 2. Proposed Model Diagram

In Smart Agriculture system it shows the real time data by sensing the agriculture field data using Wi-Fi as allows user to control the system and monitor their agriculture from anywhere of world as the application is connected to the cloud where the data from sensor is stored and allow application to connect to hardware. There uses various sensors like ,DHT (Temperature and humidity) sensor [14] for sensing the local atmosphere data, Ultrasonic sensor for sensing the distance or obstacle in the field as it provide security to the agriculture field as well as for water level indicator in the tank, Soil moisture and humidity sensor for sensing the current soil condition, water motor for supplying the water to the soil automatically by sensing through sensor, Fencing of field for security to protect the field from animals or theft as it will send notification to the farmers mobile and buzzer will start buzzing ,CCTV camera and Drone technology for continuously monitoring of farm through application, Pesticides control system [15] which provide the perfect solution from insects for their valuable crops. Proper ratio of pesticides is given to the farmer so that they can take action quickly and accurately. The application is used to control and monitor data sensed from sensor and send it to server then to user application which is connected to hardware through internet system. The android application keep the data for weeks and even for months.

We know that Indian economy is mostly depends on agriculture but the farmer who produce crops are living a poverty life and are not able to feed their family as they are considered as the god but they itself are living a beggar life. Due to which sometimes they do suicide by getting frustrated from their life. This is due to the fact that they are not able to grow quality crops and their values in the market is low because they do not provide required material to crop at the time due to which it get destroyed because of not able to get correct prediction [16]. The prediction include such as watering or pouring water to plant or soil which get wrong mostly and because of this the problem arises.

4.1. Performance Evaluation

Every instance is analysed in two categories in the binary classification model [17]. There are two categories, namely, true and false. True positive is the number of correct predictions that an instance is positive. False positive (FP): The number of incorrectly predicting instances as positive. False Positive (FP): The number of correct predictions that an instance is positive. The number of correct predictions that this sentence is negative.

Table 2. Representation of Confusion Matrix also called Contingency Table

	Observation	
Experiment	True	False
True	TP	FP
False	TN	FN

An uncertainty matrix shows the associations between observable and expected in a certain phenomenon [18]. Along the major diagonal of the table, the correct classification should be shown as true positives and true negatives. The model errors are denoted by the additional columns. A perfect math model would contain only the true positive and true negative values. From the confusion matrix, various indicators can be derived. Accuracy is the overall success rate of the classifier.

$$Accuracy = (TP + TN) / (TP + FP + FN + TN) \quad (1)$$

False Accept Rate (FAR):
It is the ratio of no of accepted data in the dataset by the total data present in the dataset

$$FAR = \frac{No\ of\ DataAccepted\ out\ side\ the\ dataset}{Total\ No\ of\ Data\ in\ Dataset} \quad (2)$$

False Reject Rate (FRR):
It is the ratio of false selected data for verification by the total data present in the system

$$FRR = \frac{No\ of\ Correcte\ Data\ Reheceted}{Total\ No\ of\ Data\ in\ Dataset} \quad (3)$$

True Success Rate (TSR): This is the relationship between the exact number of the database and the total number of total population in the database.

$$FRR = \frac{No\ of\ Correcte\ Matched\ Data}{Total\ No\ of\ Data\ in\ Dataset} \quad (4)$$

Table 3. Production: Year v/s Area

S. No	Crop_Year	Area	Production
0	1997	45500.0	156800.0
1	1998	48730.0	176455.0
2	1999	52097.0	139835.0
3	2000	31501.0	115721.0
4	2001	44550.0	176784.0

Table shows that annual production of all crops in Rajasthan State year wise. We have separated the Production of crop district wise.

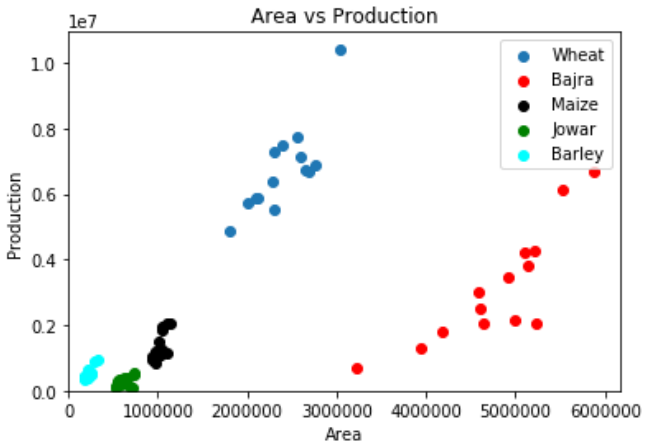

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Figure 3. Production of Crop v/s Area

Description: The above chart displays the observation points between Production Area and Total Production for various crops like Wheat, Bajra, Maize, Rice and Barley from the previous year's Statistical dataset [19, 20, 21]. Different colors are used to show the observation points for different crops. In the Statistical Analysis of existing data we can see that Wheat and Bajra needs larger production area as compared to other crops.

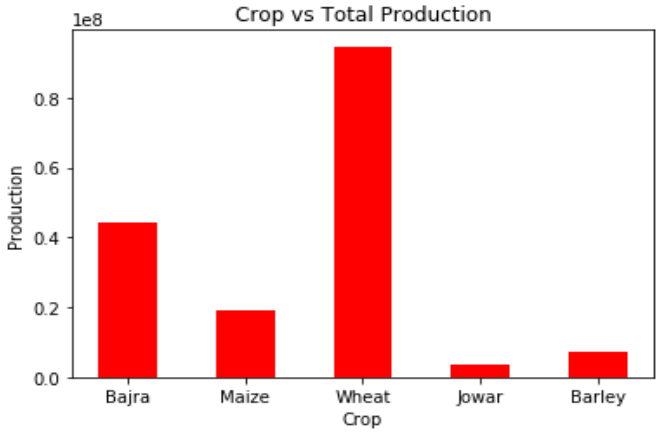

Figure 4. Production of crop

Description: The above chart displays the relation between crop and their production for various crops like Wheat, Bajra, Maize and Barley etc. from the previous year's dataset [22]. The Statistical Analysis of existing data in above chart shows that the production of wheat, Bajra and Maize is highest than other crops that's why we can say that Wheat, Bajra and Maize crops have the more suitable environment in Rajasthan [23].

Description: Different models are trained with the common dataset and then these models are used for crop yield prediction and their accuracy of prediction is calculated as per below details:

a) Linear Regression – Linear model is created using Python library and trained it with real time agriculture dataset. Accuracy of the model is calculated 63.73%
b) Ridge Regression - Ridge Regression model is created using Python library and trained it with same agriculture dataset. Accuracy of the model is calculated 63.73%
c) Random Forest Regression – This model is based on the concept of decision trees. It creates the multiple decision tree for predicting the output and finally combine the result of all decision trees to get the final prediction. This model is also trained with the same agriculture dataset and Accuracy of the model is calculated 87.08

d) Proposed Hybrid Approach – Above mentioned model are good for machine learning purpose but may not give the high accuracy for huge dataset. So in order to achieve the high accuracy we used the hybrid model approach.

This approach merges the concept of linear, Ridge and Random Forest model and creates a hybrid model with the improved accuracy calculated 93.72. In the proposed work accuracy [24, 25] is very important factor, model with the high accuracy can precisely predict the production of specific crop in the specific location and the same can be informed to farmer that what amount of crop can be produced in his/her production area. Balanced production of the crops will not affect the production of other suitable crops in the same location and this way it will not lead the increment in the cost of crop due to shortage of production and will fulfil the need of every people within the cost.

5. Conclusion and Future Scope

With fully equipped software and Internet of Things, agriculture industry can provide a better vision for next generation and make India better in coming days. It is an application based on machine learning and IOT technology. It is designed to help farmers to find most suitable crop according to their soil, climate condition of area, rainfall and production in the market to attain more profit and use minimum fertilizers. Therefore, the crop quality will definitely improve. This web application is very interactive as it uses face detection for login and use speech API's for interaction. Therefore, it is very easy to use, much interactive, and easily understandable by farmers. The basic and only need is the internet connection to use the application. There is a tremendous future of IoT in the field of agriculture, whether it is in innovation or finance. If farmers are provided with proper training about technologies, they will be able to perform much of their agricultural tasks through mobile. It allows farmers to stay in contact with their farms from anyplace. It simultaneously reduces human effort with increased productivity and boosts the economy of farmers. This plan will completely revolutionize the agriculture industry in India.

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