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IOT based Irrigation Automation and Nutrient Recommendation System

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Abstract: In today's technologically advancing world, there is need for smart agriculture. In this paper, we use two algorithms logistic regression and naive bayes for predicting amounts of water and nutrients to be released. Logistic regression algorithm is used for predicting amount of water to be released. Values received from moisture sensors are compared with the available datasets and amount to be released is calculated. Similarly, naive bayes is used to calculate the amount of nutrients to be released. Thus these two algorithms help us for more accurate recommendations. In this paper, we aim to develop a smart system which will be useful for precision agriculture.
Keywords: Internet of Things, Machine Learning, Logistic Regression, Precision Agriculture, Microcontroller.

I. INTRODUCTION

Almost everyone directly or indirectly depends on agriculture. In India, 70% of population directly depends on agriculture. In today's technologically advancing world, there is need for making agriculture smart. There are many modern technologies which can be used in developing smart agriculture. In this paper, we have proposed use of machine learning algorithms with help of IoT.

IoT is the network of physical devices and other items embedded with software, sensors which enable these objects to collect and exchange the data. IoT allows object to be sensed or controlled remotely across existing infrastructure. IoT (Internet of Things) is an advanced automation and analytics system which exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service.

Machine learning is the concept of computer science in which a system is fed with lots of information, and then that machine then makes use of this information for making further decisions related to it. There are various machine learning algorithms available. In our system we make use two algorithms

A. Logistic Regression
B. Naive Bayes.

Logistic regression is used for predicting result in a situation where there are multiple independent variables. Naïve bayes is based on Bayes theorem. It is used for finding probability of occurrence of any event in future.

In our paper, we are using algorithms for calculating amount of water and nutrients to be released at a particular instant. For predicting water release we make use of logistic regression algorithm and for nutrient recommendation we use naïve bayes algorithm.

II. EXISTING SYSTEMS

In [1], Greenhouse Management System (GHMS) is presented. GHMS will read the wetness of the soil by using moisture sensors and automatically turn ON/OFF water pump for irrigation. This paper shows the use of WSN or WMSN for precision agriculture in greenhouse. WMSN nodes are deployed in the greenhouse with moisture sensors attached to them. These sensors provide data which ultimately determines soil moisture content. This system is restricted to greenhouse only.

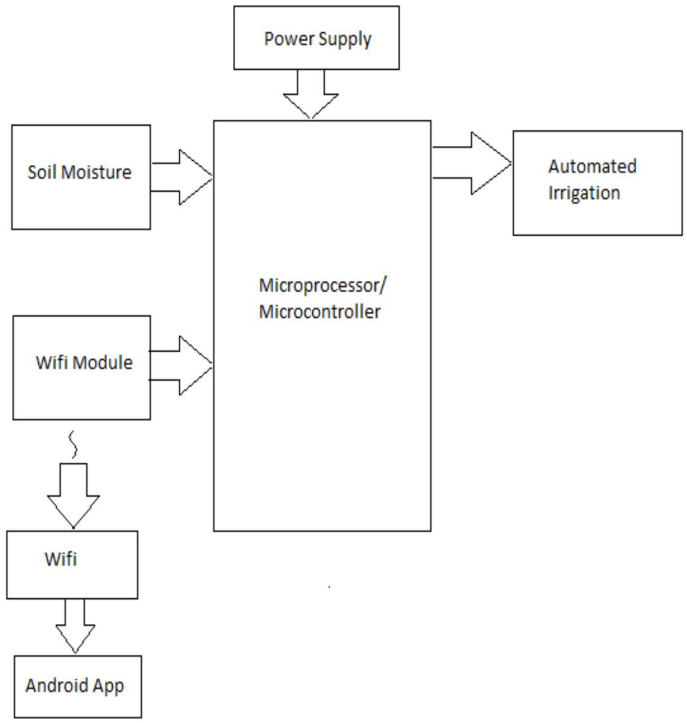

Fig 1: Existing System Architecture in [1].

Here data obtained by the sensors is compared with the threshold value and based on that the water is released. It does not determine the exact amount of water to be released.

In [2], different sensors (moisture, temperature, humidity, light) are used for monitoring crop yield and controlling the environment in a greenhouse. A system is developed for monitoring the crop yield and automated irrigation. Using wireless communication, the data retrieved from the sensors is transmitted to the database. Also a mobile application is developed with the help of which farmer can monitor the crop yield conditions from any location. Farmer receives notification regarding the crop yield condition. All the data collected from different sensors is compared with the threshold value and accordingly the farmer receives the notification. Depending on the soil moisture value and temperature, irrigation is automated.

In [3], system is designed to detect soil moisture and respond accordingly. The moisture sensors used in this system have nickel made probes which are anti-corrosive and robust material for use in agricultural system. Similar to previous system this system also has a response monitoring system which compares the values received from the sensor with the desired values and the irrigation is then initiated. If the values are below the threshold value then water is released and soil moisture is maintained. Soil moisture is measured up to the root zone of the crop thus it is useful for any crop.

In [4], system focuses on measuring soil content of the nutrients like N (nitrogen), P (phosphorous) and K (potassium). This system will check the N, P and K contents of the soil and the automatic dispensing robot will dispense the required deficient nutrient. It is an automatic dispensing robot which will dispense the right nutrient required. This system uses a color sensor which is senses the color and sends the relative electrical signal. Micro controller compares this signal with the stored value and then gives the command to the actuator drive.

The actuator drive then with help of solenoid releases the required amount of fertilizers. This system dispenses the only the required macro nutrient in right amounts.

In [5], microcontroller based automatic irrigation system is designed. This system allows irrigation in zones. In this system 80C51 microcontroller is used. A micro controller is coupled with solenoid valves in each of the plural zones and transmits the interrogation signals to each of the moisture sensors. The moisture sensors then responds by transmitting the electrical signals to the microcontroller the micro controller activates each of the solenoid valves on a given watering day for a prearranged watering interval beginning with the pre-programmed start time and lasting for a pre-programmed interval.

In [6], they have used solar panels for turning ON/OFF motor. The proposed system in this paper has two modes: 1. Automatic mode 2. GSM mode. In GSM mode, the farmer controls the pump to be switched ON/OFF. The Soil moisture readings will be sent to farmer through the GSM based on the reading farmers will decide whether to switch ON/OFF the pump. In Automatic mode, the farmer does not control the pump to be switched ON/OFF. In automatic mode the sensor value will be compared with the threshold value if the value is less than threshold the pump will be switched ON automatically and when the value meets the threshold value the pump will be switched OFF. The main components used in this system are: 1. Water level sensor. 2. Humidness sensor. 3. Soil wet sensor. 4. ARM controller. 5. GSM module 6. LCD 7. Spin cell. The limitation of this paper is that it considers only soil moisture irrigation. Also the implementation cost is high. Maintenance of the system is difficult due to the solar panels and the maintenance cost is high. Water required by different crops varies and it is not considered in this system.

III. PROPOSED METHODOLOGY

In this paper we have proposed a system consisting of soil moisture sensors, a micro controller, motor, wifi module.

Figure 2 shows the architecture of the proposed system. We make use of micro-controller arduino uno for our system. Our soil moisture sensor is connected to this micro-controller. The data acquired by the sensor is sent to our system with the help of micro-controller's wifi-module. After getting the output from algorithm, the required action will be performed by the motor driver. The details of the operation performed can be viewed on the mobile application. Similarly required action is performed on the nutrients through the relay valves.

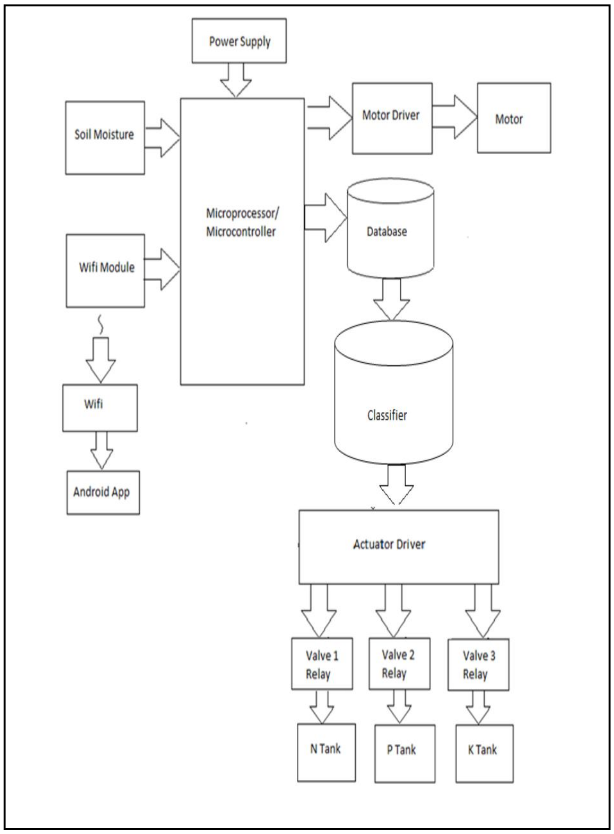

Fig 2: Proposed System Architecture.

As discussed earlier, in this system we make use of soil moisture sensors. The working of system can be briefly divided into multiple parts

A. Data Transmission

Soil moisture sensors obtain the current moisture content of the soil. This data is transferred to our database through the wifi module of the micro-controller. These values are further compared with our dataset present in the database.

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B. Automation of Irrigation

The values provided by the soil moisture sensors are then compared with the values in the dataset. Here we have a dataset prepared which contains the moisture values and action performed when that reading was obtained. The logistic regression algorithm will check the probability of occurrence of that particular moisture value.

```
Algorithm 1: Logistic Regression

Input: Threshold value of Soil.
Output: Probability to release water or not.

Start Procedure
 1.  for i := 1 to m
 2.  transformed = 1 / (1 + e^-x)
 3.      output = b0 + b1*x1 + b2*x2
 4.      p(class=0) = 1 / (1 + e^(-output))
         B0 = 0.0

         B1 = 0.0
         B2 = 0.0
 5.  prediction = 1 / (1 + e^(-(b0 + b1*x1 +
     b2*x2)))
 6.  b = b + alpha * (y – prediction) *
     prediction * (1 – prediction) * x
 7.  end
```

Fig 3: Algorithm for logistic regression

Depending on this logistic regression algorithm will be applied to calculate the probability of releasing water and amount of water to be released. Depending on the output of our algorithm the required action will be performed.

C. Nutrients Recommendation

As the water irrigation part is works, in somewhat similar pattern the nutrient recommender works. For this part, naive bayes algorithm is used. Naive Bayes algorithm works on the principle of Bayes theorem. It is used for finding the probability of occurrence of an event in future. Even for this part also we need to have a training dataset.

Initially at the first stage of crop, we need to enter the values of n, p, k of the field.

These values will be compared with the already existing initial values of nutrients in our datasets. The dataset will consist of nutrient values soil of different crops on the first day. When we enter the initial values of crops of a certain field, naive bayes algorithm will match it with its most relevant values.

For every initial value in the dataset, there will be a schedule assigned. This schedule will be the schedule followed by farmers for those particular values of soil nutrients. Hence, once the initial values are matched, the crop will be automatically assigned the relative schedule. The same schedule will be followed throughout the entire life cycle of crop.

D. Mobile Application

In our system, the end user interaction is performed through an android application. This application has the basic features of user registration and user login. After logging in, the user will have two options available for selection about either checking water level or nutrient recommender. Both the options will direct further to their respective pages which will display the detailed information.

After selecting moisture level option from crop field information page soil moisture reading, tank reading, water release, report dates are shown. The details of nutrients can also be seen in the application.

IV. RESULT

After selecting the one of the options, the resulting page will show the detailed information about the same. In case of moisture level, we get the information showing current moisture level, tank reading, whether water should be released or not, and time details. For Nutrients page, it will display crop name, values of N, P and K, Release status. As the values of nutrients vary from crop to crop, so we have option of selecting the crop and accordingly it will release the appropriate amount of nutrients.
Following table shows results of certain inputs given on the application:

SR.NO.	INPUT	OUTPUT
1.	Moisture level: 18 (from sensor)	Release water : Yes
2.	Crop Name: Maize N : 24 P : 23 K : 29	N : 23 P : 21 K : 24 Schedule Date : 61
3.	Moisture level: 35 (from sensor)	Release water : No
4.	Crop Name: Wheat N : 34 P : 36 K : 37	N : 26 P : 26 K : 25 Schedule Date: 111
5.	Moisture level: 28 (from sensor)	Release water : Yes
6.	Crop Name: Maize N : 28 P : 31 K : 16	N : 20 P : 18 K : 24 Schedule Date : 71

V. CONCLUSION AND FUTURE WORK

As a step towards technical enhancement in agriculture, our system will help in automation of important parts of agriculture. With the help of machine learning algorithms we can achieve accuracy which is very important in this field.
In future there can be devices developed for taining real time values of N, P and K.

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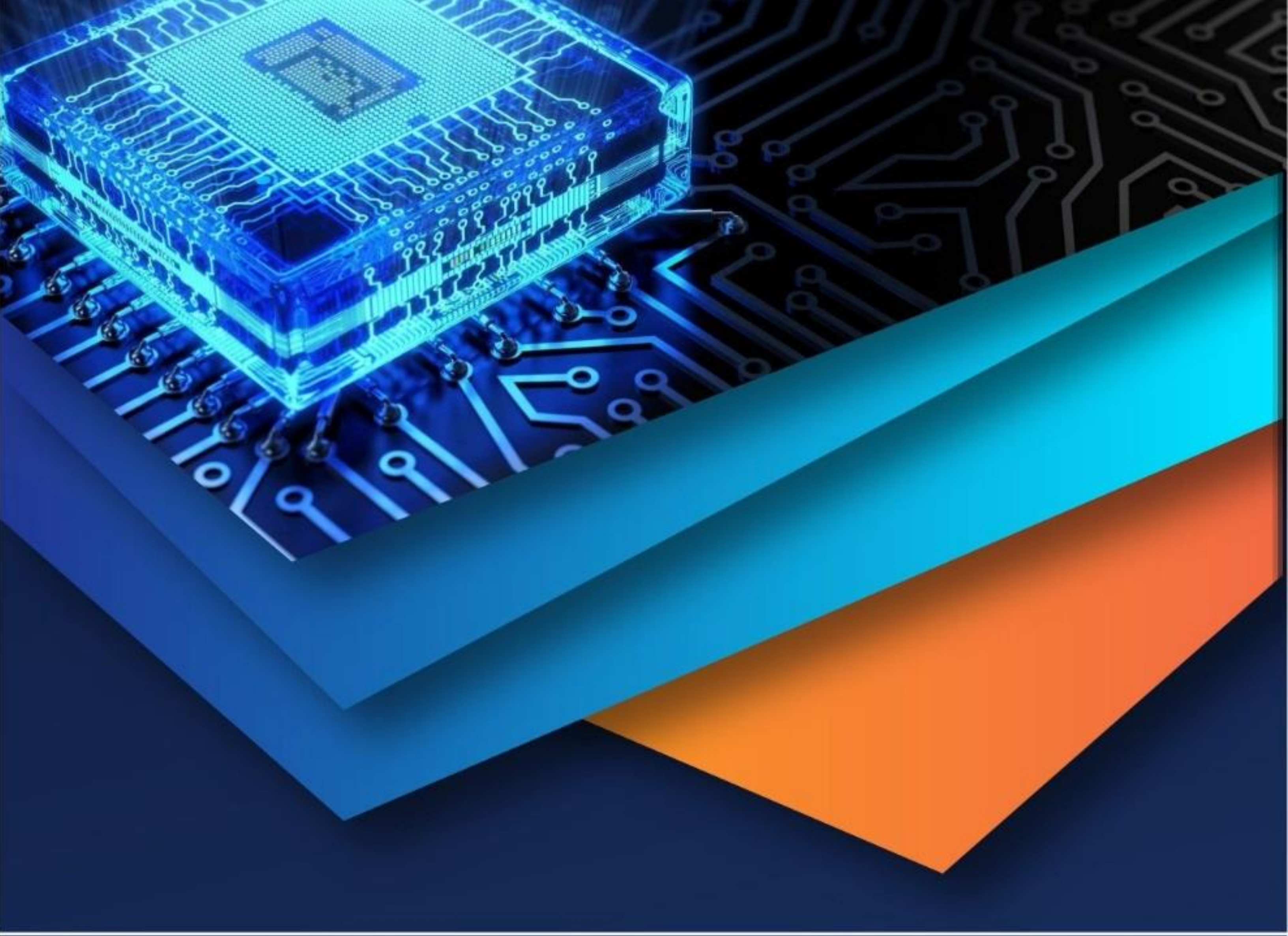

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