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INTELLIGENT FARMS

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Abstract - *Agriculture is the backbone of Indian economy. There has been a rapid increase in population hence qualitative and quantitative production of crops is expected. Along with this there are other problems in agriculture like water shortage, less man power and excessive use of pesticides. Therefore automation has been introduced in agriculture to boost the traditional methods. This type of agriculture is called precision agriculture using IoT. The project involves the use of various technologies. Wireless Sensor Networks(WSN), Cloud Computing, Data Mining and Android application are involved within the project. Basically a Wemos D1 Mini (ESP8266) along with sensors is installed in the farm. It senses the environmental parameters and sends data over WiFi to Cloud storage. This data is later mined to generate predictions. The predictions in turn will be used to inform the farmer amount of water or pesticide to be sprayed and time intervals after which it has to be repeated. There will be an Android app to inform farmer about these things. Thus the farmer will be able to remotely control operations on the farm. This will also reduce his frequent visits for these activities to the farm.*

Key Words: **IoT, Cloud computing, WSN, Wemos D1 Mini, Agriculture, Data Mining, Android**.

1. INTRODUCTION

Agriculture is the backbone of Indian Economy. Due to increase in population a large amount of quality & quantity production of crops is expected from small areas. There is shortage of water and it is necessary to increase the efficiency & reduce man-power. Excessive use of pesticides, injections & carpet leads to health issue and so it is necessary to promote technology in agriculture through which control over irrigation and usage of pesticides can be monitored & actuated. This can be achieved by the technologies such as IoT, Wireless Sensor Networks (WSN), Android & Data Mining.

2. LITERATURE SURVEY

Mohanraj I, Kirthika Ashokumar, Naren J have proposed Field monitoring and Automation using IOT in Agriculture Domain.
The paper suggests that there is scarcity of water and manpower in agriculture. So we need to automate agriculture to effectively use available resources. System design and realization are using knowledge base, which stores information to create the advisory service.

The steps in knowledge base are:

1. Realized inputs: It contains information about cost of crop, diseases, geographical conditions, weather and water.
2. Data Acquisition: it contains collecting information from different sources under one roof for analysis purpose.
3. Knowledge Flow: It describes data flow among modules of the system.

It explains the software and hardware requirements also.

The System Architecture is mentioned thereafter which contains:

1. Monitoring Plant Growth: Review of growth stages.
2. Irrigation Planner: To manage the irrigation plans and the flow of water as per need of crop and environmental conditions.
3. Problem identification: Reports problems.
4. Well Dry Checks: Well water level is checked and refilled as required.
5. Field Dry Check: To check the moisture in field.

It provides drawbacks and comparative study of developed and existing system. [1]

Raheela Shahzadi, Muhammad Tausif, Muhammad Asif Suryani, Javed Ferzund proposed Internet of things based Expert Systems for Smart Agriculture. The concept of IoT is the introductory part. It also tells problem in farming due to which we are adopting IoT in agriculture. It talks about creating an expert system (ES) for different crops which pinpoints the problems as well as suggests the solution. This system gathers lot of knowledge from different sources. Sensors operated in the field send data to base station. The ES processes data and generates results or decisions for farmer on their phone. This helps monitoring and timely decision for better production. It names a few ES developed earlier. There are these sensors in the field on an agriculture board where Xbee module is present. They send the data over gateway to the computer. The Expert System analyses and sends the predictions to farmer's mobile.[2]
T. Satish, T. Bhavani, Shameena Begum proposed Agriculture Productivity Enhancement System using IoT.

The third paper discusses about the Agriculture Productivity Environment System using IoT. It explains the importance and meaning of IOT in agriculture. IOT provides a way to manage and control the activities in farm. There can be various management systems like irrigation management, pesticide management etc. It gives an example of pesticide

management system which includes observation, inspection, identification and record tracking. It aims at increasing plant productivity, identifying harmful diseases for crops and utilizing pesticides effectively. It further explains technologies to be used like mobile app, data analytics using R-programming, Raspberry Pi 3, sensors etc. The further part is prototype architecture of proposed system which consists of nodes in field having 4 sensors each which sense the data, collect it and send it to cloud database (server side). The client side accesses this data and generates interesting patterns. For this the server side uses decision tree algorithm. The result is sent to client side/ mobile app as desired output. The algorithm of decision tree is explained, how it works along with pseudo code & flow chart provided for explanation. Pruning of DT is also explained. Basically, these predictions are made to help the farmer.[3]

3. METHODOLOGY

A. Representation of Components and Setup:

Fig -1: Setup and Components

Wemos D1 Mini and sensors are embedded on the board. Sensors used are soil sensors (for moisture), DTH11 sensor (temperature and humidity) or other sensor specific to crop. A power supply is provided to the board. A water pump motor and pesticide sprayer are present along with bridge to drive them. Wi-fi module is also present on the board for internet connectivity.

B. System Overview and Implementation Details:

Various boards will be deployed at different location in the farm. With the help of Wi-Fi modules on each board the sensor data collected will be transferred to the cloud (database).The data stored on cloud will be analyzed using specific algorithm for large amount of sensor data. The sensor data will be sent on the cloud through the Wi-Fi module. Further data mining will be performed on the data. C4.5 algorithm is used for predictions. Data analysis will help to determine the current state of farm, crop and environment. After predictions are made, suggestive measures will be generated. Standard knowledge base has ideal water-level requirement and list of specific infections to crop. Suppose the prediction indicated that the water supplied to the crop is not sufficient then we can determine the extra water that should be supplied to crop by referring the knowledge base values. Similar thing can be done for pesticide system.

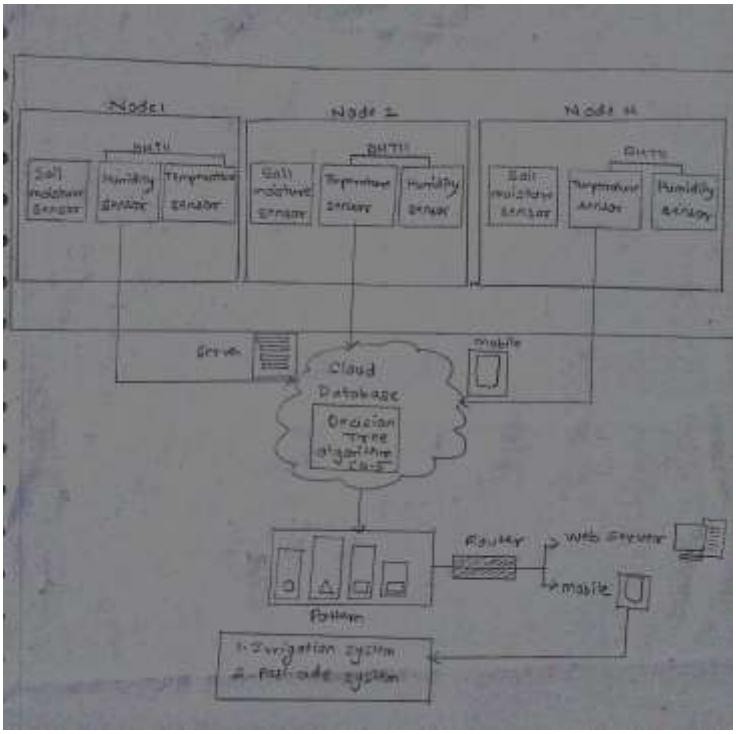

Fig -2: System Overview

This amount of water required will be sent to the farmer as a suggestive measure and he can decide whether to switch on the water supply at that time to meet the crop's water requirement. Opposite operation is suggested if water level is excessive. Farmer gets suggestions and notifications on the Android app provided. Wemos D1 Mini is compatible with Arduino software where codes for sensors are written. In the android app, when farmer presses on/off button for any of these two systems, the respective action is taken accordingly.

C. Modules:

Web Based GUI:
Server will be web based application and this module will be responsible to take inputs from admin. The GUI is developed in HTML and Java-script. Our server input will be taken through this GUI where proper validations are supported. This includes new farmer registration, viewing field values and details of the farm, etc.

Database Manager:
This module will help to handle all database related activity. All the SQL queries will be taken care in this module. A database connection polling system will be present to avoid repeatedly opening and closing database connection. The JDBC driver manager ensures that the correct driver is used to access each data source. The driver manager is capable of supporting multiple concurrent drivers connected to multiple heterogeneous databases.

Android Application:
Android application is developed for the farmer through which he can connect to the server. After that he can login or sign up. Upon login he can see the farm details like soil moisture, temperature and humidity. He can even switch ON/OFF the motor and pesticide sprayer system upon suggestions received through data mining
Other than this Arduino Uno software is used for sensor coding. On the console of this app the sensor values currently sensed are visible.

D. Algorithm:

C4.5 Decision Tree

Decision trees are most widely used classifier, consist of a set of rules which are applied in a sequential way and finally yield a decision.
The steps in C4.5 Decision tree classifier are as follows:

Step 1: To classify a new item, the C4.5 classifier first creates a decision tree based on the attribute value contained in the training data.

Step 2: Each time when it finds a set of items in the training set it recognizes the attribute that segregate the various instances in the set.

Step 3: In order to specify the best attribute that distinguish the given tuples, we use attribute_selection_method.

Step 4: The attribute_selection_method employs the Information Gain.

Step 5: The information still needed to do an exact classification is given by:
Info(D)= $-\Sigma pimi=1log2\ (pi)$
$InfoA\ (D)= \Sigma DjD \times Info(Dj)$
The term DjD is the weight of the jth partition.
InfoA (D) is the expected information required.

Step 6: Computing *Gain* (A) tells us how much we gained by branching on A
Gain(A)=$Info(D)-Info(Dj)$
Information gain measure is biased towards attributes with a large number of values
Hence C4.5 is used which uses gain ratio to overcome the problem.

Step 7: Computing *Gain* Ratio (A) tells us how much we gained by branching on A

$$SplitInfo_A(D) - \sum_{j=1}^{v} \frac{|D_j|}{|D|} \times \log_2\left(\frac{|D_j|}{|D|}\right)$$

Step 8: Attribute having the highest gain ratio is considered as the splitting attribute.

Step 9: Continue in this manner to get a clear decision of which combination of attributes gives a particular target value.

4. RESULTS AND DISCUSSIONS:

The Results of the proposed system are:
1. Server is run first along with Android code. Then farmer and admin both can register and login. After that admin gets welcome page. He can view particular farmer details, his field details and sensor values. Similarly after farmer logs in, he gets welcome page, he can add farm details, view farm details and view sensor details. This is shown in figure below.

Fig -3: Server image

2. As far as Android app is considered, the farmer connects to the server address. After that he can login and signup. On login he can view farm sensor values and suggestions provided by data mining. Later he can press ON/OFF button on the app to switch ON/OFF the irrigation and pesticide system

Fig -4: Android Menu

Fig -5: Android Sensor Values Image

Fig -6: Android Disease Information Page

5. CONCLUSION:

To increase the production of crops in agriculture and improve quality and quantity, technological support should be used. Integrating traditional methods of farming with latest technologies like IoT, Cloud, Android, WSN and Data mining will benefit the field of agriculture greatly. Hence the Intelligent Farms system has been proposed. It will help the farmers to provide timely irrigation and pesticide control to the crops. This will in turn increase efficiency and production in agriculture while also reducing unnecessary water wastage and damage to crops due to diseases.

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