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Cloud Analytics based Farming with Predictive Analytics using Artificial Intelligence

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***Abstract*—**

Our proposedSystem consists of Monitoring Farm ,cloudprocessing and pprovidinginformation and suggestions to the farmer using mobile application. Our system integrates data analytics using cloud computing and IoT concepts. Our system involves monitoring device integrated with NodeMCU ESP8266 Wi-Fi module for communication, sensors which are controlled by Arduino UNO microcontroller and device is powered by Ni-Cd Batteries or solar panel. Collecting sensed data from device in the farm and transmitting the data to the cloud server for processing crop recommendations using neural network algorithm. IBM Watson, an artificial cloud, which is used in our system. Farmers will receive suggestions of crops and fertilizers and also the information including eenvironmental and climatic conditions, real-time market prices, government schemes and natural calamities.The system also through voice call and messages in their native languages informs the user. The main aspect is framing the database based on location, climatic changes, soil and plant varieties, field factors, sensed data, and farmer's interest to guide them by providing the suggestions on crops based on the above factors to increase crop productivity.

Keywords—Monitoring farm,data analytics, neural network algorithm, market prices, crop productivity

I. Introduction

Agriculture is indispensable for human survival and nation's economy. By integrating IoT and Cloud computing concepts the proposed system monitors the field, process the sensed and real-time data and provide suggestions.Developing farmer's economy, increasing productivity and maintaining soil fertility are the primary objectives. With sophisticated and integrated ideas, we propose a real-time smart farm monitoring system for rural farms in India.by employing advanced concepts to enhance crop productivity. The main aspect considered in our system are plant growth, soil and human health care. At present, most of the smart farm systems control the irrigation system and alert systems using Wi-Fi or GSM technology. mKrishi, smart platform developed by TCS, uses image processing techniques to detect crop disease detection, monitoring the soil samples and provide technical support to farmers. mKisan, a governmental portal informs the farmers about soil and fertilizer information, market prices, and technical support to farmers also with marketing platform. For state farmers, like mKisan created an application called 'Ulavan'. So, with overcoming some disadvantages of current systems and modifications to their concepts, we develop a Intelligent Cloud Analytics based Farming systems with newer concept of crop recommendations for our Indian rural farms. Wedevelop a mobile application on android platform which also consists of marketing and community platforms. Deploying devices for large farms results in costly system and in-efficient in poor network facility areas which is not a profitable idea to work on. Hence, we adopt the concept of Human agents and drones to collect samples and from central stations situated in better network facility area the data is transferred to IBM Watson for processing. The system works on ICT platform [1]. Crop recommendation will be our primary objective of the system. Our Intelligent CAB farm system provides necessary information to the farmers with crop and fertilizers recommendations.

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In Cloud processing, we employ Artificial Intelligence concepts for crop recommendations. For our system we prefer neural network algorithm over support vector machine algorithms for better efficiency [2]. IBM Watson provides machine learning algorithm modelers, storage for collected samples, and can be integrated with android applications.

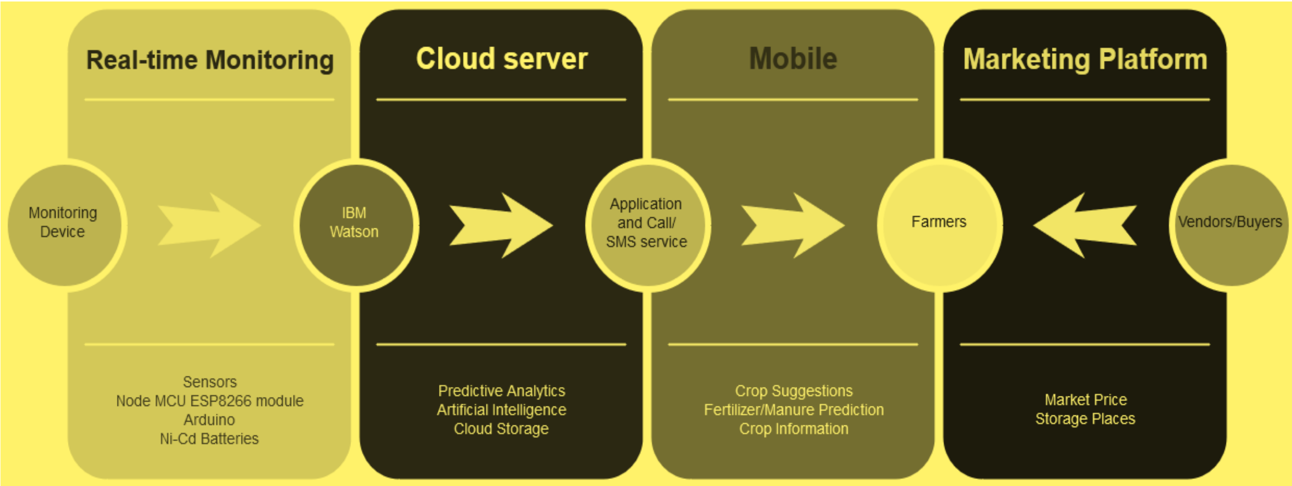

Fig 1.1Architecture diagram and flow of our System

The main disadvantage of the neural networks is training time is larger than other algorithms.Farmers would be able to increase the yield per acre based on the soil, climate and environmental conditions.The annual profit of the farmers will increase due to better productivity which is the result of the predictive analytics.The marketing platform helps the farmers to sell the crops as the negotiation is direct with the vendors.The community platform provides farmers with technical and community support from the experts from government officials and the local farmers.The mobile applications also provide storage facilities, fertilizers with its prices and availability, nearby market prices along with the soil and crop information in their native language which provides further support for them. In fig 1.1 the flow of our system is described.

II. Monitoring Phase

Monitoring Farm with device provides real-time information. The device is built with Arduino UNO microcontroller, soil pH sensor, soil moisture sensor, soil nutrient sensor, and light reflectance sensor integrated with NodeMCU ESP8266 Wi-Fi module for communication and powered with Ni-Cad batteries or solar cells [3]. Soil moisture sensor uses dielectric constant property to detect amount of moisture present in the soil and the connection with Arduino UNO microcontroller is described in fig 2.1. Connections of entire system withNodeMCU module and batteriesare described in fig 2.2. Through the NodeMCU module, locationof the farm can be detected. For monitoring,one way is a human agent who carries the device to monitor farms which are located remote areas in a regular basis and another way is designing a drone to carry the device

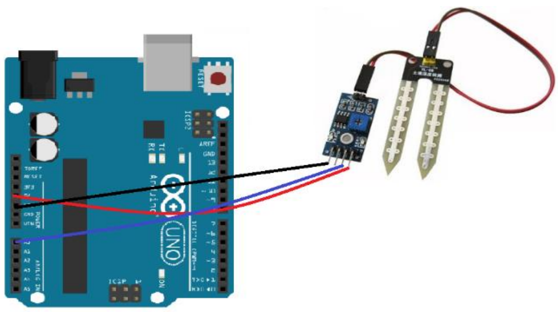

Fig 2.1 Soil Moisture sensor

to monitor farm and collects the data samples. From central stations located in strong network areas ,the collected sample data are transmitted to cloud server for further processing.

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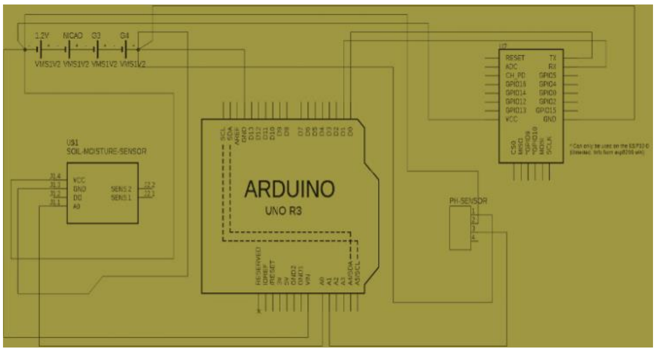

Fig 2.2 Device setup connections

A limited number of stations is required so it is cost efficient than deploying more devices in the large farms. For a farm, initially data samples arecollected for a minimum of 40 days after harvesting and during ploughing phase. Regularly the farm will be monitored to check soil and crop conditions. Soil pH sensor and Nutrient sensors are electrochemical sensors. Weuse NPK(Nitrogen-Phosphorous-Potassium)macro-nutrient sensor to measure macro nutrient content in soil. Based on the sensed data, the soil fertility and typeis determined. We use four Ni-Cd batteries per device.The Arduino is interfaced with four sensors namely soil pH sensor,soil moisture sensor,light intensity sensor and soil nutrient sensor through a breadboard.The Arduino Uno is powered by 4 Ni-Cad batteries with a power of 1.2V each.Multiple sensors can be connected to Arduino as it has 5 analog pins. The analog pins of Arduino are connected to the digital pins of the NodeMCU ESP8266 module and we obtain the values of the pH,moisture and nutrient content of the soil along with light intensity of geographical area.NodeMCU ESP8266 module and Arduino UNO microcontroller are connected using UART (i.e. Universal Access Receiver and Transmitter) method described in fig2.3.The area location, soil pH, soil moisture, nutrient content, light intensity, and type of soil are the parameters transferred to cloud server[4].

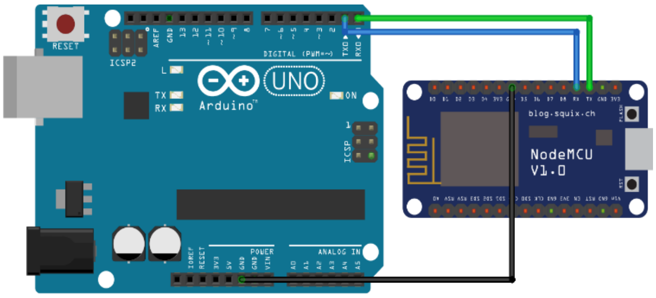

Fig 2.3 UART Connection

III. DATA PROCESSING IN CLOUD

We use IBM Watson Cloud Services, an artificial cloud, for high end processing. It is based on cognitive computing which supports IoT and Data analytics concepts. IBM Watson provides three platforms includes IBM Cloud, IBM Watson Studio and IBM IoT Platform[5].

Fig 2.4 IBM Watson Analytics

We setup the accounts in these platforms for processing data.From the central station the collected data is transferred to IBM IoT Platform where the device is registered. Onexecuting Arduino and NodeMCU programs which collectively sends multiple sensor data to the registered device in IBM IoT Watson Platform. So before sending the data IBM Cloudant plays an important role which integrates all these

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platforms.

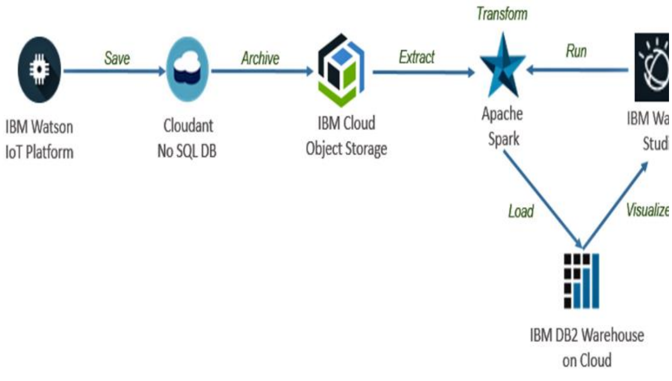

Fig 3.1 IBM Watson Architecture with Cloudant

ownership.The real-time data such as day-to-day market prices, weather forecast, and rainfall information datasets are stored in IBM Watson Studio modeler.In IBM Cloudant two databases are created. The farm database consists of collected data with location and after the execution of modeler the values are represented with integer values which are later adjusted. The Cropset database consist set value as primary value consist of options of crops which will be recommended to the farmers. The set value of farm database is compared with set value of Cropset database as options in Cropset is the farmer's required output.

IV. CROP RECOMMENDATION SYSTEM

For our proposed system,using neural networkalgorithm we recommend crops and fertilizer based on predictive analytics concepts.Based on the farm location, soil type, daily market prices, irrigation facilities,climate conditions,rainfall,soil conditions, and farmer's interest, the cloud computing engine yields the result [6]. We design our algorithm using neuralnetworksin which we process with more neurons with different weights to each with two hidden layers in fig 4.1.

IBM Watson employs cognitive computing which integrates the varioustechniques includes Artificial Intelligence, natural language processing, modelling and reasoning. In IBM Watson we create a neural network modeler where the data to be trained are stored. Further dynamically the required datasets are added to the IBM Watson Studio. IBM Watson cloud service aligns the unstructured data in regular order to produce meaningful information. Features of IBM Watson includes 16TB RAM, a 3.5 GHz POWER7 octa-core processor and can even process 500 GB per second. Better security is provided along with

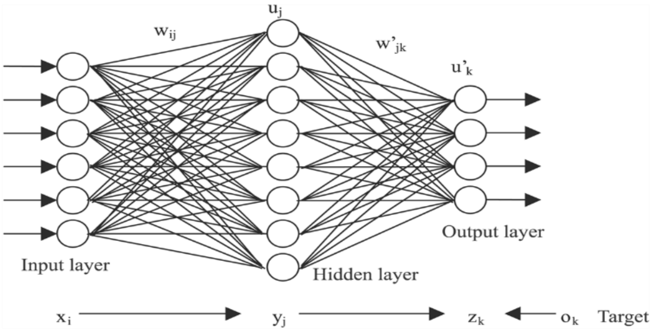

Fig4.1 Artificial Neural Network

The weight of the neurons will be modified until we get accurate results. Most of the present system uses Support Vector Machine algorithms for prediction with minimum factors. As currently, there are many farm irrigation systems based on IoT, we concentrate more on real-time farm monitoringand crop recommendation system [7]. Determining the weights to each neuron is important and harder task which will provides the efficient results.Further,with the processed data by employing knowledge discovery service of IBM Watson we can enhance the efficiency of algorithm [8].Neural Network algorithm requires higher processing and time taking in training data [9]. But it works efficient based on the collected data and learning from those databases.

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V. APPLICATION

For our Indian rural farmers in remote areas, the information is provided to the farmer through an mobile application and also via call and SMS services in their native languages. The application features include query portal, details of nearby cold storage places, crop recommendations based on predictive analytics,information on soil and plants, climate details, irrigation facilities, government schemes, marketprices of crops, bank loans, farmer-vendor marketing platform and a communication portal to connects the farmers of particular area to share the information and guided by officials. An application comprises of all these options specific to every user. The application also supports of 22 native languages. The system also guides a farmer about suitable intercropping

VI. FUTURE WORKS

In future, integration of cameras in monitoring device, crop disease detection using image processing, improvisationin the algorithmefficiency with more learning on datasets. In future Big Data Analyticscan be integrated with the system for furtheradvancements [10].

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