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Advanced Farming Using Smart Technology

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***Abstract*—** This paper describes a new approach for advanced farming in agricultural management using Internet-of-Things, Mobile-Computing and Big-Data analytics. Farmers, marketing agencies and vendors need to be registered to the Farm-Cloud module through Mobile-App module. Farm-Cloud storage is used to store the details of farmers, soil properties of farmlands, vendors and marketing agencies, e-governance schemes and current environmental conditions. Soil and environment conditions are sensed and periodically sent to Farm-Cloud through IOT. Big-data analysis on Farm-Cloud data is done for fertilizer requirements, best crop sequences analysis, total production, and current stock and market requirements. Data Mining is used to solve the queries of vendors, farmers and marketing agencies through Farm-Cloud. Sensors are used to sense the details regarding the soil and its properties of the farmland and sends it to the Farm-Cloud. Proposed model is beneficial for increase in agricultural production and for cost control of products.

***Keywords*—** Internet-of-Things, Mobile Computing, Big-Data Analytics, Cloud Computing, Sensor, Smart Agriculture, Data Mining

I. INTRODUCTION

Agriculture is the broadest economic sector and acts as a backbone of overall economic system of a country. The development of Internet-of-things has brought light to the development of agricultural are being developed in various domains. Major features of cloud computing and key techniques of internet of things can build massive data involved in agricultural production. Sensor technology is used in monitoring various factors like temperature and humidity of the farmlands. Mobile-Computing is a mature technology and applications of this exists in almost every field using this technology. Uses of all these technologies in the field of agriculture are also introduced and they are used for development in this sector.

A. Internet-of-Things (IOT)

Internet of things is defined as a system of network, which connects every object in the world with the internet by using radio frequency identification (RFID), sensors, global positioning systems, laser scanners and other information sensing devices [1]. Many applications are developed based on IOT which enabled devices for monitoring and control in different domains including industrial processes, home appliances, smart homes, health monitoring applications and smart cities. It also has made a great impact on SCOR model (Supply-Chain Operations Reference-model) of agricultural products[2]. The IOT gateway is made use in greenhouse monitoring system to make it easy for fine planting [3].

B. Cloud-Computing

Cloud-Computing is defined as a promising information technology for both individuals as well as enterprises. Cloud computing can also be used in other sectors such as environment, medicine and maintenance sectors. In agriculture cloud computing would enable corporate sector to provide all the necessary services at affordable cost to farmers in rural areas [4].

C. Big-Data Analytics

Big data analytics is examining large amount of data coming from variety of sources like sensors data, weather forecasting, and social media data. In agriculture systems big data analytics is used to increase the income and productivity of farmers. It is also used for supply chain management of farming products to minimize the production cost[5].

D. Mobile Computing

Mobile-Computing is one of the mature technology and applications of this exists in almost every field using this technology. It has also affected lots in number in our daily life due to its availability and cheaper cost of communication. It is used in almost every field including agriculture sector. Systems based on mobile computing have been proposed for sending daily and seasonal messages to farmers regarding the product information and weather information and various information regarding to their production.

E. Wireless Sensor Networks and Sensors

Wireless sensor networks and sensors are an important pervasive computing technology invading our environment. In agricultural environment they are used to examine various factors such as temperature and humidity along with other factors. It is also used in analysing different soil types and properties to classify them.

F. Data Mining

Data mining is the method to find some patterns hidden in the data. In agriculture various data mining techniques like

Genetic Algorithm and Association rule mapping, helps to find out the perfectly suitable crop suggestion for a farmer based on soil condition, weather conditions and crop details[6].

II. RELATED WORK

Many researchers have proposed different models for agriculture using one or more technologies mentioned above.

IOT gateway was used in greenhouse monitoring systems which connects wireless sensor network with the internet to ensure the operation of greenhouse system and also it is suitable for monitoring large scale greenhouse and also it makes easy for fine planting[3]. Using IOT the farmers will be directly deliver the products to the market at the reasonable price. Thus changing the whole supply chain[4]. IOT technology in terms of modern farming is applied to soilless culture and artificial layers of IOT namely sensing layer, delivery layer and control layer[7]. The IOT is used in smart farming which can achieve functions such as intelligent recognition, data acquisition, location tracking, monitoring and management [8].

Cloud computing gives out virtualized resources as a service over the Internet and also would enable corporate sectors to provide services at reasonable price to farmers in rural areas[4]. In [7] it is explained that Cloud computing is used to identify the growth of various plants by using pattern identification technology and perform dynamic monitor of growth of plants with the help of sensing objects. In[8] it is explained that Cloud computing is used to maintain flow of data and information collection and concentration of carbon dioxide, air and soil humidity, soil moisture and content of soil NPK etc and these data is recorded so that the results can be accessed rapidly by mobile user query application.

In [8] it is explained that Mobile computing provides front-end mobile services for the farmers to provide results for their queries using mobile device. The mobile computing also gives the researchers a precise view of the growing of plants, reduce the harmful factors such as natural disasters, diseases and insect pesticides on crop yield and the quality of agricultural products.

In [9] it is proposed that many data mining techniques are utilized for agriculture study space. One such technique is known as K suggests methodology that is employed to forward the pollution in atmosphere and different weather conditions. K algorithm also suggests that the approach is also employed to classify the soil and plants. Another technique called Wine fermentation method which is used in monitored mistreatment data processing techniques. By applying Data mining and optimizing techniques we can understand the soil condition and give proper recommendation of crops based on the soil condition. We can also recommend use of fertilizers and pesticides for a specific crop. In [6] they have proposed a system that with the help of Data mining techniques like Genetic Algorithm and Association rule mapping, helped to find out the perfectly suitable crop suggestion for a farmer based on soil condition, weather conditions and crop details.

In [5] big-data analytics was used to design a meteorological data storage as well as analysis platform using Hadoop framework and online logistic regression algorithm. The architecture proposed in this paper had an ability of mass storage of meteorological data, efficient query and analysis, climate change prediction.

In [10] it had proposed the utilization of sensors, Wireless Sensor Network (WSN), Zigbee network, Protocol stack, zigbee applications and the results in agricultural field area are discussed. Zigbee network was used in monitoring the crop field area without human interaction. Sensors were used in efficient growth of the crop in the field and protect the crop field. Also Zigbee wireless sensor network was used in Analysis of real time readings of temperature, humidity, soil moisture, water level and fire sensor is given by developing them in real time Result.

In [11] it was proposed that Smart sensing system provides precise results and also it had proposed that Smart irrigator system manages to spray the necessary nutrients according to the requirements of the crops.

Many researchers have proposed various models in agriculture domain using one or more of the technologies mentioned above. The dynamic model was needed, that provides an integrated approach to:

1.Observing various soil properties from various farmlands and determine the various environmental conditions periodically through portable cost effective IOT device and it must be usable to multiple users and should solve the different queries of the farmers and also crop production and harvesting details and store these details at the central place in the cloud storage. These results must be analysed for requirements of current crop, mapping of crop production to soil properties at that time, next crop to be cultivated etc at Big-Data. This is used to increase the production.

2. Connect all agricultural entities together including farmers, marketing agencies, product vendors and Ministry of agriculture and Agro-Banks. This will facilitate distribution of products from farmers to buyers and from product vendors to farmers. And also through the Ministry of agriculture, farmers will be able to get notifications about new schemes announced by the government for agriculture sector

III. PROPOSED MODEL

The proposed model of consists of the five modules namely:

1. Sensor Module
2. Mobile-App Module
3. Farm-Cloud Module
4. Data Mining and Big-Data Storage Module
5. Government and Agro Banks

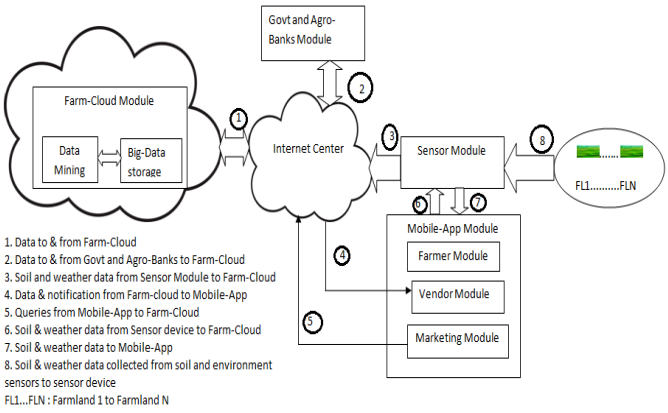

Figure1: Proposed model for Advanced Farming.

Sensor module consists of soil and environment sensors that is used to sense the soil. Mobile-App module acts as an interface between the modules. Farm-Cloud module consists of Big-Data storage and Data Mining. Government and Agro banks is an web interface that provides details of agricultural schemes and loans. It is shown in the Figure1.

1. Sensor Module

Sensor module is one of the important module in the model that is responsible for soil sampling at periodic intervals to get soil property values. In sensor module we make use of sensor kit which is portable and cost efficient device which makes use of Arduino board which is IOT enabled device with a processor, memory and graphics accelerations. The major components of this device are soil nutrient sensor devices connected to it. Soil attributes sensors for this model are soil pH sensor, soil moisture sensor, Phosphorus, Potassium, Nitrate sensors which are interfaced to the IOT device. It is shown in Figure2.

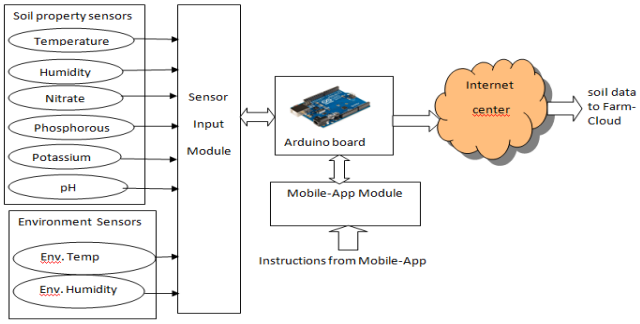

Figure2: Sensor Module

2. Mobile-App Module

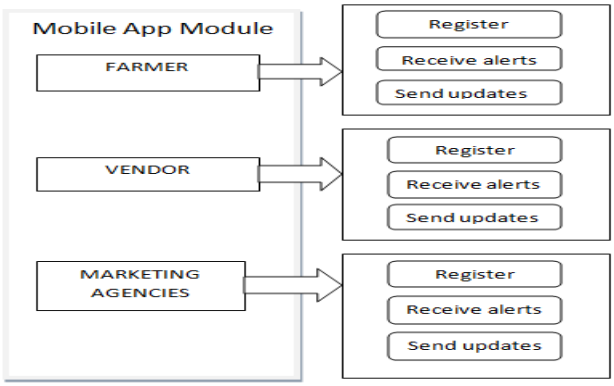

Figure 3: Mobile-App Module

Mobile app should be installed on the users mobile phone. It has three parts namely:
a. Farmer
b. Marketing agency
c. Vendors including fertilizer, pesticide providers and seed providers

Initially the user has to register to the mobile app with few details regarding to their identity information, user type, address, geographical locations and other necessary details. If the user is farmer then they has to register details regarding the farmland information consisting of approximate location and total area for each farmland. The soil information per farmland is gathered through Sensor devices. Sensor devices gets the required instructions from Mobile-App. The information will be sent and stored on Farm-Cloud Big-Data storage. Sensor device also collects and sends the soil information to cloud storage when the crop cultivation is in progress. With this app the farmers will get suggestions regarding the fertilizers required and its amount for better crop results and cost savings. With this app the users will also be able to receive the notifications. After the crop is harvested, the total production information for each crop will be sent to the Farm-cloud storage from the farmer along with current soil characteristics after cultivation of that crop. This information is stored in the Farm-cloud storage along with the time-stamp details. Marketing agencies responsible for purchasing harvested crops from farmers has to send the periodic updates related to changes in cost and their purchase requirements. Product vendors are responsible for selling fertilizer, seed, and pesticide and agricultural equipment's. Vendors have to send updates related to products and cost changes periodically. Mobile-app module is shown in Figure3.

3. Farm-Cloud Module

All the users of agriculture sector needs to be registered to Farm-Cloud through Mobile-App. Farm-Cloud storage consisting of Big-Data storage will store all the details of farmer, marketing agent details, and vendors and service providers (fertilizer/pesticide/seed and equipment providers) details and government schemes for agriculture sector including bank loans for farmers and concessions given on seed and/or fertilizers. This module also store details of periodic data collected through soil and environment sampling. As more and more number of users gets connected to this service and the data size grows rapidly over the time resulting into the Big-Data. The Farm-Cloud module with Big-Data storage, Data Mining module is shown in Figure1.

4. Data Mining and Big Data storage Module

This module is placed inside Farm-Cloud as shown in the figure. It plays important role in decision making for the fertilizer requirements for current crop based on current soil properties for better yields, crop disease prediction based on current soil properties and current weather conditions, crop yield prediction, best crop sequence analysis from the data collected over the period, best crop for corresponding soil properties, watering required based on soil moisture level. This module also gives details of region wise crop production details for each crop, total crop production for each crop in the state, based on this and current requirements for the consumers will be helpful to control the costs for each product. This database collects information over the years for soil properties and crop information details with its production amount for each farmland, inference results with which data mining can be calculated for better crop sequences to be carried for best production and to preserve good soil health. Also this database provides suggestions to the farmers for crops to be taken on the farmland with peculiar soil properties based on previous stock of agro products and current requirements in the market. Big-data analysis are carried out to estimate future production of each product based on previous knowledge base.

Application module at the Farm- Cloud storage is used for sending the notifications to the users, suggestions based on analysis, crop disease notifications based on current weather conditions and previous knowledge base.

5. Government and Agro Banks

Through the user interface of this module ministry of agriculture will be able to provide the details of recent schemes and subsidies for farmers and agriculture sector. Agro banks also provide the details of loan schemes through the UI. All these details will be stored on the Farm-Cloud storage and farmers and other beneficiaries who are registered on the Farm-Cloud storage will get this information through notifications when the schemes and subsidies are announced without physically visiting and enquiring to the government offices

IV. CONCLUSION

In this paper we have proposed a model for advanced farming using multiple techniques: IOT, Mobile-Computing, and Big-Data analytics. Through this model farmer will be able to get details regarding required fertilizers from his soil sample. This is used to improved crop production with reduction in cost of fertilizer and thus improve the agriculture sector in India. The data is collected in the database regarding crop details and soil conditions which provides Big-Data analysis for best crop and next crop to be used for farming for better production, total fertilizer requirements and other details. From the Farm-Cloud, marketing agencies and farmers will be able to get required agriculture products and servers from vendors. This model will be helpful to control the cost of agricultural products. Through Mobile-App farmers will be informed about current schemes for agriculture.

Our future work will be extended using different sensors and examining the results to get correct and better results and implementing this model and collecting data from various farmlands and analysing using different data mining algorithms suitable for agricultural for getting the desired outcome.

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