A Model for Smart Agriculture Using IoT

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***Abstract*— Climate changes and rainfall has been erratic over the past decade. Due to this in recent era, climate-smart methods called as smart agriculture is adopted by many Indian farmers. Smart agriculture is an automated and directed information technology implemented with the IOT (Internet of Things). IOT is developing rapidly and widely applied in all wireless environments. In this paper, sensor technology and wireless networks integration of IOT technology has been studied and reviewed based on the actual situation of agricultural system. A combined approach with internet and wireless communications, Remote Monitoring System (RMS) is proposed. Major objective is to collect real time data of agriculture production environment that provides easy access for agricultural facilities such as alerts through Short Massaging Service (SMS) and advices on weather pattern, crops etc.**

***Keywords*— Smart agriculture, IOT, Sensor technology**

I. Introduction

Agriculture is the basic source of livelihood of people in India. In past decade, it is observed that there is not much crop development in agriculture sector. Food prices are continuously increasing because crop rate is declined. It has pushed over 40 million people into poverty since 2010[1]. There are number of factors which are responsible for this, it may be due to water waste, low soil fertility, fertilizer abuse, climate change or diseases, *etc*. It is very essential to make effective intervention in agriculture and the solution is IOT in integration with Wireless sensor networks. It has potential to change the way of development in agriculture and gives great contribution to make it smart agriculture. The internet of things involves a three-tier system. It includes perception layer, network layer and application layer. Perception layer includes sensor motes. Information communication technology (ICT) enabled devices, sensor motes are building blocks of sensor technology. It includes cameras, RFID tags, sensors and sensor network used to recognize objects and collecting real time information. The network layer is a infrastructure of the IOT to realize universal service. It directs towards the combination of the perception layer and application layer. The application layer is a layer that combines the IOT with the technology of specific industry. The internet of things almost applied in all areas of industry, including smart agriculture, smart parking, smart building environmental monitoring, healthcare transportation and many more. Among them, agriculture is one of the important areas which targets millions of people. A brief outline of the paper is as follows. Section II explains literature survey on smart agriculture domain. Section III describes proposed problem statement. Section IV describes smart agriculture model. The proposed methodology for smart agriculture model is discussed in section V. Finally, the paper is concluded in section VI.

II. Literature survey

The research in agriculture area is enhanced in various aspects to improve the quality and quantity of productivity of agriculture. Researchers have been worked on many different projects on soil attributes, different weather conditions as well as scouting crops. Some projects worked on actual farm fields and some worked on polyhouses. Researches of Carrnige Mellon University worked on plant nursery using Wireless Sensor Technology [2]. Wireless Sensor Network based polyhouse monitoring system is explained in [3] which make use of environment temperature, humidity, CO2 level and sufficient light detection modules. This polyhouse control technology provides automatic adjustment of polyhouse. . In [4] authors have proposed development of wsn based above mentioned parameters for agriculture using ZigBee protocol and GPS technology. In some projects such as [5] authors have designed and implemented an approach in development of crops monitoring system in real time to increase production of rice plants. This system has used motes with sensors to check leaf wetness. Later on use of IoT has been proposed in [6-8]. IoT gives platform to researches to maintain real time data and send alerts immediately to farmers. IoT implementation gives easy access to information that comes from sensor nodes. IoT is also used for product supply chain business process. Cloud architecture gives additional support to IoT in maintaining Big data of agriculture information viz. history information, soil properties, fertilizers distribution, image cultivation through camera and information collected through sensors, recording information etc. Authors have analyzed collected data for finding correlation between environment, work and yield for standard work model construction. Monitoring for adverse signs and fault detection. In [9] authors have discussed the application of data mining with the help of WEKA tool and analysis model using of machine learning algorithms. In [10] authors have concentrated on crop monitoring. Information of temperature and rainfall is collected as initial spatial data and analyzed to reduce the crop losses and to improve the crop production. They have used optimization method to show progressive refinement for spatial association analysis. Although authors mentioned above have proposed many models in agriculture domain, the effective model is needed that uses new technologies and provides an integrated approach to monitor environmental conditions periodically and various soil properties of farm field through IoT devices and store these details at the central place in the cloud storage which results in Big –data over the time. It is also usable by multiple vendors or farmers who enquire about crop yield maximization. Farmer can analyze these data for fertilizer requirements for current crop. It will help for smart climate solutions and disaster prevention.

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III. Proposed problem statement

This paper presents proposed model for smart agriculture to develop real time monitoring system for soil properties like temperature, moisture, pH and to implement decision support advisory models for Pest & Disease forewarning, Crop Disease identification using image analysis and SMS based alerts. It will also be possible to control various operations of the field remotely from anywhere, anytime by mobile as well as web application.

IV. Proposed architecture

Proposed system has three modules – Farm side, Server side and Client side. Farm side deployment is as shown in figure1. It consists of six methods as follows.

1. Sensing local agricultural parameters.
2. Identification of location of sensor and data collection.
3. Transferring data from crop fields for decision making.
4. Decision support and early warming based on data analysis, domain knowledge and history generated.
5. Actuation and control based on decision.
6. Crop monitoring via camera Module.

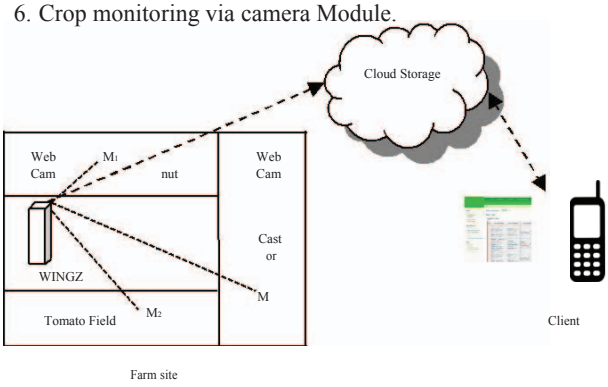

Fig. 1. Proposed SAIoT model

The solar panel supplies power for the sensors charging and server system installed outdoors, so that the system is applicable in an agricultural environment even if no external power is supplied. IOT serves the farm field through sensing local agricultural parameters, reliable transfer of data and intelligent decision support and early warning", which corresponds to the three layers of IOT, namely, perception layer, network layer and application layer.

(1) The perception layer mainly consists of Ubi-Sense mote as shown in figure 2. Ubi-Sense mote (M) is a generic sensor board having Temperature and Relative Humidity, Light Intensity, Barometric Pressure, Proximity sensing and Buzzer. Ubi-Sense mote is a generic sensor board having Temperature and Relative Humidity, Light Intensity, Barometric Pressure, Proximity sensing and Buzzer. Ubi-Sense reads values from sensor, detects Proximity IR LED and generates an alarm through Buzzer. It transmits the measured physical value from the Ubi-Sense mote over the Air.

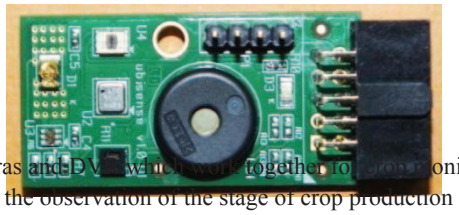

Fig. 2. Ubi-Sense mote (M)

Web Cameras and DVR which work together for crop monitoring from which the observation of the stage of crop production and similarly spectral analysis of plant images is possible to know health condition of the plants in real time.,

(2) The network layer is responsible for reliable transformation to application layer. It consists of Ubi-mote as shown in figure 3 compliant with IEEE 802.15.4 uses SoC with ARM Cortex M3 having External flash memory and supports to router and end device configurations such as Ubi-Sense mote and suitable for outdoor deployments. This technique can achieve convenient wireless connection and fast access to equipment within a short-distance. ZigBee technique uses WINGZ (Wireless IP Network Gateway as shown in figure 4 for Zigbee fits small-size and low-cost wireless network between WPAN and IP network. It works as Coordinator device for the WPAN networks mounted on single board computer. It has its own unified control and monitoring console for various wireless networks.

3) In the application layer, the system can obtain and analyze weather information from the internet, including weather forecast in the previous days. The database stores sensors data, streaming data, geological data and environmental reference values for notifying conditions into each table, and creates average statistical information by using the collected information. The DVR provides images taken from cameras to the web as streaming data and stores them in the database. Once data is gathered at the server, comprehensive analysis of such information is done. It provides an environment that users can monitor data processed by the components through a Web browser anywhere and at any time. For example by analyzing soil moisture values, the system is able to keep sufficient quantity of water needed by the crop and at the same time avoids too much water which might drown the crops and cause waste.

Fig 3. Ubi-mote

Fig. 4. WINGZ

V. Proposed methodology

Farm field may have different crop areas. In these crop areas Ubi-Sense motes are installed. Data from Ubi-Sense mote will be transferred to Ubi-mote Server side module. Decision support system will be implemented for alerts, crop monitoring. Client side module consists of web application as well as mobile application on android OS as shown in figure 5 and figure 6.

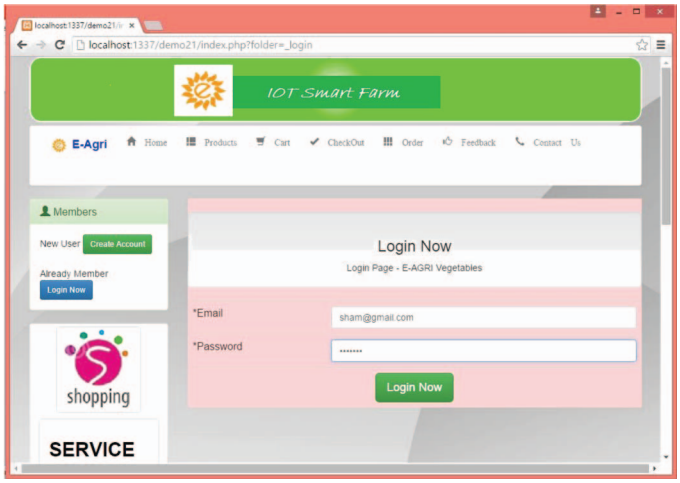

Fig. 5. Web Application

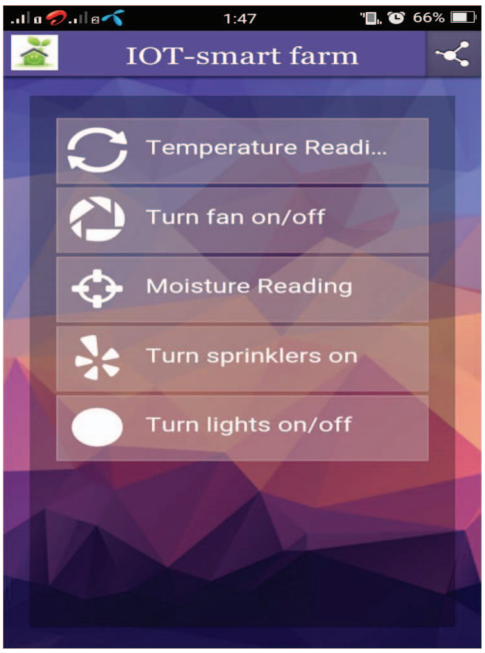

Fig. 6. Android Application

VI. Conclusion

The paper proposes a wise agricultural model in integration with ICT. ICT have always mattered in Agriculture domain. Village farmers may have planted the "same" crop for centuries, but over period, weather patterns and soil conditions and epidemics of pests and diseases changed. By using the proposed approach, received updated information allows the farmers to cope with and even benefit from these changes. It is really challenging task that needs to provide such knowledge because of highly localized nature of agriculture information specifically distinct conditions. The complete real-time and historical environment information is expected to help to achieve efficient management and utilization of resources.

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