Recent advances and future challenges of IoT in Agriculture

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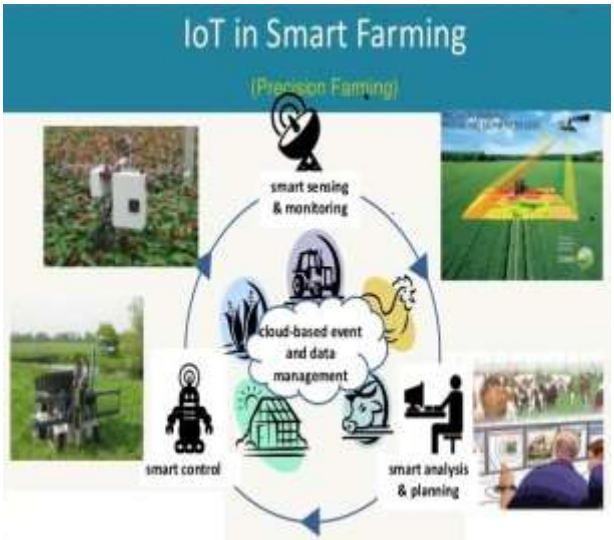
Abstract: One of the essential tasks in agricultural applications is the use of computer technology. Agriculture is mainly based on observing, measuring, and responding to inter and intra field variability in crops. Improper irrigation will result in waste of water. Proper irrigation system could be achieved by using WSN technology Farmers, researchers, and technical manufacturers are joining efforts to find more efficient solutions for solving various different problems in agriculture to improve current production and processes. Internet of Things (IoT) is a network of sensors and connectivity to enable application like agriculture optimum irrigation. Wireless sensors consist of computation, wireless communication capabilities and small nodes of sensing. Today WSN have become an important part of precision agriculture. The recent advancement in wireless technologies has enabled a wide range of applications in environment monitoring. The use of sensors helps farmers to exploit all available resources appropriately and to apply hazardous products moderately. In this paper we have discussed about the sensor network and compared various techniques used in precision agriculture.

Keywords - Precision agriculture, Wireless Sensor Networks, Wireless Sensor, Automatic Irrigation, Greenhouse

I. INTRODUCTION

India is one of the largest producers of agricultural products worldwide. About 70% of India's population depends on agriculture for their livelihood. In order to solve different problems occurring in traditional agriculture like poor real time data acquisition, small monitoring coverage area, excessive requirement of manpower, etc. precision agriculture is used [1]. Precision agriculture using a computer technology helps farmers to get control over the management of farm operations. Agriculture has been playing an important role in the economic growth of most of the countries. Agriculture sector continues to play an important role in providing extensive employment to people. Agriculture in India is considered as the land of farming. Most of the real world applications can be controlled and automated using computers, but there are still most of the people involved in agriculture tasks follow traditional methodologies. This has lead to improper agriculture management tasks and hazardous actions taken by farmers. Automation using computers has been achieved by replacing humans. The use of computer technology in the field of agriculture not only reduces the man's efforts, but also helps in increasing the yield of crops. The use of IoT in agriculture is shown in the Figure.1.

Fig.1: IoT in Agriculture



Automation through intelligent farming using computer vision, machine learning, image processing, etc., are used in different agricultural applications like sorting, plant disease detection, plant growth monitoring, quality grading but still there is a long way to go.

Sustainable approach to agriculture with the help of automation and sensor technology, benefits the society in the following ways

- Plant disease diagnosis
- Plant growth monitoring
- Conservation of water
- Sorting of fruits, vegetables, etc
- Crop quality grading.
- Better crop yield
- Time saving, accurate diagnosis of nutrient deficiency

In order to know state of the art development in automation of agricultural applications literature survey has been carried out. The paper is organized in four sections. Section 1 gives introduction, section 2 gives summary of technologies employed in agriculture, section 3 is literature of IoT and conclusion is discussed in section 4.

II. TECHNOLOGIES EMPLOYED IN AGRICULTURE

Intelligent farming is a notion quickly communicable on in the agricultural business. There are many advantages a networked farm has to provide like high-precision crop control, useful data collection, and automated farming techniques. It will provide accurate data which can be used to improve farming techniques over time. IoT has the advantage to transform the landscape of current farming methods. IoT sensors have the ability of providing farmers with details about crop yields, rainfall, pest infection and soil nutrition which are crucial to production. The agricultural experts can connect miniature computers to the network from any place by powerful wireless communication links and can supervise any detail of the farm. They may install various kinds of sensors at any place and access information about farm conditions at any time. Agribusiness faces

many difficulties, for example environmental change, water deficiencies, food safety, etc. Mobile and pervasive computing technologies give us to investigate processing outside atmosphere controlled building environments. ZigBee is a low-cost, low-power, wireless mesh networking standard. Zigbee based wireless sensor network can be utilized in different agricultural applications such as monitoring of conditions like weather, soil, crop, weed-disease detection, automated irrigation facility, storage of agricultural products etc. In order to corroborate the efficiency of these technologies in agricultural applications, comparison has been made to deploy automation in different activities of agriculture field.

A.IOT

The "Internet of Things" (IoT) is a highly favorable technology which is efficient of modernizing agriculture sector. With emerging technologies like cloud computing and Big Data, IoT provide sufficient resources and solutions to sustain, store and analyze the huge amounts of data. The data collected by IoT devices can be used to automate processes, forecast situations and enhance many activities, even in real-time. Agriculture is one of the areas that is awaiting to be high impact of the advances in the domain of IoT. The agricultural sector was highly affected by Wireless Sensor Network (WSN) technologies and is expected to be equally benefited by the IoT. According to food and agricultural organization of the United Nation (FAO) there is an increase of 70% in food production must be achieved by 2050 worldwide [7]. The rising need for high-quality products generate the demand for the modernization and reinforcement of agricultural practices. Nevertheless, the demand for high efficiency in the use of water and other resources is also required. Precision agriculture (PA) sustains a lot to the required increase of food production (Zhang, Wang, & Wang, 2002). Incorporating IoT in agriculture, enhance agricultural processes to provide better yield and requires fast, reliable, distributed measurements concerning farmers a more detailed inspection of the current situation in their farming area. It also coordinates the automated machinery in such way that improves energy consumption, water use and the use of chemicals for pest control and plant growth.

B. Wireless Monitoring Technique

Wireless monitoring technique adopts remote monitoring system using Zigbee. These nodes deliver data to a central server, which collects stores, analyze the data, then displayed as needed and can also be sent to the client. The hardware of this system consist of 8-bit AVR, bluetooth module, temperature, soil, humidity and moisture sensors, LCD. It can be used in precision farming due to its low cost and low power consuming. The system can be put up at the pump house placed far-off from the village. It is connected with the pump starter & sensors are placed at various locations in the field for acquisition of the data. Using this system the farmers can switch on their pump from their home whenever they want. [8]

C. Pervasive wireless sensor network

This technique is based on wireless sensor network which uses the design and deployment of environment monitoring system for a waxberry greenhouse shed. The environment for waxberry greenhouse should have adequate illumination, temperature and humidity to obtain better production and quality. The system is composed of four subsystems, namely, a data acquisition subsystem based on WSNs, a data collection and processing subsystem. The system adopts client server architecture, web-based information dissemination and inquiring subsystem integrated with Google maps with an alarm subsystem designed for farmers and farming technician. The system can automatically perform data collection, transmission and processing for parameters like temperature, humidity, illumination and voltage. The system uses GPRS and solar power system, and it doesn't depend on primitive facilities to establish for the sheds. A real time data diffusion integrated with google maps is provided to facilitate web-based remote information system. A real time alarm system is furnished where the alarm rules can be deliberated based on domain knowledge. The system can provide services such as SMS message and voice alerting. [4].

D. Irrigation Control Technique

This system gives techniques to estimate soil productivity, suitable to check the fertility of crop. After estimating fertility, automatic drip irrigation is finished through microprocessor to calculate soil moisture. Zigbee in drip irrigation, which provides real time feedback control system that monitors the soil moisture. In order to produce more crops per drop drip irrigation is used in which soil moisture sensor senses the moisture of soil. The microcontroller records sensor output and controls the working of motor depending upon level of soil moisture content. Microcontroller sends this data to computer through Zigbee [10].

E. Green House Technology

For greenhouse technology to be connected with wireless network, more number of sensors is needed to identify the parameters. A Zigbee sensor network can be used to maintain network performance with remote application server (RAS) to gather localized data from sensors to control the network. Wireless sensors and smart transducers are designed with some micro-controllers to perform computation and network management. Climate sensor is installed to get time to time information about wind flow, wind direction, ambient light, ambient pressure, humidity, temperature, and percentage of CO2 from inside of the green house. Soil sensor is designed to monitor the soil conditions like humidity of soil, pH value, temperature and electric conductivity of a soil. In nocturnal conditions, plants are inactive therefore maintaining high temperature is not necessary. Two temperature points nocturnal and diurnal are set in such conditions. During the daytime the sun produce the energy needed to reach the optimal temperature. To control the required humidity is done by properly controlling ventilations of the green house. The greenhouse is an event based control system based on climate. [11]

F. Zigbee in Precision agriculture

In Zigbee networking standard, the sensing technology identifies the pests in the crops, drought or increased moisture. Having such information at a real-time interval, automatic-working devices can be used to control irrigation, fertilization and pest control in order to neutralize the unfavorable conditions. This technology can be applied for wireless applications in agriculture domain. Zigbee based soil moisture sensor plays a vital role in partitioning water and energy fluxes. It provides moisture to the atmosphere for controlling and precipitation the structure of groundwater recharge. [12]

G. Monitoring of WSN in Precision agriculture

This system utilizes ultrasonic sensors, Zigbee modem, GPRS and microcontrollers. Without any human intervention, the control is done automatically by design and development of a monitoring system. Humidity sensors are used to measure the humidity of the environment, temperature sensors are used to measure the temperature and ultrasonic sensors are used to measure the water level of the ground. The sensors values are sent to the microcontroller. The microcontroller converts the analog values to digital values through the LCD display. The digital values from the microcontroller are sent through the Zigbee transmitter. The Zigbee receiver receives the signals and sends them to the microcontroller which updates the server using GPRS communication. The web page is used to view the parameters of the field and environment. The signal is received by the controller via GPRS modem. The controller gives the command to the pumping station, which is connected through the relay circuit.

III.SUMMARY OF LITERATURE REVIEW

A substantial agricultural sector confirms the food security of a county. However, it still remains a traditional sector, where innovation takes place at a slower step than in other sectors, primarily due to the high costs

involved with smart agriculture. The models discussed make use of sensors in agriculture sector without compromising on the efficiency. Furthermore, they furnish an integrated network of multiple sensors to sense almost every parameter connected with plant growth and a web-based application which allows the user to monitor the farm from anyplace. The comparison between techniques discussed is given in the Table.1.

IV.CONCLUSION

The various precision agriculture techniques using wireless sensor network has been illustrated. Combining precision agriculture with wireless sensor network facilitates the farmers to make use of crop requirements such as fertilizer, pesticides, tillage, irrigation water, etc effectively. This leads to greater produce and quality of production. Besides, adopting these techniques facilitates the farmers to easily control these requirements with more precision. It is difficult for the farmers to adopt these techniques due to high operating costs. Indian agriculture, which is primary and more of manual work that is located mostly in areas away where there is no proper communication. In such conditions GSM technology suits the most due to its low cost, easy access by the farmers etc. Considering this precision agriculture for India would impart a new path of sustained agriculture in globalized economy.

TABLE 1: COMPARISON BETWEEN EXISTING TECHNOLOGIES AND SENSORS USED BY THEM

Technology	Communication Technology used	Cost	Efficiency	Applications Used	Soil Sensor	Moisture sensor	Temperature sensor	Humidity sensor
Wireless Monitoring [8]	Zigbee	Low	Less	Machine, monitoring, security, etc	NO	YES	NO	YES
Pervasive WSN[4]	GSM,RFID	High	LTD	Communication, etc	YES	NO	NO	NO
Irrigation control[9]	Zigbee	Low	Less	Drip iirigateon, etc	YES	NO	NO	NO
Control PA using WSN[10]	RF	High	High	Communication, greenhouse etc	NO	YES	YES	NO
Zigbee in PA[11]	Zigbee	Low	Less	ISM.sensor.etcc	NO	NO	YES	YES
Monitoring of WSN in PA[12]	Zigbee, GPRS	Low	Less	Communication, etc	YES	YES	YES	YES

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