Wireless Sensor Network in Precision Agriculture

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Abstract—Wireless sensor Network is a self-organizing Network. WSN can be deployed in various environments for monitoring purpose. WSN has major applications on health monitoring, military surveillance, weather monitoring, agriculture, etc. In recent decade wireless sensor network implemented in agriculture field are encouraged in many researches. WSN in precision agriculture help to measure different environmental factors such as humidity, temperature, soil moisture, PH value of soil,etc. This precision agriculture helps to enhance the crop quality.Utilizing wireless sensor technologies and management tools can help to identify various diseases in crops, excess usage of pesticides, etc. This paper proposes the efficient use of sensor network in precision agriculture to help the farmers. This paper presents agricultural field where the sensors are used and the different types of sensors used in precision agriculture, also it suggests the environmental factors influencing agriculture.

Keywords-Green House Management System (GHMS), Arduino Uno, WMSN, PA, GIS.

I. INTRODUCTION

Agriculture is the backbone of our country. Two- third of our Indian population depends on agriculture. Now-a-days Wireless sensor network is widely used in agriculture for efficient farming and enhancing the growth of the crops. A Wireless sensor network (WSN) comprises of many sensor nodes with radio communication capabilities. A WSN node consists of sensors, analog to digital converter (ADC), micro-controller, radio frequency electronics, dc to dc power converter and a tiny power source. WSN is a modern technology which integrates the knowledge of sensors, automation control, digital network transmission, information storage and information processing [3]. This technology helps the farmers to monitor their crops, amount of water needed for the plant and the amount of fertilizers needed for the plant. Wireless Multimedia Sensor Network (WMSN) consists of a camera capable sensor node deployed in the agricultural land to sense or monitor the growth of the plant. If there is any changes in the growth of the plant or any disease occurred in the plant which is immediately intimated to the farmers via SMS. This Wireless Moisture Sensor Network uses the Greenhouse Management System (GHMS)[4]. WSN are used to assist farmers and various experimental studies on agriculture sectors are still in processing. The major motivation of this paper is to get a detailed knowledge about the use of wireless sensor technology in precision agriculture. Wireless sensor networks have high performance, low power consumption, increase the rate of production and it help to collect the distributed data. This paper help the researcher to gather information about precision agriculture and the different types of senor used to monitor the agriculture field.

In this paper Section I contain the introduction of wireless sensor networks and Section II gives information about precision agriculture. Section III tells about data communication in PA. Section IV contains the environmental factors affecting agriculture. Section V explains about the different sensors used in agriculture. Section VI contain the concludes research paper.

II. PRECISION AGRICULTURE

Modern agriculture needs larger production of food to satisfy the global needs. Soagriculture incorporate with new technology for larger production. To achieve this goal, new technologies and innovations are being applied in agriculture to provide an optimal alternative for collecting and processing information to improve productivity. In addition, the disturbing climate change and water scarcity demand new and improved methods for modern agricultural Initially precision exploitations. agriculture was implemented using remote sensing and GIS (Geo Graphic Information System). Precision agriculture is a farming practice which integrates the technology for the purpose of crop performance improvement. The alerts generated by the WSN can be forwarded in the form of messages to the farmers using the Internet and appropriate action such as application of water to the fields can be initiated by the

farmers. Precision Agriculture (PA) is an information-based and technology-driven agricultural system, designed to improve the agricultural processes by precisely monitoring each step to ensure maximum agricultural production with minimized environmental impact [3].



Figure 1 Simple Structure of WSN in PA

In Precision Agriculture it uses different types of sensors such as humidity sensors, temperature sensors, moisture sensors, etc. Each plot area in an agricultural land is monitored and controlled in precision agriculture. Reading and writing parameters are done digitally.

A. Smart Irrigation

Water is the important source for agriculture. 70% of water resources is available among worldwide. The precision agriculture helps to monitor the flow of water in the agricultural land. Here we are using moisture sensor, temperature sensor and humidity sensor for the sensing purpose. For smart irrigation, it uses Green House Management System (GHMS). There are two different methods of irrigation in smart irrigation. They are Schedule based irrigation and Feedback based irrigation [5]. In Schedule based irrigation water is supplied at specific time interval. But in feedback-based irrigation, considering the moisture content of the soil it checks the predefined value, if it reaches below then the irrigation starts to the land. This method helps to save nearly 15000ml/day. There are two ways to measure the soil moisture. They are contact based and contact free sensors. The contact-based sensors touch the soil directly and checks the moisture content using the capacitance sensors, fiber optic sensors and heat pulse sensors. In contact free sensors, detection areas cannot touch the soil. Contact free based sensors such as passive microwave radiometers, synthetic aperture radars as well as thermal methods [5]. Using these moisture sensors help to identify the moisture content of the soil.

B. Soil Monitoring

In agricultural applications, it is necessary to measure and monitor various soil related parameters such as soil moisture

content, soil water content, soil temperature, soil electrical conductivity, salinity level of the soil and climatic condition parameters, which include solar radiation level, ambient temperature, wind speed, rainfall. By measuring soil electrical conductivity, soil moisture content and soil water content, it can be ensured that optimum amount of water is used for irrigation purposes. Soil characteristics can be identified based on the soil electrical conductivity values. The soil moisture content provides the water tension level within the soil which dictates the amount of effort needed by the plant root system to absorb water from the soil. The soil water content provides an approximate estimate of the water to be applied to the agriculture field. The soil temperature over a time duration assists in determining the crop type suitability. The salinity level of the soil determines the type and the quantity of the fertilizer to be applied to the field.Selection of crops depend on the type of the soil and the environment factors of that region. The four important parameters for any type of crop are

- Soil pH
- Soil Temperature
 - Soil Moisture
- Humidity

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Soil pH is the indicate the nature of the soil that it soil is alkaline or acidity. If the soil have pH is greater than 7 the soil is alkaline and if the pH is below 7 then the soil is acidic [8]. Soil temperature and moisture play a vital role for every crop for their growth. Soil moisture is important in agriculture for irrigation purpose. Soil moisture is the measurement of water content in soil. Different types of crop and plant require different moisture level in the soil to grow. Humidity is an important parameter that must be known to a farmer because humidity generates pests and various types of crop diseases. If humidity increases at specific level then it increases the chance of various plant diseases [8].

C. Plant Disease Detection System

Plant Disease detection is a tedious process in agricultural field.The WMSN and image processing techniques and Internet of Technology (IoT) has been used to increase the cultivation yield by building a decision support system which can detect and classify the disease. The camera nodes placed in the farm captures the image of the plants and processes it to detect and segment the disease. The segmented image can be transmitted to the monitoring site using internet from which the features are extracted for further analysis.Images are extracted based on color, texture, area and cluster. Feature extraction plays a major role in classification. These features are transmitted through the sensor nodes to the gateway which is further transmitted to the monitoring site through internet[7]. The automation system available at the monitoring site makes use of the classifiers and neural networks to classify the disease after which the farmers are alerted If there is an incorrect identification, there will be a huge loss on the production.

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Wireless Multimedia sensor network (WMSN) help to monitor the disease in plants. Initially sensor captures the image of the affected leaf and segments it properly. Image segmentation is the process of grouping or separating an image into different parts [4].In leaf Disease Detection System, if there is any attract of insects the sensor networks deployed nearby will sense changes in the leaf and inform to the farmers. The information may be either through short message service(SMS). The sensors are connected through internet, immediately after knowing the changes it will inform the farmers. If the leaf disease is identified in the initial stages then, we will avoid huge loss of production.



Figure 1 Example of affected leaf

III. DATA COMMUNICATION IN PA

Wireless Sensor Network is one of the best technologies to monitor the environmental factors.WSN is a network of small sensing nodes arranged in a distributed manner. Each sensor nodes communicates and gather information and send to the server node via a gateway. The sensor nodes are limited powered small devices. Sensor network node consists of a sensor module, communication module and battery [4]. The WSN for PA requires centralized control unit with user interface, communication gateways, power elements and sensors.PA requires a unique software model for each geographical area, particular crop in particular land. Intelligent Green House Management System (IGMS) is a web-based application which contain the information about the cultivation process, real-time data from the sensors, sensor configuration environment and expert system capabilities and support[4]. The sensor used in IGMS are temperature, humidity and moisture sensors. A typical wireless sensor network consists of large number of distributed sensor nodes having limitations due to low cost and low processing capability. A sensor node consists of sub - units like sensor, signal conditioner, A/D converter, microcontroller, transceivers and power units. The sensor nodes may have additional optional units like mobilizer, localization finding system and an actuator unit. Therefore, wireless sensors coupled with the latest wireless technology will make agriculture sustainable. The coordinator is configured in Application Programming Interface (API) mode. The coordinator node being connected to the Arduino Uno, which in turn is connected to the laptop, the data can be serially monitored or it can be serially plotted

using Arduino's Integrated Development Environment (IDE) [2].

IV. ENVIRONMENTAL FACTORS INFLUENCING AGRICULTURE

Environment plays an important role in the growth of crops. Major factors influencing the growth of a plants are sunlight, water, temperature, humidity, airflows,etc. These factors help in photosynthesis, transpiration, absorption and flowering.Humidity controls the moisture loss from the plants. Light also influences the growth of individual organs of a plant. Water is taken from root system and lost through transpiring leaves. The oxygen content of the plant's root substrate is reduced if the soil is flooded with water. Therefore, enough water needs to be supplied to the plants all the time (also known as "Precision Irrigation")[4]. Soil and surrounding atmosphere temperature play an important role in irrigation. Phosphors content in soil fertility plays a significant rolein agriculture. A rich fertile soil is the main requirement of successful agriculture. Crops require varying amounts of different mineral nutrients in the soil. The degree of warmth, the duration, and the intensity of sunshine all affect crop maturity to a certain extent. Sunshine not only accelerate ripen of crops but also improves the quality of the final products. Moisture, either from the atmosphere or from the groundis absolutely essential in plant growth. Some plants are harmed by strong winds which may accelerate evaporation or physically damage the plant.

V. SENSORS USED IN PA

Sensor is a device that detects and responds to specific input such as light, heat, motion, moisture, pressure, etc. from the environment.In market, these sensors are easily available. The agriculture sensors help to monitor the agricultural fields. Various types of sensors are used in Precision Agriculture. Some of them are,

- Soil Water content sensor:Soil water content is the ratio of the amount of water present in the test soil to the total amount of test soil. The water content is calculated by a change in the capacitance value and this depends on the dielectric constant of the soil. The measurement methods are soil type dependent and hence the sensors need to be calibrated for each soil type.
- Sensor for soil moisture content: This sensor measures the soil water tension or suction, which is a direct indication of the quantum of effort to be put in by the plant root system while mining water from the soil. The drier the soil, the more strength is required to extract water from the soil.
- Soil Electrical conductivity sensor: Theelectrical conductivity (EC) of soil helps to differentiate and map various soil variables. It is used to evaluate the soil solute concentration while assessing the soil salinity hazard. By measuring EC, many physical properties of the soil can be deduced. Traditionally, the salt content of a soil is measured by making use of soil electrical conductivity sensor

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- **pH Sensor:** The pH values range from 0 to 14. The solutions having pH values less than 7 are considered acidic and the solutions having pH value greater than 7 are considered basic. In agriculture, soil pH values outside the range of 5.5 to 6.5 are considered as non-optimum as it reflects lack of availability in soil nutrients. The pH value is regulated in agriculture by the application of alkaline or acidic fertilizers, which in turn improves crop production. The pH value of soil varies within the field; thus, it is profitable to apply the fertilizer according to the spatial variation of soil _PH.
- Weed Seeker Sensor: The Weed Seeker sensor consists of an active light source and a chlorophyll identifying selective spray sensor. It detects weeds and sprays herbicide over them without spraying over the bare ground. Thus, very less chemical can be used reducing application cost.
- **Temperature Sensor:**It defines the temperature of a body. In agriculture, the soil temperature determines the type of crop grown in particular region. The temperature sensor gives alerts for peak and low temperature value.
- Wind Speed Sensor: The Wind speed sensor determines the speed of the surface wind, which is practically considered as a two-dimensional vector. Wind blowing over the Earth's surface is turbulent and is characterized by some random fluctuations of speed and direction. Wind speed is classified into instantaneous and average types. The average wind speed is the average of the instantaneous wind speeds overa ten-minute duration. The speed of the wind changes continuously, and measured values of wind speed. The measured values are transmitted as an electrical parameter. The transmitted values are stored in a server through internet. The datasets are collected and used.

VI. CONCLUSION

Precision Agriculture is an encouraging topic to the recent researcher. Precision Agriculture helps the farmer to monitor their plants growth. It helps to increase their production. PA also helps to identify the disease in plants in advance. This avoids the huge loss of production. This paper helps the researchers to learn about Precision agriculture.WSN in PA uses many different types of sensors are available in the market in low cost. This sensor sense for various parameters and an alert is given if it reaches the threshold value. The introduction of sensor technology will increase the production. Plant disease detection is one of the important for agricultural applications to increase the yield. This sensor network helps to monitor the growth and identifies any problems in agricultural land. If there is any temperature change which will be intimated to the farmers. The technology assisted agriculture and decision support system help to improve the production rate in agriculture. But in rural areas our farmers are not trying to use this new technology. This paper gives a primary knowledge about precision agriculture and various types of sensor used in agriculture. This paper suggests to use of new technology using the wireless sensor networks to improve the production rate.

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