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A Review Suitability of Wireless Sensor Networks in Precision Agriculture

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Abstract- In the present era, wireless sensor network (WSN) portrays a key role in engineering, science, agriculture and many more fields' precision agriculture (PA) is one of the fields where WSN contributes major role. PA defines as the method of using technologies to produce better quality and quantity of crop it helps in raising the profitability graph of farmers. In PA various technologies like remote sensing, satellite, drones, wireless sensor network and many more are used to provide information to the farmers. Further, integration of WSNs in agriculture can monitor the progress of the crops and provide real time data to the farmers such as moisture, temperature, water and other resources. Hence, the aim of this review is to identify the various WSNs technologies adopted for precision agriculture and impact of these technologies to achieve smart agriculture. This review also focuses on the different environmental parameters like irrigation, monitoring, soil properties, temperature for achieving precision agriculture. Further, a detailed study is also carried out on different crops which are covered using WSNs technologies. This review also highlights on the different communication technologies and sensors available for PA. To analyze the impact of the WSNs in agriculture field, several research questions are designed and through this review, we are trying to find the solutions of these research questions.

Keywords:- WSN, Precision agriculture, remote sensing etc.

I. INTRODUCTION

1. Internet of Things:

Internet of things (IoT) is a network composed of nodes which transmit or receive data without any wired medium. Each node in IoT has its own transmitter, receiver, and battery unit. The infrastructure of IoT is very small and consists of few or large number of nodes. The sensor nodes in IoT help in sensing, gathering and measuring the information from the surroundings where they are deployed and transmit the data to the users.

An IOT has small or we can say no infrastructure and having number of sensor nodes in it from ten to thousands which works together to monitor an area where they are deployed. It can be divided into two types structured and unstructured IoT. In structured IoT, each node is deployed in architectural manner and position of each node is predefined in the network. Whereas in unstructured IoT, nodes are deployed in random order and no architecture is defined in the network [1].

There are many applications areas in which IoT can help in monitoring and tracking such as military, health, environment, business, airport, home appliances, factories etc. In IoT, sensors are integrated with a radio transceiver and a set of electronics components which helps in transmission of data from source to destination. Sensor nodes

have capability to organize themselves to create ad hoc, multi-hop network which helps in creating communication link between nodes. User can give commands to sensors; as a response of these commands sensors can transmit data to the user for example a particular limit of temperature is assign to the sensor with the help of embedded language if temperature exceeds from that assigned value than sensor provides information to the user. [2]

2. Types of IOT:

Internet of things is classified into five types to monitor the parameters of surface of earth, underground conditions, and underwater conditions, multimedia and to monitor the area by the help of movement of sensors.

These five types of sensors are defined as;

2.1 Terrestrial IOT-In this type of IoT, huge number of nodes are deploying into a surface of land that can help to examine the conditions of land.

2.2 Underground IOT- As the name depict underground IOT are networks of sensor nodes which are deployed in caves, mines or underground surface for monitoring the condition of soil, moisture and military boarder monitoring.

2.3 Underwater IOT- In this IoT, sensors are deployed in the region of oceans, rivers for underwater surveillance.

2.4 Multi-media IOT- It is a network consists of sensors nodes that have ability to store, process and access multi-media data such as video data, audio files and pictures.

2.5 Mobile IOT- In this network, sensor nodes have the ability to move from one place to other. The application of such networks is military surveillance, monitoring of area, tracking of target, monitoring under water [3]

3. Components of IOT:

The basic components of IoT nodes are described as below.

3.1 Sensing Unit - These are generally made out of two subunits, namely, analog to digital converters (ADCs) and sensors.

3.2 Processing Unit - Most of the processing unit provides information on the sensor nodes. The processing unit includes a microprocessor, which is responsible for controlling the sensor.

3.3 Transceiver Unit – Transceiver unit is composed of both receiver and transceiver. It helps in sending and receiving of data.

3.4 Battery – Battery helps in providing electricity charge to the sensor nodes by the help of which nodes of IoT works.

4. Communication Technologies:

In IoT communication various technologies are used to transmit the data from agriculture field to central point. The specification of these technologies is described in Table. The IoT communication technologies used in PA is given as;

4.1 ZigBee - ZigBee is low-cost, low-rate, and less-power consumer device as compared with other wireless technologies that helps in secure and efficient transmission of data from source to destination. By applying a internet of things based on ZigBee to an agriculture field data regarding to the conditions of field is properly transmitted to the user at high data transmission rate [4].

4.2 Bluetooth- Bluetooth is a small range, low-power consuming device for internet of things which helps in transmit data from one user to other in a range of 100 meters. It operates on the frequency band of 2.4 GHz [5].

4.3 Wi-Fi- wireless fidelity (Wi-Fi) is IEEE standard 802.11b for wireless local area network which is operated in frequency band of 2.4 GHz deploy in a distributed way to cover the range of hundred meters. Wi-Fi is the most successful technology of internet of things few years ago Wi-Fi was only available on laptops but now a day's Wi-Fi is easily available in cell phones, cameras, TV etc [6].

4.4 GPRS - general packet radio service (GPRS) provides fast speed of data transmission to the users. it uses the frequency range of 2.4 GHz. GPRS provides faster and long distance connection for data transmission. Range of GPRS is spread up to kilometres according to the coverage area of GPRS [7].

4.5 WiMAX-worldwide inter-operability for micro wave access (WiMAX) is an IEEE 802.16e standard used for a long distance communication technology. With the integration of WiMAX technology, the capacity of network can be raised up to 70 mbps [8]

II. LITERATURE REVIEW

Sanchez et al., [9] proposed an integrated WSN solution for PA which helps in assimilate crop data acquisition, transmission of data to the end user and video-supervision task. The main projection is on the

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security of crops, in PA security tasks take account of intrusion detection and identification in the agriculture field. detection of intrusion and identification is done with help of video surveillance.

Video monitoring of scattered crop need a large amount of energy consumption and time to send data to end users due to the assignment of capturing, processing and sending pictures. Sensors placed in separated crops helps in sending video messages but this is a challenge because there are frame collisions due to this collision there is dilapidation or mislaid of images.

This issue is very critical because there are chances of loss of much more data. To avoid these inadequacy authors proposed a comprehensive wireless sensor network solution for precision agriculture, which incorporate video transmission on networks formerly focused only on monitoring data of crop, sinking cost and avoiding duplicate infrastructures. Detection in the field is provided by infrared motion sensors and identification of intruder is consummate with the help of camera sensors.

Zhang et al., [10] propose a method to monitor vigor (strength) of the plant by the help of various techniques using inexpensive, low power wireless sensor nodes. The vigor of the plant is non-violently monitored through technologies like embedded technology and image processing technology without any damage caused to plant and quick judgment of strength or growth of the plant is obtained.

If there is any atypical behaviour of a plant is assumed during the process of monitoring then there will be an indication of warning to end users. With the help of wireless sensor nodes deployed in the field's wastage of resources which are needed for cultivation of plant are minimised. Proposed method based on data fusion of fuzzy comprehensive evaluation helps in providing the well-organized way for monitoring the strength of plant in many phases of agriculture.

Zou et al., [11] proposed an algorithm named as OASNDFA for achieving intelligent agricultural monitoring with minimum sensor nodes deploy in the field. Selection of location of nodes is difficult in hilly areas due to factors like topographies and undesirable or unsuitable weather conditions this algorithm helps in finding the location of nodes. Proposed algorithm works on three phases first, factors to be observed and key point include the relevant factors should be determined second, mathematical model is designed with the help of obtained monitored factors after that with help of key points with maximum features mathematical model is solved.

Jiang et al., [12] proposed an algorithm named as dynamic converge cast tree algorithm (DCTA) which rely on tree structure topology. This algorithm is employ within monitoring system which is based on WSN. Sensors deployed in agriculture fields create a problem of vulnerable dynamic topology of established network so for the better data attainment in the monitoring of growth of plant DCTA algorithm is proposed. Apart from selecting reliable route of nodes for sending data DCTA also resolute the timing to instigate a broadcast task. in DCTA algorithm there are three stages a)routing which is based on dynamic routing b) adaptable time slot scheduling c)compilation and examination of data. DCTA algorithm helps in providing high data transmission between nodes.

Kim et al., [13] proposed architecture for sensor networks with autonomous robots based on beacon mode for real time monitoring of agriculture field. Farmer face a lot of problems to observe and analyze the measured result of crops and not able to respond easily to any misbehave happening in their fields like occurring of fire, intrusion attack ,lack of availability of resources this helps farmer to check the condition of crops.

The proposed beacon mode based wireless sensor network system relies on TinyOS platform. In this paper they define the structure of message for monitoring, sensor nodes which are used in fields can make a multiple beacon scheduling in the MAC layer with bop slots. Dynamic address allocations and path recovery process for unexpected link failures as well as node mobility is offered by the network layer in this architecture .proposed network architecture has the reliable transmission ratio for a real-time processing service such as fire and emergency agriculture monitoring systems under heavy traffic environments. Technology tools and platform used to make architecture of network is shown in table.

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Bapat et al.,[14] proposed a wireless sensor network to protect farms from the attacks of animal. Intrusion attacks are one of the major issues or challenges face by the farmers unwanted animals destroy the fields of farmers which lead into decrease in productivity of crops.

The sensor nodes which are deploying in the fields are equipped with PIR sensors, sound sensors, light flashers and RF module. Sensor nodes that are fixed in boundaries of field detect animal entry and send information to the central base station. Such a system can be installed easily in the fields and are cost effective if installed with proper planning's. Power consumption of sensor nodes can be minimised with the help of sleep mode option provided with the system. End users of this system are farmer they can tailor the location of nodes in their field as per the location need.

Portz et al., [15] proposed active crop sensor which sense inconsistency of nitrogen gas supply and biomass on sugarcane fields. Results collected using a N sensor and biomass sensor helps to indicate demand of nitrogen applications in sugarcane fields. The N sensor helps in detecting the inconsistency of sugarcane biomass and nitrogen uptake helps in providing the information of site-specific nitrogen supply by the soil.

Reiser et al., [16] proposed a system for autonomous navigation of field, location of nodes deploy in field and data attainment in wireless sensor network which helps in prevail over the narrow transmission range of nodes which are spatially separated. Detection and servicing of nodes can be easily done by the help of proposed system.

Smiljkovikj et al., [17] proposed an intelligent cloud based system named as Smartwine which monitors the wine production. It works on sensor network platform having centralized server system which allows more than one users to use system simultaneously. The Smartwine system helps in decrease the cost of energy, water, resources and pesticides use for wine production.

Diaz et al., [18] proposed a new methodology for the monitoring of the agricultural production process using wireless sensor network. Prior to develop new methodology authors studied different real world existing methodology based on WSN in crops. It is found that most of existing methodology have common characteristics, and lack of well defined methodology that can indentify crop independent case. By surveying and studying various kind of existing real-world set-up where WSN are deploy authors discovered that there is a existence of important similarities but there is no methodology that specifies. In this methodology there are seven phases which represent the importance of wireless sensor agriculture monitoring and provide strong foundation for building applications with high productivity gain and of optimal use.

III. CONCLUSION

Wireless sensor network plays important role in precision agriculture to monitor agricultural fields, provide proper irrigation to the crops, measure temperature and study properties of soil. In our work firstly we reviewed the value of WSN in precision agriculture and described various sensors used in agriculture with their characteristics. The deployed sensors collect data from the fields and send it to the base station for further processing and surveying.

The main aim of this study is to get information about various sensors used in agriculture, techniques and simulation used for deploying and getting information from sensors, various crops where sensors are deployed. In this work, real time simulation with the help of hardware devices like DHT11,Arduino UNO board, Soil moisture sensor, PIR sensor, Water pump and ESP8266 module, is done to measure the growth of the plant. The real time Information of regarding moisture content of soil, temperature and any intrusion occurrence in the plant is detected through proposed system.

The designed system helps in reducing the usage of water because it start irrigating plant only when there is decrease in soil moisture and if there is any occurrence of insect in surrounding area of plant so with the help of PIR sensor we can get to know about it. In future work we will increase the data transfer efficiency of our system by using better routing algorithm.

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