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Smart Agriculture Based On IoT

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Abstract - *The internet of Things (IoT) has the capability to transform the world. IoT technology has brought revolution to each and every field of common man's life by making everything smart and intelligent. IoT refers to a network of things which make a self-configuring network. The development of Intelligent Smart Farming IoT based device sis day by day turning the face of agriculture production by not only enhancing it but also making it cost-effective and reducing wastage. The aim of this paper is to propose a technology of Active Radio Frequency Identification and Wireless mesh sensor network (WMSN). Zigbee Technology platform is applied in 2.45GHz and active RFID to sustain the WSN by developing a fully automated IoT solution in agriculture for irrigation system.*

Keyword **-** *IoT, RFID, Zigbee, WMSN, Sensors*

I. INTRODUCTION

The internet of things has the capability to transform the world. We live in more efficient industries, connected cars, and smarter cities are all components of the IoT equation. However , the application of technology like IoT in agriculture could have the greatest impact. The global population is set to touch 9.6 billion by 2050. So, to feed this much population, the farming industry must use IoT. Against the challenges such as extreme weather conditions and rising climate change, and environmental impact resulting from intensive farming practices, the demand for food has to be met. One of main areas where IoT based research is going on and new products are launching on everyday basis to make the activities smarter and efficient towards better production is "Agriculture". Agriculture sector is regarded as the more crucial sector globally for ensuring food security. Talking of India farmers, which are right now in huge trouble and are at disadvantageous position in terms of farm size, technology, trade, government policies, climate conditions etc. Agricultural production requires lots of activities like soil and plant monitoring , environmental monitoring, like moisture and temperature, transportation, supply chain management , animal monitoring , pest control etc. In Agriculture sector, that uses lot of water throughout the world. This resource should be used in an efficient way without affecting the production. The obstacles in measuring and monitoring water usage and inefficient irrigation system due to human control are the main contributors to this situations. The farmers are aware that water shortage or over watering may damage the yield. They need to understand when and the amount of water is needed for specific crops. Most farmers have little knowledge of their farm and they are unaware of the methods to improve their productivity of agricultural practices. In order to overcome this problem Wireless Mesh Sensor Network (WMSN) and active Radio Frequency Identifications (RFID) for agriculture monitoring control are applied. In this paper proposed an automated irrigation system with full real-time remote monitoring and control system in the farm. The system replaces humam-to-human (H2H) and human-to-machine (H2H) to machine-to-machine (M2M) architecture, which is embedded with active RFID. It has moisture sensor and monitoring devices that are required for the farming data such as soil moisture and condition. WMSN consists of cost efficient, battery-powered sensor modules and embedded networking intelligence. The development WMSN application in agriculture gives it potential to increase efficiency, productivity and profitability while decreasing disadvantageous effects on crops and the environment in agriculture production. The real time information from the irrigation area will contribute solid base for farmers to change considerations at any time rather of taking decision based some assumed average condition.

II. PROPOSED SYSTEM

2.1. Radio Frequency Identification (RFID)

RFID is one of an operative automatic identification technology for different things. It is also thin, flexible and can penetrate between paper and plastic. The tag has an identification number and a memory that stores data such as manufacturer, product type and environmental data such as temperature, humidity of an object . In the RFID applications, the tags are attached into objects that are to be tracked. RFID is the most utilized in the real-time locating system in agriculture applications. It becomes a choice for farmers due to its low cost. RFID tags come in two forms, active and passive. In this, in spite of using the same RFID technology, they are dissimilar in many forms. In this system, active RFIDs are used to send ID that works on Zigbee platform to readers at the station.. It can be seen that active tags are controlled by a battery formed into the tag, which allows data to be transmitted over long distances compared to passive RFID. The read and write distances are much longer than for passive tags. The active RFID has a small battery

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built–in to the tag, which works as an internal power source. The batteries can sometimes be replaceable or the unit will be replaced after certain period of time, which is normally between 1 year and 7 years.

By comparing these two active and passive tags, active RFID to use in the real-time irrigation monitoring system. The RFID systems operate in low frequency, high frequency, and ultra-high frequency. Frequency relates to the radio wave sizes is used to transmit between RFID systems components. The Low Frequency (LF) band covers frequencies from 30 KHz to 300 KHz. Generally, the LF systems operate at 125 KHz or 134 KHz. This frequency band provides a short read range less than 0.5m, and has slower read speed than the higher frequencies, yet is not very sensitive to radio wave interference. While the High Frequency (HF) band ranges are from 3 to 30 MHz, most HF RFID systems operate at 13.56 MHz with read range up to 1.5m. RFID is not only used for human to machine or machine to human, but the requirement for to machine communication has expended. Thus, the attribute is suitable to be used for monitoring agriculture environment. In the irrigation system, monitored embedded system comes into a new platform for farmers to spend their energy, money and time, which will take place only when there is a requirement of water. In this proposed system, an active RFID based on 2.4 GHz Zigbee Platform is used to send ID to the reader to recognize the node that sends data for irrigation and fertilization processes without human intervention.

2.2. Zigbee Technology

Zigbee is based on the IEEE802.15.4std. and pioneered by zigbee alliance. zigbee can support large no. of nodes providing a low cost global network .The IEEE defines only the PHY and MAC layers in its std. While zigbee defines the network and application layers application profile and security mechanism due to this design the consumption of power is minimal and battery lifespan is longer .In proposed system, the mesh topology, the various sense data from moisture sensors go to WMSN that integrates with RFID tag and sprinkler will turn into a node. There plenty of nodes on the farm and each node will communicate through this zigbee technology platform. Based on that the reader will read the sensor data and stores the data to the server , which is used by a farmer for monitoring.

2.3. Wireless Sensor Network (WSN)

Wireless network refers to the technology to communicate and access the internet without cable connection between computers and other electronic devices. Sensor Network has contributed to several applications, and awareness has expended to implement the technology into the agriculture environment. WSN is one of the most important Technologies in the 21st century. WSN is an assembly of a number of low-power, low-cost, multipurpose sensor nodes communicating wireless upon a short distance. The difference between a WSN and a RFID system is that RFID devices have no cooperative capabilities, while WSN allows different network topologies and multihop communication WSN can cut down the effort and time needed for monitoring environment . As a result, money, water and labor costs can be reduced. The technology allows for remote measurements such as temperature, humidity, soil moisture and water level. There seems to be increased development towards wireless outcomes in comparison to wired-based systems. Figure 2 shows the concept of wireless monitoring that is to be applied in the agriculture environment.. This systems provides a full network coverage in large facilities such as a big farm, typically massive lengths of cabling that leads to remarkable return on investment. WSN provides an intelligent platform to gather and collect data from the sensor nodes that can detect and interact with the physical environment . Using a wireless mesh as a backbone network simplifies installation and provides an affordable medium . WSN can be used to identify soil moisture to admit the irrigation system and identify where and when to irrigate. It helps in maximizing crop yield and elevates profit. Irrigation system requires temperatures, water level, humidity sensors and moisture sensor; in this proposed system, however, moisture sensor and temperature sensor are used to detect soil moisture.

2.4. Sensors

2.4.1. Temperatur *Sensor-DS18B20.*

The DS18B20 temperature sensor provides 9-bit to 12-bit Celsius temperature measurements and has alarm function with non-volatile user-programmable upper and lower trigger points. The DS18B20 has 64-bit serial code which allows multiple DS18B20s to function on same 1-wire bus.

Technical Specifications: Unique 1-Wire Interface; Measures temperature from -55oC TO +125OC; Coverts temperature to 12-bit digital word in 750ms.

"Figure 1. DS18B20 Waterproof Temperature Sensor"

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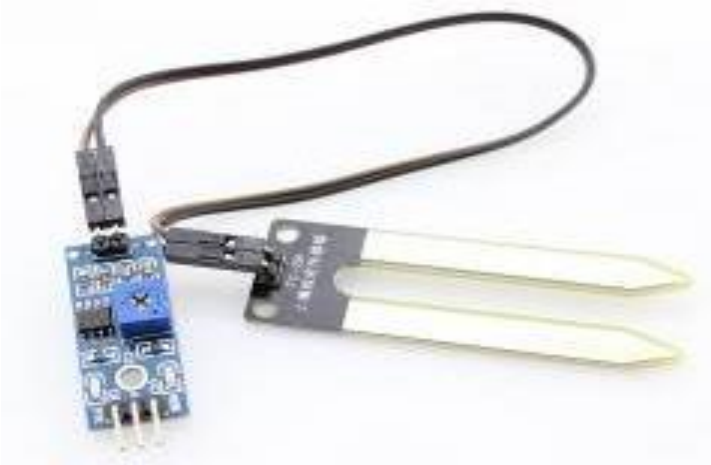
2.4.2. Soil Moisture Sensor.

Measuring the soil moisture is important in agriculture to help farmers to conduct their irrigation systems effectively. For this reason, farmers are able to use less water to irrigate crop as it is able to grow yields and the quality of the crop. Moisture sensor can read the amount of moisture nearby in the soil surrounding it properly. In this proposed system, sensor node and sprinkler will be attached together. Table 1 shows the functionality of the sensor. When a sensor detects low water level in the soil, sprinklers will supply more water. If the sensor detects excess water in the soil, sprinklers will supply less water. More water is needed when the sensor is dry and this causes the soil to conduct electricity easily (less resistance), while dry soil conducts electricity poorly . Embedding the technology with moisture sensor can save and reduce water



"Figure 2. Soil moisture sensor"

consumption. Using the moisture sensor, water does not need to function or irrigate when the sensor has the right amount of water.

"Table 1. How the sensor works"

Item	***Condition***	***Min***	***Typical***	***Max***	***Amount of water***
Output	Sensor in dry soil	0%	~	30%	High water
Output	Sensor in humid soil	30%	~	70%	Medium water
Output	Sensor in water	70%	~	85%	Low water
Output	Sensor in water	85%	~	95%	No water

III. IOT – THE PROPOSED REMOTE MONITORING SYSTEM

The remote monitoring systems are promoting IoT solution working on WSN embedded with RFID technology. The system communicates with hardware and software automatically to send data in the farm. The solution is proven and can therefore be implemented from planting to harvest as a tool for appropriate irrigation tactic to improve crop yields. Besides, the WSN nodes can effectively collect data as well. Remote monitoring for irrigation and fertilizing using WSN and RFID can ensure a good quality crop yield. In spite of the stressful environmental conditions, it increases the application efficiency of irrigation systems by 50%.

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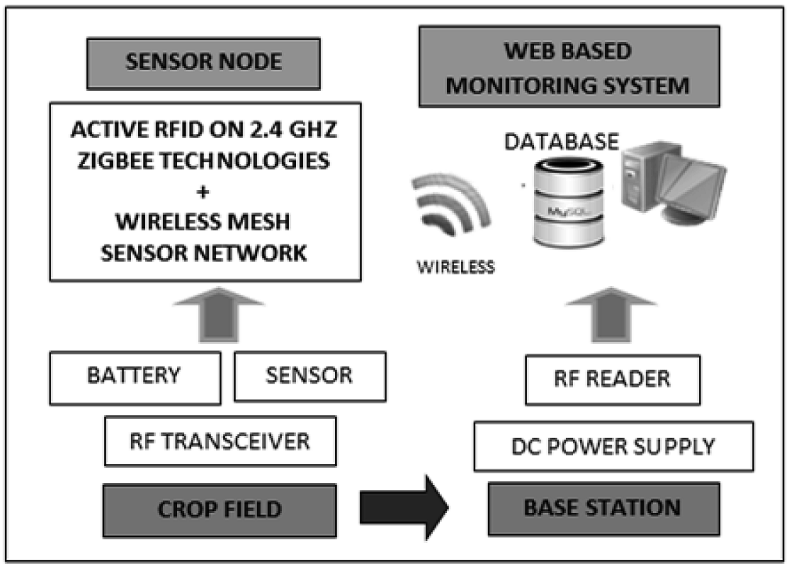
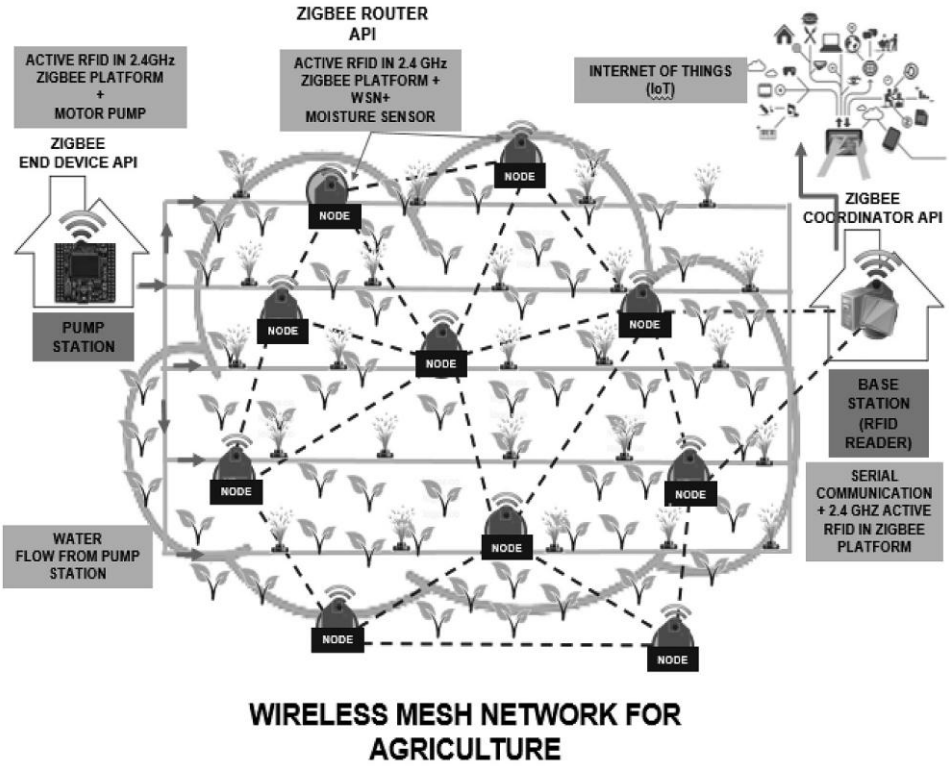


"Figure 3. The reader at the base station receives ID from the sensor node"

In this system, automatic irrigation systems are developed in the farm to collect the data from moisture sensors placed in the field. The farm will be monitored through the wireless sensor network that is integrated with the active RFID at the field. WSN will sense and monitor the environment like soil moisture and temperature. The coverage area for the experiment is 10 acres, in which 20 nodes are required in this farm. The systems proposed are very intelligent where the node always sleeps in standby mode. If the sensor senses soil in dry, the node will be activated to work in the mesh network between the other nodes to send ID to the reader. The end device of active RFID shown in Figure 3 is embedded with the sensor that represents wireless network sensor ID that works on Zigbee 2.4 GHz platform. The ID sent to the reader at the base station is used to recognize and allocate which nodes are sending data to the irrigation process automatically.



"Figure 4. Wireless mesh network for agriculture"

The full concept of the system shown in Figure 4 are active RFID on 2.4 GHz Zigbee platform and moisture sensor are embedded together to become one sensor mesh node. The moisture sensor collects data from the soil, which will be processed before sending via wireless to the controller for further action. The sprinkler will supply water based on the condition of soil. The data that are processed will be sent through the computer for monitoring by the farmers. The

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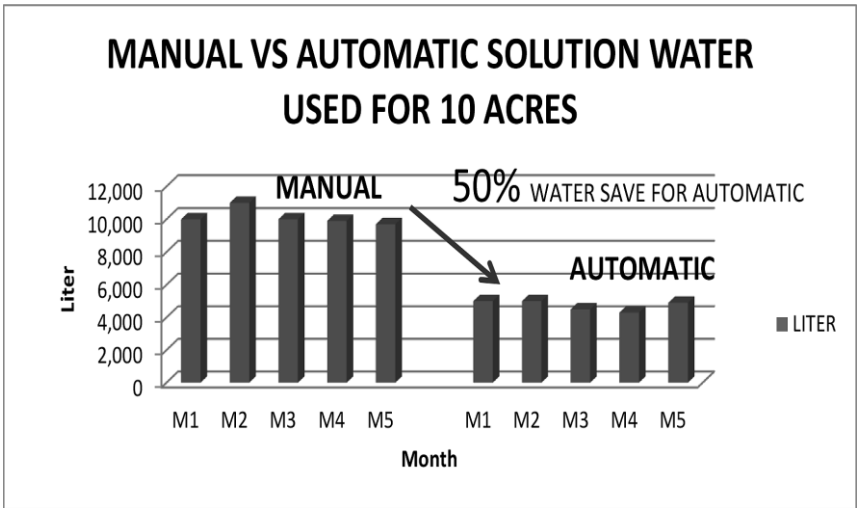
farmers can monitor their farm anywhere using internet connectivity by phone or computer. All the systems in the farm are connected to each other via wireless. The messy cabling like conventional method is not used anymore because it will be disturbing an irrigation process.

IV. RESULT

Water usage can be reduced approximately up to 50% when the embedded technology is used compared to the conventional method. In this system, the sprinkler will supply water when the moisture sensors give a signal with the right amount. Sensor in range 0-30% makes the sprinkler supply a large volume of water because the soil is in a dry state. Therefore, it needs a 100% amount of water. Meanwhile, when the sensor is in the range of 30-70%, the sprinkler will reduce water intake by 50% and supply an average volume of water to the soil. This range saves a whole sum of water. The sprinkler will stop the water supply when the moisture sensor sends data of about 85- 95%. In this condition, the soil is wet so there is no need for water to be supplied. Thus, farmers can reduce water consumption. The conventional method uses the same amount of water when it needs to irrigate every day. Over irrigation can cause the death of plants and production of farm to be affected badly. In particular, this can affect the revenue of farmers as well since water is wasted and over irrigation may cause damages to the plants.



"Figure 5. Data collected from the wireless sensor node"

WSN has a capability to represent inherent soil variability, which is present in the fields with more accuracy than the currently available system. Thus, the benefit for the farmer is a real-time support system that allows maximizing their productivity while saving water. WSN also removes the obstacle to wire sensor stations over the field and decreases the maintenance cost. The advancement of WSN applications can affect agriculture by increasing profitability, productivity and efficiencies, while minimizing unconscious impacts to the environment in many agricultural production systems . The real-time information from the fields will afford a solid base for farmers to plan strategies at any time.

V. APPLICATIONS OF IOT IN AGRICULTURE

5.1. Precision Farming

Precision Farming is also known as precision agriculture, precision farming can be thought of as anything that makes the farming practice more controlled and accurate. Precision agriculture is one of the most famous applications of IoT in the agricultural sector and numerous organizations are using this technique around the world. High accuracy is required in terms of weather information which reduces the chances of crop damage . Agriculture IoT ensures timely delivery of real time data in terms of weather forecasting , quality of soil , cost of labor .

5.2. Agricultural Drones

Drones are being used in agriculture in order to enhance various agricultural practices . The ways ground based and aerial based drones are being used in agriculture are crop health assessment, irrigation ,crop monitoring ,crop spraying ,planting and soil and field analysis. The major benefits of using drones include crop health imaging, integrated GIS mapping, ease of use, saves time and the potential to increase yields. Precision Hawk is an organization that uses drones for gathering valuable data via a series of sensors that are used for imaging, mapping and surveying of agricultural land. These drones perform in –flight monitoring and observations. The farmers enter the details of what field to survey, and select an altitude or ground resolution. From the drone data, we can draw insights regarding plant health indices, plant counting and yield prediction, plant height measurement, canopy cover mapping, field water poising mapping, scouting reports, stockpile measuring, chlorophyll measurement, nitrogen content in wheat, drainage mapping, weed pressure mapping.

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5.3. Livestock Monitoring

Large farm owners can utilize wireless IoT applications to collect data regarding the location, well-being, and health of their cattle. This information helps them in identifying animals that are sick so they can be separated from the herd, thereby preventing the spread of disease. It also lowers labor costs as ranchers can locate their cattle with the help of IoT based sensors.

5.4. Smart Greenhouses

Greenhouse farming is a methodology that helps in enhancing the yield of vegetables, fruits, crops etc. Greenhouses control the environmental parameters through manual intervention or a proportional control mechanism. As manual intervention results in production loss, energy loss, and labor cost, these methods are less effective. A smart greenhouse can be designed with the help of IoT; this design intelligently monitors as well as controls the climate, eliminating the need for manual intervention. For controlling the environment in a smart greenhouse, different sensors that measure the environmental parameters according to the plant requirement are used. We can create a cloud server for remotely accessing the system when it is connected using IoT. The IoT sensors in the greenhouse provide information on the light levels, pressure, humidity, and temperature. These sensors can control the actuators automatically to open a window, turn on lights, control a heater, turn on a mister or turn on a fan, all controlled through a Wi-Fi signal.

5.5. Crop Water Management

In order to perform agriculture activities in efficient manner, adequate water is essential. Agriculture IoT is integrated with Web Map Service (WMS) and Sensor Observation Service (SOS) to ensure proper water management for irrigation and in turn reduces water wastage.

5.6. Integrated Pest Management or Control (IPM/C)

Agriculture IoT systems assures farmers with accurate environment data via proper live data monitoring of temperature, moisture, plant growth and level of pests so that proper care can be taken during production.

VI. CONCLUSION

In this way by introducing RFID Technology and WMSN in the farming industry, growing crops and plants can be greatly optimized. WMSN reduces the wiring and piping costs, and facilitates installation and maintenance in large areas. The use of technology in agriculture is important, particularly to increase production apart from decreasing labor cost and water requirements. Thus, the WMSN technology obviously performs the most technology to improve the current irrigation systems. Soil moisture sensors are constantly improving and becoming affordable and appropriate for massive deployment in the WMSN applications.

VII. FUTURE SCOPE

Future work would be focused more on increasing sensors on this proposed system to fetch more data. Integrating GPS module in this to enhance this Agriculture IoT Technology to full-fledged Agriculture Precision ready product.

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