WSN application in rural development: Smart Irrigation management

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ABSTRACT

India has second highest agriculture land in the world. A majority of Indian population depends for their employment on the agriculture sector. Water management is a big issue of Indian agriculture sector, which affects the productivity. Indian irrigation system is mainly dependent on rain. Due to lower than expected rain and lack of water management, agriculture sector in India get highly affected every year. Therefore, irrigation system cannot be depended on rain. We have to take help of technology, if we want to increase productivity and profit in this sector. Wireless sensor networks may help to manage the use of water, increase crop productivity and provide the real time data instead of depending on prediction.

Keywords:- Wireless sensor network, Irrigation system, Soil moisture sensor, Agriculture, Communication.

1. INTRODUCTION

Wireless sensor networks are widely used in agriculture in foreign countries to increase the productivity and monitor the crop. Wireless sensors are deployed in field are divided into clusters such that each cluster contain every type of sensor. We use various type of sensors performing various task like water monitoring, keeping a track of soil moisture and climate change effects.

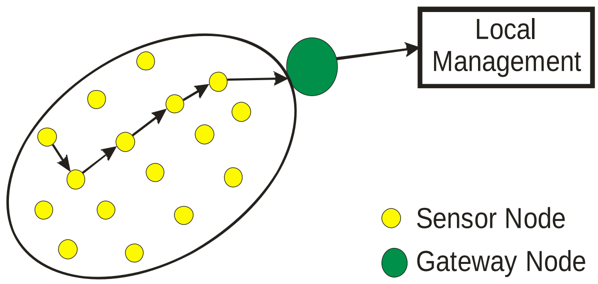

Figure 1 Wireless sensor network

Sensors of one cluster do not communicate with each other, they communicate with head node or access point. They are connected to base stations through a network. Base station is connected with local management by gateway networks to control and monitor the crops and field conditions.[1] This type of faming are called precision farming. Precision farming is the ability to handle different types of problem in productivity, increase financial return and reduce waste by using automated data collection and implementation using sensing, controlling and communication technology. [2] Wireless sensors can be deployed in field using grid topology (fix distance between each sensor) or random topology. For precision farming we use grid topology. Sensors are connected with access points that work as node. Each node works independently to record information. All nodes in the field are connected through a single network. Data of sensor are sent from one node to another node using routing algorithm. It is called multi-hop communication.[3]

2. WIRELESS SENSOR NETWORK IN AGRICULTURE

Indian agriculture system is mainly depends on rainfall. So crop failure takes place in some part of country due to lack of rain and in some part of country due to flood. Poor seeds qualities are also affect the crop production. Due to lack of cold storage, crops have to be left in open air where it gets affected by insects, rain and moisture. A system is needed for farmers to predict the requirement of crops, so they can increase the quality and quantity of crops. Sensor networks can be used to calculate the approximate values of field data. Sensor networks will be deployed in ground where the input for sensors will be soil moisture. To connect this sensor network with wireless module, information of field can be sent to remote place and field station system can be controlled and monitored from there. WSN provides real time feedback of field and crop's conditions. This system includes data collection, monitoring and material application to get maximum growth by using minimum resources. WSN system requires a central control unit with user interface, communication gateways and routers, power elements and sensors. Different sensor devices are used for sensing the different parameters like water levels, soil moisture, temperature etc. To calculate these parameters, sensors are installed in the field. A number of sensors are used to cover the entire field. These sensors are wirelessly connected through a network to a remote station. Each sensor is worked as a node. All nodes perform minimal data processing and send data to base station. Routing between initial node and destination node is shown in figure in which shortest path between nodes is found by minimal data processing. Nodes can be connected with each other using different topologies like tree topology, mesh topology. [4],[5] Data collection should be done on an hourly basis to get better results. Less frequent monitoring may be acceptable for certain slow growth crops and areas that have very stable, uniform climate conditions. Many crop-modeling methods are used to calculate the growth of crops and monitor on various environmental constraints like moisture, nutrients, water etc. There is a simulating model named decision support system for Agro technology Transfer (DSSAT). This model is used to observe growth, development and yield of crop. Agricultural production system simulator (APSIM) is another simulating model, which is used to integrate the information, derived by different researchers. [6]

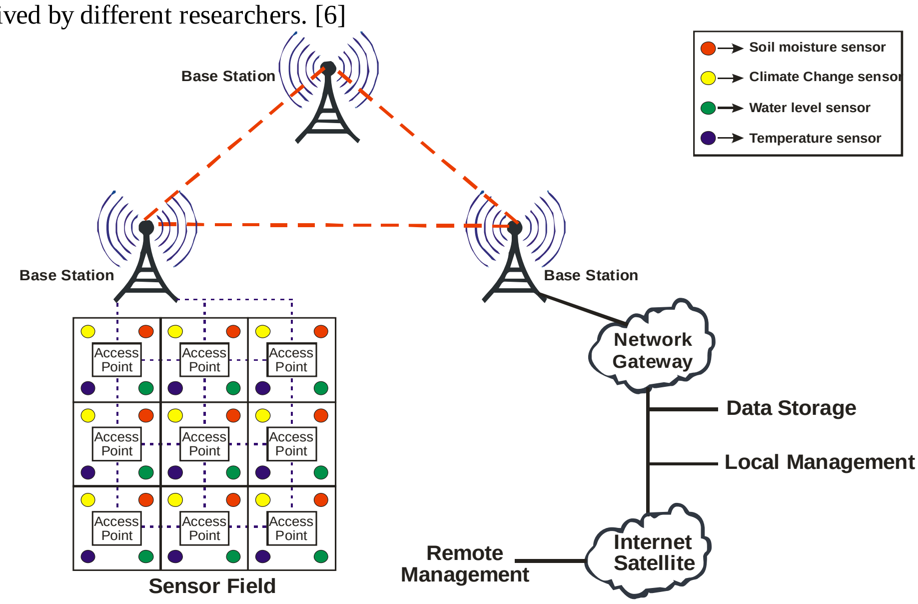

Figure 2WSN model in Agriculture Applications

The proposed model of WSN in agriculture application is shown in figure. Different type of sensors are used for monitoring such as soil moisture sensor, climate change sensor, temperature sensor and water level sensor using grid topology. Each sensor is connected with an access point. Each access point works as a node. Each node is connected with one another in the field. Using minimum path algorithm, data of every sensor is sent to base station by these nodes. Base stations of different fields are connected with each other using network layer. A network gateway is used to connect these base station to local management of the system. This network gateway can be connected with remote user using internet satellite so we can control and monitor the system from a remote place.

3.WIRELESS SENSOR NETWORK IN IRRIGATION

In India, we are using conventional methods of irrigation such as surface irrigation. In surface irrigation, entire field is filled by water. Due to evaporation and lack of knowledge of how much water should be used, water gets wasted on large scale. For growth of the plant sunlight, air, water, soil and nutrients are basic input needs. In the conventional irrigation method, normally the plant is irrigated at the interval of 8-15 days & the water distribution uniformity is limited up to 33% only. This means the irrigation efficiency is reduced & plant does not get the total applied quantity of water. The plant utilizes only 35% to 40% of the total quantity of water in reality. To get better productivity, estimate the water requirement of plant, automatically on/off the water supplying motor according to need of the field, to know the status of irrigation system, micro irrigation system can be connected to wireless sensor networks (WSN). Both drip irrigation and sprinkler system can be controlled and monitored by wireless sensor network. [7]. Irrigation interval for it is in the ranges of 1 to 4 days. It is the best way to utilize water and fertilizer efficiently under the farm conditions. Yield increases up to 230% and it saves water up to 70%. As we know that WSN is a combination of wirelessly connected sensors. Sensor part can be electronic, electrical or mechanical device that is attached with a electronic wireless device. As wireless communication devices, we can use 434 MHz RF modules, Zigbee module, Bluetooth, GSM module etc. In this project, we are using 434 MHz RF module connected with soil moisture sensor. Soil moisture sensor is a VLSI chip. It consists of silver wire that is installed in soil to sense the water availability in roots of crop.

These silver wire-sensing devices are connected with a comparator. There are two stations one is field station where soil moisture sensor is connected with 434 MHz RF transmitter and another is base station where motor is connected with 434 MHz RF receiver. Motor can be connected with drip irrigation system or sprinkler irrigation system. [8]

Proposed Model

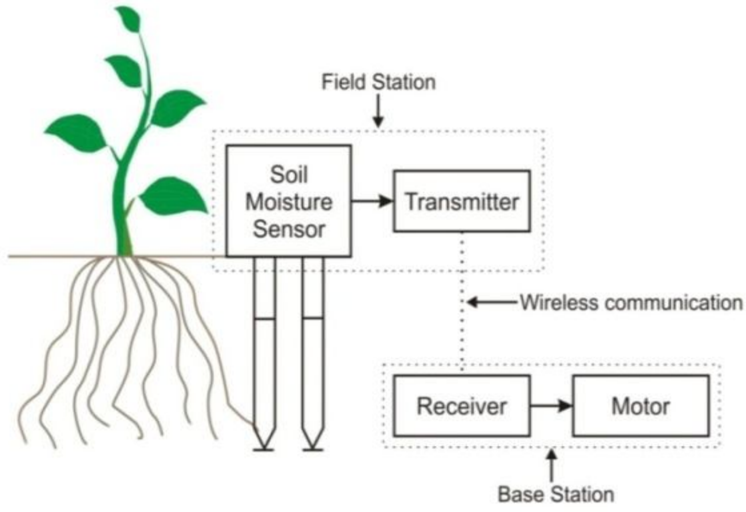

Figure 3 WSN model in irrigation Applications

The proposed model of WSN in irrigation application is shown in figure in which sensor's end point is installed at the end point of crop's root. Length of sensor can be varied according to the different types of soil. Soil moisture sensor is wirelessly connected with motor to operate the motor according to the conditions. This combination of sensor and wireless module is known as wireless sensor network. In wireless sensor network, we can connect many number of sensor to a remote station where each sensor will work as a node and using routing process we can transmit data from one node to another node and all information of field station can be sent to remote station.

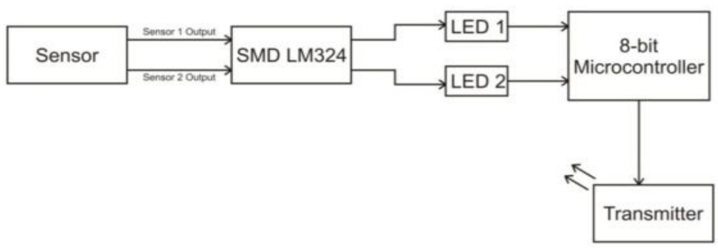

Figure 4 Block diagram of field station

There is a field station where sensors are installed and there is a base station where motor is used to supply the water when needed. Block diagram of field station is shown above. There is a sensor having two legs of silver wires, which are installed in soil. These sensors are connected with a SMD LM324 comparator. LM324 comparator is a package of four independent op-amp comparators. It has 14 pins in which eight pins are input pins, four output pins for four comparator, one pins is for voltage supply and one pin is for ground. Here it is used to compare the water availability in roots using sensor. Comparator is connected with an 8-bit microcontroller. Here, we are using AT89c51 microcontroller. This microcontroller has 40 pins in which 32 pins are used as input and output pins. The output of comparator is sent to microcontroller and according the values of comparator, it operates the motor. Microcontroller is connected with a 434MHz RF transmitter that transmits the output of microcontroller to base station. Two SMD (surface mountable device) LEDs are connected between comparator and microcontroller. When water is available at roots of crops, value at comparator is high & according to the programming, LED will be low and motor will be off and when water is not sensed by sensor at roots, value at comparator will be low & according to the programming, LED will be high and motor will be on.

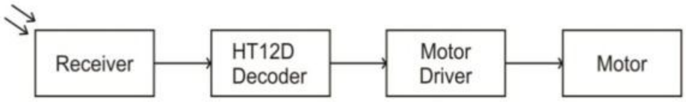

Figure 5 Block diagram of base station

At the receiver end, there is a 434MHz RF receiver. It receives data from field station. Then data is sent to HT12d IC. It is a decoder that decodes data, which was encoded by 8-bit microcontroller. It has 18 pins in which, eight pins are address pins and four pins are data pins. Decoded data is sent to motor driver. Motor driver is used to drive motor by amplifying the low power data. One motor driver can operate two motors. Motor can be connected with drip irrigation system or micro irrigation systems to supply the water to crops.

4.RESULTS

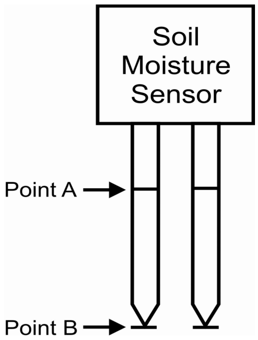

Figure 6 Soil moisture sensor

After designing the field station and base station for precision farming using WSN, we got some results for different type of soils. When soil type is black and sensor length from point A to B is 15cm, water will reach from A to B in approximate 6 to 7 second. For different soils, water will reach from A to B in different time slots.

1. If time is fixed for water to reach from point A to B, is 6 to 7 second, then we have to vary the length of sensor according to the soil.

Table 1 Vary length of sensor

S.no	Soil Type	Time taken by water to travel 15 cm	Vary length of sensor from A to B point to fix time
1.	Black	6-7 second	15 cm
2.	Sand	4-5 second	18 cm
3.	Ash	3-4 second	20 cm
4.	Sitapura (Raj. India) Area soil	6-7 second	15 cm
5.	Stone sand	1-2 second	25 cm

1. If we fix length of sensor from point A to B is 25 cm, then we have to provide different time delays for different soils at the time of starting the motor.

Table 2 Time delay to fix the length of sensor

S.no	Soil Type	Adjustable length (If Maximum Length=25 cm)	Time delay to fix the length of sensor
1.	Black	25-15=10 cm	3.3 second

2.	Sand	25-18=7 cm	2.3 second
3.	Ash	25-20=5 cm	1.6 second
4.	Sitapura (Raj. India) Area soil	25-15=10 cm	3.3 second
5.	Stone sand	25-25=0 cm	0 second

5.CONCLUSION

In this paper, we are using wireless sensor network for precision agriculture that will greatly improve the agriculture production by controlling and monitoring the crop. This system provides us the exact data of climate change, field temperature, ground water level and other need of crop to improve the crop productivity. This real time data can be sent at remote place by using internet satellite. It will also help to save labour cost and save water up to 70% as compared to conventional irrigation method.

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