# AGRICULTURE REFORMS USING WIRELESS SENSOR NETWORK

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***Abstract: Rapid increase in population made improvement in farming practice necessary. Advancement in wireless sensor network made this idea possible, which was nearly impossible few decades ago. Real-time data can be collected using Wireless sensor network. Which can be useful for tak-ing various types of decision for farming practice such that better quality of crops can be gained using limited amount of resources. Greenhouse is the advanced facility available in which climate conditions can be controlled. We are going to design a flexible sensor based agriculture management system for controlled environment like greenhouse.***

## I. INTRODUCTION

Precision Agriculture refers to a series of practices and tools necessary to correctly evaluate farming needs[1]. Traditional agriculture is practiced by performing a particular task, Such as planting or harvesting, Without any predetermined data. But by collecting real-time data on weather, Soil and air quality, smarter decisions can be made. In order to achieve precision control to production environment, It is necessary to perform three tasks namely, First monitoring parameters such as temperature, humidity and illumination which are associated with the production environment, as these parameters are the main influential factors for the product yield and quality. Secondly, control and management decision is determined based on the analysis of the collected data. Finally, based on the control decision, automatic or manual control mechanism is implemented to complete the required environment control and adjustment.[2] Data collection techniques can be classified as wired and wireless. Wired sensor network uses wires to transfer data in the network. Wireless network transmits data through various wireless communication technologies such as IEEE 802.11 , IEEE 802.15.4 etc. The problems with wired sensor network are installation is quite expensive, maintenance is difficult, limited mobility and scalability. Wireless sensor networks(WSNs) consists of many sensors which are deployed in monitored area. Many hybrid wireless sensor networks such as terrestrial WSN, Wireless underground sensor network (WUSN) are used for precision agriculture. Greenhouse is the advance facility available in farming practice. In greenhouse we can control climate parameters such that it makes good quality of crops. Using greenhouse out-of season crops can be gained. Climate parameters can be set exactly at the value which is required by crop. So it increases crop's yield. Some architectures are proposed for specific applications of precision agriculture such as irrigation, fertilization etc. But there are some common issues in all the architectures such as limited lifetime of sensors, cover-age problem, path loss due to soil-air communication, change in topology while changing crop those are need to be addressed. Traditional farming practice is based on assumptions only. Resources are provided by predetermined data. In the time when we have scarcity of resources and huge demand of food it is necessary to improve our farming practice. Greenhouse is advanced facility which provides controlled climate conditions. But it requires daily or more frequent monitoring. Sensor technology is growing very fast. So sensors are available in small size and low cost. Hence using sensors in agriculture is good idea. There is some architecture available for greenhouse. But some of them are specially designed for some specific crop. Another limitation of those architectures are while changing the crop, topology of the sensor network may change. So modification of system becomes necessary. Flexible architecture for at least a group of crops is needed nowadays.

## II. ARCHITECTURES USING WSN

### *A. An Environment Monitoring System For Precise Agri-culture using WSN*

Following figure shows architecture of Environment monitoring system for precise agriculture using WSN [2].Which is deployed in a red bayberry greenhouse located on a hill side.

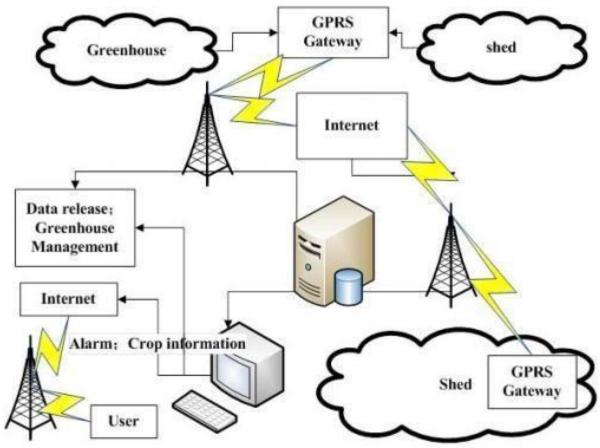


Figure 1. System Infrastructure

  

Functionality of components in architecture is as following:
Data Acquisition subsystem: it is deployed inside the shed. it consists of a number of TelosB wireless sensor nodes to acquire data .the onboard sensors include photosensitive, temperature and humidity sen-sors.the nodes uses MSP 430F16(low powered microcontroller) and CC420(Zigbee transceiver) chips to reduce power consumption. the node sends collected data to gateway node.

Gateway node: It collects data from sensor nodes and forwards it to remote server using GPRS module.

Server: it gets data from gateway node and processes it using collection module.
it has three subsystems as following:

– Collection module: it Divide packets, perform error checking and store necessary data in database.

– Web-based component: Google maps technique is integrated into this system to deliver location aware information dissemination and inquiring service.

– Alarm Subsystem: Threshold values of physical quantities are stored in a database. When the collected data shows value above threshold, alarm is raised by this subsystem and SMS is sent to the authority.

When this system is deployed in a red bayberry greenhouse following Results are observed:

The system functions as it is expected System uses GPRS and solar power system, it doesn't rely on external power

The whole area of shed can be covered by grid topology of sensor nodes.

There are some issues in this architecture which need to be addressed: The architecture depends on TelosB node's working. If Telos B node can't work in some type of environment then this architecture can't be applied.

B. Data Collection using Data Mules

We need many sensors to cover the whole field. so equipment cost and power requirement becomes high. to solve this problem data mules can be used. A data mule is a vehicle that physically carries a computer with storage between remote locations to effectively create a data communication link. Same concept can be applied here but instead of vehicles a computer is attached with workers or equipment those passes through field regularly. they will collect data from sensors deployed in field and store it memory and pass it to network nodes when it comes back from field.[3]
Limitation:
Data mules are not useful for real-time data collection

we also need good localization algorithm to track equipment and people moving through space.

sparse distribution of sensor network motes using data mules for data forwarding won't support localization algorithm that rely on triangulation.

*C. Autonomous Irrigation System Using WUSN With Center Pivot System*

Precision agriculture includes irrigation with soil requirement information. So that water is used efficiently. It is necessary to know the need of water content in the soil to decide how much water should be applied. For that purpose, Hand-feel method is used in traditional agriculture. But hand-feel method gives only qualitative information. But for precision agriculture quantitative information is needed. For that purpose sensors are deployed in the soil. Sensors provide real-time data of soil.[1] Traditional soil moisture sensor needs to be installed early in the growing season and need to be removed before harvest. So it requires additional time and labor requirement. An architecture is proposed for autonomous irrigation system using wireless sensor network with center pivot system.(WUSN- CP)[1]. Figure 2 shows design of this architecture. Two types of nodes are used namely, Underground (UG) node, which is deployed in soil, secondly, aboveground (AG) node, which is deployed in aerial environment.

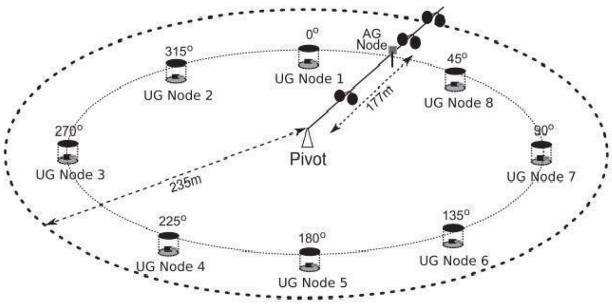


Fig 2. Autonomous Irrigation System Using WUSP-CP

Center pivot consists of segment pipes supported by trusses and mounted on wheels with sprinklers placed along its length. One end of pipeline is connected to a pivot element at the center of the irrigating area is called pivot point. The machine moves in a circular pattern. the water is fed through the pivot and sprinkled out as the machine moves.AG node is attached on the pipeline. UG nodes are deployed in the soil at depth of 30-100 cm such that it covers whole area of the field.UG node collects humidity of soil and transfers this data to AG when it is in communication range of UG node.AG node processes that data and decides the speed of CP. Lower speed CP will Sprinkle more water in that area. so when the soil is dry speed of CP is kept slow.

Three types of communication links are established during this communication.

UG2UG: both the sender and the receiver are buried underground and communication is through soil

UG2AG: The sender is buried in the soil profile and receiver is located above ground.

AG2UG: An above ground sender node sends mes-sages to underground nodes.

This architecture is deployed in corn field at the south central agricultural laboratory .where mica2 sensor nodes are used. There are some linitations of this architecture as following:
Path loss during soil-air communication

The UG node and AG node sends 100 packets to each other to know location of AG node. This needs to use bandwidth of network and also needs memory to store location.

The received signal strength depends on direction of rotation of CP.

  

## III. GREENHOUSE MANAGEMENT

Farming in Greenhouse needs more monitoring than farming in field. So it needs more manpower. Basic activities performed in a crop cycle are as following:

Fumigation: Formaline is mixed with water and applied on soil. After that soil is covered by poly-thin for some time. Water is applied on soil. Bed of soil is prepared for crops. During which irrigation system is implemented. (All the main lines and submain lines with drip irrigation pipes are implemented) Crop is planted on bed. Irrigation is done. Support is provided to crops (using net or thread) Pest control is performed. Humidity and temperature is maintained using ventilation, forgers, fans. Following parameters need to be monitored for per-forming above mentioned activities. Soil salinity and pH value Soil humidity level Soil and environment temperature Level of Nutrition in soil Existence of pest, weed, birds, animals Sunlight

## IV. MODULES IN AGRICULTURE MANAGEMENT SYSTEM

There are different modules in agriculture management system. Individual module can be handled with many approaches. Some approaches are discussed here.

### *A. Irrigation*

There are three types of irrigation systems in green- house: Drip/Trickle and Micro-jet Systems: For trickle/drip or micro-jet systems, the crop is irrigated frequently (daily) and requires the soil to be maintained at a constant moisture level.

Sprinkler Systems:

Cycle of irrigation with start time and length of irrigation cycle is pre-programmed. But it can be interrupted by some device to start cycle earlier than its regular time.

Micro-Sprinklers:

It is the category between Drip irrigation and Sprin-kler system. Soil remains less wetter than drip irrigation and more than sprinkler irrigation.

1) Irrigation using tensiometer: A tensiometer mea-sures soil moisture. It is an instrument designed to measure the tension or suction that plants' roots must exert to extract water from the soil. This tension is a direct measure of the availability of water to a plant.[5] It is normally calibrated in kilopascals (from 0 to 100 kPa). Tensiometers operate successfully up to approximately 75 kPa. A reading of 0 kPa indicates saturated soil in which plants will suffer from lack of oxygen. Optimum plant growth occurs when the soil is kept wetter than 30 to 40 kPa for coarse textured soils (sands) and 50 to 60 kPa for medium-textured and heavy-textured soils. Readings in excess of 70 kPa indicate that the soil is dry enough to reduce growth.

The basic flow of this system is shown in figure 1.

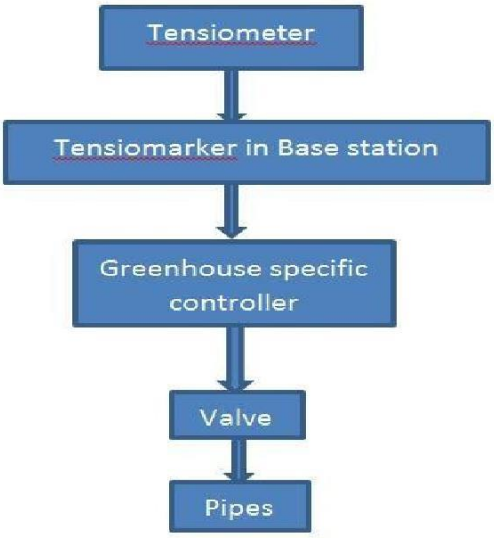


Figure 3 Irrigation Using Tensiometer

As shown in figure reading of analogue tensiometer is interpreted by tensiomarker and it decides the irrigation time, Then sends that message to greenhouse specific controllers. Those controllers control valves. Thus water in pipeline is controlled. Tensiomarker takes reading from two tensiometer and interpret it, display it in digital form and take decisions based on previously programmed threshold values. It works in two modes as following. If two tensiometers are at the same place but different depth then it accepts request of only one tensiometer at a time and let the other tensiometer wait for some time. If two tensiometers are working independently, each generates a start irrigation signal when crossing the set-points.


Figure 4 Base station Controller

Base station controller is shown in figure 2. This system works perfectly fine but placement of tensiometer is big question. Tensiometer should be placed in such way that minimum amount of modification is needed for crop change.

### *B. Climate control*

It is easy to control climate parameters in greenhouse. Temperature and humidity are main two parameters which need to be controlled. As shown in figure 3 temperature and humidity sensors are installed in greenhouse. They send data to base station. Base station controls fan, sprinkler, curtains, forgers to maintain humidity and temperature.

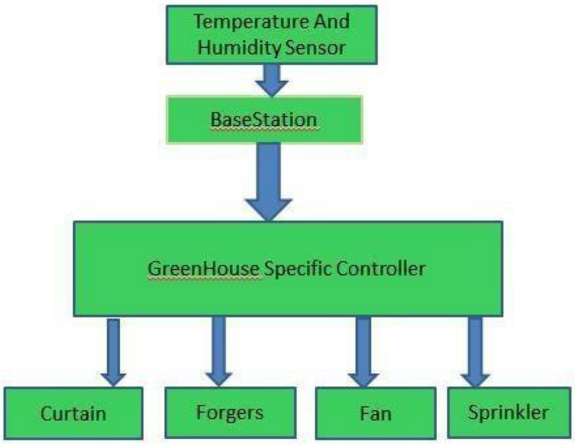


Figure 5: Climate control module

*C. Ec-pH control*

Ec means Electric conductivity of soil which indicates presence of salt in soil water mixture. The more the salts, higher the electrical conductivity. [7] pH is indicative of acidic/sodic nature of soil. Soil with more than 8.5 pH is harmful for crop.[7] Ec and pH both needs to be monitored continuously for better growth of crop. Ec-pH control module is there in base station which has two sensors to measure Ec-pH. One sensor is at input water line and another is at output waterline. It measures Ec-pH of input water and add required chemicals to get required Ec-pH. After that it again checks that whether targeted Ec-pH is achieved or not. Limitation of this approach is Ec and pH are measured at source side. It should be measured from soil directly to get exact result.

*D. Weed Control*

Weed is unwanted plant which grows with crop using water and nutrition provided for crop. Hence it affects on quality of crops. So it needs to be removed. Generally weed control techniques are divided in two categories:[8] Preemergence: Map of whole field is created with soil texture and organic matter content. And using that map herbicides are applied at intervals statically.

Postemergence: Weed is detected and then action is taken to control it. Preemergece techniques are static. They don't react in an unwanted event instantly. Postemergence techniques are real-time and more effective than Preemergence techniques. There are many postemergence techniques as following.

Camera and spray:

There is an module which contains a camera and herbicide spray in it. This module is passed through greenhouse. Camera detects presence of weed and sprayer sprays herbicide on it. but there are some limitations in this system as following

– High resolution camera is required
– If weed looks like crop it would not be detected

WeedSeeker, GreenSeeker: They are special type of devices available in marked which works on concept of infrared light. Following figure shows working of them.

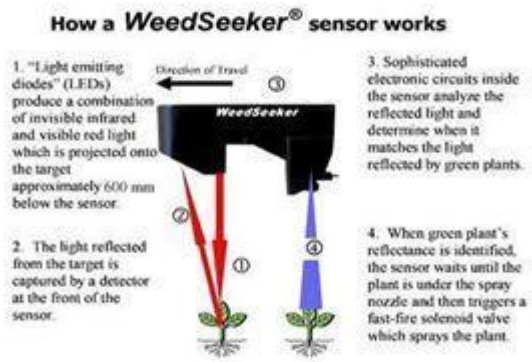


Figure 6: How weed seeker works

But reflectance characteristic of crop and some weeds are same so it can't be detected. Weed Scouting:[8] A weed switch box is used. It contains switches corresponding to different types of weed. Scout switch on for a weed when he is passing thought it and records its geographical coordinates. And switch off when weed is no longer seen. That data is stored using GIS and projected on map. The vehicle for spaying herbicide has GPS receiver and apply necessary herbicide using data collected by scout. Semi Automated system:[10] A vehicle with camera and automatic sprayer is moving in field. It can automatically spray herbicide when weed is detected. It can also be controlled and re-routed from base station. Communication between vehicle and base station is wireless.

*E. Pest Control*

Existence of pest is detected by the climate parameters. There are some fuzzy algorithms which decides the existence of pest using values of temperature, humidity of environment and moisture level on leaf of crop.[11]

## V. CONCLUSION

It is observed that there exist many architecture for precision agriculture application.[12] but their validity depends on sensor nodes they have used and crops on which it is deployed. To overcome these limitations we are working on an architecture that is applicable on different types of crops.

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