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# Agricultural Management using Wireless Sensor Networks - A Survey

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**Abstract.** Agriculture is the backbone of any Country's economy and there is a strong correlation between agricultural growth and economic prosperity. We need a new and effective technology which can improve continuously the productivity, profitability, sustainability of our major farming systems. In this paper we have discussed three types of Management systems used in Agriculture from remote area. In the first category we have discussed about the different systems used in Green House Management using Wireless sensor networks. In the second category we have discussed about the Irrigation Management using Wireless sensor networks. Finally we have also discussed about the Storage Management using Wireless Sensor Networks.

**Keywords:** Wireless Sensor Network, Sensor node, Green House Monitoring System, Irrigation Management systems, Storage systems.

## 1. Introduction

Growing plants is both an art and a science. About 95% of plants, either food crops or cash crops are grown in open field. Since time immemorial, man has learnt how to grow plants under natural environmental conditions. In some of the temperate regions where the climatic conditions are extremely adverse and no crops can be grown, man has developed methods of growing some high value crop continuously by providing protection from the excessive cold, which is called as Greenhouse Technology. So, Greenhouse Technology is the technique of providing favourable environment condition to the plants. It is rather used to protect the plants from the adverse climatic conditions such as wind, cold, precipitation, excessive radiation, extreme temperature, insects and diseases. It is also of vital importance to create an ideal micro climate around the plants. This is possible by erecting a greenhouse, where the environmental conditions are so modified that one can grow any plant in any place at any time by providing suitable environmental conditions with minimum labor.

As shown in Fig.1, Wireless Sensor Network (WSN) consists of spatially distributed sensors [1] to monitor physical or environmental conditions such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location.

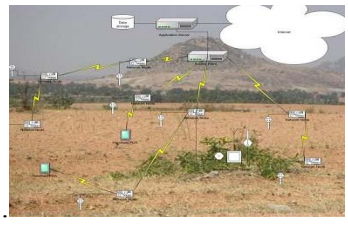

Fig. 1: Wireless Sensor Network

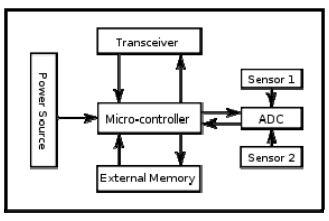


Fig. 2: Sensor Node

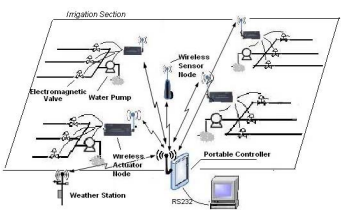


Fig 4: Irrigation Management system

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A sensor node (mote) is capable of performing some processing, gathering sensory information and communicating with other connected nodes in the network. As shown in Fig. 2, it is made up of four basic components, sensing unit, a processing unit, a transceiver unit, and a power unit. Sensing units are usually composed of two subunits: sensors and Analog to digital converters. Each sensor node is capable of only a limited amount of processing and power. But when they are coordinated with other nodes in the network, they have the ability to communicate, measure and actuate in great detail.

# 2. Agricultural Management

## 2.1 Green House Management

Many wirelesses devices are introduced to monitor and control the Green House parameters like Humidity, water pH, wetness, soil wetness, Light intensity and temperature. In this category we have discussed about the different Green House Management systems. A Web based distant monitoring and control for greenhouse systems using the Sun SPOT modules [2] presents a solution for distant monitoring and control of the greenhouse system via internet. It has a web based user interface with possibility of managing the sensors and actuators. This Web based distant monitoring system uses a high end PIC microcontroller based developer board with Ethernet adapter that will allow you to monitor and control the laboratory from any Internet connection. This solution offers a live video stream from the greenhouse's camera and allows monitoring the growth of the plants. With the usage of Sun SPOT based wireless sensor network is realized the environment monitoring. The described system is highly customizable and easily adaptable to particular deployment requirements.

The green space monitoring system based on Wireless Sensor Network [3] is designed to monitor environmental factors for urban green space. By using a Wireless Sensor Network, the real-time distribution of temperature and humidity gathered from the real environment clearly reflects the dynamics of temperature and humidity both inside and outside the green space. Meanwhile, the data of the heat absorbed and the humidity released by urban green space can also be obtained. Finally, it is obvious that temperature and humidity were different inside and outside the urban green space, the green space has a positive effect on cooling and humidifier, and the trend of the changes in the temperature and humidity is gradually “pervasive” from east to west.

The WSN based automatic control system to prevent dew condensation in the greenhouse environments [4] has come up with the solution for different problem. This system is composed of sensor nodes for collecting data, base nodes for processing collected data, relay nodes for adjusting the environment inside a greenhouse and an environment server for storage and processing of collected data. Using the Barenbrug formula for calculating the dew point on the leaves, this system is realized to prevent a dew condensation phenomenon on the crop's surface acting as an important element in diseases generation. They also constructed a test bed the usual greenhouse in order to verify the performance of their system with regard to dew condensation control.

An Embedded systems approach to Monitor Green House [5] is an approach to measure parameters in the Green house. They have designed a system consists of sensor circuits, PIC microcontroller, RS 232 serial communication, LCD module to display the parameters, GSM modem to update user, mobile receiver, and required power supply unit. The output of the sensors are given has input to the micro controller to control, display the parameters and update the owner. Any parameter changing with set parameter for Green House systems, the micro controller will read and stores periodically, in turn it updates the user by sending SMS by service provider. The program is written in microchip’s MPLAB IDE 8.4.

Since the requirement for the green house differs from different plants a specific system is designed to monitor temperature, humidity and luminescence monitoring system using in flowers growing [6]. This paper presents a proposal of a monitoring system using Wireless Sensor Networks applied to the flowers crop. Advances in technology enabled researchers in the field of wireless sensor networks to forecast unprecedented growth of ubiquitous applications. Because of the limited energy storage capability of sensor nodes, energy consumption is one of the most challenging aspects of these networks and different strategies and protocol deals with this area. A new scheme of low-power temperature and humidity monitoring system

[7] based on Wireless Sensor Network (WSN) is proposed to overcome the weakness of the ones at present. In this paper, a star topology is used as the structure of network, and the microcontroller unit (MCU) as the main control device in base station and slave stations. Slave stations use SHT11 digital temperature and humidity sensor to complete data acquisition, and exchange data with base station by low-power multi-channel nRF905 transceiver chip. This paper introduces the hardware and software of the base station, using the communication protocol and frequency hopping (FH) mechanism to ensure the reliability of data transmission, increasing the robustness of the system. The result shows that this system has the advantage of portable, flexible arrangement, a large coverage area, low power consumption, and small disturbance.

The combination of WSN and fuzzy control [8] is aiming at the features of environmental information monitoring, a multi-parameter monitoring system is designed by Xinrong and Chang based on low-power ZigBee wireless communication technology to improve overall the level of system automation and monitoring. The monitoring results for temperature and humidity have shown that this system is stable, high reliable in data transmission and easy to use, and can be widely used in various areas of automatic monitoring of environmental parameters.

Another practical energy saving method [9] was constructed in different environment to verify the efficiency of the system. This research apply new technology to build up active & intelligent energy-saving system focus on system operation instead of materials or components, with those auto-detect mechanism and auto-judged back-end agent software, then deliver feedback control signals through bi-direction wireless communication interface, this system can effectively achieve the goal of energy-saving. Green house environment monitor technology implementation based on android mobile platform [10] is an advanced technology introduced by different kind of monitoring system. In this paper they use mobile phone as monitoring terminal, monitoring green house environment.

Recently, intelligent systems for agricultural production are being developed for safe and low cost food production. Plant factory provide high yield by growing multiple crops and making efficient use of land and resources. Plant growth is facilitated by maintaining humidity, temperature, CO2 concentration and light intensity and these factors need to be monitored and maintained for an automated system. In this paper, they have proposed a control system for a LED based plant factory consisting of ZigBee [11] wireless mesh network, and remote monitoring via Internet. A major novelty of the system is the use of LED lighting instead of fluorescent lighting due to its low power consumption, long life and useful narrow band. LED lighting system provides an efficient and economical lighting system that facilitates plant growth by varying light intensity and frequency according to light conditions and growing requirements and also helps in reducing production costs and speeding growth. Prototype of the proposed system has been installed in a small part of greenhouse. Data acquisition and remote management of the system has shown very satisfactory performance.

The wireless sensors networks (WSN) are defined as the collection of sensor nodes that perform a specific task and they are representing one of the technological solutions to automatize and improve the management of crops. This paper summarizes the work carried out to provide an efficient control mechanism of microclimate [12] into greenhouses through the implementation of an infrastructure of Wireless Sensors Network to control environmental parameters. A crop of tomato was selected as a case study in which a physic network topology was deployed. Additionally, a management data application was developed taking into account usability parameters in order to create a tool easily accepted by the future users.

## 2.2 Irrigation Management

People now are working actively on intelligent irrigation systems because of their advantages in labor-saving and water saving. Wireless technology as shown in Fig. 3, known for its easy installation and maintenance, is thought preponderant to develop automatic irrigation network and becoming a hot research. Water reservation control is a crucial facility especially in the irrigation system for agricultural activities. It is important to make sure the amount of water in the reservoir is always at its appropriate level and able to be flowed to irrigation system when it reaches the maximum level to prevent water from flooding the surrounding area. When the reservoir is at its low level, a flow of water from other sources must be allowed to maintain appropriate level of reservation.

The application of wireless sensor network (WSN) for a water irrigation control monitoring [13] is composed of a number of sensor nodes with a networking capability that can be deployed for an ad hoc and continuous monitoring purpose. The parameters involved in the water reservation control such as the water level and motor movement of the gate controlling the flow of water will be measured in the real time by the sensors that send the data to the base station or control/ monitoring room. In this paper, the fundamental design and implementation of WSN featuring a Zigbee Technology together with the IEEE 802.15.4 compatible transceiver and the simple water flow control circuit is proposed. The developed platform is cost-effective and allows easy customization. Several preliminary results of measurement to evaluate the reliability and effectiveness of the system are also presented.

Precision irrigation [14] is an important practice in water- saving agriculture cropping system, which allows producers to maximize their productivity while saving water. While the accurate irrigation amount is difficult to obtain as the impact factor was too much. In order to solve this problem, a fuzzy decision-making method of irrigation amount based on ET and soil water potential was designed in this paper. And the soil water potential and crop evapotranspiration (ET) were selected as input variables of the fuzzy controller. The wireless sensor network (WSN) was used to transmit the irrigation control signal including the soil water potential signal and the relative humidity, air temperature, solar radiation, wind velocity and so on. The test results show that the method and system has many advantages, such as economic, practical, with high communication reliability and control accuracy.

At present, labor saving and water-saving technologies a key issue in irrigation. A wireless solution for intelligent field irrigation system dedicated to Jew's-ear planting in Lishui, Zhejiang, China, based on ZigBee technology [15] was proposed in this paper. The hardware architecture and software algorithm of wireless sensor/actuator node and portable controller, acting as the end device and coordinator in ZigBee wireless sensor network respectively, were elaborated in detail.

### 2.3 Storage Management

The food price has been rising constantly in recent years, so it is increasingly urgent to solve the problems of security of grain-storing with the popularization of the agriculture science and technology. The conventional manual method of measuring the humiture of the Granary could no longer meet the needs of the agricultural development because of the rapid development of the information technology. With the development of sensor network technology, it is an inevitable trend to adopt the intellectualization to control the temperature and humidity in the granary. Here we have discussed two storage management systems to monitor temperature and humidity in the granary. The wireless sensor network [16] is developed in this paper to test and control the temperature and humidity of the barn. Specific procedures are after processing the variable information which is gathered by the humidity and temperature sensor, by using Zigbee agreement they will transfer the packets with wireless data transmission among all these nodes and then send it into PC. It will show the temperature and humidity of the barn in the upper machine interface. If the parameter is more than the scope of the set value of PC, they can make a corresponding adjustment through ventilation system and then make them to a reasonable.

There is another system implemented using XBee/XBee Pro module [17]. This paper designed and implemented a WSN monitoring system for grain depot to monitor temperature and humidity in the grain depot with stable performance including data collection, transmission, storage etc. The nodes can use battery to supply energy and is installed conveniently. This system has been widely used in small and medium-sized granaries. An Automatic monitoring system of granary based on WSN [18] is invented by Ling Xu & co is a new concept to store granary. This system consists of the automatic monitoring unit and the receiving unit using the intelligence sensor technology and the wireless communication technology, a popular form of sensor network in recent years. It can be widely used for humiture monitoring system of the granary.

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