

A Survey on Applications of Wireless Sensor Networks in the Agricultural Field



Engineering

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ABSTRACT

WSN represent an enabling technique for low power wireless measurement and control application .The elimination of wires provide significant cost savings as well as improved reliability for many long term monitoring and control applications. This paper presents a survey on various WSN applications in the agriculture field such as smart irrigation, monitoring climatic condition, Pest and disease management, mobile robotics, health care , textile, green house management, nutrition management etc. Agriculture has played a key role in the development of human civilization. Due to increased demand of food people are trying to put extra efforts and special technique to multiply food production using WSN. The analysis of the above parameters has proved to be accurate and less time consuming as compared to traditional methods. Various applications of WSN can improve the decision making for precision agriculture to yield food products with better quality, low cost and it can be helpful in reducing the excess of pesticides and insecticides.

1. Introduction

Agriculture is one of the strongest sectors of Indian economy. India is the second largest country in agricultural output according to IMF and CIA world fact book 2015. According to Economic survey of India (2006-2007), it contributes about 17% of GDP and more than 49% of Indian population depends on agriculture. Agriculture contribute one sixth of export earnings per annum. Average yield of India is just 30% to 50% of the highest average yield in the world. A new developing technology called precision agriculture leads to enhance farm output and also make the farm input profitable, reduce error and cost. WSN consists of a large number of densely deployed small sensor nodes with sensing, computation and wireless communication capabilities. This survey mainly focuses on applications of WSN in various domains of agriculture field.

Literature Review

Green House Management:

The proposed Green House Management system to [6] monitor and control the microclimatic parameters such as temperature, humidity, soil moisture and photo sensor along with Zigbee network connected in mesh topology. Real time monitoring of these parameters and appropriate controlling actions are taken such as water sprinkler for irrigation, and for thermal management a coolant fan with $\pm 20\%$ tolerance. But it results in acoustic noise and high power consumption. A GUI based application developed on java platform facilitates controlling appliances remotely in green house monitoring system.

The proposed system in [1] i.e. Green House management using ARM controller is a closed loop irrigation system and adaptive. Once the system senses the soil moisture, it supplies the necessary phosphorous / fertilizer to maintain the plant growth. NPK micro-sensor is useful for measuring primary macro nutrients in soil and supply data to farmers. For this purpose drip irrigation is connected by means of solenoid valves for automatic valve controlling and pump operation. The quality of product is improved by efficient use of fertilizer and smart irrigation.

The proposed system in [2] green house system with programmable system on chip technology (PSOC) along with high bandwidth spectrum or cognitive radio technology for smooth data traffic and remote control of green house parameters. This system employs climatic sensors inside and outside the green house and soil sensor to control the water flow of irrigation system in green house. Depending on the changes in the temperature, light, humidity, wind speed, the climatic sensor inside the green house takes the necessary control actions.

2.2 Robotics in Agriculture:

The proposed system in [16] uses WSN technology along with robotic platform reduce the number of sensor nodes and hence the cost. The sensors selected are movable along with robot such as E-nose sensor which smell the plant when it is under disease attack and reflectance based optical sensor determines the health of the plant by absorbing specific wavelength in the NIR Spectrum.

There are also nitrous oxide sensors to detect the water logging and night activated acoustic sensor to inform the farmer about the intrusion of wild animals. Ad-hoc routing for communication between various nodes provide automatic reconfiguration and robust against the failure of individual nodes. TinyOS software can be used to program the sensor nodes above mentioned. RTOS (Real Time operating System) can also used with microcontroller for real time monitoring of agricultural farm.

An Intelligent agriculture Environment monitoring system [11] using autonomous mobile robot monitor the crop field environmental factors such as PH level, water level and temperature are sent to a robot through IEEE 802.15.4 Zigbee wireless technology and it send the information to the farmer using GSM Module. A line following robot which can follow a black line with white surface deployed with 6 IR sensors for moving right, left, forward side of the farm. Ultrasonic sensors are used in robot for avoiding obstacles.

The proposed system in [17] will provide a powerful WSN accompanied with mobile robot gives a cost effective tool for sustainable management of environment and agriculture .A mobile robot carry the sensor such as NH_3 and CO_2 and a wireless gateway. The mobile robot collects the data from sensors when it close to the individual sensor for every one hour and also the location of robot through the signal strength indicator. RSSI (received signal strength indicator) parameter is measured as relative distance between mobile robot and fixed sensor mote.

2.3 Thermal Imaging:

Thermal remote sensing in agriculture [8] is gaining popularity in the recent years due to reduction in cost of the equipment and simple operational procedure. Potential use of thermography in agriculture includes nursery monitoring, irrigation scheduling, soil salinity detection, disease and pathogen detection, yield estimation, maturity evaluation and bruise detection .Thermal imaging systems are evaluated based on their thermal sensitivity, scan speed, image resolution, and intensity resolution. The drawbacks in this system are high resolution thermal imaging are costly and its accuracy depends on environmental

and weather condition where thermal behavior of crops vary with climatic condition.

2.4 Role of Mobile in Agriculture:

In this paper a smart phone become a useful tool [13] in the agriculture sector because of their mobility and the cost of the device is accessible to all users. Farmer get assistance from agricultural experts and government extension workers, about market, weather and new crop diseases through Toll free number and help to increase the productivity.

Many smart phones are equipped with sensors including accelerometer (Acceleration and rotational force), GPS (motion sensor), Light sensor (Photometer), Temperature sensor (Thermometer), gyroscope, barometer (Pressure) and cameras both front and rear facing with high resolution. **Magri** apps are used to find the disease in a leaf based on its color but it need expert advice for identification of disease in remote laboratories. Other external factors affecting the smart phone applications are poor mobile network coverage and battery of mobile.

The aim of the [9] is to propose a state of art wireless sensor technology in agriculture where the farmer can replace its traditional techniques in farming. A low power 2.4 GHz micaz mote MDA300 with standard Irrometer soil moisture sensor, atmospheric pressure sensor MPX4115A, leaf wetness sensor deployed in sensor node. Mote View a graphical user interface is used to check system status. Mote View is running on PC based on Microsoft Visual SC++ IDE. This information is useful for agro-ecological specialist to gain efficient management and utilization of resources.

The paper [14] describe a precision agriculture plays a vital role in weed management and savings in pesticide about 30%. According to Roger's innovation diffusion model, crop production in specific area results in huge amount of savings at EU-25 level. Around 5-10-20% of fertilizer savings were estimated with the aim of site-specific fertilizer reduce material cost and 15% of pesticides saved.

2.5 Smart Irrigation Management

The proposed system [12] is designed to control water level, presence of toxic gas and moisture content of the soil. PIC 16F877 microcontroller converts the analog data from different sensor to digital and displayed on LCD through Zigbee wireless transmission. MQ-7 sensor can detect CO₂ concentration from 20 to 2000ppm. X-CTU is a window based application provided by Digi's RF product with simple GUI to monitor and control the crop field parameters.

The proposed paper [7] production of sesame in India depends on climatic condition and soil condition. Sesame is intolerant to excess water and it need different amount of water at different stages of plant growth. Sesame is heat tolerant and its tolerance limit is 60F. Productivity of crop decreases if the temperature is decreased. Soil Ph will be 5-8 for moderate production. Atmel ATmega128 @ 8 MHz with frequency band 2400MHz-2483.5MHz processor is implemented using TinyOS that runs on MICAZ and decision is sent to farmers in the form of SMS alert.

2.6 Detection Of disease in Plants:

The work in paper [10] focuses its research on WSN for groundnut crop with weather based Pest and disease Management. This system implement two decision advisory support model for groundnut disease and one model for pest control. TDMA based approach for network coordination provides multi hop routing and control information dissemination.

The gateway is based on ARM Cortex-3 processor running the CooCox operating system and interface with WSN mote and GSM modem. Cost benefit analysis was conducted for individual

randomized block design (RBD) based on number of fungicide treatments applied. During Kharif season both DSA model perform similarly and interchangeable. But during the Rabi season macroclimate model fails to detect the disease, since the humidity remains unaffected by the sprinkler irrigation.

In this paper [3] author proposed a statistical model for detecting and classifying fungal disease. Statistical features from different fruits like mango, pomegranate and grapes using Gray level Co-occurrence matrix (GLCM), gray level run length matrix (GLRM), are extracted from fruit images. The average classification accuracies are 91.37% and 86.15% using GLCM and GRM features. But in the proposed system average accuracy can be increased to 94.085% using block wise features.

The proposed system [15] consists of a camera to capture the plant image, four lights to control illumination and a laptop is used for processing the signal to estimate nitrogen content in the leaf and the results are compared with the chlorophyll content of the crop measured by SPAD meter. The processing of color plant image was done in MATLAB 7.0 and the minimum accuracy is 65% with an average accuracy of 75% for successful estimation of nitrogen content in the leaf by its color image features.

2.7 Monitoring Climatic Conditions:

The proposed system [5] prevent the moisture stress of trees, salification and also provide an efficient use of water resource. RF module is used for measuring soil moisture and a low power UDEA -434Omni directional antenna was connected. Sensor based site specific irrigation is low cost wireless irrigation system and monitor water content of the soil.

WSN collaborated with aerial robotics [4] a real time monitoring of frost in vineyards during the spring season. Quadrotors flying over the vineyards shipping a mote and calculate various parameters signal quality, packet loss and number of nodes covered monitoring the environmental variables. Ad-hoc communication protocol and user friendly operator interface for handling the system and monitoring the data has been implemented.

Conclusion:

In this research work, a survey on different agricultural based applications using wireless sensor networks and their technologies and standards was carried out. Some of the most relevant applications of precision agriculture were analyzed and the conclusions used to identify the challenges that need to be addressed.

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