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Research Article

AGRICULTURAL APPLICATIONS USING IoT BASED WSN

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A R T I C L E I N F O

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A B S T R A C T

The Agriculture has a significant role in the socio-economic fabric in India. India ranked in the world's five largest producers of over 80% of agricultural produce items. Agriculture is the backbone and is the economy of India. In India 75% people depends on Agriculture and depends on natural resource of water rainfall. Huge population requires significant water resource. In India 70% of people requires fresh water. Green revolution started long back in 1967to agricultural products. But Crops damaged due to irregular and uncertain monsoon, excessive / limited rainfall, flood / draught. Huge losses occur due to over irrigation, water logging, or under irrigation. Negligent maintenance of farm irregular/ improper supply of water, made more water consumption then the amount of rain fall. In 2014-15 massive amounts of crops had been lost due to poor storage service and unforeseen weather conditions.

INTRODUCTION

Agriculture has a significant role in the socio-economic fabric in India. India ranked in the world's five largest producers of over 80% of agricultural produce items. Precision agriculture, also called satellite farming is a cultivation management concept based on observing, measuring and responding to inter and intra variability in crops. The precision agriculture is the ability to define a decision support system for farm management with the motive of optimizing the cultivation of crops, and amount of returns on inputs while preserving the crop resources so as to improve the land productivity. Farming management is the flow of activities carried out by a farmer in the farm component of the field which consists of various phases like temperature, soil moisture and water level. Farmers need to note the records of these factors manually (or on paper) to grow the crops properly. Since, agricultural fields are so far away from the farmers house, it is a very tedious task for them to go their frequently to maintain the crops and remember the records. Farmers need to have in knowledge about these environmental factors for some period of time to carry out the appropriate actions such as to spray pesticides, and to manage the hardware which causes inconvenience in their work due to longer distance between their farms and houses.

Due to advancement in technologies and reduction in size, sensors are becoming involved in almost every field of life. Agriculture is one of such domains where sensors and their networks are successfully used to get numerous benefits. Selection of sensors and their effective utilization to solve agricultural domain problems has been an arduous task for novice users due to unavailability of conglomerated information in literature. The aim of this paper is to review the need of wireless sensors in Agriculture, WSN technology and their applications in different aspects of agriculture and to report existing system frameworks in agriculture domain. Wireless Sensor Networks' application in various aspects of agriculture is reviewed. Available system frameworks for agriculture domain are presented [1].

IoT is an integrated part of future internet and can be defined as a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual "things" have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network. Considering the functionality and identity as central it is reasonable to define the IoT as "Things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental, and user contexts". A different definition, that puts the focus on the seamless integration, could be formulated as "Interconnected objects having an active role in what might be called the Future Internet". The semantic origin of the expression is composed by two words and concepts: "Internet" and "Thing", where "Internet" can be defined as the world-wide network of interconnected computer networks, based on a standard communication protocol, the Internet suite (TCP/IP)", while "Thing" is "an object not precisely

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identifiable" Therefore, semantically, "Internet of Things" means "a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols". In the IoT, "things" are expected to become active participants in business, information and social processes where they are enabled to interact and communicate among themselves and with the environment by exchanging data and information "sensed" about the environment, while reacting autonomously to the "real/physical world" events and influencing it by running processes that trigger actions and create services with or without direct human intervention. Interfaces in the form of services facilitate interactions with these "smart things" over the Internet, query and change their state and any information associated with them, taking into account security and privacy issues. IoT finds its applications in many fields like environmental monitoring, agriculture, health monitoring, home automation, transportation etc.

Related Work

This review covers developments in non-invasive techniques for quality analysis and inspection of specialty crops, mainly fresh fruits and vegetables, over the past decade up to the year 2010. Presented and discussed in this review are advanced sensing technologies including computer vision, spectroscopy, X-rays, magnetic resonance, mechanical contact, chemical sensing, wireless sensor networks and radio-frequency identification sensors. The current status of different sensing systems is described in the context of commercial application. The review also discusses future research needs and potentials of these sensing technologies. Emphases are placed on those technologies that have been proven effective or have shown great potential for agro-food applications. Despite significant progress in the development of non-invasive techniques for quality assessment of fruits and vegetables, the pace for adoption of these technologies by the specialty crop industry has been slow. Advances in instrumentation have made it possible to introduce a variety of sensors. Computer vision linked to robotics is a basic component of automated operations. A need for portable equipment for use in the field and packinghouse is recognized. Wireless sensor networks increase sensing capacity for crop production and quality monitoring. The basic sensing techniques are mostly available, but need further technological development [2].

With the advances in electronic and information technologies, various sensing systems have been developed for specialty crop production around the world. Accurate information concerning the spatial variability within fields is very important for precision farming of specialty crops. However, this variability is affected by a variety of factors, including crop yield, soil properties and nutrients, crop nutrients, crop canopy volume and biomass, water content, and pest conditions (disease, weeds, and insects). These factors can be measured using diverse types of sensors and instruments such as field-based electronic sensors, spectro radiometers, machine vision, airborne multispectral and hyper spectral remote sensing, satellite imagery, thermal imaging, RFID, and machine olfaction system, among others. Sensing techniques for crop biomass detection, weed detection, soil properties and nutrients are most advanced and can provide the data required for site specific management. On the other hand, sensing techniques for diseases detection and characterization, as well as crop water status, are based on more complex interaction between plant and sensor, making them more difficult to implement in the field scale and more complex to interpret. This paper presents a review of these sensing technologies and discusses how they are used for precision agriculture and crop management, especially for specialty crops. Some of the challenges and considerations on the use of these sensors and technologies for specialty crop production are also discussed. High resolution remote sensing imagery has the potential for yield estimation for specialty crops. Application of machine vision in agriculture is enhanced by the use of task-specific wavelengths in the visible and beyond the visible spectrum range, leading to more successfully accomplished tasks. There is a need for developing easy-to-use and low cost commercial VRA systems for specialty crops. Plant diseases can be detected with optical sensors [3].

Recent advances in sensor and wireless radio frequency (RF) technologies and their convergence with the Internet offer vast opportunities for development and application of sensor systems for agriculture. The objective was to create regional and on-farm sensor networks that provide remote, real-time monitoring and/or control of important farming operations that add value through improved efficiency and efficacy of targeted management practices. This paper describes hardware and software components of technologies we developed for regional and on-farm sensor networks and their implementation in two agricultural applications in Washington State, an agricultural weather network and an on-farm frost monitoring network. The regional sensor network consists of our AWN200 data logger equipped with a 900 MHz, frequency hopping, spread spectrum (FHSS) radio configured into master-repeater-slave network for broad geographic coverage. A single master is configured with multiple repeaters to provide a RF line-of-sight telemetry backbone network. Independent network backbones from disparate geographic regions are then aggregated in a central database via standard Internet protocols for further processing and dissemination. The network is deployed in a star topology in which a strategically placed base radio is responsible for network synchronization, data collection from remote stations within the network, and re-broadcasting collected data to roamer radio units attached to mobile computers and/or directly to the Internet. Problems encountered were mainly associated with power management under periods of low solar energy and with electrostatic discharge (ESD) damage to gallium-arsenide (GaAs) based transmit-receive switches in the radios during storms, a problem now corrected. Both systems have been made commercially available to growers via a novel arrangement between WSU and a local manufacturer [4].

Precision agriculture is a field which provides one of the most suitable scenarios for the deployment of wireless sensor networks (WSNs). The particular characteristics of agricultural environments - which may vary significantly with location - make WSNs a key technology able to provide accurate knowledge to farmers. This knowledge represents a valuable resource because it enables real-time decision making with regard to issues such as establishing water saving policies while providing adequate irrigation and choosing the right time to harvest the fruit based on its maturity. This article proposes a methodology consisting of a set of well-defined phases that cover the complete life cycle of WSN applications for agricultural monitoring. We have studied different existing real-world scenarios where WSNs are being applied. Based on this study we have discovered that there exist significant commonalities but no methodology that specifies the best practices that should be used in the general, crop-independent case. The lack of a general methodology negatively impacts the amount of effort, development time, and cost of developing applications.

We are proposing a methodology to guide the development of applications for the agricultural domain based on WSN. We are leveraging the existing state-of-the-art to collect a set of common actions and best practices for agriculture monitoring based on WSNs. The methodology represents the backbone of WSN agricultural monitoring applications and provides a solid foundation on which applications can be built with significant productivity gains and facility of maintenance. We validate our methodology by using it to develop a research project; our approach proved to considerably facilitate the development process [5].

A variety of technologies for reducing residential irrigation water use are available to homeowners. These “Smart Irrigation” technologies include evapotranspiration (ET)-based controllers and soil moisture sensor (SMS) controllers. Testing was performed on two types of SMS controllers at three soil moisture threshold settings. Mini-Clik rain sensors (RS) comprised six treatments at two rainfall thresholds and three different irrigation frequencies. A time-based treatment with 2 days of irrigation per week without any type of sensor (WOS) to bypass irrigation was established as a comparison. All irrigation controller programming represented settings that might be used in residential/commercial landscapes. Even though three of the four testing periods were relatively dry, all of the technologies tested managed to reduce water application compared to the WOS treatment, with most treatments also producing acceptable turf quality. Reductions in irrigation applied were as follows: 7-30% for RS-based treatments, 0-74% for SMS-based treatments, and 25-62% for ET-based treatments. The SMS treatments at low threshold settings resulted in high water savings, but reduced turf quality to unacceptable levels. The medium threshold setting SMS-based treatment produced good turf grass quality while reducing irrigation water use compared to WOS by 11-53%. ET controllers with comparable settings and good turf quality had −20% to 59% savings. Reducing the irrigation schedule by 40% and using a rain sensor produced water savings between 36% and 53% similar to smart controllers. Proper installation and programming of each of the technologies was essential element to balancing water conservation and acceptable turf quality. Water savings with the SMS controllers could have been increased with a reduced time-based irrigation schedule. Efficiency settings of 100% (DWRS) and 95% (TORO) did not reduce turf quality below acceptable limits and resulted in substantial irrigation savings, indicating that efficiency values need not be low in well designed and maintained irrigation systems. For most conditions in Florida, the DWRS schedule (60% of schedule used for SMS treatments) can be used with either rain sensors or soil moisture sensors in bypass control mode as long as the irrigation system has good coverage and is in good repair [6].

A soil property monitoring system based on WSN technology was developed and deployed in a wheat field. The system included a local WSN with multiple sensor nodes to acquire soil property data, a data sink, and a long-distance cellular network to transmit field data to a remote database. The quality of service of the system was evaluated based on the average packet delivery rate and valid data rate, which were both above 95% for each sensor node during the tests. The system could provide users an easy access of real-time field data. Precision agriculture approach is based on field information with high spatial and temporal resolution. Wireless sensor network (WSN) is one of the most promising technologies allowing uninterrupted, unsupervised, remote data collection. Special issues are involved in the design and development of WSN systems deployed under remote field conditions. Interferences from canopy and soil can make significant impact on system reliability [7]. The farmers can easily check out the current conditions of crops and farms at anytime and anywhere. Moreover, we also developed a robot platform with network based mobility function for mobile surveillance [8].

For the latest 10 years, many authors have focused their investigations in wireless sensor networks. Different researching issues have been extensively developed: power consumption, MAC protocols, self-organizing network algorithms, data-aggregation schemes, routing protocols, QoS management, etc. Due to the constraints on data processing and power consumption, the use of artificial intelligence has been historically discarded. However, in some special scenarios the features of neural networks are appropriate to develop complex tasks such as path discovery. In this paper, we explore the performance of two very well-known routing paradigms, directed diffusion and Energy-Aware Routing, and our routing algorithm, named SIR, which has the novelty of being based on the introduction of neural networks in every sensor node. Extensive simulations over our wireless sensor network simulator, OLIMPO, have been carried out to study the efficiency of the introduction of neural networks. A comparison of the results obtained with every routing protocol is analyzed. This paper attempts to encourage the use of artificial intelligence techniques in wireless sensor nodes [9].

Recently, adopting an optimized irrigation system has become a necessity due to the lack of the world water resource. Moreover, many researchers have treated this issue to improve the irrigation system by coupling the novel technologies from the information and communication field with the agricultural practices. The Wireless Sensor and Actuators Networks (WSANs) present a great example of this fusion. In this paper, we present a model architecture for a drip irrigation system using the WSANs. Our model includes the soil moisture, temperature and pressure sensors to monitor the irrigation operations. Specifically, we study the case where a system malfunction occurs, as when the pipes burst or the emitters are blocked. Furthermore, we differentiate two main traffic levels for the information transmitted by the WSAN, and by using an adequate priority-based routing protocol, we can achieve high QoS performances for the priority information. We have performed extensive simulations through TOSSIM simulators. The results show that our solution gives better performances in terms of delay and packet delivery ratio. Also we have realized a real test-bed to investigate the effectiveness of our approach. The experimentation results show considerable gain compared to other state-of-the-art protocol [10].

Due to advancement in technologies and reduction in size, sensors are becoming involved in almost every field of life. Agriculture is one of such domains where sensors and their networks are successfully used to get numerous benefits. Selection of sensors and their effective utilization to solve agricultural domain problems has been an arduous task for novice users due to unavailability of conglomerated information in literature. The aim of this paper is to review the need of wireless sensors in Agriculture, WSN technology and their applications in different aspects of agriculture and to report existing system frameworks in agriculture domain [11].

Monitoring different parameters of interest in a crop has been proven as a useful tool to improve agricultural production. Crop monitoring in precision agriculture may be achieved by a multiplicity of technologies; however the use of Wireless Sensor Networks (WSNs) results in low-cost and low-power consumption deployments, therefore becoming a dominant option. It is also well-known that crops are also negatively affected by intruders (human or animals) and by insufficient control of the production process. Video-surveillance is a solution to detect and identify intruders as well as to better take care of the production process. In this paper, a new platform called Integrated WSN Solution for Precision Agriculture is proposed. The only cost-effective technology employed is IEEE 802.15.4, and it efficiently integrates crop data acquisition, data transmission to the end-user and video-surveillance tasks. This platform has been evaluated for the particular scenario of scattered crops video-surveillance by using computer simulation and analysis. The telecommunications metrics of choice are energy consumed, probability of frame collision and end-to-end latency, which have been carefully studied to offer the most appropriate wireless network operation. Wireless node prototypes providing agriculture data monitoring, motion detection, camera sensor and long distance data transmission (in the order of several kilometers) are developed. The performance evaluation of this real tests-bed scenario demonstrates the feasibility of the platform designed and confirms the simulation and analytical results [12].

1. General applications of IoT are as follows.
2. Media
3. Infrastructure management
4. Manufacturing
5. Energy management
6. Medical and health care systems
7. Building and home automation
8. Transportation

Applications of WSN in the agriculture environment monitoring

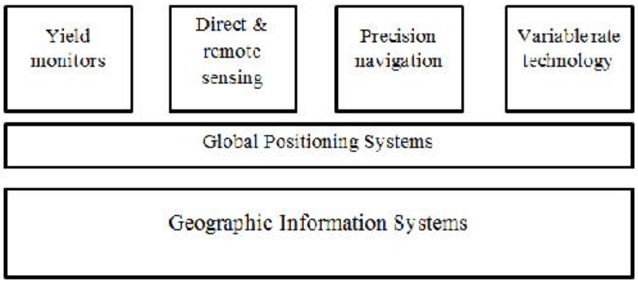
Environmental monitoring: The agricultural environment protection does the agricultural modernization based on WSN. The monitoring system comprises of four main parts which are sensor nodes, sink node, transmission networks and monitoring terminal. The system comprises of larger number of wireless sensor nodes in agricultural environment [13].

Applications of Greenhouse parameter control in precision agriculture

This is the best technique used in agriculture. It is using for automatic environmental changes using sensor devices in WSN. This method includes precision agriculture using programmable system on chip technology. Types of sensors and controlling parameters in green house include air temperature control, humidity control, and soil condition control [14].

Precision Agriculture

Precision agriculture is a management strategy which identifies analyses and manages within field variability for increased profit and reduced environmental impact. It is an integrated agricultural management system incorporating several technologies. The technological tools often include the global positioning system, geographical information system, yield monitor, variable rate technology, and remote sensing. The Fig 2.1 shows the building blocks of precision agriculture.



Issues in Precision farming: Precision farming is being talked about everywhere and many manufacturers make at least some efforts to offer information on the possible use of their machines for precision farming. However, quite a number of problems must still be solved before numerous farmers can practice precision farming.

- Precision of positioning
- Combination of mapping and real-time systems
- Algorithms for reduction and processing of the amount of collected data
- Models of calculating the optimal amount of applied factor

CONCLUSION

Sensor technology and WSN are the great attention seeking strategies in modern days. Internet of Things (IoT) is a technology in which everyday objects form an Internet network through which they can communicate with each other. It ensures the connectivity to physical objects rather than traditional connectivity devices like laptop, desktop and mobiles. Every device in Iot must have an identity, mostly an IP address. The IoT is fast converting agriculture into smart agriculture. The paper presents the comprehensive study on applications of IoT in agricultural field in WSN. This technology is increasing day by day in agriculture field.

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