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A SURVEY ON WIRELESS SENSOR NETWORK AND IOT IN PRECISION AGRICULTURE

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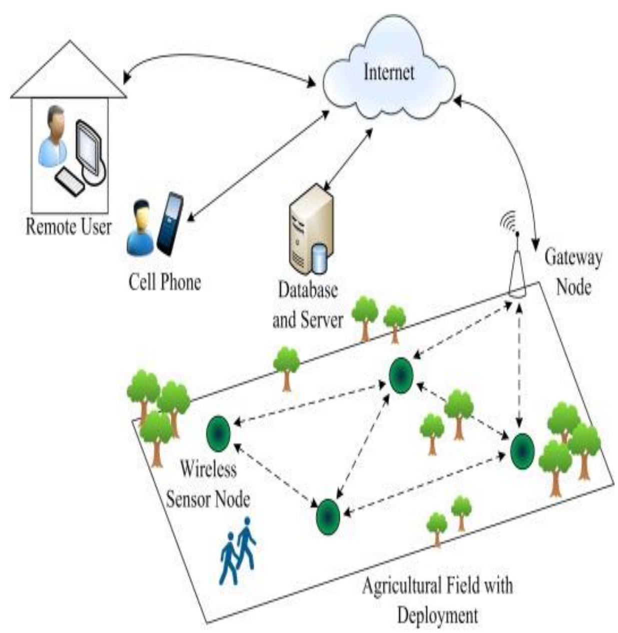
ABSTRACT: In recent years, with the increasing population and decreasing irrigated land, meeting world's food demands is becoming a great challenge. Wireless sensor Network is widely used in agriculture field. It provides a new direction of research in agricultural domain. WSN gives various benefits such as crop monitoring, crop management and water management. Farming is one of the major domain where WSN is used. It is very difficult to do the field management manually. The aim of this paper to survey the need of WSN in agriculture field such as real time data capturing from field, devices used etc.

Keywords: [Wireless Sensor Network, Agriculture, crop monitoring & management, water management, data capturing.]

1. INTRODUCTION

Wireless sensor network (WSN) technologies have rapidly developed over the years. Modern agriculture needs tools and technologies that can improve production efficiency, product quality, postharvest operations, and reduce their environmental impact. Automation in agriculture brings about a fundamental contribution to what is now known as precision agriculture (or precision farming). A definition of precision agriculture may be the following: the technique of applying the right amount of input (water, fertilizer, pesticide, etc.) at the right location and at the right time to enhance production and improve quality, while protecting the environment Agriculture can be considered as one of the most favorable facilities for WSNs to improve food crop yields and minimize the burden of farmers. WSNs are used as cost-effective processes to increase agricultural yield.



Architecture of WSN with Agriculture

2. NEED OF WSN IN AGRICULTURE

Sensors are used for collecting live data from field and process it. Agriculture domain poses several requirements that are following:

Collection of real time data from field such as soil moisture, temperature, humidity and rainfall etc.

Processing on captured data.

Send alert message to user/ farmer.

Monitoring of distributed land.

Management of water requirement to crop.

Accordingly, WSNs have been used in different agricultural applications, such as for monitoring climate and using soil nutrient data to forecast the health of crops and the quality of agricultural products. Irrigation planning can be predicted using WSNs by observing weather conditions (such as temperature and humidity) and soil moisture. Other sensor nodes can be added to the existing WSN to improve the parameters of the agricultural monitoring system and to make the network scalable. However, some challenges have hindered the agricultural application of WSNs, such as determining optimum deployment schemes, measurement periods, routing protocols, energy efficiency, cost, communication range, scalability, and fault tolerance. In this paper aim to present the existence studies of wireless sensor networks which are used for agriculture field. This paper will explain in details the merits and demerits of the existing studies.

3. LITERATURE SURVEY

1. V. Palazzi, F. Gelati, U. Vaglioni, F. Alimenti, P. Mezzanotte, L. Roselli (2019) proposed an RFID-based autonomous leaf-compatible temperature sensing system for precision agriculture. The wireless transponders are based on the EM4325 chip by EM Microelectronic, which features an integrated temperature sensor. The chip is made to operate in semi-active mode and the required energy is supplied by a flexible commercial solar cell. The antenna is manufactured on a PLA substrate by adopting the adhesive copper tape technology and the layout is optimized to obtain a compact transponder, suitable for being applied to leaves. When the plant is correctly hydrated its temperature is lower than the air temperature due to the transpiration phenomenon. Consequently, from the leaf-air temperature gradient the water deficit of the plant can be determined, thus making it possible to provide irrigation only when needed. A field test demonstrates that the sensors can be successfully deployed to monitor leaf temperature and, through the analysis of the leaf-to-air temperature differential, they can be used to check the water stress status of crops.

Merits

The metallic lines with the lumped components can be easily detached and can be processed as traditional electronic waste, while the substrate can be treated as organic waste, thereby drastically reducing the amount of electronic waste.

We can monitor the water stress level of plants.

Demerits

PLA substrate is not to be transparent.

2. K. Visalini, B. Subathra, Seshadhri Srinivasan, Korkut Bekiroglu, Giovanni Palmieri and S. Thiyaku (2019) proposed Sensor Placement Algorithm with range constraints (SPARC), which optimally places sensors considering their range. This investigation presented an approach to deploy WSN in precision farming applications with range constraints and fusing low-resolution RS information. We first showed that the problem of optimal sensor placement with range constraints is NP-hard and cannot be solved with existing tools. To overcome this, we proposed a novel two stage solution technique called the SPARC. In the first stage, the sensors were optimally placed to reduce the estimation error, and in the second stage, the sensor placements which violated the range constraints were projected on to the feasible space. The two step approach solved an otherwise computationally hard problem. The results were demonstrated with WSN deployed using off-the-shelf sensors with no guarantees on precision.

Merits

The proposed SPARC was able to place the sensor with range constraints.

Demerits

Problems involving connectivity increase the computational burden notably.

3. Zeng Hu; Longqin Xu; Liang Cao; Shuangyin Liu; Zhijie Luo; Jing Wang; Xiangli Li; Lu Wang (2019) introduced relay-aided Non-orthogonal multiple access (NOMA) into the uplink transmission in WSNs in agriculture. For a typical periodic and bursty short-range uplink transmission, NOMA technique is able to accommodate more sensor nodes with the same number of the REs. A mixed transmission scheme including both uplink and downlink transmission has been proposed for WSNs in agriculture, in which traditional OMA is applied in downlink transmission and relay-aided MONA scheme is employed in uplink transmission from the sensor nodes to the sink node. Due to massive connectivity and high sum data rate of NOMA, WSNs with NOMA can support higher data rate to the sink node, reduce the power consumption of sensor nodes and prolong the lifetime of the networks. Non-orthogonal multiple access (NOMA) can transmit multiple symbols simultaneously on the same RE by splitting them in the power domain and distinguish them according to diverse power levels of different symbols. The performance of sum data rate and outage probability of application of NOMA in uplink transmission is analyzed.

Merits

Non-orthogonal multiple access (NOMA) has great potential to satisfy the very high data rate and massive connectivity demand both in uplink and downlink transmissions.

It can improve the overall throughput of the network.

NOMA can achieve lower outage probability, higher average throughput and better energy consumption efficiency.

Demerits

If error occurs in single user due to SIC, decoding of all the other users information will be erroneous. This limits maximum number of users to be served by each of the clusters of the cell.

4. Emilian Vlasceanu, Dan Popescu, Loretta Ichim (2019) presents an unmanned aerial system (UAS), based on multi-UAV (unmanned aerial vehicle) architecture, integrated in Internet, able to collect data from ground wireless sensor networks (WSNs), deployed on large areas for prevention agriculture. It acts a server or a data dispatcher to GCSs and is the equipment that intermediates sending commands to UAVs. GCSs can register to IPBox, from where they receive a series of access rights to certain key modules: a) Edit points at UAV level (Waypoints, Home, Landing, Takeoff); b) Modify speed, altitude, heading parameters; c) Payload control (in the case of a mobile-video payload); d) Make the checklist; e) Antenna control (GDT). The contributions were focused on the way of mission planning and data collection: navigation algorithms, transfer of flight trajectory in UAS, storing trajectories to UAS ground part, and data transfer between WSN and UAV.

Merits

Maintaining the GDT as a central node of the network which will keep in touch with GCSs, without the need for an over the-internet communication paths;

The connection between the GDT and the remote server will be done over the Internet.

Demerits

UAVs may not meet the required scientific benchmarks.

5. Nisar Ahmad, Ali Hussain, Ihsan Ullah and Bizzat Hussain Zaidi (2019) proposed an application of Wireless sensor network (WSN) and Internet of Things (IoT) in precision agriculture (PA). In this methodology, where different wireless sensor nodes are deployed in field for data collection. These nodes are connected with each other according the cluster tree topology. Different sensors gathering information related to soil moisture, humidity, temperature, ultraviolet index and air quality are directly connected to Arduino UNO by analog pins. A program has been written in C/C++ to read the analog pins where these sensors are connected. Wireless sensor node is developed as main module of the project. This sensor node is consisted of Arduino UNO, infield sensors and XBee radio module. This research uses the Arduino UNO- a microcontroller board based on ATmega328P microcontroller. The self-powered precision agriculture based experimental setup's functionality is completely tested and real time sensor measurements are successfully transmitted using cluster topology to the server. This information is stored on cloud and then accessed by the end user where it is visualized using a GUI.

Merits

Automatic control of irrigation is made possible by setting a threshold value at server.

Demerits

Less secure on the grounds that programmers can enter the get to point and get all the data.

6. Volodymyr Romanov, Igor Galelyuka, Hanna Antonova, Oleksandra Kovyrova, Volodymyr Hrusha, Oleksander Voronenko (2019) developed wireless sensor network (WSN) for express-diagnostics of agricultural plants' state, created the appropriate hardware, software and methodological support. The developed network now is implemented and under field tests both in open agricultural lands and in smart greenhouses. The main contribution of this paper is the design and fast-prototyping of WSN, taking into account the requirements of application task concerning field usage, long time of autonomous operation and measuring environmental parameters. That caused modeling of developed network to estimate its parameters before practical realization. The system are based on small autonomous programs that exchange data by means of intranet or internet protocols (e.g. ZigBee or http-protocol) and allows processing queries from different users and acquires data from WSNs distributed on large territory.

Merits

The developed applied software helps users to select the optimal duration of measurement for getting more precise results to make correct managerial decision.

Demerits

The scattered deployment of sensor nodes with a long data-gathering period can help extend the network lifetime.
When the agricultural field faces many obstacles, the communication link may be weakened or lost as a result of signal attenuation. The sensor nodes in WSNs are supplied from the battery, thereby preventing connections to the main supply in the deployment location.

7. Anqi Rao, Hanqin Shao, Xiaotong Yang design (2019) proposed a smart agricultural management platform based on UAV and wireless sensor network. During the development, the whole platform is divided into three layers including the perception layer, the network layer and the application layer. ZigBee network that consists of dozens of ZigBee devices is applied to gather data and send it to the MS which fly along a predetermined flight route. The MS accesses each ZigBee network during its flight so as to realize the data transmission from the perception layer to the application layer through LTE. A web application is deployed in the robust application server that located in the cloud to provide monitoring and management interface to users so as to achieve various kinds of functions of the platform. After experiments, the platform function is completely normal and operates stably. Further, the platform can be easily expanded by replacing modules due to its modular design. Using MS to realize data collection, not only can collect sensing data of a number of lands in a short time, but also greatly improved the intelligence of agricultural production, it is suitable to introduce this platform to smart agriculture construction. Since the data packets are collected by MS in each land, the number of transmission hops in WSN is greatly reduced, so the energy consumption of the network is effectively balanced.

Merits

The total energy consumption of WSN is reduced and extend the time-to-live of WSN.

This will effectively alleviate the "energy holes" problem in traditional WSNs that use static sinks.

Demerits

A sensor node is usually equipped with rechargeable batteries, which have limited capacity and pose a challenge to long-term application.

8. Devi Kala Rathinam. D, Surendran. D, Shilpa. A, Santhiya Grace. A and Sherin. J (2019) presents wireless sensor nodes are used to monitor the crops. The yield of agriculture should be increased rapidly to fulfill the food requirements of population throughout the world. Now days Wireless Sensor Network (WSN) used for solving many real time problems. WSN plays vital role in many field like transport, medical, military, mobile phones, home appliances and so on. Agriculture is one of the important sources for all living things. But nowadays agriculture crops are affected due to many environmental changes. To overcome this WSN takes important role in the field of agriculture. In agriculture WSN used for monitoring, measuring temperature, irrigation system, measuring water supply and so on. WSN helps the farmer to produce the crop with high quantity and reduce the cost of yield. Agriculture gets affected by climatic change, environmental change, and natural disaster. Using WSN the soil and water management can be done. Here wireless sensors are used so the cost of implementation is very low. The temperature, humidity and some other theft detection can be made using sensors.

Merits

It helps to increase the productivity of agriculture.

The human effort is reduced by automatic process and it encourage the farmer to develop the farm land.

Demerits

This is not fit for large area of land. The main drawback is, internet connectivity is required at all the time to communicate the data to farmer.

9. Gaia Codeluppi, Antonio Cilfone, Luca Davoli, and Gianluigi Ferrari (2019) proposed VegIoT Garden: a modular IoT Management Platform for Urban Vegetable Gardens. The SA-oriented VegIoT platform described in this paper allows to gather, monitor, and analyze sensor data collected from an urban vegetable garden. The adoption of the proposed IoT-oriented platform improves garden management, providing the farmer with a tool to solve multiple issues and suggesting proper actions to be taken in various cultivation phases. For instance, monitoring soil moisture allows to understand when plants watering is required, while analyzing soil temperature allows to understand which is the best week to seed, as well as which seeds germination would be the fastest. Furthermore, monitored parameters can also be visualized in order to find meaningful trends, useful in detecting (and preventing) possible crops' diseases. To do this, VegIoT is composed by a WSN (GaWSN), a gathering node (HN), and an iOS mobile App (MN).

Merits

It reaches a fair trade-off between costs, adequate communication standardization level, good modularity degree, and scalability. This can be exploited to easily introduce new SNs and functionalities into the network.

Demerits

It can't predict farm productivity and to prevent plant diseases.

10. Haider Mahmood Jawad, Aqeel Mahmood Jawad, Rosdiadee Nordin, Sadik Kamel Gharghan, Nor Fadzilah Abdullah, Mahamod Ismail, and Mahmood Jawad Abu-AlShaeer (2019) proposed Accurate Empirical Path-loss Model Based on Particle Swarm Optimization for Wireless Sensor Networks in Smart Agriculture. two accurate path-loss models were derived based on the relationship between RSSI and distance in a farm field. The path-loss models were formulated based on EXP and POLY mathematical functions using the MATLAB curvefitting tool from the RSSI data collected in an alfalfa farm field. However, the formulated path-loss model was not sufficiently accurate. The R2 values between RSSI measurement and regression line were 0.9392 and 0.8307 for EXP and POLY functions, respectively. Therefore, two new path-loss models were proposed to improve the R2 . These formulated models combined an EXP equation with PSO (EXP-PSO) and a POLY equation with PSO (POLY-PSO). PSO was used to determine the optimal coefficients of EXP and POLY functions. Based on the EXP-PSO and POLY-PSO path-loss models, the performance of the regression line was significantly improved by gaining an optimal straight-line fitting over the RSSI data. Thus, the ideal fitting model was obtained, where an R2 of 1 was achieved. In addition, the EXP-PSO outperformed the POLY-PSO in terms of error and MAE, where it achieves MAE of 1.636.

Merits

It can be used to present a solution for optimization problems.
The idea of PSO mainly depends on particles (which are categorized as a swarm), which can change their speed toward the best solution at each step.

Demerits

It will not adopt to assess the potential deployment based on future wireless Internet of Things technologies in a farm field.

CONCLUSION

This survey paper has given us an idea on various activity and research which is going on in the area of application of technology (WSN) in agriculture. Also the applications of simulation in the field of agricultural to take an educated guess, so as to minimize their loss of yield, decrease the cost, etc. Different existing methods have been studied and we also mentioned the merits and demerits of those methods, but their efficiency to reach the expected result is still lagging. The traditional followed practices are not working under the current scenario, which needs to improve. Sustainable agriculture practices will help to balance the demand of food as well as it is handling natural resources properly.

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