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Smart Agriculture Monitoring System using WSN Technology

[1] B. Balaji Bhanu, [2] Mohammed Ali Hussain, [3] N. Geethanjali, [4] A.Prasad
[1] Research Scholar, Dept. of CSE, SCSVMV University, Kanchipuram, Tamilnadu, India
[2] Professor, Department of ECM, KL University, Vaddeswaram, Andhra Pradesh, India
[3] Professor, Dept. of Computer Science & Technology, Sri Krishnadevaraya Univ., Anantapuramu, India
[4] HOD, Dept. of Computer Science, Vikrama Simhapuri Univ., Nellore, India

***Abstract*- The advancement in the Wireless sensor networks (WSN) technology and the applications of Internet of Things (IoT) has driven a great attention in industry as well as in our daily life. This paper focuses on the use of WSN in monitoring agriculture. It includes various features like water management monitoring, GPS based remote controlled monitoring, moisture, temperature sensing, and proper irrigation facilities. WSN technology enables the continuous monitoring of soil properties and environmental factors. Various sensor nodes are deployed at different locations in the farm. Monitoring of different agricultural parameters can be done by any remote device or internet services through interfacing of sensors, Wi-Fi, camera with microcontroller. Smart farming is an emerging concept, as IoT sensors are capable of developing data base about agriculture parameters. This paper aims in making use of evolving technology i.e. IoT and smart agriculture using automation. Monitoring environmental factors is the major aspect to improve the crop yield efficiently.**

***Keywords*: Agricultural environment monitoring, IoT, WI-Fi, Wireless sensor networks.**

I. INTRODUCTION

During recent days, with the migration of farmers from countryside to the towns and the rising of human costs put more emphasize on the intelligent system. The exploring of using wireless sensor system to keep an eye on the field is hot, during these years the complexity and the accuracy of the system have made great improvement. The technology of Internet of Things (IoT) continues the development of agricultural facilities. Mobile embedded systems such as the Internet of Things technology in modern agriculture are gradually widened. Using of wireless sensor networks can reduce the impact of human intervention and the farmland environment. Extensive use of automation, intelligent remote-controlled production equipment can obtain crop information. Through these, people who stay at home can monitor a variety of field information. This can achieve the scientific cultivation, scientific monitoring and production management and promote modern agriculture development pattern [1]. The Internet of Things (IoT) technology has been playing an important role in the modern Information technology. With the help of internet, local physical data can be uploaded to a specific website. People who get permission can visit it. With these functions, people can easily make monitoring and manage the things remotely. When specific to this system, a network can be designed, shows the data collected by the sensors system. It can technically be divided into two parts, one is monitoring, and the other is to control. In the monitoring part, upload the physical index in the field (such as temperature, moisture and sun light intensity etc.) to the internet [2]. Fig.1 shows the overall architecture diagram of the smart agriculture system using IoT.

The Design of Agriculture using Internet of Things (IoT)

The agricultural system based on the Internet of Things technology is divided into three layers:

1.perception layer,
2.transport layer and
3.application layer.

Perception layer is mainly responsible for data-aware acquisition; Transport layer is mainly responsible for the perception of data transmission; Application layer is mainly responsible for sensing data analysis, statistics, and early warning, automatic control and scientific decision-making

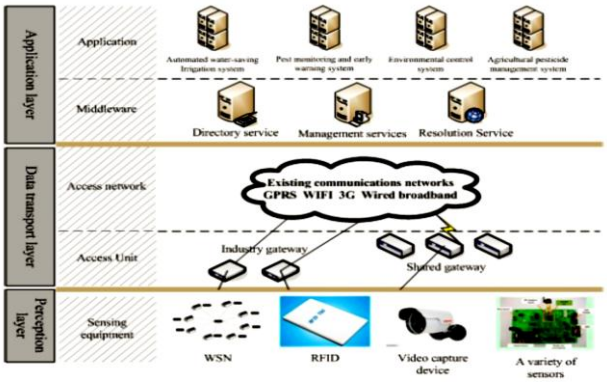

Fig. 1 The architecture diagram of smart agriculture system using IoT

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Wireless Sensor Networks

Wireless sensor networks include wireless sensor nodes, sink nodes, the routing node, the central base station, network data server and remote access node. Sensor node is responsible for the collection, a variety of soil and environmental parameters of the storage location. These parameters include air temperature, humidity, sun shine intensity, soil temperature, moisture, pH value. Sensor node sends data to the sink node through a variety of means of communication. Aggregation node is responsible for data collection, filtering and storage in wireless sensor clusters, and to communicate with the wireless routing nodes forward data timely.

Implementation of the IoT system for Agriculture Project

On the basis of the research of facility agricultural structure and key technologies, sensing technology, infinite communication technology, computer network technology, agricultural resources, database technology, Internet of Things technology were used to build management technology platform for agriculture. It develops intelligent, accurate scientific production management for the majority of cooperatives, growers, facilities and agricultural enterprises and other users. Developed science intelligent precision operation scheme can make reasonable use of resources; improves product yield and efficiency; and improve the quality of agricultural products so as to enhance the market competitiveness of industry standards and product.

Proposed IoT based remote monitoring system

The remote monitoring systems are promoting IoT solution working on WSN embedded with RFID technology. The system communicates with hardware and software automatically to send data in the farm. The solution is proven and can therefore be implemented from planting to harvest as a tool for appropriate irrigation tactic to improve crop yields. Besides, the WSN nodes can effectively collect data as well. Remote monitoring for irrigation and fertilising using WSN and RFID can ensure a good quality crop yield. In spite of the stressful environmental conditions, it increases the application efficiency of irrigation systems by 50%. The collaboration has been made with local farmer company that runs the herbaceous plants on a farm located in Ipoh, Perak. This collaboration facilitates research and development of this project, while helping the company to increase productivity and reduce operating costs. [3]

In this system, automatic irrigation systems are developed in the farm to collect the data from moisture sensors placed in the field. The farm will be monitored through the wireless sensor network that is integrated with the active RFID at the field. WSN will sense and monitor the environment like soil moisture and temperature. The nodes will be ready, immediately after their deployment in the required field. The systems proposed are very intelligent where the node always sleeps in standby mode. If the sensor senses soil in dry, the node will be activated to work in the mesh network between the other nodes to send ID to the reader. The end device of active RFID shown in Figure 2 is embedded with the sensor that represents wireless network sensor ID that works on Zigbee 2.4 GHz platform. The ID sent to the reader at the base station is used to recognise and allocate which nodes are sending data to the irrigation process automatically.

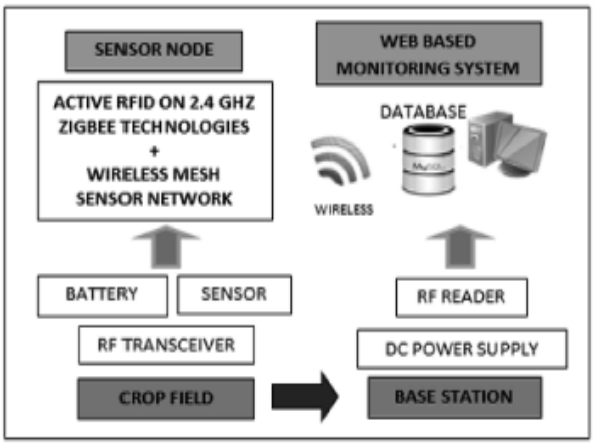

Fig. 2 An ID is received from the sensor node at the base station

From the data collected, it can be concluded that using the proposed system on the farm has its benefits. Water usage can be reduced approximately up to 50% when the embedded technology is used compared to the conventional method. In this system, the sprinkler will supply water when the moisture sensors give a signal with the right amount. Sensor in range 0-30% makes the sprinkler supply a large volume of water because the soil is in a dry state. Therefore, it needs a 100% amount of water. Meanwhile, when the sensor is in the range of 30-70%, the sprinkler will reduce water intake by 50% and supply an average volume of water to the soil. This range saves a whole sum of water. The sprinkler will stop the water supply when the moisture sensor sends data of about 85- 95%. In this condition, the soil is wet so there is no need for water to be supplied. Thus, farmers can reduce water consumption. The conventional method uses the same amount of water when it needs to irrigate every day. Over irrigation can cause the death of plants and production of farm to be affected badly. In particular, this can affect the revenue of farmers as well since water is wasted and over irrigation may cause damages to the plants. Besides that, the irrigation processes need a number of workers for the conventional method, as it is time consuming.

Major Applications of choosing WSNs:
The salient features of WSNs that have enabled as a potential tool for automation in the agricultural domain are highlighted as follows. [4]

(i) Intelligent decision making capability: WSNs are multi-hop in nature. In a large area, this feature enhances the energy efficiency of the overall network, and hence, the network lifetime increases. Using this feature, multiple sensor nodes collaborate among themselves, and collectively take the final decision.

(ii) Dynamic topology configuration:
To conserve the in-node battery power, a sensor node keeps itself in the 'sleep mode' most of the time. Using topology management techniques, the sensor nodes can collaboratively take these decisions. To maximize the network lifetime, the network topology is configured such that the minimum number of nodes remain in the active mode.

(iii) Fault-tolerance: One common challenge in deploying the WSNs is that the sensor nodes are fault-prone. Under such circumstances, unplanned deployment of nodes may lead to network partitioning, and in turn, the overall performance of the network is affected. However, in countermeasure, the sensor nodes can 'self-organize' by dynamically configuring the network topology

(iv)Context-awareness: Based on the sensed information about the physical and environmental parameters, the sensor nodes gain knowledge about the surrounding context. The decisions that the sensor nodes take thereafter are context-aware.

(v) Scalability: Generally, the WSN protocols are designed to be implemented in any network irrespective of its size and node count. This feature undoubtedly widens the potential of WSNs for numerous applications.

(vi)Node heterogeneity: WSNs are often assumed to be comprised of homogeneous sensor attached devices. However, in many realistic scenarios, the devices are heterogeneous in respect of processing and computation power, memory, sensing capability, transceiver unit, and movement capability.

(vii) Tolerance against communication failures in harsh environmental conditions: Due to the wide range of applications in open agricultural environments, WSNs suffer the effects of harsh environmental conditions The WSN protocol stack includes techniques to withstand the effect of communication failures in the network arising due to environmental effects.

(viii) Autonomous operating mode: An important feature of WSNs is their autonomous operating mode and adaptiveness. In agricultural applications, this feature certainly plays an important role, and enables an easy as well as advanced mode of operation.

(ix) Information security: The WSNs carry raw information about on-field parameters. To ensure the security of sensed information, WSNs provides access control mechanisms and anomaly detection to restrict unauthenticated users.

Potential applications in agriculture field:
Following are the possible agricultural applications which are implemented using WSNs.

1. Irrigation management system: Modern day agriculture requires an improved irrigation management system to optimize the water usage in farming. The alarming reduction of ground water level is another motivation for the requirement of an advanced system. In this context, micro-irrigation techniques are cost-effective and water-usage efficient. However, micro-irrigation efficiency can be further improved based on the environmental and soil information. In this regard, WSNs are applied as the coordinating technology.
2. Farming systems monitoring: Currently, various improved systems and devices are used in farming. Thus this improved system manages the devices and eases the overall operation, and enable automation in faming. Also, such remote monitoring systems help towards enabling improved management in large agricultural fields. Further, with the input of additional information such as satellite images and weather forecasts, the system performance can be improved.

3. Pest and disease control: Controlled usage of pesticides and fertilizers helps increasing the crop quality as well as minimizing the farming cost. However, for controlling the usage of pesticides, we need to monitor the probability and occurrence of pests in crops. To predict this, we also need the surrounding climate information such as temperature, humidity, and wind speed. A WSN can autonomously monitor and predict these events over a field of interest.

4. Controlling the usage of fertilizers: Plant growth and crop quality directly depend on the use of fertilizers. However, optimal supply of fertilizers to proper places in fields is a challenging task. The use of fertilizers for farming may be controlled by monitoring the variation in soil nutrients such as Nitrogen (N), Phosphorous (P), Potassium (K), and pH.

Consequently, soil nutrition balance may also be achieved, and hence, crop production quality is also maintained. Studied the effectiveness of mobile nodes to improve agricultural productivity in a smart system with a precision sprays.[6]

5. Cattle movement monitoring: A herd of cattle grazing a field can be monitored using WSN technology or Radio Frequency Identifier (RFID). Thus, real-time monitoring of any cattle is also achieved. This technology can be implemented further to monitor whether any cattle is moving near the vegetation fields or not.

6. Ground water quality monitoring: The increased use of fertilizers and pesticides lead to decrease in the quality of ground water. Placing sensor nodes empowered with wireless communication help in monitoring the water quality.

7. Greenhouse gases monitoring: Greenhouse gases and agriculture are closely related to each other. Green house gases are responsible for increasing the climate temperature, and have direct impact on agriculture. On the other hand, greenhouse gas emission comes from various agricultural sources.

8.Smart farming: Smart farming is targeted to generate greater productivity with reduced costs. Wireless ad-hoc and sensor networks are utilized in precision farming to gather field data which can then be analyzed to find the best farming conditions.

IoT Cloud

IoT makes it possible as the ability to transfer data over a network without requiring any human interaction To-human or human-to-machine. The architecture of the Internet of the objects relies mainly on 4 processes allowing to collect, to store, to transmit and to treat data from the physical world. The role of the different processes presented is described as follows:

• Collection of data: refers to the action of transforming an analog physical magnitude into a digital signal.

• Interconnect: allow you to interface a specialized object network with a standard IP network (e.g. Wi-Fi) or consumer devices.

• Store: qualifies the aggregation of raw data, produced in real time, meta tagged, arriving in an unpredictable way.

• Finally, presenting indicates the ability to restore information in a way that is understandable to humans, while offering a means of acting and / or interacting

Summary

It is a trend to use information technology to lead the development of modern agriculture. It has an important meaning for overcoming the bottleneck of resources and the environment of the agricultural development, transforming agricultural development, and enhancing the competitiveness of agriculture. As a comprehensive application of technology in different disciplines, facility agricultural based on Internet of Things technology integrates a variety of technologies such as sensor, automation, communications, computer and plant sciences. It can be predicted that facility agricultural will have a rapid development in the promotion of agricultural machinery, sensors, information and communications and cloud computing technologies. It will play a major role to improve the overall efficiency of agriculture, promote the upgrade of modern agricultural transformation [7]. This concept is created as a product and given to the farmer's welfare.

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