A Survey on Smart Agriculture using Internet of Things

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***Abstract*:- Agriculture is the broadest economic sector and plays an important role in the overall economic development of a nation. Traditional way of agriculture results in low yielding of crops due to many factors. Hence, Smart agriculture helps in increasing the productivity and solving issues caused due to the critical environmental factors. Smart agriculture is an automated technology using the Internet of Things. Different implementation methods have been proposed for this purpose. This paper provides a brief look about the various techniques for implementing smart agriculture and each method is discussed elaborately.**

Keywords: Internet of Things, Smart objects, RFID, ZigBee.

INTRODUCTION

Agriculture is the basic necessity for humans to survive as it is the main source of food grains and other raw materials. It plays a vital role in the economic growth of our country. Traditional method of agriculture results in low yielding of crops due to some environmental conditions such as critical temperature, humidity and soil moisture. Hence it is necessary to modernize the agriculture by implementing Internet of Things (IoT) which increases the productivity. Smart agriculture is a technique of implementing Internet of Things in agriculture to solve many issues. Internet of Things is the integration of sensors and other devices connected to the internet through a wired or wireless medium for communication. IoT consists of things that are connected anytime, anywhere which enables remote access of resources. In the concept of Internet of Things every object is connected with each other through a unique identifier so that it can transfer data over the network without involving human to the human interaction. Each object in the IoT has three capabilities such as awareness, representation, and interaction. Awareness is the ability of the smart objects to understand and sense other objects. Representation is the ability of the objects to present according to the programming concept. Interaction is the ability to communicate with each other. Internet of Things consists of the sensing layer, the access layer, the network layer, the middleware layer and application layers. Internet of Things has four main steps such as information collection, two-way transmission, treatment and feedback control. The key agent of IoT is RFID (Radio Frequency Identification). Every object in IoT is addressable, recognizable, readable and locatable through the internet by using RFID. ZigBee is a short-range, low-rate wireless technology used for communication over the network.

RELATED WORK

Smart agriculture can be implemented using various methods. Various techniques are discussed in this section. Each technique uses different

processors, platform, architecture and communication modules having its own advantages and applications. Based on the necessity a technique can be used to facilitate the farmers. The sensors deployed in the field collect the real time data and send it to the server. The data is processed and the recommendations are sent to the farmer as a message.

A. The Applications of WiFi-based Wireless Sensor Network in Internet of Things and Smart Grid

The authors collaborates the technique of WiFi based wireless sensor network in Internet of Things and smart grid to maximize the bandwidth. The features of WiFi-based Wireless Sensor Network (WSN) are higher bandwidth and data rate, non-line-transmission ability, large-scale data collection and it is highly cost-effective [1].

Smart Grid plays a vital role in smart power generation, intelligent transmission, substation and intelligent power use. The authors aims at collecting the real-time information through the sensors and providing suggestions to the farmer such as temperature, humidity, wind, air station, rainfall, soil moisture, soil compaction, soil conductivity, pH value, soil nitrogen.
The advantage of the WiFi-based Wireless Sensor Network (WSN) is it can be used in applications which require video monitoring data.

B. The study and application of the IoT technology in agriculture

The authors aim at developing software for monitoring the fields. The critical temperature, humidity and soil signals gathered from the sensors are transmitted by a wireless network through the M2M (Machine to Machine) platform. The software design includes user interface module, network communication module, data collection module and data processing module [2].

The temperature sensor directly turns the temperature signal to digital signal which is read by the MCU (Micro

Control Unit). Humidity sensor gathers the analog signal from the fields but MCU cannot read analog signal hence AD convertors are used to convert the analog signals to digital signals. These processed data are displayed by the LCD screen.

The advantage of this technique is high performance and it is user friendly.

C. Smart agriculture based on cloud computing and Internet of Things

The authors make use of Internet of Things; Cloud computing, Visualization and SOA technology that monitors the plant factory for agriculture modernization and to enhance the productivity of crops. Cloud computing based on internet enables computer and other resources to access the shared hardware and software. The cloud platform involves four layers namely physical layer, resource pool layer, management and middleware layer and SOA construction layer. The advantage of cloud computing is the end user do not need to have a professional knowledge about cloud. Internet of things enables remote access of resources. It consists of three layers namely sensing layer, delivery layer and control layer [3].

Hardware resources are integrated by visualizing technology to achieve dynamic distribution of resources and load balancing. This scheme involves management of cloud computing customization application and processing these services, organizing and coordinating service nodes in data center. This technology includes tracing and controlling farm security. It takes record of quality and security related information in logistics process.

The advantage of this scheme is crop management, estimation of productivity effect and management measures.

D. Relevance of Internet of Things in Animal stocks chain management in Pakistan's Perspective

The authors discuss the significant role of Internet of Things in emerging technologies, especially in the animal product application. It ensures people's food quality by controlling the food diseases. It also aims to provide agricultural Product Supply Chain Management (APSCM).

APSCM is a network structure that is based on logistics, information flow and capital flow. It is based on two technologies namely EPC and RFID. Each product is labeled with an EPC code stored in electronic tags which is used to recognize the product in real time scenario. Here, EPC is used to trace the product activities and to boost the integrity of APSCM. RFID is used to read these tags and to monitor the existence of the product. It then transfers the data to the middleware for further processing. RFID and network database are used to integrate all types of production.

The advantage of this paper [4] is to increase the communication technologies in order to connect the things into objects anywhere, anytime and any media.

E. Managing the upcoming ubiquitous computing

The authors aim to prevent the network that is being flooded by the uncharacterized traffic. It consists of three domains namely system monitoring and management, ubiquitous computing and cognitive radio. System monitoring and management uses tools to measure, monitor and manage the complex system to achieve better quality [5].

By identifying the internal mechanism of the system, the tool improves the global behavior. This system is managed and monitored by the common cycle which measures and observes the data, then analyze the data to build a new set of knowledge, and take a decision. This paper also describes about ubiquitous computing that make use of WSAN, which contains objects giving intelligence to the environment, and RFID which identifies the basic objects in WSAN that offers a new solution for a variety of areas from environmental monitoring, to smart museum. The function of a cognitive software defined radio (SDR) is also mentioned. Here the radio signals are processed by the software running on CPU.

F. An expert system for seedling weeds identification in cereals

The author develops a knowledge based system used for decision making process. It identifies the problem and informs the end user or farmer to take the corresponding action. It collects data from different weed seeds and prepares a data sheet with 11 characters which is treated as primary key for managing records [6].

These data are stored in the knowledge base. It includes several phases that consist of problem selection, knowledge acquisition, knowledge representation, program testing and evaluation. It also makes use of IF-THEN-ELSE rules. The transactional data are fed into the database which is then converted into facts and rules. And this system also contains a user interface based on GUI (Graphical User Interface). Major activities of the system are collecting the weed seed information for processing, search query, weed thumbnail which is used to identify the seed characteristics.

This system helps to organize and synthesize knowledge and information of different types.

G. Expert System Model for Identification Pests and Diseases of Forest Tree

The authors developed an expert system that is used for identification, recognition and forest management. It includes two methods such as inference method, and several alternative of certainty and uncertainty method. A

knowledge base is also developed. A Graphical User Interface (GUI) is designed for user interactions. The expert system typically comprises of two essential components, including a knowledge base that captures the domain-specific knowledge and an inference engine consisting of algorithms for manipulating the knowledge represented in the knowledge base. It also consists of consultation and development sides. The consultation side provided consultation interface to end-user for to do consultation with the expert system, inference engine, certainty and uncertainty method and temporary results. The development side has two users that interacts with the expert system namely the expert system and a knowledge engineer [7].

The knowledge base of the expert System is used for the identification of several forest tree plantations that describes a relational database which includes the information of trees, symptoms, pests, diseases, control activities and set of rules. The inference engine mainly involves two approach, namely forward chaining and backward chaining. Finally, the system user interface consists of two interfaces namely consultation interface and development interface. The consultation interface is used by the end-user to get solutions or answers from a problems or questions. The development interface is used by an expert and knowledge engineer for developing activities including adding rules, knowledge base and knowledge refinement.
The advantage of this system is to identify the pests and disease that affects the crops.

H. Integrating RFID and smart objects into a unified Internet of Things architecture

The authors integrate the concepts of RFID and smart objects with IoT to cover the whole service lifecycle for the application provided. This paper aims at overcoming current issues regarding architectural models by analyzing the layered lightweight and open middleware. RFID provides information regarding the tagged object by browsing an internet address for that object. IoT is the combination of smart objects. Smart objects provide data about themselves and their environment. Smart objects carry chunks of application logic to provide logic and to enable interaction among humans and other nearby objects. Smart objects can track the entire existence of an object from the time before it was made. Smart objects have dual nature [8].

On the one hand, it participates to a worldwide infrastructure of networked things. On the other hand, it is described by its: social representation. The implementation issues regarding this paper are middleware solution. This author describes about the service lifecycle involving the following steps such as Service composition environment including wizards and semantic language backend, Transformation which provides tailored service, Dynamic deployment of these services into IoT building blocks. The RFID is restricted by the RFID tags and readers.

The disadvantage is the smart object is applicable only to the objects supporting complex functionalities which limit the scope of IoT. The author in future aims to provide an infrastructure in terms of scalability, adaptability and performance maximization.

I. Research on key technology and applications for Internet of Things

The authors discuss the importance of IoT and RFID in this paper. Internet of Things achieves interconnection of all things anywhere, anytime with accurate control and reliable transmission. Various layers are 1. Access Layer: To transfer information from sensing layer to network layer 2.Network Layer: To integrate the information resources of the network 3.Middleware Layer: To manage and control real-time information 4.Application Layer: To integrate the function of the bottom system. In this paper, RFID technology is used for machine recognition of enemy aircraft. It can also be used for production management, transportation, high confidentiality and high reliability of RFID devices. Antenna technology is the key feature of RFID [9].

Electronic Product Code (EPC) is used to construct real time network sharing information. EPC consists of EPC encoding, PML, ONS Server, readers, EPC tags and Internet. ZigBee includes three main areas: Hardware platforms, Network

communication protocol and Information processing technology. This technique can be mainly used in industrial controls, home automation, digital agriculture and medical monitoring.

J. A web based Tomato Crop Expert Information system based on artificial intelligence and Machine Learning Algorithms

The authors develop an expert system based on artificial intelligence and machine learning to monitor the tomato crops. Using this tomato crop expert advisory system the user can get static information about different diseases, symptoms, chemical controls, preventions of the tomato crop. The user should interact with the expert system online and has to answer the questions asked by the expert system. Depending upon the response the system displays its control measures. This system uses ID3 algorithm and some optimization algorithm for providing the results. It is the web based Expert System and the program is divided into two parts namely Information System and Advisory System [10].

Based upon the symptoms collected as data the ID3 algorithm validates the information and displays the result to the user by using Rule based system or Optimization algorithm. ID3 algorithm generates a decision tree from the collected data.

This system provides Horticulture related advices and facilitates by providing recommendations without the need of experts.

K. Expert System to Detect and Diagnose the Leaf Diseases of Cereals

The authors design an expert system which is an intelligent computer programs that offers solutions related to specific problems in a given domain. Expert system reduces the information that the users need to process, reduce personnel costs and increase output. A method is designed where abnormalities are automatically identified, which reduces the risk of human error. This could be achieved through an image processing component with a diagnostic problem solver. Image processing is a powerful tool that accepts images as an input and it produces the output. Automatic knowledge acquisition system of Pulse Expert provides user-friendly interface to the domain experts for entering, storing and structuring the domain specific knowledge. Identification of plant diseases is the task that is handled by plant pathologists. The farmers are not capable to identify the leaf diseases of the cereals. They can recognize the common disease symptoms. This expert system is a database, which stores all the information of the leaf diseases of rice. This software provides the facilities to identify the disease and to suggest the remedy conveniently. Edge detection is a fundamental tool in image processing, machine vision and computer vision [11].

The main purpose of detecting sharp changes in image brightness is to capture important events. In the proposed expert system, pixel by pixel comparison algorithm has been implied to compare two images of the leaf disease of a cereal. The image of the infected cereal plant is compared with the images stored in the database. Non-experts find it difficult to identify the symptoms of the diseases. The non- experts are always dependent on experts for the right information regarding the leaf diseases of cereals. The disadvantage is some diseases have similar symptoms making it difficult for the non-experts as well as experts to identify the disease correctly and to specify the right remedy. This will greatly reduce the losses happened to the crop as they get the required information on time.

The advantage is web based expert system can be accessed from any web enabled computer at any time.

L. *A framework of an expert system for crop pest and disease management*

The authors discuss the major issues faced by farmers due to pest and disease. Rule based system is the most common methodology used to manage the crop pest and disease. Rule based system uses IF-THEN rules. Two modes of rule based system are forward chaining and backward chaining. Knowledge based system is an extension concept derived from the rule based system. Knowledge based system is implemented for crop pest and disease management. Fuzzy expert system is also used where it has to attain values between 0 and 1.

The basic components established are knowledge base, inference mechanism, knowledge acquisition and user interface. After acquiring the required knowledge, the knowledge will be used for constructing the knowledge base. The knowledge is stored in textual format. Five modules are suggested for implementation in the proposed framework contains five modules that are crop's information module, user input module, diagnose module, treatment module and result module. The diagnosis module is the main operation of the expert system. This module is interconnected with the inference engine which integrates the working memory, rule based and fuzzy expert system. An Expert system has the advantage of speeding up pest and disease diagnosis. The knowledge attained from this proposed framework, help researchers to highlight issues in the agriculture domain [12].

In future in author aims for the development of an expert system pertaining to the agriculture domain

CONCLUSION

Agriculture if implemented with Internet of Things can minimize the losses. WSN are used in video monitoring data and it provides higher bandwidth, but WSN is less secured. Collecting data from sensors and processing with MCU, is relatively slow. Integrating smart objects and RFID is another widely used method, but the smart object is applicable only to the objects supporting complex functionalities which limit the scope of IoT. Usage of knowledge based expert system makes decision using the inference engine but the disadvantage is that it works only with a narrow domain of knowledge. The issues met are bandwidth, performance, and video monitoring of data. ZigBee communication module is low cost, reliable and a self-healing one. Security is the major issue addressed by using the ZigBee module.

REFERENCE

[1] Li, Li, Hu Xiaoguang, Chen Ke, and He Ketai. "The applications of WiFi-based wireless sensor network in internet of things and smart grid." In Industrial Electronics and Applications ICIEA, 2011 6th IEEE Conference on, pp. 789-793. IEEE, 2011.

[2] Zhao, Ji-chun, Jun-feng Zhang, Yu Feng, and Jian-xin Guo. "The study and application of the IOT technology in agriculture." In Computer Science and Information Technology ICCSIT, 2010 3rd IEEE International Conference on, vol. 2, pp. 462-465. IEEE, 2010.

[3] TongKe, Fan. "Smart Agriculture Based on Cloud Computing and IOT." Journal of Convergence Information Technology 8, no. 2 ,2013.

[4] Talpur, Mir Sajjad Hussain, Murtaza Hussain Shaikh, and Hira Sajjad Talpur. "Relevance of Internet of Things in Animal Stocks Chain Management in Pakistan's Perspectives." International Journal of Information and Education Technology 2, no. 1 ,2012.

pp. Carvin, Denis, Philippe Owezarski, and Pascal Berthou. "Managing the upcoming ubiquitous computing." In Proceedings of the 8th International Conference on Network and Service Management, 1276-280. International Federation for Information Processing.

[6] Gonzalez-Andujar, J.L., C.Fernandez-Quintanilla, J. Izquierdo, and J. M. Urbano. "SIMCE: An expert system for seedling weed

identification in cereals." Computers and electronics in agriculture,Vol. 54, no. 2 ,pp.115-123,2006.

[7] Andri Pranolo, Siti Muslimah Widyastuti and Azhari, " Expert System Model for Identification Pests and Diseases of Forest Tree Plantations", Int. J. Advance Soft Compu. Appl, Vol. 9, No. 2, July 2017 .

[8] Evangelos A, Kosmatos, Tselikas Nikolaos D, and Boucouvalas Anthony C. "Integrating RFIDs and smart objects into a Unified Internet of Things architecture." Advances in Internet of Things 2011 ,2011.

[9] Chen, Xian-Yi, and Zhi-Gang Jin. "Research on key technology and applications for internet of things." Physics Procedia 33, pp. 561-566, 2011.

[10] Babu, MS Prasad. "A web based tomato crop expert information system based on artificial intelligence and machine learning algorithms." ,2010.

[11] Kaura, Ramanjeet, Salam Dina, and P. P. S. Pannub. "Expert System to Detect and Diagnose the Leaf Diseases of Cereals." International Journal of Current Engineering and Technology , Vol. 3, no. 4 , 2013.

[12] Kamarudin Shafinah, Noraidah Sahari, Riza Sulaiman, Mohd Soyapi Sohd Yusoff and Mohammad Mohd Ikram " A framework of an expert system for crop pest and disease management" Journal of Theoretical and Applied Information Technology , 2013. vol. 58 no.1.