Agricultural Crop Monitoring using IOT- A Study

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Abstract— The Internet of things (IOT) is remodeling the agriculture enabling the farmers with the wide range of techniques such as precision and sustainable agriculture to face challenges in the field. IOT technology helps in collecting information about conditions like weather, moisture, temperature and fertility of soil, Crop online monitoring enables detection of weed, level of water, pest detection, animal intrusion in to the field, crop growth, agriculture. IOT leverages farmers to get connected to his farm from anywhere and anytime. Wireless sensor networks are used for monitoring the farm conditions and micro controllers are used to control and automate the farm processes. To view remotely the conditions in the form of image and video, wireless cameras have been used. A smart phone empowers farmer to keep updated with the ongoing conditions of his agricultural land using IOT at any time and any part of the world. IOT technology can reduce the cost and enhance the productivity of traditional farming.

Keywords*—component, formatting, style, styling, insert *(key words)

I. INTRODUCTION

In 1995, "thing to thing" was coined by BILL GATES. In 1999, IoT (Internet of Things) was come up by EPC global. IOT interconnects human to thing, thing to thing and human to human. The goal of IoT is bring out a huge network by combining different types connected devices. IoT targets three aspects Communication, automation, cost saving in a system. IOT empowers people to carry out routine activities using internet and thus saves time and cost making them more productive. IOT enables the objects to be sensed and/or controlled remotely across existing network model. IOT in environmental monitoring helps to know about the air and water quality, temperature and conditions of the soil, and also monitor the intrusion of animals in to the field. IOT can also play a significant role in precision farming to enhance the productivity of the farm.

II. LITERATURE SURVEY

Balaji Banu [1] designed a wireless sensor networks to observe the conditions of the farming and increasing the crop yield and quality. Sensors are used to monitor different conditions of environment like water level, humidity, temperature etc., The processors ATMEGA8535 and IC-S8817 BS, analog to digital conversion and wireless sensor nodes with wireless transceiver module based on Zig bee protocol are used in the designing the system. Database and web application is used to retrieve and store data. In this experiment the sensor node failure and energy efficiency are managed.

Liu Dan [2], Joseph Haule, Kisangiri Michael [3] and Wang Weihong, Cao Shuntian [38] carried out experiments on intelligent agriculture greenhouse monitoring system based on ZigBee technology. The system performs data acquisition, processing, transmission and reception functions. The aim of their experiments is to realize greenhouse environment system, where the of system efficiency to manage the environment area and reduce the money and farming cost and also save energy. IOT technology here is based on the B-S structure and cc2530 used like processing chip to work for wireless sensor node and coordinator. The gateway has Linux operating system and cortex A8 processor act as core. Overall the design realizes remote intelligent monitoring and control of greenhouse and also replaces the traditional wired technology to wireless, also reduces manpower cost.

Joseph haule [3], Dragoş Mihai Ofrim, Bogdan Alexandru Ofrim and Dragoş Ioan Săcăleanu [18] have proposed an experiment that explains the use of wsn used in automating irrigation. Irrigation control and rescheduling based on wsn are powerful solutions for optimum water management through automatic communication to know the soil moisture conditions of irrigation design. The process used here is to determine the proper frequency and time of watering are important to ensure the efficient use of water, high quality of crop detection delay throughput and load. Simulation is done for agriculture by OPNET. Another design of wsn is deployed for irrigation system using Zig bee protocol which will impact battery life. There are some drawbacks as wsn is still under development stage with unreliable communication times, fragile, power consumption and communication can be lost in agricultural field. so automate irrigation system and scheduling based on wireless sensor networks are used. WSN uses low power and a low data rate and hence energy efficient technology. All the devices and machines controlled with the help of inputs received via sensors which are mixed with soil. Farmers can analyze whether the system performs in normally or some actions are need to be performed.

Vijay Kumar [4], Lin Zhang, Min yuan, Deyi Tai, Xia Oweixu, Xiang Zhan, Yuanyuan Zhang [13] studied the work of rural farming community that replaces some of the traditional techniques. The sensor nodes have several external sensors namely leaf wetness, soil moisture sensor, soil pH, atmospheric pressure sensors attached to it. Based on the soil moisture sensor the mote triggers the water sprinkling during the period of water scarcity and switches off after adequate water is sprinkled. This results in water conservation and soil pH is sent to the base station and in turn base station intimates the farmer about soil pH via SMS using GSM model. This information helps the farmers to reduce quantity of fertilizers used. A development of rice crop monitoring using WSN is proposed to provide a helping hand to farmers in real time monitoring and increasing the rice production. The automated control of water sprinkling and ultimate supply of information is implemented using wireless sensor network.

G. Nisha [5], Chun-ling Fan, Yuan Guo [10] proposed a wireless sensor based automated irrigation system to optimize water use for agricultural purpose. The system consists of distributed wireless sensor network of soil moisture, and temperature sensors mounted in the crop field. Zigbee protocol is used to handle the sensor information and water quantity programming using algorithm with threshold values of the sensors sent to a micro controller for irrigation system. Data inspection is done using by using solar panel and cellular internet interface. A wireless camera is fixed in crop field to monitor the disease area using image processing technique.

Meng Ji-hua [6] conducted a research on growth of cereal crop seedlings, as well as the status and trend of their growth. This paper introduced the design, methods used and implementation of a global crop growth monitoring system, which satisfies the need of the global crop monitoring in the world. The system uses two methods of monitoring, which are real-time crop growth monitoring and crop growing process monitoring. Real-time crop growth monitoring could get the crop growing status for certain period by comparing the remote sensed data (NDVI, for example) of the period with the data of the period in the history (last year, mostly). The differential result was classified into several categories to reflect the condition at difference level of crop growing. In this system, both real-time crop growth monitoring and crop growing process monitoring are carried out at three scales, which are state (province) scale, country scale and continent scale. Global crop growth monitoring system was found in this design and built a system that can monitor the global crop growth with remote sensing data. The system showed the characteristics of fast, effective, high credibility and operational in its run.

Alan Main-waring [7], A. Sivasankari, S. Gandhimathi [36] have provided an in-depth study of applying wireless sensor networks to real-world habitat monitoring. A set of system design requirements are developed that cover the hardware design of the nodes, the design of the sensor network, and the capabilities for remote data access and management. To evaluate this implementation, have deployed an initial prototype network at the James San Jacinto Mountains Reserve (JMR) in Idyllwild, California. JMR is a 29-acre ecological preserve, representing just one of the University of California System Natural Reserve System's 34 land holdings. JMR climate is different from GD and weather changes can exists for long time. The data collection can be made easy from previously inaccessible using a micro-measurement scale.

Lei Xiao [8] Fiona Edwards Murphy, Emanuel Popovici, Ṕadraig Whelan, and Michele Magno [21] Proposed agriculture monitoring system using wireless sensor network (WSN). The conditions can be monitored in real time are temperature, light intensity, and humidity. The experiment involves the hardware and software design of the built modules, network topology and network communication protocol with the challenges. Design explains how the node can achieve agricultural condition information collection and transmission. The system is compact in frame work, light weight, good in performance and operation. It improves the agricultural production efficiency automatically.

Ling-ling LI [9], Wen-Yao Zhuang, Miguel Costa Junior, Pedro Cheong, Kam-Weng Tam [12] have proposed system uses ZigBee technology. This research deals with hardware and the software of the network coordinator node and the sensor nodes. The theoretical and practical results show that the system can efficiently capture greenhouse environmental parameters, including temperature, humidity, and carbon dioxide concentration and also clears the normal communication between nodes and the network coordinator, good network stability. The implementation explored values used in the complex greenhouse environmental monitoring

Fu Bing [11], V.Sandeep, K. Lalith Gopal, S. Naveen, A.Amudhan, L. S. Kumar [23] have proposed the transition from precision agriculture to modern agriculture in China. The agriculture intelligent system was based on IOT which is introduced for organic melons and fruits production and quality. Many of the technologies were used in the system, such as RFID, sensors and etc., The system contains three platforms to monitor agriculture and fruits. The intelligence agricultural system based on internet has been applied to the melon and fruit production, it plays a role which is not only that the farmers have lesser working hours, but also to improve the ability to save costs, improve the quality of fruits.

Yunseop Kim [14], R. Balamurali, K. Kathiravan [15] have proposed the design for wireless sensor network (WSN) for a water irrigation control and monitoring that is composed of a number of sensor nodes with a networking capability that is deployed for an ad-hoc for the purpose of ongoing monitoring. The parameters used in the water reservation control are water levels and motor movement of the gate controlling the flow of water which is measured by the sensors, which will sense the condition and forward it to base station or control room. This proposed system offers a low power consumption with high reliability based on the result. The use of high power WSN is suitable for tasks in industries involving huge area monitoring like manufacturing, mining constructing, etc., The system discussed here is very easy to install and the base station can be placed at the local residence close to the area of monitoring where a person requires minimal training at the beginning of the system installation.

Giuseppe Anastasi [16] designed a WSN-based system to monitor the productive cycle of high-quality wine in a sicilian winery. This project aimed to ensure overall good quality of the production. The design incorporates accurate planning in field, the stored product preservation. Wireless Sensor Networks are deployed as the sensing infrastructure of distributed system to control prototype productive chain, nodes have been deployed both in the field and in the cellar, where wine aging is produced. The data is collected at a main unit in order to process inferences that suggest timely interventions that preserve the grapes quality.

Rwan Mahmoud [17], Chen XianYi, Jin Zhi Gang, Yang Xiong [33] describes the security issues of Internet of Things which are directly related to the wide application of the system. Beginning with the architecture and features of IOT, expands many security issues that exist in three layered architectures, and came up with solutions to the issues. The safety measures concerned with it, the ones about perception layer are particularly viewed, including algorithm and key management, security routing protocol and data fusion technology, as well as authentication and access control, etc.

Dragoş Mihai Ofrim [18], Zulhani Rasin, Hizzi Hamzah Mohd, Shahrieel Mohd Aras [24] designed an improved system for environmental monitoring and controlling in terms of efficiency, flexibility and performance. Some parameters that have been taken into consideration are resolution, accuracy, acquisition rate, energy consumption, flexibility etc., The designed system allows multi-point monitoring at any location, without any need of wired connection and have intelligent sensors. The measuring point density offers high accurate data even from the remote locations. A split is created, in terms of physical connection, between the measuring, monitoring and control parts, making the system extremely flexible. The disadvantage of this system is regarding power consumption, which is a key factor of wireless sensor networks. Therefore, the sensor nodes require a good resource management in network. This paper uses Zig bee protocol. Improvements and further developments of this system predicts: alternative energy resources, algorithms for energy saving, increased connectivity and reduced traffic. To monitor the parameters from a greater distance, this system could be supplied with GSM or Wi-Fi transmitters, to be able to transfer the information through existing telecommunication networks.

Rachel Cardell-Oliver [19] described the design and implementation of a reactive event driven network for environmental monitoring of soil moisture and evaluates the effectiveness of this solution. A novel feature is to create a solution is its reactivity to the environment: when rain falls and soil moisture is changing rapidly, measurements are collected frequently, whereas during dry periods between rainfall event measurements are collected much less often. Reactivity allows to focus on dynamic responses and limit the amount of useless data gathered, as well as improving robustness and network lifetime. The main aim of this experiment is to demonstrate a reactive sensor network that can deliver useful data on soil moisture responses to rainfall. The Pin-jar network meets the goal of providing useful data on dynamic responses of soil moisture to rainfall. Future work will focus on addressing the limitations of the current prototype in robustness of packet delivery and network longevity, and in guaranteeing network response to events of interest. Authors plan to generalize event-condition-action framework for programming reactive sensor networks.

Duan Yan-e [20] explained the agricultural information technology (AIT) widely applied to every part of agriculture and is going to become the most efficient means and tools for enhancing agricultural production and for making use of complete agricultural resources. Agriculture Information Management affects the range of agricultural information and efficiency of agricultural production. In this experiment, on the count of introducing the concept of agricultural information management and analyzing some of the features of agricultural data, the design method and architecture of Intelligent Agriculture MIS was designed in detail, finally, the proposal gives an implementation illustration of system in agricultural production.

Fiona Edwards Murphy [21] proposed system uses Wireless Sensor Network (WSN) technology to monitor a honeybee colony and collect information about activity within a beehive as well as its surrounding area. The project uses low power WSN technologies, including novel sensing techniques, energy neutral operation, and multi radio communications including cloud computing to monitor the conditions within the colony. WSN is modern new technology, it is a important concept of the Internet of Things. A complete solution is presented including a smart hive communication with data aggregation and visualization tools. Future work will focus on improving the energy performance of the system, introducing a more specialized set of sensors, implementing a machine learning algorithm to extract meaning from the data without human supervision; and securing additional deployments of the system.

P. Tirelli, N.A. Borghese [22] found that monitoring pest insect population is currently a issue in crop protection. The system here is currently based on a distributed imaging device operated via a wireless sensor network that is able to automatically capture and transmit images of trapped areas to a remote host station. The station validates the density of insect evolution at different farm locations and produces an alarm when insect density goes over threshold. The client nodes are spread in the fields, which act as monitoring stations. The master node coordinates the network and retrieves captured images from the client nodes. During a monitoring period of four weeks the network operating regularly, predicts a pest insects' population curve correlated to daily evaluation obtained by visual observations of the trap and hence the feasibility is determined.

Nguyen Tang Kha Duy [24], K.Sathish Kannan and G.Thilagavathi [35] found a versatile solution in an effort of improving the accuracy in monitoring the environmental conditions and reducing human power for industrial household's shrimp farming. The component is capable of collecting, analyzing and presenting data on a Graphical User Interface (GUI), programmed with Lab VIEW. The proposed system saves the cost of hiring labor as well as the electricity usage. The system design proposes a versatile, low-cost, and commercial version which will function best for small to medium size farming operations as it does not require any renovation or reconstruction of the pond. This method is updating the sensor information and reflecting the real factors of environmental shrimp fanning. At present this system also provides many options which are user friendly allowing the updates to farmer with all the necessary farming factors resulting in good production. The system has high scalability for households or farming businesses on a large scale. Authors proceeds to test the reliability of the system in real life applications.

Zulhani Rasin [25], Wang Weighing and Cao Shuntian [39] presented a remote intelligent monitoring system (RIMS) based on ZIGBEE Wireless Sensor Network (WSN). In RIMS data is transmitted to the controlling center through ZIGBEE Mesh Network and the remote control will be available. The redundancy router nodes are designed to improve the transmitting reliability. This paper uses the wireless mesh network instead of placing the cables in the field, to avoid cable problems and deployment. Except the wireless central receiver, the system will keep on working as usual in case of failure of any node.

R. Balamurali [26], Narut Soontranon, Panwadee Tangpattanakul, Panu Srestasathiern, Preesan Rakwatin [32], Chen XianYi, Jin Zhi Gang, Yang Xiong [33] have discussed precision agriculture for real-time monitoring of environmental conditions of a farm like temperature, humidity, soil PH etc. The values of monitored parameters are communicated to the remote server in order to take appropriate action, instead an actuator or an automated system can also be used to take appropriate action based on the measured parameters over a period of time. This paper analyzes the various routing protocols like AOMDV, AODV DSR and Integrated MAC and Routing protocol (IMR) for precision agriculture using WSN. This analysis draws conclusions that Integrated MAC and Routing Algorithm is best suitable for multi-hop routing for precision agriculture using Wireless Sensor Network (WSN) in-terms of Network life time. The network lifetime is considered as the time at which the first node in the WSN dies. The work may be enhanced to analyze other network parameters like throughput and end-end delay.

Sonal Verma [27], Chen XianYi, Jin Zhi Gang, Yang Xiong [33], A. Sivasankari and S. Gandhimathi [36] have experimented the potential utility of an inexpensive camera observation system called crop phonology recording system which is as an alternative approach for the observation of crop growth condition. The design explored the availability of day time exposure values recorded in the header region of EXIF-formatted JPEG files by RGB and NIR-cameras and proposed using vegetation indices, ev-NDVI, ev-SR, and ev-CIgreen, which were calculated from the combination of daytime exposure values and cDN. The study found that ev-VARI worked the best for maize and ev-CIgreen for soybeans when estimating green LAI. ev-VARI was also the best in estimating green leaf biomass in maize and NRBINIR in soybean. This camera-based vegetation index has possibility to estimate a wide variety bio-physical parameters, a choice for high-frequency observations at many locations of vegetation.

Elias Yaacoub [28], K.Sathish Kannan, G.Thilagavathi [34] proposed the deployment of a wireless sensor network to monitor and analyze air quality in Doha. Data stored on the server is subjected to intelligent processing and analysis in order to present it in different formats for different categories of end users. This experiment brings out a user-friendly computation of an air quality index to disseminate the data to the general public and also the data presentation for environmental experts using dedicated software tools, for example- the R software system and its Open-air package. Depending on the target end-user the stored data can be accessed and displayed in different formats.

Jinhu Liao [30], Chen XianYi, Jin Zhi Gang, Yang Xiong [37], Weimin Qiu, Linxi Dong, Haixia Yan, Fei Wang [38] have proposed a remote monitoring system, which can monitor agricultural land in real time and makes good decisions. The system collects data from a farm by using Zig Bee modules, which makes data fused by using high performance controller ARM micro controller and transfers the data to a remote computer by using GPRS modules to take an informed management decisions by using computer. This is not only a solution to improve the level of agricultural production, but also to reduce human the costs very effectively.

Nelson Sales [31] experimented with interconnection of smart objects embedded with sensors that enabled them to interact with the environment and among themselves, forming a Wireless Sensor Network (WSN). These network nodes perform acquisition, collection and analysis of data, such as temperature and soil moisture. This type of data can be applied to automate the irrigation process in agriculture for decreasing the water consumption, which would result in monetary and environmental benefits. Authors proposed to use cloud computing which has the high storage and processing capabilities, the rapid elasticity and pay-per-use characteristics makes an attractive solution to the provided might help researchers to highlight issues in the agriculture domain

III. CONCLUSIONS

Internet of Things has enables the agriculture crop monitoring easy and efficient to enhance the productivity of the crop and hence profits for the farmer. Wireless sensor network and sensors of different types are used to collect the information of crop conditions and environmental changes and these information is transmitted through network to the farmer/devices that initiates corrective actions. Farmers are connected and aware of the conditions of the agricultural field at anytime and anywhere in the world. Some disadvantages in communication must be overcome by advancing the technology to consume less energy and also by making user interface ease of use.

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