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RESEARCH ARTICLE

A proposed model on intelligent processing and cloud-based IOT scheme for remote crop monitoring

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ABSTRACT

The development of smart farming has drawn the attention of the uses of information and communication technology in the agriculture field. There are many productive ways in IoT for cultivating the soil and raising the livestock in the agricultural sector. This paper explores various IoT applications in remote crop monitoring systems. It is a challenging task of analyzing massive amounts of unstructured data acquired from the sensor devices. This paper aims at developing an agricultural Internet system. The three layers in the system of IoT in agriculture are perception layer, transportation layer and application layer and each layer is investigated separately. Three-layer architecture is proposed in the applications of precision farming. For processing and analyzing, this design collects the data and sends it to the cloud-based back-end. After examining the data can be directed to front-end nodes again.

Key words: Internet of Things (IoT), Agriculture, Crop monitoring, Cloud computing, Sensor networks.

INTRODUCTION

In general, Internet of Things (IOT) is referred as the interconnected objects in daily life. The basic terminologies involved in IOT are Actuators, Sensors, and Gateway Protocol. The remote sensor data can be easily accessed by the objects together with Internet connection (Qiu, 2013). The underlying intention of IOT is pervasive existence in the environment around us. Some of the objects are sensors, mobile phones, and actuators; Radio Frequency Identification Tags (RFID), etc. These objects interact with each other to reach common goals through the unique addressing scheme. The essential part of IOT is smart connectivity and context-aware computation with existing networks. Internet of Things (IOT) deals with different areas of applications. The application areas are logistics, retailing, e-health, energy, agriculture, aviation, and industry (Guo and Zhong, 2015). The employment of sensor devices in the agricultural domain has brought solutions for many challenges faced by the farmers. The lacking in manpower, production area, and water makes the involvement of sensors in the agriculture. The monitoring of crop condition, soil moisture, and the water level is done effectively without the human intervention using the sensor devices. The sensing devices namely, Remote Spectral Sensing (RSS), Electrochemical Sensors (ECS), and Bio Sensors (BioS) are used for monitoring and sensing crop, soil, climate and natural conditions. Each sensor has different functionalities generating disparate data utilized for the analytical process. These sensors observe the plant and soil quality when the electromagnetic energy surfaces on the ground.

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The electromagnetic energy is sunlight. The idea is to make the transformation from traditional agriculture to modern agriculture. Modern agriculture is the term describes the production employed in the cultivating field (Hubei, 2016 and Baranwal, 2016). The mobile sensors collect the information from the fixed land and stores in the cloud for easy accessing the data. This process helps the farmers to find and solve the problem in a proper time. The employment of IoT in agriculture makes use of three approaches namely sensing, cloud storage, and transportation. Sensors for automatic measurement technique allows for on-the-go soil mapping. The application process circulates the sensed data over the network to the monitoring devices. The agricultural data is transferred using the Transmission Control Protocol (TCP) / Internet Protocol (IP) over the Internet gateway.

The crop condition is monitored through the automated sensors. The observed data is transferred using the Wi-Fi and stored in the cloud. The cloud storage gives the advantage of easy access to data, scalability, and optimization of data. The data is analyzed and the feedback is sent to further more improve the quality of the crop and soil. Wireless Sensor Network (WSN) plays a key role in IoT (Khattab, 2016). WSN is the wireless network consists of free devices connected to the network to monitor the environmental status. The use of WSN in many applications increases as the productivity, efficiency, and commercially successful is achieved (Ryu, 2015). In our paper, we designed the framework into three levels with cloud architecture. The framework collects the data from the front end sensors, and it is processed by the back-end cloud. Based on the framework we developed the integrated agriculture system helping the farmers in all aspects.

Literature Survey

Smart farming has come into existence at the end of the last decade. In 2002, Zhang *et al*. demonstrate that the agricultural quality is increased by using more sophisticated devices which sense chemical and biological aspects. The spatial and temporal variability of a large field is considered using a technique called precision agriculture. Some of the technologies used in precision technology are wireless communications, remote sensing, microelectronics, Global Positioning System (GPS) and Geographic Information System (GIS) (Zhang, 2002). Lihua Zheng *et al*. developed a smart mobile farming service system based on GIS, GPS, and WSN (Wireless Sensor Network) technologies. They have achieved the following results: the information about the field could be accessed by Personal Digital Assistant (PDA) in real time, and the power consumption was controlled. From each sampling site, the embedded GIS collect the GPS data and the farming data. The primary function of WSN and farming PDA is to gather the real data efficiently. To get the detailed farm land data in real time, the host PC and the agricultural PDA exchange data in real-time. It is used to make irrigation decisions based on the farm data. (The main idea behind developing the remote farming management system was to visualize the agricultural information at any time and make irrigation decisions accordingly (Zheng, 2011). In the same year, Xiao *et al*. discusses that there is a continuous and extensive research in measuring and monitoring the agriculture environment. These technologies play a significant role in farming for detection of light, temperature, and humidity using wireless sensor networks. The collected data is observed and processed on a server, and the information is reported to the farmer through mobile devices (Xiao, 2010). Zhao Liqiang *et al*. proposed an agricultural application of crop monitoring system based on WSN. The IOT has a significant contribution towards agriculture information. They have implemented two types of nodes and accomplished a system network. They introduced system software, image sensor node, and scalar sensor node architectures. With their experimental results, they showed the monitoring system works reliably. The researchers forecasted the future work is improving the power consumption andadapting to complex environmental changes (Liqiang, 2011). In 2014 Kaewmard *et al*. shows that Water and Environmental Management are the important aspects of smart farming because it affects the growth of plants directly. In addition to that, there are other advantages in using water management technology and wireless sensor network for measuring environmental measurements. These technologies are low running cost and simpler (Kaewmard, 2014). The authors of (van de Kerkhof, 2015), made a spatiotemporal analysis for smart farming of field measurement and remote sensing. The report depicts the average production of Soybean, Maize, Rice, and Wheat before and after the introduction of IOT in agriculture. The primary focus of their project is to provide all necessary information for crop management in a visual way. They have investigated different methods of visualization, data processing, and analysis. Initially, they have calculated the correlation coefficient all image pairs. In linear regression analysis, images with higher existence indication are used. The researchers say that the future work would be focused on biophysical properties. In the same year, Ciprian *et al*. proposed a Cyber-Physical System (CPS) architecture model towards precision agriculture. They presented an integrated system architecture for monitoring potato crop which is based on design technologies and CPS architecture. This system helps farmers in increasing the farm productivity by taking appropriate decisions. This work is an initiation towards precision agriculture for other researchers (Rad, 2015). In (Wolfert, 2017).

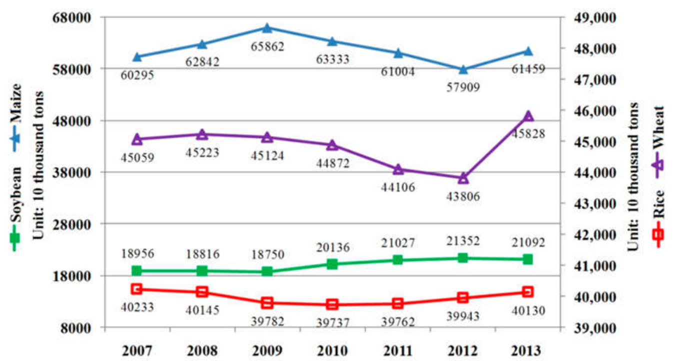

Figure 1. Average production of Soyabean, Maize, Rice, and Wheat analysis

Wolfert *et al*. made a review on cyber-physical farm management cycle, which emphasizes the use of communication and information technology. They conducted the review of big data applications in Smart farming, and several conclusions can be drawn from this paper on smart agriculture. They have discussed with the applications mainly from Europe and North America. The scope of their review was not about geographical analysis rather drawn answers to the formulated research questions. The questions are as follows:

What role does Big Data play in Smart Farming?, What stakeholders are involved and how are they organized?, What are the expected changes that are caused by Big Data developments? .They provided the list of the main issues: Data ownership and related privacy and security issues, Data quality, Intelligent processing and analytics, Sustainable integration of Big Data sources, Business models and Openness of platforms. The authors recommend focusing on the governance issues rather on technical matters.

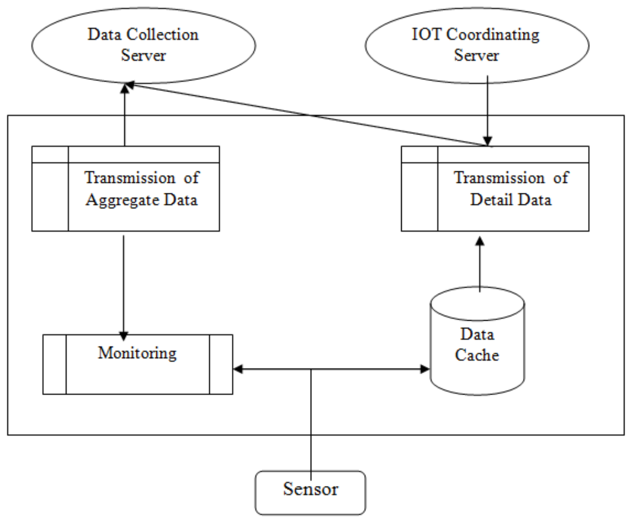

Figure 2. IOT framework for Crop Monitoring System

The proposed framework for Crop Monitoring System depicts the components of remote crop monitoring system in IOT. Initially, the sensor monitors the PH level of soil, temperature, the growth of the harvest every second. The sensor collects the information and stores in the data cache. The detailed data in the data store is transmitted to data collection server for further processing. The aggregated data obtained from the sequential process of monitoring are also sent to the server for monitoring the results. There is also another server namely IOT Co-coordinating server for simpler interaction and synchronization.

which measured soil moisture and temperature and was utilized in automated irrigation scheduling. Multiple sensor nodes were deployed in the field and were attached to a centrally located receiver which provided the total amount and timing of irrigation at different locations in the area (Vellidis, 2008). The Crop Watch system analysis has expanded its assets through the growth of new operational methodology.

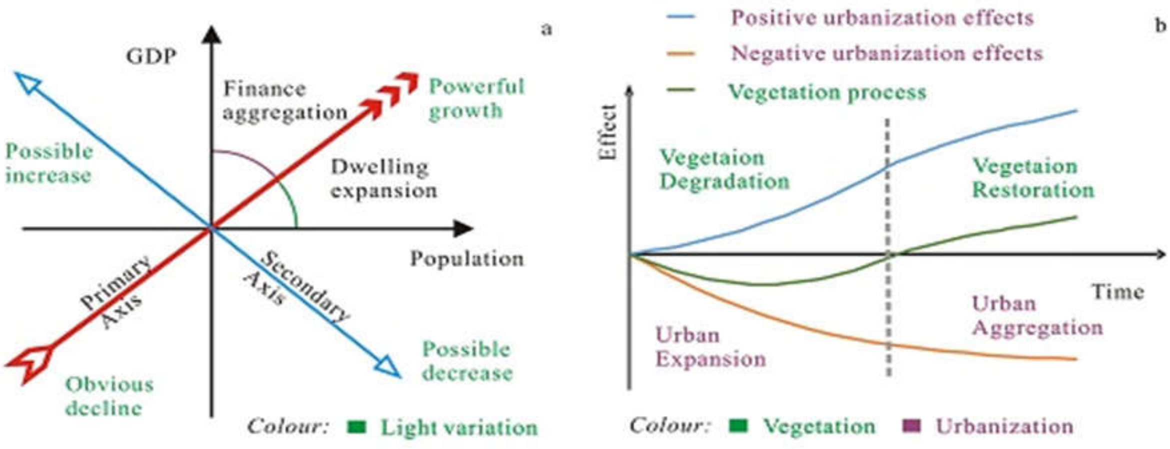

Figure 3. Urbanization stage and the effect on night light and vegetation

Through monitoring the remote crop condition accurately, it is a possibility to increase the agriculture revenue in across the world. The sensors used for agricultural purposes are Electronic, magnetic sensor optical sensor, airflow sensor, an acoustic sensor, electrochemical sensor, mechanical sensor. The sensors play the vital role in remote crop sensing. The data is stored in the cloud server as it is viewed anywhere, and at any time. The agricultural experts monitor the records in the cloud server and provide necessary precautions for the growth of crop in the farm field. There is a significant need to supply real-time farm information like soil moisture, temperature, and pH to the farmer. They are necessary soil parameters that influence overall crop growth and consequently the agricultural products. Monitoring of soil moisture in various regions of a farm can aid in overall irrigation management. Different plants require different irrigation strategies and using real-time data of soil moisture a worker can increase yield by maintaining maximum soil moisture for an individual plant. As an example, while water logging is threatening for the lifespan of the majority of the plants, it is crucial for paddy farms. Sometimes the standing water in paddy fields gets heated by sunlight and negatively affects plant growth. To avoid such situations, farmers drain off the hot water and refill their paddy fields with fresh water. Real-time soil moisture and temperature monitoring can be utilized to ease a few of these problems faced by farmers. Soil temperature alone is a significant factor to find out the crop growth; it's been discovered that soil temperatures below 20deg C inhibit nitrogen fixation leading to declining in the ground fertility (Miq, 1985). Changes in acidity of soil may improve the availability to plants of different nutrients in several ways. As pH of soil increases, ions such as iron, aluminum, manganese, copper, and zinc become less soluble. Thus neutralizing a ground makes the situation more favorable to the growth of bacteria and increases processes through which nutrients are created open to plants (Na, 2016). Numerous researchers and manufacturers invented sensors to assess the mechanical, chemical and electrical properties of soils. The authors vellidis *et al*. developed a comparatively inexpensive sensor array

The thirty-one countries incorporate more that 80% off together production and exports of maize, rice, soybean, and wheat. Fig.2 was analysis made by Bingfang Wu *et al* (Wu, 2015). However, the linking between vegetation degradation and urbanization performs to be intricate and nonlinear and merits a sequence of long-standing explanations. On the root of the Normalized Difference Vegetation Index (NDVI) and the image's digital number (DN) in nighttime stable light data (NTL), we outlined the spatiotemporal relationships amongst expansion and vegetation degradation of unlike cities by consuming a basic NTL standardization technique and Theil-Sen regression. Fig3 and 4 were about the analysis made by Yanxu Liu *et al*. in 2014 (Liu, 2015). In the related paper, Mill and Hummel developed a real-time soil analysis system predicated on Ion Selective Field Effect Transistor (ISFET) technology. An automated soil extraction system was used, and ISFETs were used to calculate the soil pH and nitrate content. Adamchuk *et al*. developed an automated soil sampling system that has been attached to a shank and had a pH meter with a flat work surface electrode. They used linear regression to calibrate their results with soil pH obtained by standard laboratory tests. An over-all trend present in the above-mentioned studies was that electrical or electromagnetic sensors were useful for measuring pH value, temperature and moisture content of soil. However, there's been an inability in implementing a relatively inexpensive, precise and a real-time sensor system for this purpose (Birrell, 2001).

Conclusion

This paper is an analysis of the progress of smart farming. The smart farming has drawn the attention of the uses of information and communication technology in the agriculture field. This paper discovers about several IoT presentations in remote crop monitoring systems. It is an unusual assignment of evaluating massive quantities of unstructured data attained from the sensor devices. This paper aims at developing an agricultural Internet system. An IoT outline for crop monitoring system was formed. Numerous studies were stated by different authors to recognize the development of Crop Watch monitoring system. This analysis aids us to continue advance in the study of the crop Watch tracking system.

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