(IJITR) INTERNATIONAL JOURNAL OF INNOVATIVE TECHNOLOGY AND RESEARCH
Volume No.4, Issue No.1, December - January 2016, 2727 – 2731.

A Literature Study on Agricultural Production System Using IoT as Inclusive Technology

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Abstract: **The IoT (Internet of Things) based agricultural convergence technology is a technology to create a high value such as improvement of production efficiency, quality increase of agricultural products in the whole process of agricultural production[1][2]. In addition, implementing precision agriculture, which is an alternative to the future agriculture, through the convergence technology allows prediction of supply and demand, real-time management and quality maintenance during the entire life cycle of agricultural products [3]. We make a literature study on the cited title and present it in the form of this note.**

I. INTRODUCTION

Methods of harvest forecasting have become increasingly elaborate. Highly refined statistical techniques in agriculture are now being used to extract information from past data and to project prediction values of economic variables. To a large extent, these advances in the science of harvest forecasting have been made possible by progress in IT technology. But, solitary statistical techniques do not provide perfect future situation. Therefore, it is necessary to analyze correlating monitoring crop environments with statistical information about harvest. It is expected that from IoT-based decision support system, this information on statistical pattern of crop can be obtained. The purpose of this study is to improve the agricultural forecast supporting information system, so that real-time forecast will be possible . To this end, it will be needed to manage IoT devices and gather information on them more appropriately. The IoT-based agricultural production System consists of three parts: relation analysis, statistical prediction, and IoT service. This system is designed an agricultural decision support system to predict crop growth by monitoring periodically using the IoT sensor technology [4]

Precision Farming

Precision agriculture makes use of a range of technologies that include GPS services, sensors and big data to optimize crop yields. Rather than replace farmer expertise and gut feeling, ICT-based decision support systems, backed up by real time data, can additionally provide information concerning all aspects of farming at a level of granularity not previously possible. This enables better decisions to be made, resulting in less waste and maximum efficiency in operations.The disciplines and skills now required for agriculture include computer-based imaging, GPS technology, science-based solutions, climate forecasting, technological solutions, environmental controls and more. Precision agriculture is sometimes known as 'smart farming', an umbrella term for easier comparison with other M2M based implementations such as smart metering, smart cities and so on. It is based on sensor technologies whose use is well established in other industries, e.g. Environmental monitoring for pollutants, eHealth monitoring in patients, buildings management for farm soil monitoring and so on.For all M2M implementations, IT systems gather, collate, analyze the data and present it in such a way as to initiate an appropriate response to the information received. For farmers and growers, a wide variety of information regarding soil and crop behavior, animal behavior, machine status, storage tank status emanating from remote sites is presented for action by the farmer.

The Smart Farming Ecosystem

The complexity of smart farming is also reflected into the ecosystem of players. They can be classified in the following way: Technology providers – these include providers of wireless connectivity, sensors, M2M solutions, decision support systems at geomapping applications. Providers of agricultural equipment and machinery, farm buildings, as well as providers of specialist products (e.g. seeds, feeds) and expertise in crop management. Customers: farmers, farming associations. Influencers – those that set prices, influence market into which farmers and growers sell their products. The end users of precision farming solutions include not only the growers but alsofarm managers, users of back office IT systems. Not to be forgotten is the role of the veterinary in understanding animal health. Also to be considered are farmers co-operatives, which can help smaller farmers with advice and funding.The cost of smart farming is still high for any but the largest farms. Farm offices now collect vast quantities of information from crop yields, soil-mapping, fertilizer applications, weather data, machinery, and animal health; these are all factors that influence farming such as soils, nutrition and weather. Data is the fundamental building block of smart farming, whether the data comes from a soil sample or a satellite correction signal. For example, data points collected can highlight both spatial and temporal variability within a field. Many factors can contribute to this variability; under-standing the effect each factor has can only be measured and managed using statistical analysis of the data.Everyday farming applications are starting to move into the cloud, with the aim of delivering benefits in terms of data access, synchronization, storage and even cost to the farmer. The rising use of smartphones and tablets on farms means that apps can be used to cache data offline until it can be synchronized; data need no longer be tied to a single computer in a single location.

The adoption of smart farming solutions is not rapid. The reasons for this are primarily cost – only large farms can afford the investment, and the industry is by nature conservative. That said, government agencies are stimulating adoption of new technologies through subsidies and projects. The figure below show the different types of technologies involved in smart farming.

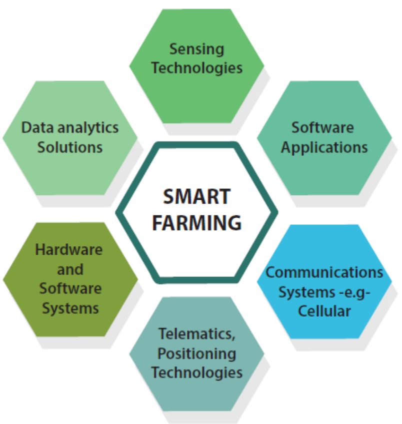


Figure The Technologies Involved In Smart Farming

Towards Smart Farming –Agriculture Embraces the IoT

What makes precision agriculture special is the IT system at the other end of the supply chain, the decision support system at the back office. Whilst the technology is still in its infancy, the notion of 'the connected farm' is coming closer, particularly farming activities are some-how connected not only to each other, but also to a raft of historical data such as weather events, climate, economics, product information and specifications, machine settings etc. This is what the IoT is all about, connecting systems so as to allow an integrated, multidimensional view of farming activities, enabling deeper understanding on how the whole ecosystem works. Precision farming would become 'decision farming' or 'smart farming'. From an M2M perspective, the agricultural sector is still considered a minor sector. How-ever, M2M technologies and all the technologies around the IoT vision are key enablers for the transformation of the agricultural sector towards the smart farming vision. The more immediate impact of M2M technologies in agriculture are around providing remote connectivity between sensors in the field and farm information management systems. This is a consequence of the greater public focus on issues such as food safety and wildlife preservation. The figure shows how the smart irrigation involves collection of all the data for optimal irrigation. For these reasons, it is believed that the use of precision agriculture is bound to grow, not least because of the urgency of the problems the world faces regarding food security in the long term. However, because the technology is in its infancy and not widely understood, this growth will be slow at first compared with sensor based technologies in other industries.

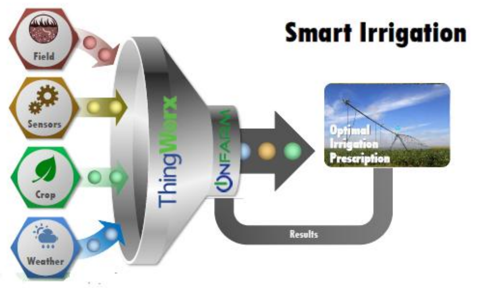


Figure Smart Irrigation.

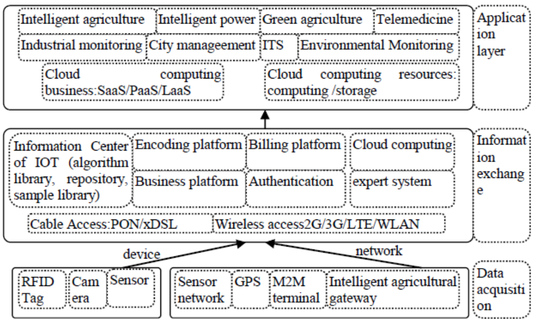
Research work on IoT

Directing at the current development condition of the internet of things and based on the available technology analysis of the internet of things, analysis and research on the internet of things in terms of technological levels and systems are made. Started from three aspects, respectively, data collection, network service, date fusion and computation, analyzing the technologies like RFID, ZigBee, sensors, Cloud Computing and so on are done, based on which further the technological system framework of the internet of things are brought forth. Moreover, analysis and research works on the sensor nodes of the system, analysis and discussion on the various technologies involved are carried on. Internet of Things refers to a network allows a series of intelligent activities like identification, positioning, tracking, monitoring and management by linking devices like RFID, Smart Sense, GPS (Global Positioning System) etc. in objects to wireless network via interfaces to endow objects with intelligence, therefore realize the communication and dialogue between human and objects as well as objects and objects. Moreover, series of research and exploring works have been launched. There are certain blindness in the research and development of the

IOT technology. In terms of the proper definition, the fundamental principles, the architecture and the system model of IOT, there are plenty of questions to be considered and discussed. Based on the current IOT technology analysis, by analyzing and discussing the technological levels and systems of IOT, it is going to start the research on the architecture and the framework of IOT. Started from the intelligent transportation, logistic scheduling and tracing and base station monitoring, IOT extends its application domain to public oriented personal medical treatment, intelligent home furnishing and so on, and its applications can be found in all walks of life. However, being in the preliminary stage and asking for innovations, IOT hasn't been popularized in large scales.

Processor Architecture of IOT System

Based on the research and analysis on IOT's critical technologies, in the general technological system architecture of IOT, it ensures the size of IOT, mobility and security. Data collection layer consists of two-dimensional code tags and readers, RFID tags and readers, cameras, sensors, GPS, sensor gateways, sensor networks and other equipment and technologies. The layer of information exchange is based on network of IOT and communication technologies, such as mobile communication network and the Internet, which is a converged network formed by a variety of communication networks and the Internet. It includes information center, management center of IOT, expert systems and cloud computing platform. Application layer refers to solutions of integrating IOT technologies with industrial technical expertise to achieve a wide range of application with intelligent technologies. It consists of a variety of servers and its main functions include the collection, transformation and analysis of the gathered data as well as the adaptation and triggers of things for users.



Architecture of Monitoring System

In the process of agricultural production, the most critical part is the true time data collection in terms of temperature, moisture, and soil temperature and soil moisture content. By making use of the IOT platform and GPRS/TD, by means of SMS, WEB, WAP and other methods, can make the users dealing with agricultural production acquire these real-time information. Monitoring System for Agricultural Standardized Production based on IOT aims at the target of making information collection in crop growing and carrying out systemic monitoring towards the plantation area, crop pattern, crop growing, the breaking out and development of agricultural damages, crop output and so on. The monitoring system is composed by the wireless sensor monitoring network and distant monitoring information system. ZigBee sensor nodes set in the plastics tents or greenhouse collect the critical index in crop growing like air temperature, moisture, soil temperature, moisture, illumination intensity, CO_2 concentration and so on. The control center receives data, analyze and express them. Once environmental parameters go beyond the set values, it is possible to make message alarming. By making use of cell phone or remote computer, researchers can make real-time control on the environmental conditions and information in the crop growing spot. Monitoring system is composed by three parts: (1) sensor node, sending the information like atmosphere collected by the senor in periodicity to the monitoring. (2) Gateway. Located in the edge of sensor network. Realizing the interconnection and communication between the sensor network and internet. (3) Monitoring and management center of agriculture environment (user), being responsible for the information storage, procession, evaluation and so on. Users are able to visit the dataof the environmental monitoring center by means of internet and they can make real-time inquiry via the center. Sensor network is basically comprised by sensor board which is set with sensors of air temperature and moisture, soil moisture and temperature, soil PH value, light intensity and CO_2 concentration. Temperature and moisture sensors are more and more widely applied in the areas of industrial and agricultural production, whether, environment protection and so on. Data procession module is comprised by microprocessor, data storage circuit and embedded operation system and it is the core component of sensor node. Moreover, it is responsible for data's storage and procession, scheduling system tasks, carrying out the communication protocols and so on.

Prerequisites of IOT Applications in Agriculture

The Accessible, Affordable, Interactive crowd sourcing platform for sustainable agriculture would provide a means for sharing information regarding traditional sustainable agricultural methods, techniques, tools, tips, etc. and allow interactivity and offline data entry for consolidated information upload. Addressing the food security/water security with sustainable agriculture, the solution must provide supplementary information/services such as third-party agricultural, micro-finance services, etc. for farmers. It must also provide a centralized repository for a variety of information such as traditional sustainable farming techniques, crop diseases, etc. coming through various sources, allow interactive farming, easy access to users over various devices such as mobile phones, computers etc in addition toproviding multi-lingual support of traditional practices with modern value.

Structure of IOT for Agriculture

The system hasthree layers, namely, sensor layer, transport layer, application layer. Their functions are as follows:

- **Sensor/Information Collection Layer:** The main task of this layer is to achieve automatic and real-time transformation of the physical figures of real-world agricultural production into digital information or data that can be processed in virtual world through various means.
- **Transport/Network Layer:** The main task of this layer is to collect and summarize the agricultural information. Transport Layer is the nerve center and cerebra of IoT for Agriculture, transmitting and processing data.
- **Application Layer:** The main task of this layer is to analyze and process the information collected so as to cultivate digital awareness of the real word. It is a combination of IOT and Agricultural Market intelligence.

An Overview on Wireless Sensor Technologies for the Development of Agriculture

This work provides an overview on recent development of wireless sensor technologies which will useful for developing the wireless network for the development of agriculture methods and also provides the standards for wireless communications as applied to wireless sensors. Different sensors are used like Temperature Sensor, Humidity Sensor and Soil Moisture Sensor for the field data and central server for the data processing.Agriculture has played a major role in human history; human developed different methods for the development of crops, these methods are applied to the crop by checking the atmospheric conditions. The agricultural progress has been a crucial factor in worldwide social and economic change. In the traditional methods human labor will provides the weather and land condition, according the condition discussion will be taken.

System provides the different data from the different types of sensors like Temperature Sensor, Humidity Sensor and Soil Moisture Sensor. Agriculture system based on three module i.e. Agriculture environmental parameters measurement, which will be received from the different sensor, The Data are received by the central monitoring server, which will be transfer or received different module like ZigBee and third module the central server which provides the result [7]. Fig. provides the basic methodology of the system.

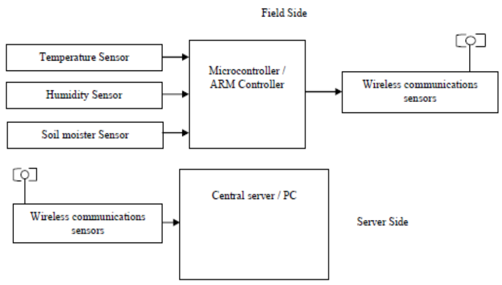


Figure: Basic methodology of the system.

Multidisciplinary Model for Smart Agriculture using Internet-of-Things (IoT), Sensors, Cloud-Computing, Mobile-Computing &Big-Data Analysis

The agriculture industry in India still needs to be modernized with the involvement of technologies for better production, distribution and cost control. They have proposed a multidisciplinary model for smart agriculture based on the key technologies: Internet-of-Things (IoT), Sensors, Cloud-Computing, Mobile-Computing, Big-Data analysis [8]. Farmers, Agro-Marketing agencies and Agro-Vendors need to be registered to the AgroCloud module through MobileApp module. AgroCloud storage is used to store the details of farmers, periodic soil properties of farmlands, agro-vendors and agro-marketing agencies, Agro e-governance schemes and current environmental conditions. Soil and environment properties are sensed and periodically sent to AgroCloud through IoT. Bigdata analysis on AgroCloud data is done for fertilizer requirements, best crop sequences analysis, total production, and current stock and market requirements.

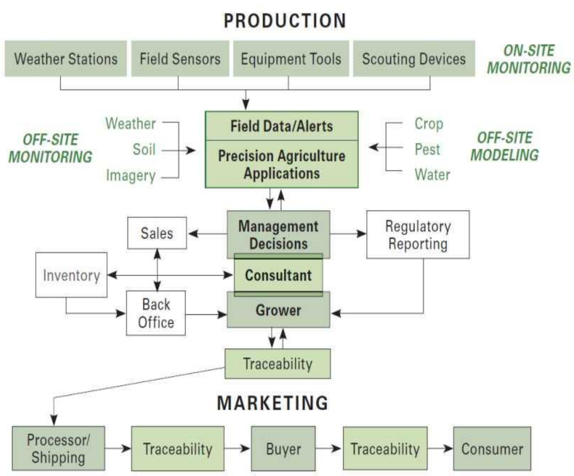


Figure Flow Diagram of Agricultural Production System

II. CONCLUSIONS

The IoT-based agricultural production system has built on the long-standing desire of farmers to ensure their land remains productive into the future. It also addresses the community's expectations and concerns for safe food and for environmental protection. An agricultural production system for the agricultural production using IoT technology and implemented it as GUI visualization software was designed. The IoT based agricultural production system through correlation analysis between the crop statistical information and agricultural environment information has enhanced the ability of farmers, researchers, and government officials to analyze current conditions and predict future harvest. Additionally, agricultural products quality can be improved because farmers observe whole cycle from seeding to selling using this IoT based agricultural production system. The production system can be improved to support more types of products and provide more services. By taking advantage of IoT technology, the efficiency of agricultural production can get a significant improvement. With constantly improving, agriculture IoT must be able to lead agriculture production to a new era.

III. ACKNOWLEDGEMENTS

The author thanks Dr.S.Sridhar, Professor and Dean, Cognitive & Central Computing, R.V.College of Engineering, Bangalore, India for communicating this article to this Journal for publication after modifications. The author also thanks Dr.G.Shobha, Professor and Head, Department of CSE, R.V.College of Engineering, Bangalore, India for the support given.

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