SMART FARMER- IOT ENABLED SMART FARMING APPLICATION

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The digital breach between agricultural producers and IoT technologies has reduced in the last years. In the future, these technologies will allow improving productivity through the sustainable cultivation of food, as well as to take care of the environment thanks to the efficient use of water and the optimization of inputs and treatments. IoT technologies allow developing systems that support different agricultural processes. Some of these systems are remote monitoring systems, decision support tools, automated irrigation systems, frost protection systems, and fertilization systems, among others. Considering the aforementioned facts, it is necessary to provide farmers and researchers with a clear perspective of IoT applications in agriculture. In this sense, this work presents a systematic literature review of IoT-based tools and applications for agriculture. The objective of this paper is to offer an overview of the IoT applications in agriculture through topics such IoT-based software applications for agriculture available in the market, IoT-based devices used in the agriculture, as well as the benefits provided by this kind of technologies.

INTRODUCTION

With the recent advancement of the Internet of Things (IoT), it is now possible to process a large number of sensor data streams using different large-scale IoT platforms. These IoT frameworks are used to collect, process and analyse data streams in real-time and facilitate provision

of smart solutions designed to provide decision support. Existing IoT-based solutions are mainly domain-dependent, providing stream processing and analytics focusing on specific areas (smart cities, healthcare etc.). In the context of agri-food industry, a variety of external parameters belonging to different domains (e.g. weather conditions, regulations etc.) have a major influence over the food supply chain, while flexible and adaptive IoT frameworks, essential to truly realize the concept of smart farming, are currently inexistent. In this paper, we propose Agri-IoT, a semantic framework for IoT-based smart farming applications, which supports reasoning over various heterogeneous sensor data streams in real-time. Agri-IoT can integrate multiple cross-domain data streams, providing a complete semantic processing pipeline, offering a common framework for smart farming applications. Agri-IoT supports large-scale data analytics and event detection, ensuring seamless interoperability among sensors, services, processes, operations, farmers and other relevant actors, including online information sources and linked open datasets and streams available on the Web.

IoT is a technology that mainly resolves the interconnection between human to a thing, thing to thing, and human to human. IoT is a world-shattering technology that signifies the future of computing and information interchange. It is based on the communication between intelligent sensors, RFID (radio-frequency identification), GPS (global positioning systems), infrared sensors, remote sensing, mobile communication, and other communication networks. It refers to a network of objects and is often a self-configurable wireless network . The basic purpose of IoT is to make a huge

network by the combination of diverse sensor devices such as GPS, RS, RFID, laser scanner, and networks to comprehend the information sharing of global things. IoT can encompass millions of networked embedded smarts devices also called smart things; these smart things are capable of accumulating information about themselves, their environment, and associated smart devices and interconnect this information to other devices and systems via the all connecting Internet. IOT applications include diverse areas including transportation, smart agriculture, atmosphere, marketing, supply chain management, health care, infrastructure monitoring, etc. To achieve a comprehensive perception, intelligent processing and reliable transmission between information sensing equipment and systems, all physical objects can be individually interconnected and addressable in accordance with agreed protocol according to the needs of different applications INTERNET OF THINGS (IOT) IOT is a technology that mainly resolves the interconnection between human to a thing, thing to thing, and human to human . The term " Internet of Things" refers to the connection of objects, equipment, vehicles, and other electronic devices to a network for the purpose of data exchange .The Internet of Things is increasingly being utilised to connect objects and collect data. As a result, the Internet of Things; use in agriculture is crucial .IOT is the future of computing and information interchange .The term "Things" in the Internet of Things refers to anything and everything in day-to-day life which is accessed or connected through the internet .IOT is an advanced and analytics system that deals with artificial intelligence, sensor, networking, electronic, cloud messaging, etc., to deliver complete systems for the

product or services. IOT can encompass millions of networked embedded smarts devices also called smart things, these smart things are capable of accumulating information about themselves, their environment, and associated smart devices and interconnect this information to other devices .IOT applications include diverse areas including transportation, smart agriculture, atmosphere, marketing, supply chain management, health care, infrastructure monitoring, etc. To achieve a comprehensive perception, intelligent processing and reliable transmission between information sensing equipment and systems, all physical objects can be individually interconnected and addressable in accordance with agreed protocol according to the needs of different applications. Agriculture is another important domain for IOT. IOT systems play an important role for crop and soil monitoring and give a proper solution accordingly. IOT leads to smart farming. Using IOT, farmers can minimize waste and increase productivity. The system allows the monitoring of fields with the help of sensors. Farmers can monitor the status of the area.

IOT IN AGRICULTURE

Countries like India depends heavily on agriculture for their development. Agriculture is essential to India in economy and people survival. The purpose of this project is to create an embedded-based soil monitoring and irrigation system that will reduce manual field monitoring and provide information. The method used to help farmers increase their agricultural output. A pH sensor, a temperature sensor, and a humidity

sensor are among the tools used to examine the soil. Based on the findings, farmers may plant the best crop for the land. If the fields are known to be dry automatically it gets monitored ,as a result the water gets released from the drip irrigation system . Weather-based smart watering system and effective drip irrigation system must be devised that can automatically regulate water flow to plants based on soil moisture levels as told before .As a result the crop doesn't dried out and grows healthy. Agricultural Irrigation is very important for the production of crops. There are many methods posted to control the water loss in agriculture .But still nothing worked ,because the farmer doesn't know how many amount of water is needed for a particular crop and which crop need additional water for nourishment . Irrigation means planting the crops by water. Automated irrigation is the method which saves the water from up to 97% as compared to traditional methods. By using these modern methods like ICT productivity can be improved without unnecessary wastage of water. Internet of Things technique in irrigation for the purpose to save water. Soil constitution is related with the availability of elements of nourishment plant requires as well as the presence in soil of elements and chemical composition that exist at different proportion that are best nourishment to plants and soil organisms and appropriate water to plant is most essential for all of the other nourishment to work at best.

IoT applications for smart agriculture:

Along with the development of science and technology, the urgent requirement for breakthrough solutions and technologies aiming at

improving productivity and efficiency in the agriculture sector has led to adoption of the IoT.

The IoT applications in agriculture, including

(1) Monitoring

(2) Tracking and traceability

(3) Smart precision agriculture

(4) Greenhouses

Typical Applications of IoT in Smart Agriculture:

In recent years, a series of IoT applications for agriculture have been introduced. According to survey results, we divided these applications into categories based on their purpose, including monitoring, tracking and traceability, and greenhouse production. The detailed results are presented in the following subsection.

Monitoring:

In the agriculture sector, factors affecting the farming and production process can be monitored and collected, such as soil moisture, air humidity, temperature, pH level, etc. Monitoring information, such as soil condition, moisture, and temperature, and the prediction of natural factors, such as rainfall and weather, support the control of growing conditions of crops, helping farmers plan and make

irrigation decisions to optimize production and reduce labour costs. In addition, the collected data, combined with big data processing technology,

can provide recommendations for implementing preventive and remedial solutions against pests and diseases in farming.

Tracking and Tracing:

In order to meet the needs of consumers and increase profit value, in the future, farms need to demonstrate that products offered to the market are clean products and can be tracked and traced conveniently, thereby enhancing the trust of consumers in product safety and health-related issues. In order to solve this problem, a series of tracking- and tracing-based problems for the smart agricultural sector has been proposed, Tracking and tracing agricultural products, thereby allowing consumers to know the product's entire history. These solutions enable tracking and tracing some of the data collected along the supply chain, ensuring that consumers and other stakeholders can identify products' origin, location, and history.

Smart precision agriculture:

Smart precision farming helps to improve productivity and production efficiency and is suitable for large-scale farms. Nowadays, suppliers of precision agricultural equipment have IoT modules built into their machines, allowing machines to operate autonomously and remotely via the Internet.

Greenhouse Production:

A greenhouse consists of walls and a roof, which are usually made from transparent materials, such as plastic or glass. In a greenhouse,

plants are grown in a controlled environment, including controlling for moisture, nutrient ingredients of the soil, light, temperature, etc. Consequently, greenhouse technology makes it possible for humans to grow any plant, at any time, by providing suitable environmental conditions illustrates a smart agriculture IoT system for monitoring greenhouse farming factors based on IoT ecosystems. Recent studies indicated that solutions integrating IoT, big data processing, and artificial intelligence could be applied in greenhouses to reduce labour and energy efficiency. Moreover, it also provides direct connections between the greenhouse farms and the customer.

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 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.

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. 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 base 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.

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 geo mapping 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. 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.

Precision farming would become ‘decision farming’ or ‘smart farming’. From an M2M perspective, the agricultural sector is still considered a minor sector. However, 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.

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, 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. 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. IoT 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. 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 CO2 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.

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.

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. 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. System provides the different data from the different types of sensors like Temperature Sensor, Humidity Sensor and Soil Moisture Sensor. 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. Farmers, Agro-Marketing agencies and Agro Vendors need to be registered to the Agro Cloud module through Mobile App module. Agro Cloud 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 Agro Cloud through IoT.

Benefits of IoT in Agriculture

The main benefits of IoT in agriculture identified in this literature review are briefly described below.

• Community agriculture in urban and rural areas taking advantage of hardware and software resources and large amounts of data.

• Logistic and qualitative traceability of food production that allows reducing costs and the waste of inputs through the use of real-time data for decision making.

• Generation of business models in the agricultural context that allow establishing a direct relationship with the consumer.

• Crop monitoring that allows reducing costs as well as the theft of machinery.

• Automatic irrigation systems that work according to temperature, humidity, and soil moisture values that are obtained through sensors.

• Automatic collection of environmental parameters through sensor networks for further processing and analysis.

• Decision support systems that analyze large amounts of data to improve operational efficiency and productivity.

CONCLUSION

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.