

Development of IoT for Smart Agriculture a Review



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Abstract The Internet of Things is the hot point in the Internet field. The concepts help to interconnect physical objects equipped with sensing, actuating, computing power and thus lends them the capability to collaborate on a task in unison remaining connected to the Internet termed as the “Internet of things” IoT. With the help of sensor, actuators and embedded microcontrollers the notion of smart object is realized. Wherein these smart objects collect data from the environment of development, process them, and initiate suitable actions. Thus, the Internet of things will bring hitherto unimaginable benefits and helps humans in leading a smart and luxurious life. Because of the potential applications of IoT (Internet of Things), it has turned out to be a prominent subject of scientific research. The importance and the application of these technologies are in sizzling discussion and research, but on the field of agriculture and forestry, it is quite less. Thus, in this paper, applications of IoT on agriculture and forestry has been studied and analyzed, also this paper concisely introduced the technology IoT, agriculture IoT, list of some potential applications domains where IoT is applicable in the agriculture sector, benefits of IoT in agriculture, and presents a review of some literature.

Keywords IoT · Smart agriculture · Agricultural IoT · ITU

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1 Introduction of the Internet of Things

ITU (International Telecommunication Union) defined the Internet of things as: “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 [1]. 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 [2]. It refers to a network of objects and is often a self-configurable wireless network [1]. 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 smart 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 (Fig. 1) [3].

IOT applications include diverse areas including transportation, smart agriculture, atmosphere, marketing, supply chain management, health care, infrastructure monitoring, etc. [1]. 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 [2].

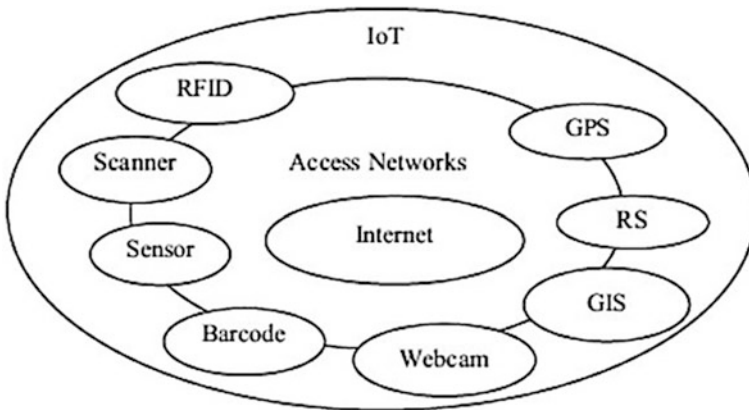


Fig. 1 Conceptual model of IoT [3]

2 Problem Statements

This paper focused on a basic trade that is Agriculture, which is closely related to the welfare of any nation and the people's livelihood [4]. In India, Agriculture sector is shrinking day by day which disturbs the ecosystem's production capacity. There is a burning requirement to resolve this problem in the area to reestablish vitality and place it back on higher progression.

The reemerging of the worldwide recession has caused flows across both the developed and the developing economies [1]. Agriculture domain required to be more competent and irrepressible to ensure universal food security. Farmers of India are at excessive detriment in terms of technology, size of farms, government policies, trade, etc. The Internet of Things technology can diminish some of the problems of Indian farmers [1].

While in the world, agriculture is experiencing industrialization, it is very significant to develop "agricultural information network". Agricultural information network has become the trend of enlargement for the world's agriculture [5]. In concern of the Indian agriculture development, "agricultural information network" is a major concern in stimulating agricultural development and its transformation.

In India, there are many problems in the agricultural information system. For example, here more importance is given to hardware instead of software and cannot deliver high eminence information to get production requirements of farmers. Besides, information is not adequately used by the farmers of India and the influence of information on a rural area, agriculture, and farmers are not remarkable.

The demand and supply of agricultural products has not been controlled properly, because of the demand and the consumption of the agricultural crops could be anticipated quantitatively, nevertheless, the deviation in crop and production by the weather change, change in cultivated area of farms, damage by insects, disease in crop, etc., could not be truly predicted [5]. To change this situation and endorse the speedy development of agricultural information network, it is required to use the Internet of Things to appreciate smart agriculture [5].

3 Applications of IoT in Agriculture

In the domain of digital Agriculture, IoT supports a variety of applications like soil and plant monitoring, crop growth observing and selection, precision agriculture, irrigation assessment support, greenhouse environment monitoring and control systems, monitoring of food supply chain etc. [1]. Following are the established technologies that are used in applications of IoT in agriculture:

Sensor Technology in Agriculture: Vast variety of sensors are used in agricultural products such as soil moisture sensors, water-level sensors, equipment used to sample the state of the atmosphere at a given time meteorological sensors (monitors

the current state of atmosphere), heavy metal detection sensors, biosensors (detection of an Analyte), gas sensors (detects presence of gas), and so on.

RFID Technology: RFID is extensively used in animal tracking and identification. It helps to achieve intelligent monitoring, recognizing, traceability of animals, and their management.

Radio Transmission Technology in Agriculture: Self-organizing wireless data transmission can be achieved with ZigBee wireless sensor networks. In large-scale farming, it has been widely used for data transmission.

Intelligent irrigation Technology: Based on satellite positioning network [4] and “shallow wells underground cables + field + automatic irrigation system pipe” [4] technology, it can accumulate irrigation water, irrigation, electricity, and time data to accomplish automation of farmland irrigation and through a complete analysis of information technology software to monitor irrigation.

Technical Quality Safety of Agricultural Products: In the agricultural industrial chain (production–circulation–sales) [4], recording and monitoring of the chain can understand the entire procedure of regulation.

Precision Seeding and Spraying Techniques: Depending on the technology combined with Global Positioning System (GPS) navigation technology, seeding technology, and fertilization at a variable rate, it can achieve identical implementation of the spraying, planting, and refining the consumption of pesticides, seeds, and so on [4].

4 Benefits of IOT in Agriculture

There are various benefits and advantages to use IoT in agricultural sector some of the benefits are as follows:

Efficiency of input: It will improve the efficiency of inputs of agriculture like Soil, Water, Fertilizers, Pesticides, etc.

Cost reduction: It will reduce the cost of production.

Profitability: It will increase the profitability of farmers.

Sustainability: Improves sustainability.

Food safety: It will help to accomplish the Food Safety Mission.

Environment protection: It plays important role in the environment protection.

5 Literature Review

This paper [6] discusses the various applications of IoT and cloud computing in the field of agriculture and forestry. According to the text, the use of IoT plays an important role in smart agriculture. The basic technologies of IoT like laser scanner,

RFID, photoacoustic electromagnetic sensors, etc. these technologies can be used to make great innovations in agricultural. Basically in agricultural information transmission, precise irrigation, intelligent cultivation control, agricultural product safety, and many more. This paper also focuses some applications of IoT in forestry. IoT can play an important role in forest identification and wood tracking and its management. Finally, this paper concludes that the integration of IoT and cloud computing has become a tendency.

In this research work [2], possible applications of the Internet of Things in agriculture for sustainable rural development has been identified. Various business opportunities related to agriculture domain and its benefits that can be generated, using the Internet of Things is discussed in this text. This literature is intended to stimulus strategy on the acceptance of IoT in agriculture and rural development. According to the literature, developers can use IoT technologies to build country-specific technologies based on the agricultural domain. Development of technology will uplift the standard of people and support poverty alleviation.

In this research work [7], many challenges related to the agricultural domain were, addressed. An architecture was also framed for meeting these challenges. According to the text of this paper, farmers should be guided on the right time during different stages of crop growth. In this research work, a knowledge base is created. This knowledge base has various crop details. These crop details speak about knowledge acquisition, market availability, geospatial data flow and the weather prediction data. Monitoring module includes monitoring of various stages of growing plant, calamity check, planning for irrigation, crop profit calculation, etc. Per day need of water of a plant is calculated using evapotranspiration method. This method is based on the devised algorithm. At last, a comparative study was prepared among several applications existing developed system, having properties like efficiency, the knowledge base, reliability and monitoring modules.

This research work [8] explains the importance of cloud computing in IoT and the importance of these two technologies in Agricultural System. In this paper, it is discussed that IoT is closely correlated to cloud computing. The relation between IoT and cloud computing was explained in such a way that IoT gets influential computing tools with cloud computing. In this research work, an agricultural information cloud is assembled. In this agricultural information cloud, smart agriculture system is constructed through the assemblage of the Internet of Things and RFID. Component of IoT generates a large amount of data like data generated by using RFID, sensors, wireless communication etc. this large amount of data is handled by agricultural information cloud. It is concluded that, in the agricultural information network, hardware resources are integrated into the resource pool for achieving the dynamic distribution of resources and to balance the load, it improves the efficiency of resource use.

In this paper [9], an application prototype for precision farming using a wireless sensor network with an IoT cloud is proposed. In this work, an alert system for the control of water stress of plants using IoT technology was presented. The first part of this paper described the steps of the creation of the decision support system intended for an agricultural community in order to be able to estimate the quantities

of water required. For irrigation management, the farmer will on the benefit from a dashboard software in the form of a graph, to monitor in real time the variations of the soil conditions and on the other hand, a process of notification by SMS will be transmitted via the application when a critical level is reached to avoid water stress. This application can be improved to make it a very sophisticated one envisages the integration of the method of evapotranspiration to calculate the water requirement of a plant per day in the system of decision support.

In the paper [10], a “Greenhouse monitoring system” with a combination of wireless communications and Internet is proposed. The “greenhouse monitor system”, designed using IoT has the definite precision of control and monitor, it is very easy to operate and the interface of this system is user-friendly and this system offers real-time monitoring of the environmental parameters in the greenhouse. This system also has some characteristics like high performance, run reliable and can be improved easily.

This paper [11] explains the architectural components of Internet of Things, shows some application areas where Internet of Things is applicable, discussed about some challenges that have to be discussed along with the securities issues that require consideration like extensive deployment, standardization, interoperability, security of data, efficient spectrum usages and unique identification, gathered object safety, security, and energy consumption. IoT getting rapid momentum due to advances in sensing, actuating, and RFID technologies. It aims at blending the virtual world with the real world seamlessly.

In this research work [12], a platform Phenonet is developed using an open-source platform called OpenIoT. Phenonet is basically a semantically enhanced digital agriculture use case. This paper demonstrated the applications and efficiency of Phenonet in a number of use cases. The researchers demonstrated that how an OpenIoT platform can help to handle the challenges encountered by the Phenonet application. In project Phenonet, the basic concept of the collection, validation, processing, annotation, and storing of data captured from smart sensors in the field has been proposed. The related semantic queries, reasoning, and experimental results are presented.

In this paper [13], an application for precision agriculture, a customized architecture for agriculture, based on IoT is presented. This is a cloud-based IoT architecture. This project is applicable to various precision agriculture applications. The research proposed a three-layer architecture. The first layer collects the environmental information and supplies for needed actions. The second layer is a gateway layer, this layer connects the front-end and back-end via Internet or network in which data can be stored and processed. Researchers built a prototype of this architecture to test and illustrate its performance. The efficiency of the proposed architecture is demonstrated by the performance evaluation results.

6 Conclusion

Issues regarding agriculture, rural area, and farmers have been always deterring India's growth. Agricultural modernization is the only solution to these three problems. Still, India's agriculture is far away from modernization. The use of IoT in agricultural modernization will possibly solve the problems. Based on features of IoT and cloud computing, cloud service, SOA (service-oriented architecture) and visualization technologies can generate huge data involved in agricultural production. RFID with IoT technologies can help to build plant factory that can control agricultural production automatically. A perfect use of modern technology and IoT and blend of them can stimulate the rapid development in the modernization of agricultural system. Use of smart IoT in agriculture could effectually solve the issues concerning farmers, agriculture, and rural area.

According to the above analysis, information technology personnel and agricultural scientist should be encouraged to exchange ideas. Especially, those persons understand planting and understand IT can innovate and promote the modernization of farming. Modernization of farming can improve agricultural production and management, the goal of environmental protection and energy saving could be achieved. By using IoT in agricultural, farmers would be able to understand the current choice of agricultural soil, they would be able to know which crops are appropriate for farming in the current stage, other environmental information of farmland, through intelligent analysis and better management.

In the meantime, the following scenario could be seen: Instead of toiling the field in hot water, farmers would be able to manipulate on computers like a mobile phone or on some intelligent tools, to understand watering, cultivating, seeding, reaping, then they can easily finish heavy farm labor. Continued and rapid development of microelectronic technology, network technology is an opportunity for professionals to actively explore the technological development of modern agriculture. Use of Internet of Things is playing important role in the development of world's modern and smart agriculture which sets a foundation for industrial development.

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