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Implementation of Internet of Things in Agriculture Zone

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Abstract: The agricultural sector is among the largest providers of employment. It is the backbone of our nation. Although there is a large area under cultivation, still there is no maximum yield. Reasons for this can be, insufficient rainfall, deficiency of parameters needed by a plant to grow healthy, farmers may not aware about the timely requirements of the crop. The inception of Internet brought a new outlook to all the businesses. The conventional models were refurbished and enhanced for large-scale adoption. Advancements in technology led to the Internet of things, which is an extension of the network of computers to the network of smart devices. This paper reviews about the realization of Internet of Things (IoT) in the field of agriculture. It provides a comprehensive review of its framework, considerations and implications in implementation.

The paper aims to educate the reader on the IoT technology in agricultural practices and its operational requirements. Ag riculture IoT function is explored along with some examples from the real. The use of IoT in the fields will help the farmers reap the benefits of its technology manifold.

Keywords: Internet of Things (IoT), Information and Communication Technology (ICT), Implementation, Smart Agriculture.

INTRODUCTION

This idea originates from the smartness notion given by technologies like Internet of Things, Big Data and Cloud computing etc. Agriculture IoT [1] can be viewed as a network of sensors, cameras and devices which will work towards a common goal of helping a farmer do his job in an intelligent manner. These devices will be self-sufficient in a way that they will not need human interference to communicate with each other. In other words, the devices are equipped with the intelligence of knowing the time and reasons for interacting with other devices.

Figure 1: Agriculture IoT

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The sensors and cameras are mainly used to collect data about the weather conditions, soil's moisture, nutrient contents, images of crops to detect pest attacks, animal husbandry supervision, food transportation and marketing etc. John Deere has introduced their products in the market. These are sensors which are used for monitoring fields through data collected by them. This data is used for effective pest control and field management.

Figure 2: John Deere's Field Connect system used to collect soil, moisture and other data

The main ideas are summarized below:

- Monitoring the fields in a more scientific way by collecting data through sensors and devices
- Help in smart management of fields and greenhouses with respect to watering needs, pest control etc.
- Help to achieve higher yields of crops along with their enhanced quality
- Better disaster control through prior information and alerts
- Help improvise the whole supply chain from farmers to the market
- Effective supervision of animal husbandry
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PRACTICAL TRENDS AND CHALLENGES

Agricultural industry, governmental agencies and growers have exceedingly critical needs for skills and innovations in computing and information technology. Accordingly, demand for computer and information technology field and university research has increased over decades and has exploded in recent years. Precision agriculture is also one of the major research drivers and a leader in quest for innovation. As a result, the emergence of new business models, services and markets and technological advances will also contribute to substantial growth in GDP. Lack of training is one of the main challenges in adoption of precision agriculture. Other factors hindering the precision agriculture adoption are cost, return on investment and lack of precision agriculture big data analytics.

THE WORKING OF AGRICULTURE IoT

The whole process revolves around the collection of data for use by the farmers and other stakeholders. This is the most crucial part of its working. The devices used range from sensors to cameras and satellite images. The second part consists of the network which will transfer the data generated by the devices as mentioned earlier. Different types of network technologies like GSM, LTE, Wi-Fi and 3G may be used depending upon the availability and requirements. The third part consists of data collection and computing technology like the Cloud services. The cloud servers can be made available independent of the locations and hence most suitable for IoT systems. The data can be stored and computed upon on such servers. The cloud services can be taken on a pay-per-use policy as they are becoming popular for this reason. The last part of the system will be the Big Data analytics tools which can work on the huge amount of data generated and stored on the cloud servers to excavate important patters and trends in the data [4]. For example, weather predictions and market analysis can be done

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using such tools. Steps involved in working of agriculture IoT are:

1. Data collection by Smart devices

2. Data transfer using networks

3. Data storage and computation on Cloud servers

4. Data analysis using Big Data tools

EFFECTIVE APPROACHES

One approach is that the diverse departments in universities can expand and develop education, research activities tailored to their disciplinary demands. By leveraging collaboration and utilizing core resources, on-going education and research efforts can achieve a level of success and scale that would not be possible with only the personnel and resources within their respective departments. This structured cross-disciplinary approach will also be more cost-effective in leveraging resources and avoiding duplication in the challenges in the field. Particularly, centers to catalyze and support collaborative research, education precision agriculture computational analytics and informatics, Internet of Things (IoT) among participating units across the departments need to establish.

Moreover, a signature constellation of undergraduate and graduate programs in precision agriculture computational analytics and informatics, rooted in participating department will play a vital role in sharing an innovative interdisciplinary core and collaboration on visible, cross disciplinary projects. Industry university cooperative research can be conducted by forming consortiums of industry and stakeholders across the country to leverage viable outcome. Through the application of state-of-the-art approaches and technologies and leveraging existing infrastructure, including advanced phenotyping and genetics, new techniques can be developed to maximize yield and nutrition while conserving water resources. Development of test beds and platforms to implement and test new precision agriculture technologies for monitoring, planting and harvesting through farmer engagement will aid in technology adoption. These test beds will also be useful in evaluation of in-field sensing, decision making, data science and visual analytics solutions. Moreover, by targeted research development in controlling contamination of agricultural products during all stages of production and processing a new era can be created for a sustainable and healthy society. Pilot studies are also needed for innovations in storage and transport of grains, fruits and vegetables to minimize loss caused by pests.

The agriculture is becoming exceedingly vulnerable to the soil degradation, water scarcity, deteriorating mountain ecosystems and intense weather patterns such as floods, drought etc. However, there are major gaps in our understanding of changes in agriculture and how these changes will affect agriculture [6]. Improved knowledge needs to be acquired to anticipate, plan and adapt to these changes and to gain new grounds in agriculture. Among all existing techniques, granular activated carbon (GAC) is a growing technology in PFAS treatment in water. However, there is a significant lack of data and procedure development in terms of fundamental understanding of medium properties. The adsorptive and destructive technologies are considered for both soil and water. Other remediation approaches are anion-exchange, chemical oxidation, electrochemical oxidation, soils stabilization and thermal technologies. These treatment technologies are not best suited to provide PFAS management systems with almost real-time sensing data to facilitate fast decision making. To meet the need of practical approaches to manage the potential environmental impacts of per and polyfluoroalkyl substances PFAS, environmental researchers must develop and implement new technologies to enhance detection and control of PFAS with fewer inputs. Enhanced techniques that are more practical and efficient in control, treatment, destruction and removal of PFAS in soils are needed. This complex and arduous task requires interdisciplinary endeavors that combine various environmental sciences.

The improved knowledge of different soil systems will contribute to the development of better underground sensing techniques [2]. Lack of long term, large scale soil measurements is a major challenge as the existing models to predict different soil properties are developed using small scale test beds and field measurements that also involves removal of soil from field locations for laboratory analysis. New technologies are needed to better understand the carbon and nitrogen cycle. To achieve this objective, the technology researchers and soil scientist have to play a dynamic role to develop advanced in-situ systems capable of measuring physical, chemical and biological properties of soil in large scale fields containing different types of soil. In this regard, the recent advancements in the field of health and energy can be employed in precision agriculture.

Effective and reliable soil moisture sensing and irrigation management techniques also depend on advances in underground sensing and communication technology. Major challenges in these areas are manual installation and removal of soil moisture sensors during pre and post-growing seasons and privacy concerns of the farmers about their fields. To overcome these precision agriculture adoption barriers, underground IoT with long term sensing capability coupled with wireless underground communications and networking are needed. To build technology-aware, advanced precision agriculture practices the innovation and automation in underground sensing and secure communications, data collection, analysis, and visualization will play a vital role. Sensors for soil and water quality across networked landscapes need to be developed. Moreover, integration of advances in precision agriculture data analytics and remote sensing into working systems, indigenous and local information is required.

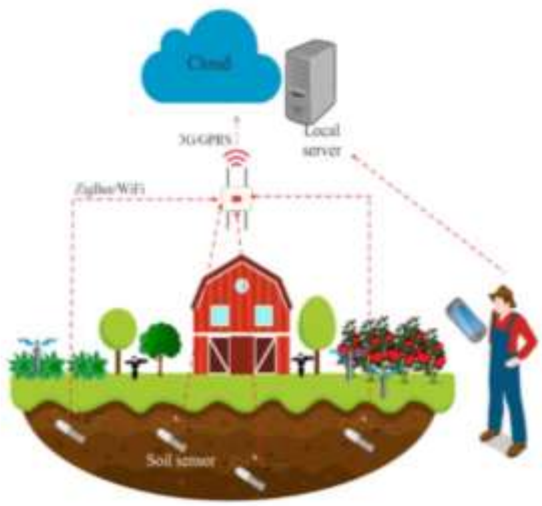

Figure 3: A Modern Irrigation System

IMPLICATIONS OF IMPLEMENTATION

The large-scale implementation of Agriculture IoT is possible only with the support of the government. It can facilitate the adoption by introducing user-friendly schemes and policies. It can provide the devices and infrastructure at subsidized rates which are not affordable by the farmers otherwise. The gaps in agriculture supply chain need to be managed. The role of middleman needs to be reconsidered and dealt with in order to provide maximum benefits to the farmers and the consumers [10]. These gaps may hinder the wide-scale adoption of such technology. The lack of awareness and required skills in the farming community shall be taken very seriously. The farmers need to be made aware of the benefits of IoT in their works. Training programs can help the farmers in understanding the use of new technology

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and get rid of their fears. They need to come out of the traditional methods of farming in order to survive the dynamics of the world. The various implications have been listed below:

- Lack of knowledge and skill
- Lack of awareness and social farming
- Agriculture IoT is in the experimental phase
- Gaps in the agriculture Supply Chain
- Huge infrastructure costs
- Lack of government investment and policies

CONCLUSION

The use of latest technology in every field is the way of functioning of the modern world. No such field can progress and yield maximum potential, which is not incorporating the use of advanced techniques and innovations. Agriculture is a field which has mostly relied on traditional methods and experiences till now, however the changing times have exhibited their impact on agricultural practices and they have started to adapt to the dynamics of change. The use of Internet of Things (IoT) in agriculture will not only improve the yields but also effectively manage all the farm activities. Many companies have launched their products in the market which will cater to the needs of farmers who wish to adopt smart farming. The implementation may have certain implications like cost factor and lack of knowledge but it can nevertheless be worked upon to reap the benefits to the most. There is an urgent need to bring changes in agriculture as a majority of population depends on it for their living.

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