A Review of Agricultural IoT: Challenges, Applications & Future Research Direction

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ABSTRACT

The field of wireless communication has had significant boom in wireless communication, mostly driven by increasing demand for connectivity and technological advancements in low power transceiver development. An Agriculture IoT (AIoT) refers to the technology to enhance agricultural sustainability, productivity, and efficiency. The agricultural IoT uses artificial intelligence to build a network of interconnected systems by fusing digital sensors, IoT devices, advanced analytics, and cloud computing. Agricultural products will be in high demand by 2030 because of the 40% raise in global population. IoT technology is currently utilized in various industries, including agricultural for automation processes.
Therefore time is saved, total productivity is increased and decisions are made more effectively and resulting in higher crop yields. AIoT is also being utilized more to keep updated on the sustainability of agricultural supply chains, environment and water usage. Several IoT applications and problems have been covered in this paper. There is also an outline of potential future agricultural research directions.

Keywords: Precision agriculture, Sensors, Smart agriculture.

1. INTRODUCTION :

The IoT has several use such as smart homes and connected industry (Park, E et al. 2017), smartcity (Zanella, A et al. 2014), connected car (Husni, E 2016), smart-agriculture (Brewster, C et al 2017), connected building and campus (Sastra N.P et al 2016), health care (Islam, S et al 2015), linked industry, and logistics (Li, L et al 2011). By using the Internet as a platform for communication and information sharing, the Internet of Things seeks to merge the digital and physical worlds (IERC 2015). The Internet of Things is a network of interconnected computers, mechanical and digital devices, items, animals, and people that can communicate via a network and share data without needing to communicate with each other or with computers. One of the main topics of interest in this article is the application of IoT to agriculture.. By 2050, there will likely be a significant need for food due to the projected 9.7 billion people on the planet. For this reason, along with the loss of natural resources, land for agriculture, and consistent weather patterns, the majority of nations now place a high value on food security. In order to meet the world's food demands in the upcoming years, there will be a shift in the global adoption of IoT in conjunction with data analytics (DA) (Dlodlo, N et al 2015). It is projected that the number of IoT devices installed in the agriculture industry would rise from 30 million in 2015 to 75 million by 2020. The integration of IoT with DA will enable smart agriculture to produce high yields and operational efficiency, as predicted by Wolfert, S. et al. (2017) and [Elijah, O. et al. 2017].
Throughout the years, smart agriculture and food production have made use of wireless sensor networks (WSNs), with a focus on traceability, automation of machine and process management, precision agriculture, environmental monitoring, and WSN utilization (Wang, N. et al 2006).
With its ability to self-diagnose, self-organize, self-configure, and self-heal, WSN is a very practical solution for smart food processing and agricultureAccording to Wang, N. et al. (2006), radio frequency (RF) transceivers, sensors, microcontrollers, and power supplies make up the wireless sensor network

(WSN). Having said that, there has been a paradigm change from using WSN for smart agriculture to using IoT as the engine for smart agriculture since the introduction of IoT. The Internet of Things combines a number of contemporary technologies.This is only a format. The side headings can be customised according to the type of Research paper.

2. CONTRIBUTIONS OF STUDY :

Inspired by the need to ascertain the most recent trends, obstacles, and potential paths for this innovative IoT-driven smart agriculture, our goal in this study is to compile the most recent findings from smart agriculture research, emphasizing the most recent application areas, trends, opportunities, and difficulties as well as projected future paths. The study's major contributions are so summed up as follows:

- We have analyzed these applications' scopes and evaluated the main IoT applications in smart agriculture to highlight the current condition of these applications.
- To provide readers and future scholars with a more comprehensive comprehension of the current state of academic achievements on this topic, we have looked at a number of important concerns, existing patterns, and probable future directions within the framework of the investigated application sectors.

3. CHALLENGES :

After going through the most important and recent uses of smart agriculture, our primary goal within this segment is to continue the discussion of the major obstacles and promising prospects facing this field. Thus, we first discuss the main problems that we found in the latest research and that have to be addressed immediately to make the domain more sustainable in the sections that follow.

Security and privacy

The rapid growth of communication technology and the Internet of Things has given rise to new security and privacy concerns. Potential attacks on various smart agricultural systems could lead to significant security problems in the widely utilized IoT-powered smart environment (Kim, W. et al. 2020; Navarro, E. et al. 2020). These problems could include network and communication disruptions, compromised agricultural data accumulation, and host characteristics. All of its stakeholders are unfamiliar with precision agriculture's use of smart technology and remote administration, nevertheless, because the agricultural environment is primarily mechanized. Cyber security, data leakage, and data integrity are the most frequent threats that would hinder the implementation of smart agriculture solutions. Attackers would have the ideal opportunity to get access to systems as a result. Given that smart farming environments frequently include internet-connected digital appliances, this poses a large array of safety weaknesses which may have disastrous consequences disastrous consequences. Therefore, further research is required to develop and implement effective security solutions (Kim, J.,et al 2019).

Knowledge and perspective on utilizing technology

Farmers' attitudes and understanding on technology adoption may hinder the adoption of smart agriculture, even though some farmers still choose to practice traditional agricultural methods (Sott, M. K. et al 2019). But their lack of experience and understanding can keep them from putting this cutting-edge technology into practice since they can't completely appreciate its advantages and drawbacks (Zhang, S. et al., 2014). As a result, to promote the adoption of the technology, suitable knowledge-transfer sessions and incentive schemes ought to be established.

Dreadful / Volatile climate conditions

Given that some problems, like the state of the environment have not evolved throughout time. While others are in connection with the quick development of technical solutions, physical dangers and hazards are significant factors that may inhibit the growth of smart agriculture.(Kim, J. et al 2019). IoT device are frequently utilized in public areas., with the exception of greenhouses, and are frequently exposed to inclement weather in the majority of agricultural locales. Droughts, wind, rain, and humidity all have an influence on the network environment and reduce the precision and performance of the system. Consequently, it's critical to build Internet of Things devices that can survive these temperature variations.

Reliability and scalability

Furthermore to a range of network gateways, protocols, and underlying middleware, smart agriculture usually employs an enormous quantity of sensor nodes to service these IoT devices.. Reliable and

scalable network applications are necessary for processing such a vast volume of data in order to manage such a complicated task ([Alreshidi, E. et al 2019].

IoT Applications in Precision Agriculture

Through automation and optimization of all practical agricultural aspects, precision agriculture helps farmers improve their standard of living by enhancing agricultural productivity and cultivation. IoT Sensors are helpful for keeping track ofsoil quality, precipitation, and moisture content. These measurements can then be optimized to boost yield.

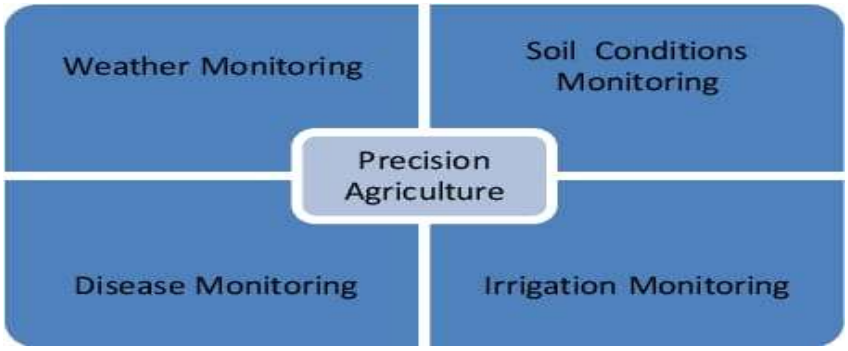

Fig 1: IoT in Agriculture Applications

The main elements of IoT applications for precision farming are shown in Figure 1. In IoT precision agriculture, weather, soil quality, plant disease, and irrigation monitoring are the four main pillars.

1. Weather Monitoring

Agriculture is impacted by a wide range of significant meteorological elements, including temperature, humidity, wind, air pressure, and others. These data are collected by wireless or linked sensors and are transmitted to cloud servers. Mapping the collected data with climate conditions and applying analytical technology will decide the next measures to boost agricultural growth.

2. Diseases Monitoring

Many Internet of Things (IoT)-based agricultural applications, like disease diagnosis and monitoring, have gone digital, enabling farmers to make well-informed decisions considerably more quickly. The plants' health is assessed using machine learning and image processing techniques. An Internet of Things-based system has been implemented to track pests and wheat illnesses (Sott, M. K. et al 2021).

3. Soil Contents Monitoring

Among the most challenging tasks in agriculture these days is soil monitoring. Soil characteristics such as temperature, pH, moisture content, and humidity are essential for agricultural cultivation.

4. Irrigation Monitoring

The Internet of Things (IoT) adds more creativity to the standard irrigation system by incorporating real-time weather and soil data. Irrigation is only done when it is necessary in light of the previously mentioned criteria. Farmers will have the ability to maximize their water resources and cut down on irrigation costs thanks to this ([Alreshidi, E et al 2019).

4. FUTURE RESEARCH DIRECTONS :

The way farmers run their businesses and farms could be completely changed by research into the real-world uses of Internet of Things in agriculture. There are numerous opportunities to put creative and effective solutions into practice for controlling water use, agricultural growth, and environmental conditions (Bali, V.et al 2010). The following research avenues ought to be investigated in order to fully utilize IoT in the agriculture sector:

1. Industry-Specific Solutions: IoT solutions that are available off-the-shelf are frequently too general and do not meet the needs of the agriculture sector. There needs to be research done on creating custom solutions that satisfy industry-specific needs.

2. Regulatory Framework: To encourage the adoption of IoT applications in the agriculture sector, a clear regulatory framework must be in place. Data security and privacy policies, responsible data usage standards, and other pertinent requirements are all included in this. It is crucial to do research in order to create a responsible regulatory structure (Bhatnagar, D et al 2015).

3. Efficient Network Infrastructure: It is necessary to address the development of wireless networks with suitable coverage for rural areas in order to facilitate the effective application of IoT solutions in the agriculture industry. More investigation is needed to create network solutions that meet the demands of the farming sector (Bhatnagar, D et al 2015).
4. Security and Privacy: For linked devices to be discouraged from being used, data security and privacy must be guaranteed. Data encryption and authentication methods are important topics of research.
5. Low-Cost Solutions: Farmers who may not be able to purchase pricey solutions are frequently involved in agricultural operations, which are primarily located in rural areas. Research is required must provide solutions that are reasonably priced without sacrificing quality (Kumar, V et al 2014).
6. **Machine Learning and Artificial Intelligence Integration:** Numerous potential applications of artificial intelligence and machine learning exist in the field of agricultural process optimization. It is critical to do research on the potential applications of artificial intelligence and machine learning for Internet of Things applications in the agricultural industry.

5. CONCLUSION :

In-depth discussions of open problems, difficulties, and potential future study areas are included in this paper's survey on IoT-based agricultural applications. Additionally, th prospective fields of research in the future are is paper offers a summary of how IoT technology will transform the agriculture industry, assisting farmers in better managing their properties while also generating more income. It is anticipated that by 2050, the agriculture sector and farmers would benefit from IoT technology in helping to meet the world's food demand.

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