Recent Trends in Smart Farming Using Internet of Things Technology

Dhiraj Kapila

Research Journal of Agricultural Sciences
An International Journal

P- ISSN: 0976-1675
E- ISSN: 2249-4538

Volume: 12
Issue: 04

Res Jr of Agril Sci (2021) 12: 1250–1255

CARAS

Res. Jr. of Agril. Sci. (July-Aug 2021) 12(4): 1250–1255
www.rjas.org

Research Review

Recent Trends in Smart Farming Using Internet of Things Technology

Dhiraj Kapila*[1]

Received: 06 May 2021 | Revised accepted: 25 Jun 2021 | Published online: 24 July 2021

ABSTRACT

Smart agriculture is an automated and directed information technology implemented with the IOT (Internet of Things). IOT is implementing sharply and globally applied in all wireless domains. In this study, wireless sensor technique and interfacing of wireless networks of IOT technology has been studied and revised based on the physical condition of agricultural system. A hybrid technique with internet and wireless communications is projected. Main aim of this technique is to gather real time data of agriculture production environment that offers simple admittance for agricultural services such as alarms through Short Massaging Service (SMS) and give smart assistances on weather form, crops etc.

***Key words*:** Smart farming, Technology, Internet, Recent trends, Drone

Today the IOT has interrupted [1] many industries and the farming Industry isn't an exemption. The research proposed that till the end of 2018, the associated agriculture market hoisted at USD 1.8 billion internationally and the alteration hasn't stationary yet. It is predictable to raise to USD 4.3 billion by the end of year 2023 at a yearly growth of 19.3%. The IOT technique has understood the intelligent wearable's, interlinked devices, automated machinery, and driverless vehicles. Moreover, in agriculture, the IOT has carried the extreme impact. Recent figures expose that the worldwide population is nearby to influence 9.6 billion by the end of year 2050. And to provide food to this enormous population, the farming industry is restricted to espouse the Internet of Things technology. Amongst the issues like thrilling weather conditions, environmental changes, nature impact, IOT is eliminating these issues and assisting people to meet the needs for more crop.

Throughout the globe, industrial innovations such as tractors and harvesters come off and brought into the farming operations in the late 20th century. And the farming Industry trusts deeply on advanced ideas due to increasingly growing need for food. The engineering IOT has been a lashing force behindhand raised agricultural production at a least price. In the next decade, the usage of d IOT driven smart solutions will upsurge in the agriculture processes. In fact, some current statics reveals that the IOT technology installation will shows a CAGR rate of twenty percent in the farming industry. And the large production of farming devices will increase from 112 million in 2019 to 225 million by year of 2024. Due to nonexistence of persistent and dependable digital network structure, an IOT technology service provider as well as the agricultural business owners had met implementation issues in remote or less established regions. But, some digital communication providers are making it probable by presenting satellite connectivity and disbursing cellular networks.

Fig 1 Overview of smart farming using IOT enabled technology [1]

The need of IOT technology raises sharply in agriculture industry when the wireless sensors were first introduced in the farming operations. But the challenge with the conventional method of using sensor technique was not able to obtain the real time information from the sensors. The sensors utilized to record the data into their linked memory device and later on its was able to deal it. With the

* Dhiraj Kapila
✉ dhiraj.23509@lpu.co.in

[1] Department of Computer Science and Engineering, Lovely Professional University, Phagwara - 144 001, Punjab, India

start of Industrial IOT in farming, extreme advanced wireless sensors are being used. The sensors are nowadays linked to the cloud via mobile/satellite network.

The applications of IOT in the farming industry has facilitated the agriculturalists to monitor the liquid tank levels in real time which makes the farming process more effective. The development of IOT technology in farming operations has brought the utilization of wireless sensors in each step of the agricultural process like how long and how much resources a crop seed requires to become a fully grown crop. IOT technology in agriculture has now recommended as a next trend of green revolution. The advantages that farmers are receiving by adapting IoT are double. It has helped farmers cut their costs and at the same time increase crop yields by enhancing farmers decision-making approach with accurate information.

Various applications of IOT in agriculture

Intelligent farming is an advanced and efficient model of doing farming and yielding a crop in a maintainable way. It is an aspect of bringing connected devices and emerging technologies altogether into farming. Intelligent Farming mainly depends on IOT because it eliminates the requirement of physical work of agriculturalists and cultivators and thus swelling the productivity of crop in all probable manner. With the recent technological developments in agriculture, the IOT has introduced tremendous benefits such as effective water usage, input optimization and much more. What made a difference were the tremendous benefits and in recent times has become the way a revolutionized farming.

IoT-based Smart Farming strengthens the entire Agriculture system by real-time field tracking. The Internet of Things in Agriculture has not only saved the producers' time with the aid of wireless sensors and interconnectivity, it has also minimized the wasteful usage of resources such as power and water. IOT not only under control various climate factors such as humidity, temperature, soil etc. but also and offers a crystal-clear analysis of climate changes in actual-time.

The following are the benefits of adopting new technology - Internet of Things in Agriculture:

Climate conditions

Weather plays a very important role in agriculture. And having insufficient knowledge about environment severely disintegrates the crop production quantity and efficiency. Yet IoT solutions let you realize the actual weather conditions in real time Sensors are mounted inside and outside the farming fields. Sensors collect climate data that can be used to select the right or best crops that can cultivate and flourish under the specific environmental situations. The entire IOT ecosystem consists of sensors which can sense and monitor real-time climatic conditions such as moisture, rain, windspeed, temperature and many more very precisely. Multiple number of sensors are accessible to determine all these parameters and program to meet your intelligent farming needs appropriately. These sensors track crop situation and surrounding weather condition. If there is any alarming weather conditions, then an alert is being sent farmer. What is removed is the need for actual existence in challenging climatic situations that ultimately improves productivity and allows farmers to yield more benefits from agriculture.

Fig 2 Monitoring of climate conditions using IOT [1]

Precision farming

Precision agriculture / precision Farming has become one of Farming's most famous IOT practices. By incorporating smart farming practices such as animal monitoring, automobile tracking, farm observation, and productivity monitoring, it enables the farming operation more accurate and supervised. The purpose of precision farming is to examine the data obtained by sensors in order to deal appropriately. With the aid of wireless sensors, the precision Farming lets farmers to generate accurate information and interpret the information in order to make smart and quick actions. There are many precision farming approaches such as groundwater management, livestock management, automobile tracking and many others that play a crucial role in enhancing productivity and profitability. With the aid of Precision Farming, soil health situation and other associated variables can be monitored to improve functional effectiveness. Not only this, a farmer can also monitor the real-time working situations of the linked devices to measure the water and nutrient quantities.

Fig 3 Overview of precision farming with IOT [1]

Smart greenhouse

To make our greenhouses intelligent, IOT has allowed climate forecast stations to change the climate conditions dynamically as per a specific set of guidelines. Implementation of IOT in to make smart greenhouses has minimized human interference, hence rendering the whole system cost-effective and enhancing efficiency at the same time. For example, with utilizing of solar enabled IOT sensors produces innovative and cheap intelligent greenhouses. Such sensors capture and relay the information in real time, which enables to track the greenhouse condition in very precisely in real time. Fluid intake and greenhouse

status can be tracked through emails or SMS notifications with the assistance of the wireless sensors. Auto controlled and intelligent irrigation is achieved with the support of IOT. technology These sensors supplies details about levels of heat, moisture, temperature and illumination.

Fig 4 Making of smart green-houses using IOT [1]

Data analytics

The traditional database system does not have adequate capacity for saving the data from the IOT sensors. In intelligent agriculture, cloud computing-based information storage and end user IOT Framework perform a significant role. Such devices are expected to play a significant role in allowing for improved activities. Sensors are the main source of mass information gathering in the IOT platform. Using data analytics technology, the information is examined and converted into useful data. The data analytics technique support to evaluate weather situations, livestock states and crop conditions. The generated data leverages technical advances and so makes best decisions. Using the IOT enabled mobile applications, the farmer will know the crop's actual-time situation by collecting the sensor Use of IOT technology in the farming Industry has supported the farmers to improve crop productivity and soil sustainability, thereby increasing the product capacity and eminence.

Fig 5 Analyzing crop health using big data analysis [1]

Agricultural drones

Technological breakthroughs have nearly pioneered agricultural processes and the advent of agricultural drones is the huge interruption to this trend. Both ground and flying drones are utilized for crop health analysis, crop inspection, irrigation, crop harvesting, and farm observation. With solid plan and real-time data-based preparation, the UAV technology has provided the farming industry a huge makeover and growth. UAV Drones with infrared or hyperspectral sensors recognize certain areas that need irrigation adjustments. Once the seeds begin to grow, the wireless sensors demonstrate their health and measure their level of vegetation. Intelligent drones decreased the effect on the atmosphere.

Fig 6 Deployment of smart drones for crop monitoring [1]

Livestock monitoring

IOT technology frameworks help farmers to gather information about their livestock's spot, welfare, health and safety. This knowledge allows them to recognize their livestock's situation such as identifying infected and sick animals so that famer can isolate from the group, stopping the infection from transmitting to the other animals of the herd. The company having name JMB North America provides the illustration of one application of IOT technology in which they offer cow tracking solutions to cattle producers? Out of the numerous explanations recommended, one of the solutions is to assist the cattle producers spot their cows that are expecting and going to give birth her calf soon.

IOT benefits for smart agriculture

Agriculture facilitated [2] by Internet of things technology has facilitated the farmers to apply new technical solutions to the information tested over time. This helped them to bridge the slit between output and producing quality and quantity. Information Ingested by collecting and importing data or storage from various sensors for real time utilization in a database to confirms immediate action and to give less harm to crops. There are numerous benefits that can be obtained from the utilization of IoT in IOT enabled smart farming.

a) Community farming: Usage of IOT enabled solution will help the farmers to indorse community farming predominantly in village areas. The IOT technology can be used to indorse solutions that permit the civic to exchange data and information, upsurge communication amid farmers and specialists in farming [3]. Also, through the usage of IOT enabled smartphone applications and IOT facilities devices can be shared within the public through free or paid services.

b) Safety control and fraud prevention: In the agricultural industry, the issue is not only limited to

adequate growth but also the responsibility to ensure healthy and tasty food supply There have been numerous cases in food scam which embraces contamination, forged, artificial augmentation [4]. This deception poses health issues and can have adverse financial impact [5-6]. The use of IoT technologies will resolve a few of the factors of food fraud such as product dignity, process integrity, human integrity and information integrity. IOT can be used to deliver logistics trackability and qualitative trackability of food [7].

c) Competitive advantages: The rising in food production and the use of advanced technology are prepared to make the agricultural industry very profitable. The development of information-driven farming using IoT would also open up new opportunities in trading, tracking and advertising. Farm inputs such as fertilizers and insecticides enhance production by lowering costs and eliminating crop waste. Use of actual time information would provide the market advantage to that farmer who embrace the need the IOT enabled platform.

d) Wealth creation and distributions: IoT implementation can create new trade models where individual farmers will escape the "middle men" abuse and can be in direct touch with customers making to huge profit.

e) Cost reduction and wastage: One of IOT technology's obvious returns is the ability to monitor devices and equipment electronically [8]. Utilizing IOT technology in agriculture can assist the farmer to save time and expenditure in examining large fields as opposed to workers manually examining the field either by the automotive use or by walking. The ability to determine when, where or which chemicals or pesticides to be applied using IOT would lower down the costs and waste.

f) Operational efficiency: Operational output applies not only to farmers but also to agricultural-related decision and policy makers, such as federal agencies and pseudo-governmental organizations. Data collected via IoT from farm monitoring schemes may serve as inspiration in agricultural operations. These strategies may include preventing disease transmission, wildfire outbreaks, reward programs and providing other financial benefits and services. Furthermore, farmers may take full benefits of IOT technology and data analytics to make timely and accurate decisions about field management and field activities. The ability to accurately record livestock or crop health status would assist farmers with a precise and effective diagnosis and prescription of medication by veterinarian or agriculture officer. This would help to ease losses. Also, with the utilization of IOT technology, logistics of farm food can be enhanced. Also, the usage of the IOT technology in the supply chain will give full support to deliver real time balancing amid the needs and resources.

g) Awareness: IOT is supposed to drive small-cost applications and connectivity to the agricultural wireless network services. For this reason, market information, rates, and facilities can be obtained via smartphone applications. Also, government facilities and controlling standard concerning different farm crop can be made voluntarily available. In addition, customers who are attracted towards organic crops and fresh foodstuffs can effortlessly trace farmers or be notified when new foodstuffs are offered.

h) Asset management: IoT will allow real-time surveillance of farm assets and equipment against theft, parts replacements, and timely preservation of routines.

Various key challenges of smart farming using IOT technology

There are numerous issues that are associated with placement and application of IOT technology. Few challenges has investigated as safety and secrecy, data convergence and proprietorship, nonexistence of interoperability, heterogeneity of IoT devices, hesitation in trade models [9-10].

A. *Business issues*

The profit margin in the farming sector is very small and as such there is a requirement to manage trade-off between the implementation of Internet of things enabling technologies against the future gains. Hence, we present various key business challenges linked to the IOT placement by taken care about the cost and trade models.

1) *Cost*: There are numerous costs factors linked with the implementation of IOT in farming which can be classified into arrangement cost and processing cost. The arrangement cost concerning with the buying of IOT technology hardware such as IOT equipment's, gateways, core site infrastructure. The operating cost requires continuous payment for the use of centralized resources or IOT platforms that provide data gathering, IoT device management, and communication among other networks.

2) *Business models*: Farmers would be interested in business models that supports revenue generation from the data accumulated from their farm using IoT technologies. Many extra operating costs exists that are the costs related to information sharing between IOT equipment's, gateways and cloud servers, power and maintenance. IoT service providers manipulate the data generated and this stays an issue of contention among producers to control and own their data.

3) *Lack of adequate knowledge*: A major factor delaying the acceptance of IoT in agriculture is the lack of sufficient awareness of IoT and its execution, particularly among farmers residing in remote areas. It is common in underdeveloped countries, where most producers are often residing in rural locations and poorly educated. The farmer's incapability to practice data could be a main barricade if humanoid interferences are not offered [11].

B. *Technical issues*

1) *Interference*: The distribution of immense IoT equipment's for farming and other drives will origin interfering issues particularly with the IoT equipment's employing the unlicensed spectrum, such as "ZigBee, Wi-Fi, Sigfox, and LoRa ". The intrusion caused may lead to data loss and diminish the IoT ecological system efficiency. The technology for making IoT apps using the unauthorized evidence of spectrum infringement would contribute to the device's cost extra. In comparison, it is expected that using IoT tools running with authorized spectrum would reduce unwanted intervention. However, the recycle of nonorthogonal multiple entry arrangement or frequency reuse can still cause interference among IoT instruments using mobile authorized spectrum, due to limited carrier deployment in the cell phone band.

2) *Security and privacy*: There are numerous security threats that required to be considered at various level of the IOT ecology. Lack of sufficient protection could contribute to data loss, link security, and access to raw on-field configuration details and other critical proprietary information. This can negotiation the modest rewards of private field owners.

3) *Choice of technology*: There are many newly established IoT solutions, some of which are already going through pilot trials. The correct choice of IoT platforms is a huge challenge, as the deployment of emerging technologies requires a lot of expenditure.

4) *Reliability*: It is projected that the IoT applications will be deployed outdoors. It will introduce the devices to severe climatic conditions that may leading to deprivation of installed sensors as well as shortcomings in communication. To safeguard the expensive hardware from severe weather conditions, such as flooding and storms, external protection of the installed IoT sensors and devices must be established.

5) *Scalability*: Billions of IoT devices are expected to be deployed in the agriculture sector. Existing gateways and protocols will need to support large number of IoT devices/nodes. This will require intelligent IoT management system for each node and identification numbers.

6) *Localization*: There are numerous aspects that needs to be addressed for placement of IOT equipment's. Such influences comprise the capability for the IOT equipment to support plug and play functionality, i.e., be plugged wherever and linked to the rest of the globe with negligible configuration or positioning extra devices, such as gateways [12].

1. Future trends and opportunities of smart farming with IOT

From our investigations and evaluation of recent trends in the application of IOT in farming, we present the future trends based on the following areas: 1) technological innovations; 2) application scenarios; and 3) business and marketability.

A. Technological innovation

More and more IoT strategies will begin to emerge, and novel and disruptive technologies will be launched, particularly in the farming sector. Some of the areas identified are discussed as follows.:

1) Deployment of low power wide area (LPWA) technologies: The LPWA is likely to rule the farming sector as this technology delivers numerous benefits and advantages, such as less energy, less power and wide-range communication. The announcement of the "3GPP NB-IoT" standard and acceptance by several telecom companies will fascinate many exploration interests in exploring the usage of "NB-IoT" communication technologies. This will allow huge-scale pilot testing of IOT in farming [10].

2) Universal platform: Deployment an IOT framework for farming purposes would move from particular crops or livestock to a universal framework (also known as a universal platform) proficient of managing any crop and livestock. This will permit a system that can be effortlessly adjusted to sustenance a diversity of applications oscillating from dealing and monitoring of crops and livestock to trading of crop to local stores and customers. Such a model system will be free of any spatial and national constraints and can act as the instigator in farming for many IoTs.

3) Security: IOT technology system security and end-to-end data protection will continue to draw further interest in the investigation. More investigation work is required in the implementation of IoT device that can facilitate novel protection schemes, such as innovative signcryption method [13]. The sign cryption merge digital signature and data encryption to avoid snooping and illegal alteration on penetrating data. New protection measures need to be studied and new initiatives introduced to avoid physical attacks and intruders from the IoT applications.

4) Spectral and energy efficiency: Diverse technologies, such as ultra-narrowband channels (Sigfox and Telensa) and spread spectrum (LoRa and Ingenu) are accepted in order to accomplish the needs of low power wide area [14]. Many low power wide area complaint resolutions are being moved out to novel techniques that can support large information, extensive distance exposure, huge path-loss linkage budget, and prolonged battery lifespan are mandatory.

5) Artificial intelligence and data analytics: The use of machine learning to model crop production and disease prevention based on agricultural data and weather information is required to do further research. The example is the use of artificial intelligence for disease identification from photographs transmitted via smartphones [15]. Data analytics procedures that can execute huge quantity of information ate rapid rate associated to the IOT communiqué time are predictable to be implemented.

6) Privacy-Preservation: End-to-end confidentiality-preservation approaches that allow data to gather information while retaining the confidentiality of users have been suggested to address IoT data breach challenges [16-17].

7) Real time monitoring: As hundreds of numerous kinds of wireless sensors are to be installed in the farm for actual time monitoring, a modest network supervision protocol must be implemented to support interaction between objects and server with least overhead conceivable Recent protocols are especially designed for network devices and can cause heavy network traffic and congestion on the networks as well as enhance the power demands for the IoT applications.

B. Application scenarios

Software systems, IoT devices are being formed, and work is ongoing into technological developments that can deliver IoT implementations at reasonable cost. Most of the recent research contributes to prototyping and tested and small-scale monitoring. It requires massive-scale pilots to analyses the functionality and usefulness of IoT technologies in farming [10]. Ongoing research work will observe more of huge scale trial in the whole supply chain and farm-foodstuff applications not only in the advanced

countries but as well as in the developing nations in Asia and Africa.

C. Business and marketability

1) Cost reduction: The enhanced energy consumption of the IOT equipment and devices, lessening in actual size, and immense productivity is predictable to reduce the cost of IOT solutions for farming. Ongoing research work will see expansion of inexpensive sensors, exploration on grouping of diverse deployment situations, discovering the usage of shared licensed and unlicensed message passing technology in order to minimalize arrangement and working cost.

2) Policies and regulations: Further research on implementation and optimization of policies in the use of IoT in farming is predicted. The presence of state administration or department of agriculture should also be considered when planning on IoT policies and rules in farming that might vary from area to area. This will enable primary acceptance of IoT in farming.

CONCLUSION

Internet of Things (IOT) enabled smart farming has facilitated the development of modern technical solutions This has assisted to bridge the breach between productivity and excellence and amount crop yield. Data Consumed by locating and introducing information from the numerous sensors for actual time usage or storage in a record confirms rapid action and least harm to the crops. With continuous end to end smart operations and upgraded business course execution, crop gets processed quicker and supplies to superstores in quickest possible time duration. This investigation described and addressed the advantages of IoT and data analysis and the open challenges. IoT is supposed to deliver many benefits for the farming sector. Nonetheless, a variety of problems still need to be addressed in order to make this affordable for small to medium-sized farmers. Safety and cost are main concerns. It is estimated that the adoption rate of IoT in farming will increase rapidly as competitiveness rises in the farming sector and supportive strategies are introduced accordingly.

LITERATURE CITED

1. Anonymous. 2021. https://www.biz4intellia.com/blog/5-applications-of-iot-in-agriculture.
2. Olakunle E, Tharek AR, Igbafe O, Chee YL, Hindia MN. 2018. An overview of Internet of things (IoT) and data analytics in agriculture: Benefits and Challenges. *IEEE Internet of Things Journal* 5(5): 3758-3773.
3. Bo Y, Wang H. 2011. The application of cloud computing and the internet of things in agriculture and forestry. *Proc. Int. Joint Conf. Service Sci*., May 2011. pp 168-172.
4. Marvin HJP. 2016. A holistic approach to food safety risks: Food fraud as an example. *Food Research International* 89: 463-470.
5. Tähkäpää S, Maijala R, Korkeala H, Nevas M. 2015. Patterns of food frauds and adulterations reported in the EU rapid alert system for food and feed and in Finland. *Food Control* 47: 175-184.
6. Manning L. 2016. Food fraud: Policy and food chain. *Current Opinion Food Science* 10: 16-21.
7. Folinas D, Manikas I, Manos B. 2006. Traceability data management for food chains. *British Food Journal* 108(8): 622-633.
8. Asplund M, Nadjm-Tehrani S. 2016. Attitudes and perceptions of IoT security in critical societal services. *IEEE Access* 4: 2130-2138.
9. Chen S, Xu H, Liu D, Hu B, Wang H. 2014. A vision of IoT: Applications, challenges, and opportunities with China perspective. *IEEE Internet Things Journal* 1(4): 349-359.
10. Brewster C, Roussaki I, Kalatzis N, Doolin K, Ellis K. 2017. IoT in agriculture: Designing a Europe-wide large-scale pilot. *IEEE Commun. Management* 55(9): 26-33.
11. Newell A, Yao H, Ryker A, Ho T, Nita-Rotaru C. 2015. Node-capture resilient key establishment in sensor networks: Design space and new protocols. *ACM Computer Surveys* 47(2): 24.
12. Biral A, Centenaro M, Zanella A, Vangelista L, Zorzi M. 2015. The challenges of M2M massive access in wireless cellular networks. *Digit. Commun. Network* 1(1): 119.
13. Shi Y, Han J, Wang X, Gao J, Fan H. 2017. An obfuscatable aggregatable signcryption scheme for unattended devices in IoT systems. *IEEE Internet Things Journal* 4(4): 1067-1081.
14. Anonymous. 2017. Real wireless: A comparison of UNB and spread spectrum wireless technologies as used in LPWA M2M applications. Accessed: Sep. 20, 2017. Online available: www.thethingsnetwork.org/
15. Plantix. 2017. Accessed: Sep. 25, 2017. Online available: https://plantix.net
16. Jayaraman PP, Yang X, Yavari A, Georgakopoulos D, Yi X. 2017. Privacy preserving internet of things: From privacy techniques to a blueprint architecture and efficient implementation. *Future Gener. Comput. System* 76: 540-549.
17. Song T. 2017. A privacy preserving communication protocol for IoT applications in smart homes. *IEEE Internet Things Journal* 4(6): 1844-1852.