Journal of Advances in Management, Engineering and Science (JAMES)
Volume 01, Issue 01, March 2023

# INTERNET OF THINGS AND UNMANNED AERIAL VEHICLE IN SMART AGRICULTURE

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**Abstract:** Unmanned Aerial Systems (UAVs) and the Internet of Things (IoT) are two cutting-edge technologies being used in crop fields to usher in a new era of precision farming. In this study, we conduct a literature review on the state of research concerning the integration of UAVs and the Internet of Things in agriculture. UAVs may be used for surveillance, the distribution of pesticides and insecticides, and the identification of errors in bioprocessing, all of which have the potential to save farmers money and improve the quality of their harvests. Both multi-mode and single-mode UAV systems will function admirably in this setting. However, this chapter also highlights the benefits and uses of IoT & UAVs in agriculture, as well as the difficulties associated with connecting these technologies in outlying areas.

***Keywords:*** *Internet of Things, Unmanned Aerial Vehicles, Smart Farming, Wireless Sensor Networks, Agriculture.*

## 1. INTRODUCTION

When talking about farming in the context of the Fourth Industrial Revolution, the phrase “smart farming” works well. The convergence of the Fourth Industrial Revolution advances with what is being called the “Second Green Revolution” is what makes agricultural technology so fascinating right now. Disruption to the agribusiness sector, the farm sector, and farmers throughout the world is occurring at an unprecedented rate. As a less obvious use of IoT technology than, say, health monitoring, transportation, or manufacturing, “smart farming” (also known as “Agricultural IoT”) is often disregarded. I believe that the Internet of Things will soon become the most critical use of IoT and that it will transform every element of industrial agriculture, from the way farmers operate to yields per acre.

The Internet of Things (IoT) is a game-changer in the realm of wireless networking. The fundamental idea is the communication between different kinds of physical devices across the Internet by use of predetermined addressing systems. Industries as diverse as manufacturing and logistics, healthcare and transportation, automotive and intelligent buildings and agriculture all stand to benefit from the Internet of Things implementations. The Internet of Things (IoT) can improve farming by providing data on a variety of physical aspects. Wireless Sensor Networks (WSNs) play a crucial part in IoT technology since the large bulk of IoT applications across markets rely on wireless data transfer.

As our technical capabilities increase at a rapid pace, we become increasingly dependent on machines to do formerly human tasks. Agriculture and water management are two areas where a man may genuinely shine. In order to commercialize in the industry while keeping prices down in some areas, various sensors and electrical devices are employed. Uncrewed aerial vehicles (UAVs) may be used for a variety of purposes in agriculture, including reconnaissance, the application of pesticides and insecticides, and the identification of errors in bioprocessing, all of which can help farmers save money and sharpen their abilities. In this scenario, either a single-mode or multi-mode UAV system would work. With proper coordination and collaboration, a network of UAV clusters connected to terrestrial infrastructures, GCS, or satellites can outperform the capabilities of a single UAV system. Because of this, the most significant contribution is the mobility model and specifications, which outline the most efficient routing protocol for every given agricultural use case.

## 2. LITERATURE SURVEY

A new and optimistic age of agriculture and food production, dubbed “Agri-Food 4.0,” is on the horizon, thanks to the successful integration of numerous major emerging technologies by the agricultural industry. Among these are the Internet of Things (IoT), sensor technologies, sensing, UAV technology, LPWANs, Lora Wans, and WSNs, among others [1]. The technologies used in “smart farming” fall into three main categories: data collection, data processing/analysis/evaluation, and precision application. UAVs, on the other hand, are used in intelligent farming for tasks like image analysis and agricultural monitoring, where additional viewpoints are invaluable [2]. Uncrewed Aerial Vehicles (UAVs) help with more than only picture analysis and agricultural field processing; they also provide comprehensive situational awareness by monitoring a field of interest. Additionally, UAVs may transmit data to ground-based tracking stations, which can be very helpful. Prospecting, spraying of pesticides and fertilizers, seed sowing, weakening identification, salinity evaluation, mapping, and planting are just some of the many agricultural applications for UAVs [3].

The term “smart agriculture” refers to a modern farming idea that makes use of Internet of Things (IoT) technology to increase agricultural output. Growers that employ intelligent farming techniques are better able to maximize the benefits of fertilizers and other inputs, so increasing both crop quality and yield. Modernity in the field is impossible for farmers to maintain around the clock. Furthermore, the farmers did not have enough knowledge to make use of a variety of instruments for determining the optimum environmental conditions for their crops [4]. They may use the data gleaned from IoT devices to run an automated system that operates without human supervision and guides farmers to the best possible decisions in the face of any farming challenges [5]. Even if the farmer isn’t physically there, the message can travel and instruct them, perhaps leading to expanded farming operations and higher yields [6]. By 2050, the world’s population is expected to have grown to an astounding 9 billion. Consequently, Internet of Things (IoT) technologies is essential in agriculture to feed such a vast population and make effective use of farmland and other resources, which are in short supply in some areas [7]. Farmers are losing money due to unpredictable weather events brought on by global warming, but with the help of the Internet of Things (IoT) Smart Farming application, they can mitigate their losses [8].

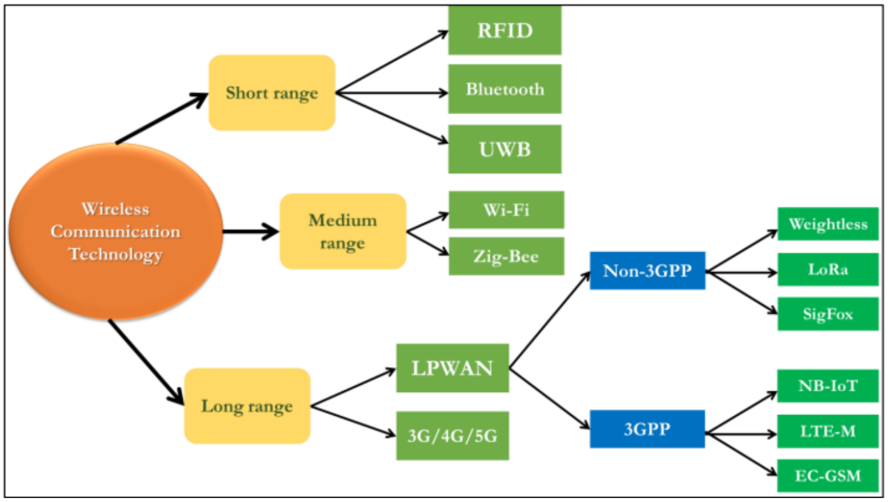


Figure 1. Agriculture communication infrastructure

Many sectors, including agricultural regions, have significantly benefited from the IoT system in recent years. But when it comes to agriculture (Figure. 1), communication infrastructure like base stations or Wi-Fi is woefully inadequate, impeding the growth of the Internet of Things in this industry. One of the primary humps when introducing the IoT in the agriculture business is the poor state of communication infrastructure and related facilities in developing counties and rural areas [9]. In the absence of a stable communication system, the information gathered by wireless sensors will remain unshared. Uncrewed Aerial Vehicles (UAVs) can be used as an alternative means towards this goal [10]. Data for future processing and study is gathered thanks to the UAV system's link to a vast network of wireless sensors. UAVs, sometimes referred to as "drones," are among the most widely used robot innovations in modern smart agriculture [11]. Farmers are increasingly turning to uncrewed aerial vehicles (UAVs) like drones to keep an eye on and manage crop growth. In the rugged areas, where human mobility is complex, and the crops maintain differing heights, some UAVs are being abandoned to spray water and other pesticides powerfully [12].

## 3. DIFFERENT TYPES OF AGRICULTURAL UAVS

The term "Internet of Things" (IoT) is used to describe a network of interconnected physical devices that can collect and process data, perform remote sensing and monitoring, and store data in discrete blocks. The Internet of Things (IoT) is a platform-agnostic environment in which the devices themselves are growing more imaginative, the processing is becoming more intelligent, and the connectivity is yielding more and more valuable data [13]. In addition, IoT gadgets may communicate with one another and with other devices and software in real-time.

The following elements constitute an IoT-based device:

- Input/ Output interface for Sensors
- Input/ Output interface for Sensors
- Interface for connecting to the Internet
- Interface for Memory and Storage
- Interface for Audio/ Video

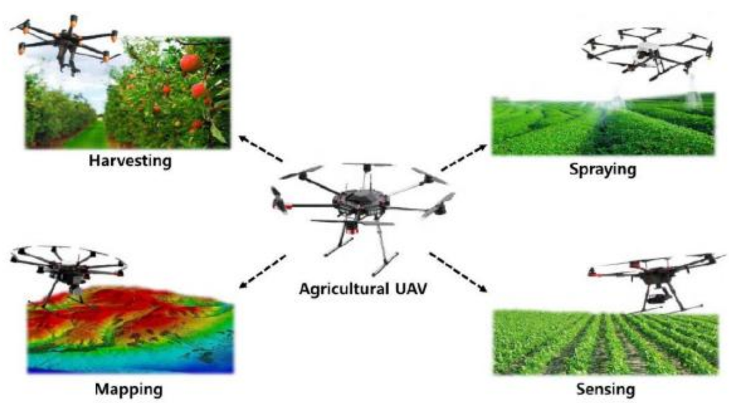


Figure 2. use of IoT applications

Also shown in [Fig 2] is the use of IoT applications in cattle. The utilization of the Internet of Things and Body Area Networks was examined to determine the health of dairy cows (WBANs). An external wireless channel with a frequency of 868 MHz has been identified as suitable for Long Range (LoRa) applications. The results indicated that a log-normal route loss model well explained the global fading. Snail detection using a WSN was first proposed. In addition to detecting snails, the suggested network might also be used to merge statistical models of snail identification with environmental factors like temperature or humidity [14]. Weed identification and management are two of the most important and fruitful uses of UAV technology in modern farming [15]. When it comes to weed detection in rice fields, a novel approach was presented that combines pixel-size multi-spectral and high-resolution RGB photos [16].

### 3.1 Applications of IoT and UAV in Smart Agriculture

Smart agriculture makes extensive use of the Internet of Things and uncrewed aerial vehicles. Some benefits of the Internet of things and uncrewed aerial vehicles in smart agriculture are discussed using a system model in this section [17].

#### I. Smart irrigation

Cameras mounted on agricultural UAVs offer fantastic views of specific problem areas on farms. Farmers may use the cameras to monitor their fields and make adjustments to the areas with low soil moisture, parched crops, and waterlogged zones [18]. Such precise observations were either not possible with conventional agricultural practices, were incompletely accomplished, or were prohibitively expensive due to the necessity of enlisting the services of professionals to undertake the work and produce good results [19]. However, nowadays, UAVs aid farmers by giving them an edge in organizing these tasks on their own.

#### II. Smart crop monitoring

Appropriate sensing of various restrictions on a farm is what crop monitoring is all about. One of the initial elements of smart agriculture is automatic monitoring. Sensors in a prime location can pick up signals and transmit them to a hub automatically, where they can undergo further analysis and command. In order to regulate factors like plant density, plant height, colour, form, leaf size, etc., sensors are employed [20]. Soil moisture, agricultural water limitations like pH level, and climatic factors like airspeed, prevailing winds, rains, radiation, barometric pressure, warmth, humidity, etc., may all be easily managed with the use of IOT and UAVs. As an added bonus, distant sensing is a highly effective kind of presence [21]. Due to the cheap cost of sensors, UAVs flying at lower altitudes may link to remote sensors, allowing for more effective and economical crop management. Because of this, high-resolution records are now being attained by excluding various sorts of artificial factors, such as weather.

### III. Smart pest management

Detection, evaluation, and elimination are the three pillars around which pest control is typically built. It is via the development of raw images captured by UAVs or remote sensing satellites above the crop zone that the most cutting-edge approaches to assessing the presence of infections and pests have been produced. As a result, remote sensors can defend vast areas for less money and more efficiently. UAV Internet of Things (IoT) sensors, on the other hand, are mature enough to perform a broader range of activities in data collection, from environmental sampling to plant health and pest problems over the whole crop cycle. As an example, unlike with remote sensing, IoT-based computerized traps may collect, count, and depict bug kinds, as well as upload information to the Cloud for complete research.

### IV. Forecasting

Smart agriculture’s primary element is forecasting, which makes use of both current and past information to anticipate and calculate critical metrics reliably. Some examples of tools used for predicting include scientific demonstrations and machine learning. Among the many machine learning models made available by UAVs is a regression model for estimating soil phosphorus quantity, a model for predicting soil moisture or the detection of plant disease, an Artificial Neural Network model for predicting field temperatures, etc.

### V. Livestock monitoring

Keeping an eye on livestock is a challenging and time-consuming task in modern agriculture, which has a negative impact on productivity and profitability. This 5G drone that uses the Internet of Things may be used to keep an eye on animals from afar. More and more scientists are interested in studying Unmanned Aerial Vehicles (UAVs) for their potential as an agricultural tool. This research investigates the challenge of using a fleet of uncrewed aerial vehicles (UAVs) to monitor and keep tabs on animals on a pasture, including cattle and sheep. Since the mobility of each specific animal cannot be disregarded, we will suppose that they have all been outfitted with GPS collars. We further assume there are enough UAVs to survey the entire pasture, and our goal is to determine the best way to spread them out such that the average distance between them and the animals is as short as possible. First, we provide an approach for using UAVs to conduct sweep coverage. The initial positions of all targeted creatures can be gathered by deploying UAVs to achieve sweep coverage for the whole pasture. Following this, use streaming k-means clustering to establish and modify the UAV deployment depending on the original positions and received updates from the GPS collars.

### 3.2 Current Trends and Future Challenges

The yield, the amount and quality of the farmed goods, and the growth in profits have all been shown to improve as a result of the incorporation of IoT technology into diverse agricultural techniques. Users have begun to see the benefits of IoT since it may aid in decision-making and provide assistance. However, there are several challenges that must be addressed before the IoT can reach its full potential in terms of technical complexity, customization, user-friendliness, installation, functionality, and system efficiency. Improving farming procedures that restrict the unique aims of farmers will ultimately be the most significant barrier to the widespread adoption of IoT in agriculture.

UAVs were initially used for aerial surveys and crop monitoring in the agricultural industry. Early benefits of using UAVs have surfaced despite the technology’s constraints, which are mostly related to power autonomy and communication efficiency. Researchers, IT professionals, and farmers alike have come to appreciate the many ways in which uncrewed aerial vehicle (UAV) technology may improve the agriculture sector. Weed identification and management are two areas where uncrewed aerial vehicles (UAVs) have played, and will continue to play, a crucial role. End-users now have the opportunity to efficiently manage weeds in cultivation thanks to the nature of this farming problem and the airborne capabilities of uncrewed vehicles.

Further leveraging the potential of UAV technology is possible through the use of machine learning algorithms to multi-spectral photography data gathered by UAS. Additionally, the comparative benefit of such a technology in agricultural practices was highlighted through the possibility of feature extraction for various vegetation indicators using UAV technology and multi-spectral data. Phenotyping at the field level is another crucial aspect of agriculture that benefits significantly from UAV technology. Using UAV systems, farmers may conduct field-level phenotyping to evaluate plant growth and anticipate harvest output more accurately. The advantages of UAV technology over stationary cameras have been demonstrated once again in the field. The use of UAVs in the area has allowed for the early detection and resolution of various complicated challenges in agriculture.

## 4. CONCLUSION

This paper presents a variety of intelligent agricultural use cases, outlining the benefits and applications of deploying IoT with UAVs in farming, recognizing the challenges and constraints of connection of IoT and UAVs in distant places, and presenting a wide range of communication methods. Limitations in communication methods and range were discussed in this chapter. Also, a system model is used to illustrate how IoT and UAV might be used in smart agriculture. Several agronomic concerns with mart farming need to be resolved. Precise irrigated with salts minimization, effective and rational fertilization, and pesticide use, substantially lowering polluting aquifer, proper weed control, hence enhancing agricultural production, and effective operation of crop diseases inside the field are all examples. Goods are produced prediction in farms, as well as plant-by-plant monitoring of crop growth using effective and exact 3D modeling algorithms; efficient transfer of nutrients from roots to seeds using non-intrusive techniques; food traceability using new approach; and delivery of quality certified products to consumers are all novel aspects of the agricultural industry’s future.

## REFERENCES

1. Al-Fuqaha A., Guizani M., Mohammadi M, Aledhari M., Ayyash M (2015) Internet of things: A survey on enabling technologies, protocols, and applications, IEEE Communications Surveys Tutorials, 17 (4), 2347–2376.

2. Atzori L, Iera A., Morabito G. (2010) The Internet of things: A survey, Computer Networks, 54 (15), 2787 –2805.
3. H. S. Abdullahi, F. Mahieddine, R. E. Sheriff, Technology impact on agricultural productivity: A review of precision agriculture using uncrewed aerial vehicles, in: P. Pillai, Y. F. Hu, I. Otung, G. Giambene (Eds.), Wireless and Satellite Systems, Springer International Publishing, Cham, 2015, pp. 388–400.
4. Berni J, Zarco-Tejada P, Suárez L, González-Dugo V, and Fereres E (2009). Remote Sensing of Vegetation from UAV Platforms using Lightweight Multi-spectral and Thermal Imaging Sensors. Int.Arch.Photogramm.Remote Sen.Spatial Inform Sci, 38(6).
5. Elsenbeiss H, and Sauerbier M (2011). Investigation of uav systems and flight modes for photogrammetric applications. The Photogrammetric Record, 400-421.
6. Chouhan S. S., Singh U. P., and Jain S. (2020) Applications of computer vision in plant pathology: A survey, Arch. Comput. Methods Eng., 27 (2), 611-632.
7. Crabit, A.; Colin, F.; Bailly, J.S.; Ayroles, H.; Garnier, F. (2011) Soft water level sensors for characterizing the hydrological behaviour of agricultural catchments. Sensors, 11, 4656–4673.
8. Elarab M, Ticlavilca A M, Torres-Rua A F, Maslova I, and McKee M (2015). Estimating chlorophyll with thermal and broadband multi-spectral high-resolution imagery from an unmanned aerial system using relevance vector machines for precision agriculture. International Journal of Applied Earth Observation and Geoinformation, 32-42.
9. Hachem, S.; Mallet, V.; Ventura, R.; Pathak, A.; Issarny, V.; Raverdy, P.G.; Bhatia, R. (2015) Monitoring noise pollution using the urban civics middleware, In Proceedings of the 2015 IEEE First International Conference on Big Data Computing Service and Applications, Redwood City, CA, USA, 52–61.
10. Gubbi, J.; Buyya, R.; Marusic, S.; Palaniswami, M. (2013) Internet of Things (IoT): A vision, architectural elements, and future directions, Future Gener. Comput. Syst. 29, 1645–1660.
11. N. Sabri, S. A. Aljunid, R. B. Ahmad, M. F. Malek, A. Yahya, R. Kamaruddin, M. S. Salim, Smart prolong fuzzy wireless sensor-actor network for agricultural application, J. Inf. Sci. Eng. 28 (2012) 295–316.

12. Medela, A.; Cendón, B.; González, L.; Crespo, R.; Nevares, I. (2013), IoT multiplatform networking to monitor and control wineries and vineyards, In Proceedings of the 2013 Future Network Mobile Summit, Lisboa, Portugal, 1–10.
13. R. Ehsani, M. Sullivan, Soil electrical conductivity (ec) sensors, extension factsheet, aex565-02. (2002).
14. Torres-Ruiz, M.; Juárez-Hipólito, J.H.; Lytras, M.D.; Moreno-Ibarra, M. (2016) Environmental noise sensing approach based on volunteered geographic information and spatio-temporal analysis with machine learning. In Proceedings of the International Conference on Computational Science and Its Applications, Beijing, China, 95–110.
15. Samir, K.C. and Lutz, W., 2017. The human core of the shared socioeconomic pathways: Population scenarios by age, sex and level of education for all countries to 2100. Global Environmental Change, 42, pp.181-192.
16. Le Mouël, C. and Forslund, A., 2017. How can we feed the world in 2050? A review of the responses from global scenario studies. European Review of Agricultural Economics, 44(4), pp.541-591.
17. Thomasson J A, Sui R, and GE Y (2011). Remote sensing of soil properties in precision agriculture: a review. Front Earth Sci, 229-238.
18. Islam, N.; Ray, B.; Pasandideh, F. (2020) IoT Based Smart Farming: Are the LPWAN Technologies Suitable for Remote Communication? In Proceedings of the 2020 IEEE International Conference on Smart Internet of Things (SmartIoT), Beijing, China, 270–276.
19. Navulur, S.; Prasad, M.G. (2017) Agricultural management through wireless sensors and Internet of things. Int. J. Electr. Comput. Eng., 7, 3492.
20. Zavatta G (2014) Agriculture Remains Central to the World Economy, 60% of the population Depends on Agriculture for Survival, NetExpo.
21. Zheng, R.; Zhang, T.; Liu, Z.; Wang, H. (2016) An EIoT system designed for ecological and environmental management of the Xianghe Segment of China's Grand Canal. Int. J. Sustain. Dev. World Ecol, 23, 372–380.