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UAV surveying and mapping information collection method based on Internet of Things

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ABSTRACT

The unmanned vehicles (UAVs) are most useful communication elements in current technology platform. The emerging communication applications like IoT, cloud and Datamining are most prominent to surveillance. This research study is concentrated on IoT (Internet if things) based UAVs design based on information collection methodology. Autonomous flying vehicles with IoT connectivity to ensure site health and safety applications. It goes through the fundamental limits and flaws of current state-of-the-art solutions for the same goal, such as route planning optimization challenges, lightweight machine learning (ML) and machine vision algorithms, coordination in IoT communications, and IoT network scaling. As a result, this article will assist the reader in delving deeper into a variety of open research questions.

1. Introduction

Incorporating information and communications technology (ICT) with traditional agricultural methods is causing a fourth revolution (Farming 4.0). A wide range of promising new technologies might revolutionize agricultural practices. The IoT, unmanned aerial vehicles (UAV), big data analytics, and machine learning are just a few of the technologies that are being applied in this industry. Farmers can monitor a wide range of agricultural characteristics, such as environmental circumstances, economic expansion status, soil properties, irrigation, pest and fertilizer management, and green - house production environments, using a variety of tools thanks to the increasing use of technology in agriculture.

Because smart farming decreases the ecological imprint of conventional farming, it is considered green technology. Leaching issues and emission levels may be reduced even further in precision farming by using efficient irrigation techniques and minimizing the use of fertilizers and pesticides in harvests.

An IoT is a game-changing advancement in wireless communication technology. The core idea is that various physical items or devices may be linked to the Internet using appropriate addressing systems. Industry, transportation, healthcare, automobiles, smart homes, and agriculture are just a few of the sectors where IoT technology may be put to use. IoT devices may help improve agricultural operations by providing relevant data on a broad variety of physical aspects. Wireless sensor networks (WSNs) play a critical role in IoT technology since wireless data transmission is used by the great majority of IoT applications in different sectors.

Unmanned aerial systems (UAS) may also be used as sensors and/or communication platforms in precision agriculture. Its advent with inexpensive alternative technology has facilitated climate condition monitoring, temporal resolution, and high spatial, and the recording of pictures. Today, the usage of unmanned aerial vehicles (UAVs) in agriculture is growing to help farmers monitor and make decisions on the field. Drones are used for a wide range of agricultural purposes, including irrigation and pesticide application. Using UAS technology and new 3D reconstruction modelling tools, researchers have been able to monitor agricultural development on a plant-level. In the agricultural industry, new and promising "Agri-Food 4.0″ technologies are being integrated to create a new and more efficient agriculture-food system. LPWAN and long-range wireless access networks (like LoRaWAN) are among the IoT technology's many features, which also include smart sensors and remote sensing. Data collection, data analysis, and evaluation and precision application technologies are all components of smart agriculture, and individual countries such as the United States, Brazil, India, Italy, and Ireland have successfully implemented different combinations of these new technologies in smart agriculture.

2. Related work

IoT and UAV may be used to monitor agricultural diseases and pests from both a micro and large perspective. It is possible to gather

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agricultural growth weather information in real time using affordable sensor nodes in the IoT. A cloud data centre receives and analyses photographs taken by UAVs to determine the extent of damage caused by pests and illnesses using spectrum analysis technologies [1]. Alsamhi, S. H. et al. [2] improved intellect smart cities, an overview of newly suggested methodologies and applications for collaborative drones and IoT is presented in this article. Using IoT-enabled collaborating drone technology and the Internet of Things (IoT), these smart cities may gather data, protect citizens' privacy and security, handle disasters, reduce energy consumption, and improve city quality. For the most part it's concerned with quantifying how smart cities are in terms of things like environmental stewardship, quality of life and public safety. Agricultural IoT and UAV technologies are examined in this study, which includes a review of the most recent studies. UAV systems may also be used in a variety of agricultural settings, including some that are difficult to access. One of the most essential technologies in the field of precision agricultural is IoT& UAV, which we believe are two of the most transformative [3]. It is possible for fires to erupt in a wide range of locations including open regions, agricultural lands, woods, office buildings, and residences. UAVs and wireless sensor networks are used in this article in order to identify fires at an early stage and prevent damage. According to the simulation findings, the suggested system's fire detection rate is up to 98% better than previous methods [4]. Incorporating IoT with UAVs might result in an airborne UIoT system, which could deliver a variety of value-added services both above and below the earth's surface. As a result, current MAC protocols for the IoT are examined in this research project. A look at the UIoT MAC protocol's communication architecture and design concerns is first discussed [5]. Recent studies have indicated that the Internet of Things (IoT) has the potential to revolutionize several sectors, including agriculture. Modern ICT (Information and Communication Technologies) are being used in agriculture. In addition to presenting the excellent outcomes, this session will showcase the IoT hardware and software for smart farming [6]. Large-scale IoT is increasingly being utilized in a wide range of industries because to the fast advancement of information technology. Finally, the suggested answer is tested in an experiment. The trial results suggest that the method can enhance data collecting efficiency [7]. An UAV to power IoT wireless nodes is presented in this work, along with a study of the most efficient way to allocate resources using dynamic game theory. Numerical models are used to demonstrate the suggested model and approach's efficacy [8]. Simulation findings demonstrate that the DSC-UAV surpasses the competition in terms of data collecting efficiency while retaining high success rates, low average access delays, small block probabilities, and low collision probabilities. This is a validation of the proposed analytical models [9]. Data collection via UAVs is hampered by buffer overflows at the IoT node and by lossy aerial channels, which make transmission difficult. There are a lot of network states and activities in POMDP for an IoT network supported by a UAV in reality; however the most recent information is not accessible at the UAV. When using a UAV with out-of-date network information, it is suggested that an onboard deep Q network (DQN) be used 10]. In order to fulfil the rising need for food to feed the world's expanding population, agribusiness is increasingly turning to cutting-edge technology like the IoT, UAV the Internet of Underground Things (IoUT), and data analytics All relevant technologies, their use cases and current case studies as well as research papers demonstrating their usage in Agriculture 4.0 will be discussed in Refs. [10,11].

3. Methodology

Sustainability and Intelligent Agriculture with IoT and UAVsBy 2050, the world's largest population is expected to reach over 10 billion, needing a 70.00% increase in the food supply. Drones, robotics, AI, the IoT, and big data are all required to meet the soaring food demands in the agriculture industry today. IoT and drones in smart agriculture might take agricultural outcomes to previously inconceivable levels, as we'll

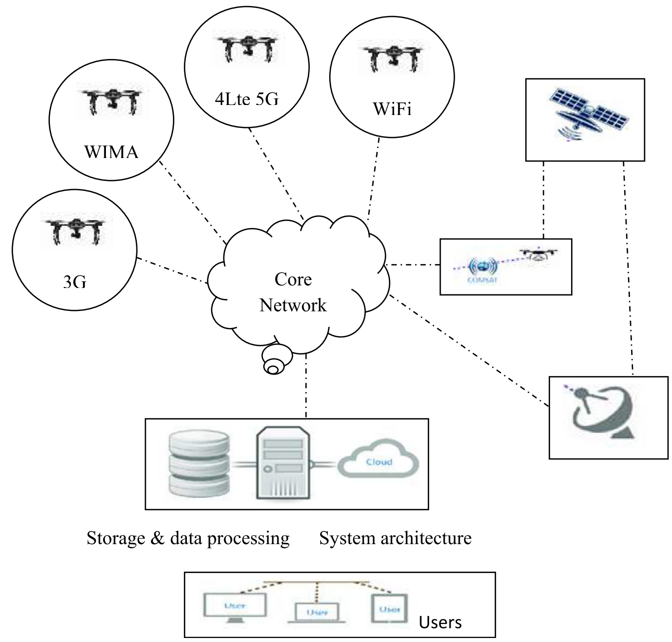

Fig. 1. IoT applications in different sectors.

discuss in this portion of the sectionIoT in Smart agricultures:Camera technology, internet service, cellular technologies, sensed and transmitted data, and more all play a part in the Agricultural Internet of Things (AIoT). The usage of wireless communication technology is essential to the success of IoT systems, which may be characterized by spectrum, transmission distance, and use cases. Perception, network, and application layers are the three layers of IoT, as shown in Fig. 1.

There are a wide variety of sensors, terminal devices, wireless sensor networks (WSN), and so on that make up the perception layer Sensors at this layer gather data on temperature, wind, moisture, nutrient concentration, crop diseases, insect pests, and more. In order to do further processing and analysis, the data collected by embedded devices is sent to a higher network layer, as shown in Fig. 2. Agricultural and animal products are tracked and monitored using these devices. When it comes to temperature and humidity management in warehouses and distribution centers, wireless sensor networks (WSNs) are often used. RFID technology, on the other hand, is the best example of a linked gadget. Data is stored on RFID tags in the form of the Electronic Product Code (EPC), which may subsequently be read and altered by RFID Readers in the agriculture sector.

In order to communicate wirelessly, protocols and standards are used. It is simpler for gateways and end nodes to connect to the internet using IEEE 802.15.4, a wireless standard. These include ZigBee, Sigfox, WirelessHART, ISA100.11a and ISA100.11b, Bluetooth Low Energy (BLE), DASH7 and other protocols. The following are the transmission distance categories for these standards:

- Bluetooth, RFID, and UWB are all examples of short-distance wireless communications technologies.
- Technologies for medium-distance wireless communication that extend from 10 to 100 m ZigBee and Wi-Fi are included in this group.
- There are a number of different types of long-distance wireless connection, including as cellular networks and Low Power Wide Area (LPWA) technologies that fall under the Non-3GPP (LoRa, Sigfox, and Weightless) or 3GPP (NB-IoT, LTEM, EC-GSM) classifications.

Classifications of communication technologies are shown in Fig. 3.

Classifications based on communication distance:Short-range applications should use IEEE 802.15.4-based protocols [11], which are intended for Low-Power Wide-Area Networks (LPWANs). With a data

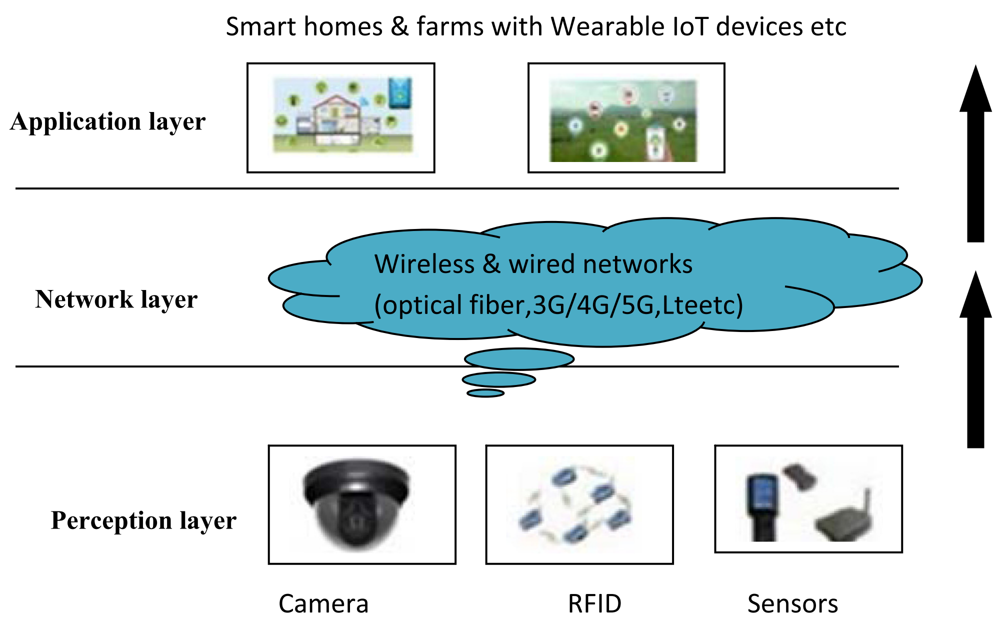

Fig. 2. IoTarchitecture

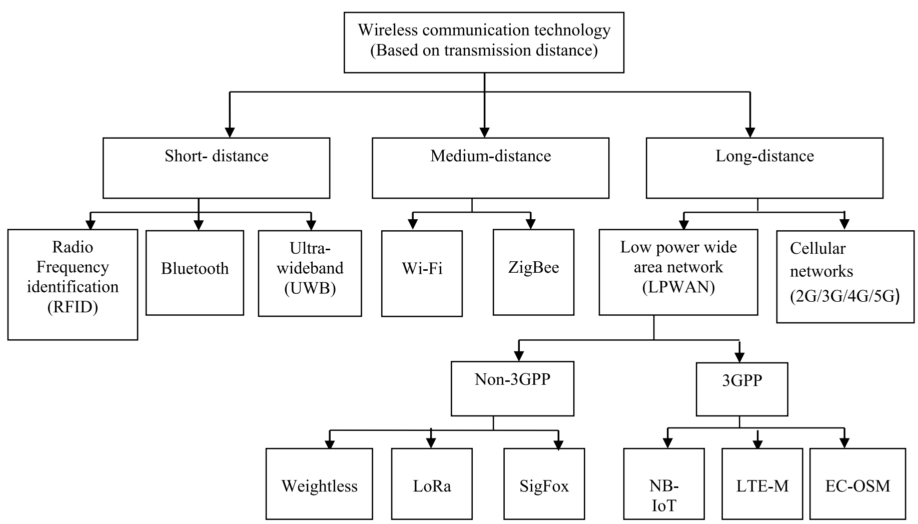

Fig. 3. Communication technologies used in Smart Farming based on the Internet of Things (IoT).

rate of 20 Kbps to 250 Kbps and a variety of frequencies including 433 MHz, 868 MHz, 915 MHz, and 2.4 GHz, it also has a maximum LoS range of 100 m. When it comes to long-distance networking, IEEE 802.11 is the finest option for you. There are some situations in which mobility is vital, and the IEEE 802.11p standard was published in 2010. This release seems to be especially relevant to agricultural settings because of its wide transmission range, maximum permitted power of 1 W, and the less disturbed band of 5.9 GHz ISM frequency [9].

$$X(t) = Hs(t) + n(t), t = 1, \ldots, N \text{ ——} \tag{1}$$

$$H = \begin{bmatrix} H^{(V_r,V_t)} & H^{(V_r,H_t)} \\ H^{(H,V_t)} & H^{(H_r,H_t)} \end{bmatrix} \tag{2}$$

$$R_K \approx log_2\left(1 + \lambda_k P_{TOT} {h_k}^2\right) \tag{3}$$

$$h(n) = \sum_{i=0}^{L-1} h_l \, \delta(n-1) \tag{4}$$

$$Y = XH + V \tag{5}$$

$$\begin{bmatrix} Y[0] \\ y[1] \\ : \\ y[N-1] \end{bmatrix} = \begin{bmatrix} X[0] & 0 & \cdots & 0 \\ 0 & X[1] & \vdots & \\ \cdots & 0 & \ddots & 0 \\ 0 & \cdots & 0 & X[N-1] \end{bmatrix} \begin{bmatrix} H[0] \\ H[1] \\ : \\ H[N-1] \end{bmatrix} + \begin{bmatrix} V[0] \\ V[1] \\ : \\ V[N-1] \end{bmatrix} \tag{6}$$

Only long-range technologies can provide enough coverage, and this is why they are so highly sought after. Mobile communications techniques including 3G, 4G, Long Term Evolution (LTE), and 5G are the most suited and reliable standard for precision agriculture since it needs large amounts of real-time data to be transported and analysed. For example, in LTE-Advanced Release 10, downlink data rates may reach 3 Gbps and uplink data rates can reach 500 Mbps, with a latency of less than 10 ms. In addition, real-time Device-to-Device (D2D) communication is projected to be provided via the 5G communication infrastructure, allowing for vehicle navigation. Another benefit is that a large number of devices per square kilometremay be supported Higher frequency bands allow 5G

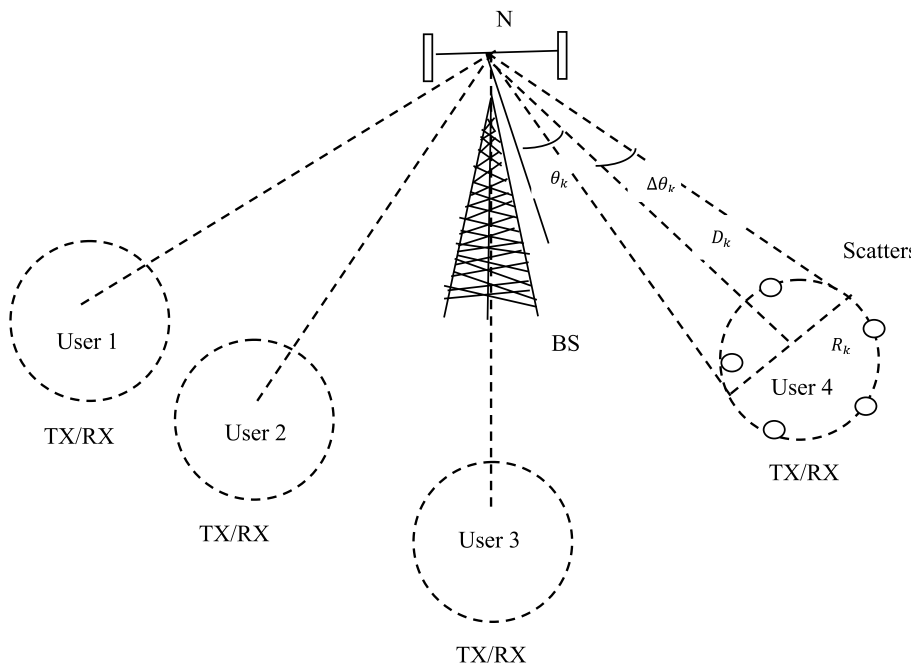

Fig. 4. Communication with UAVs.

to provide greater channel bandwidths than LTE. In rural areas, 5G technology may provide new possibilities for agricultural equipment, thanks to faster data rates and longer transmission distances. There are, however, concerns about 5G's availability and economic sustainability for rural areas shown in Fig. 4.

The most reliable long-range communication technology for the IIoT IEEE 802.11ah and LoRa/LoRaWAN (IoT). IEEE 802.11 was revised in 2017 to support Internet of Things (IoT) applications like smart metering [9]. This technology has a wider range of coverage and uses less power than Bluetooth and IEEE 802.15.4 while still using 900 MHz license-exempt frequencies. Tens of thousands of devices within a 1-km radius may be connected by a single access point. But LoRaWAN is one of the most promising battery-powered wireless node protocols for an LPWAN network Following this part, we'll go into further detail on LoRaWAN.

The layer of the application: At the high level of IoT technology, advantages and utility are most clearly seen at the application layer. Soil, water, and plant and animal conditions are all monitored by a variety of smart structuresor systems in this tier. The early detection and treatment of disease and insect pest infestations, as well as the safety of agricultural products, are made possible thanks to these layers, and as a consequence, productivity may be enhanced.

It's now feasible for a bunch of drones outfitted with various sensors and 3D cameras to operate together as a swarm, allowing landowners

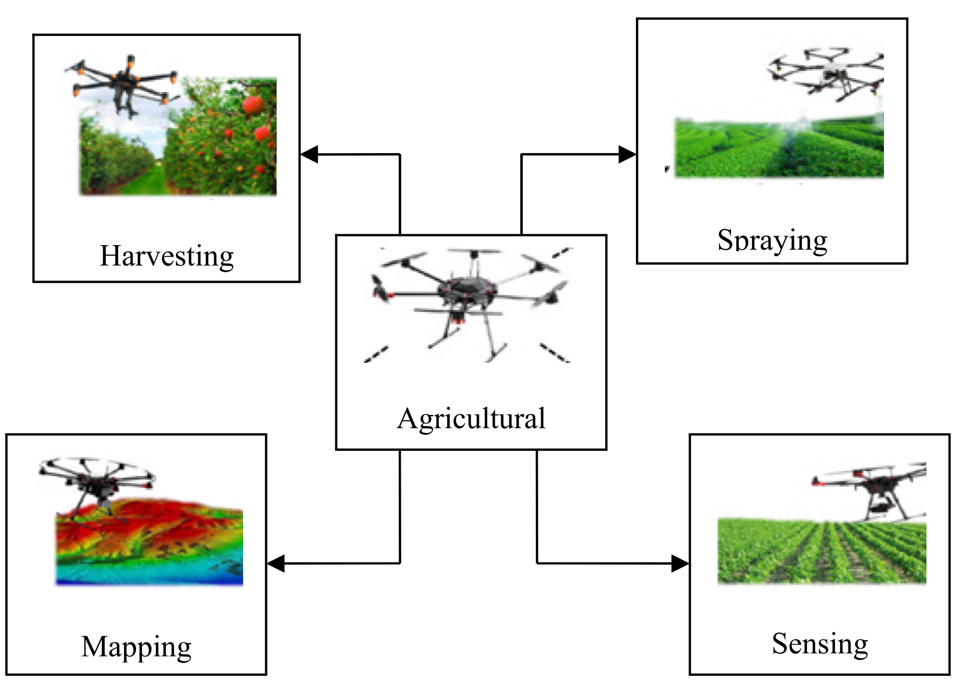

Fig. 5. Different types of farming UAVs.

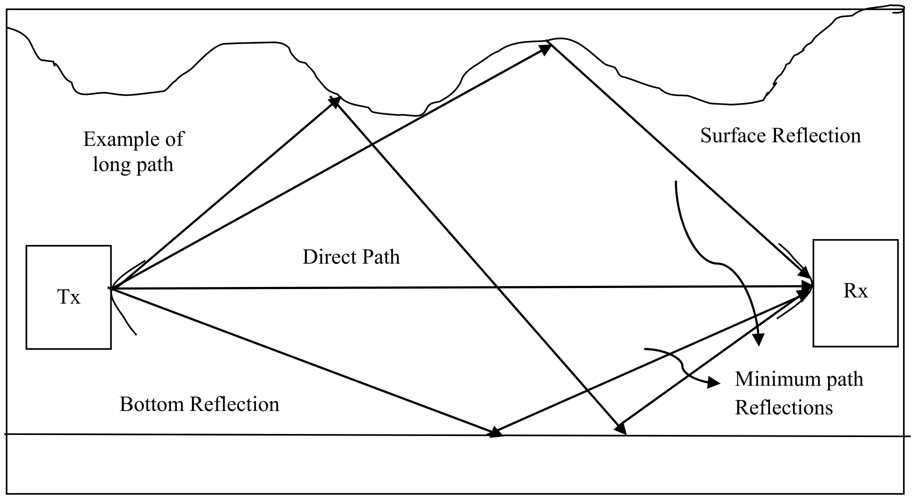

Fig. 6. UAVs modeling.

more control over their property's administration. Farmers may get a bird's eye view of their fields with these agricultural UAVs, allowing them to better monitor and control their operations while also increasing stability, production, and measurement accuracy. They've also helped expand several agricultural fields, such as the prospecting and spraying of fertilizers and pesticides, the detection and removal of weeds, seed planting, the evaluation of fertility, and mapping. UAVs have made great strides in recent years, but there is still no. of problems that need to be addressed, including battery efficiency, limited flying duration, communication distance and payload. Since energy is a limited resource for UAVs, researchers have concentrated on minimizing the amount of power they require.

However, more effort must be put forward in order to overcome the issue of poor connection. In this work, we outline the connection limits of agricultural UAVs so that researchers may perform research to resolve these concerns. Shown in Fig. 5.

A wide range of smart agricultural applications may benefit from the integration of IoT and UAVs. Smart farming may be used in a variety of ways, and this section focuses on some of the more frequent.

Monitoring: Many parts of a farm may be monitored at any one moment using the word "monitoring". Automated monitoring is one of the first smart agricultural elements to be used on a large scale. Data may be automatically collected and sent to a gateway through sensors situated in important areas. Sensors monitor a variety of plant characteristics, including leaf area index and plant height. In addition to the salt and pH level of irrigation water, they can also measure parameters such as pressure changes, temperature and humidity, wind speed, wind direction, rainfall, radiation, etc. This is an excellent example of how remote sensing may be used to its fullest potential. Low-altitude UAVs equipped with remote sensors can monitor crops efficiently and cost-effectively because of their little weight. High-resolution data may be obtained by eliminating different limitations, such as weather.

Mapping: Agricultural fields may be mapped in 2D or 3D using UAVs. These maps, for example, show the agricultural area, soil conditions, crop state, and infection inside the crop. Researchers used UAV photos to produce high-resolution maps of radiation interception spatial changes. Precision agricultural activities such as separating fruit quality regions, detecting deforestation areas, and maintaining agronomic control over homogenous zones all benefit from the usage of these maps.

Detecting Weed and Infestation: Weed and infestation detection using unmanned aerial vehicles (UAVs) is another smart farming application that may be quite beneficial. Pest infestations and diseases in crops cost an estimated $33 billion in yearly damage in the United States, according to a research. In order to minimize the harm, early diagnosis is vital. Using multispectral cameras placed on a UAV, researchers were able to gather data on the vegetation index of grapes. Weed identification, infestation detection, weed mapping, and other uses call for vegetation indices of this kind, which may be found in this dataset. Weed and pest detection in crops and plants has been studied extensively using RGB cameras, hyper spectral cameras, and multi-spectrum sensors placed to UAVs.

Planting Seeds and Seedlings: The use of UAVs may certainly improve the efficiency of seed and seedling planting. They made use of a UAV-based system to deliver seeds, fertiliser, and other plant nutrients efficiently and on schedule. Scientists are now working on building UAVs with image recognition technology and an improved planting strategy for the planting of seedling and seedlings.

Spraying Pesticides and Fertilizers: For fertilizer and pesticide application, UAVs have demonstrated to be more effective and faster than speed sprayers or wide-area sprayers. Sickness and pollution among agricultural workers are inversely proportional to the quantity of pesticides used on each hectare of land under cultivation. Decontamination of up to 50 ha per day is possible with the use of UAVs, which need just around 10 min of labour per 0.5-ha area [6]. Utilizing unmanned aerial vehicles (UAVs) is a great way to save money on labour costs. In citrus plantations, for example, researchers used a UAV to spray fertilizer at different heights to identify the optimal degree of preventative labour.

Forecasting: Forecasting is an important part of smart farming since it makes use of both current and past data to predict and estimate important traits. Scientific modelling and machine learning are two technologies that are often used in the forecasting process. For example, ANNs have been used to assess soil phosphorus concentration, forecast moisture levels, and identify plant diseases using regression models and ANNs.

Controlling: Automated monitoring in IoT-based smart agriculture results in a system that automatically adjusts to specified thresholds for the monitored variables. Controlling may also benefit from forecasting. It is possible to decrease production losses by using smart irrigation systems, which activate watering based on forecasts of drought conditions, for example Weather predictions and real-time soil moisture and temperature sensors have been utilized to manage a completely autonomous watering system. It is possible to manage the pace of feeding, fertilization, and weed control technologies using sensors placed in tractors and unmanned aerial vehicles (UAVs).

4. Results and discussion

Inter symbol interference, inter channel interference, and peak average power ratio PAPR factors have degraded the implementation of multi carrier communication in UAV channels. A developing impulse

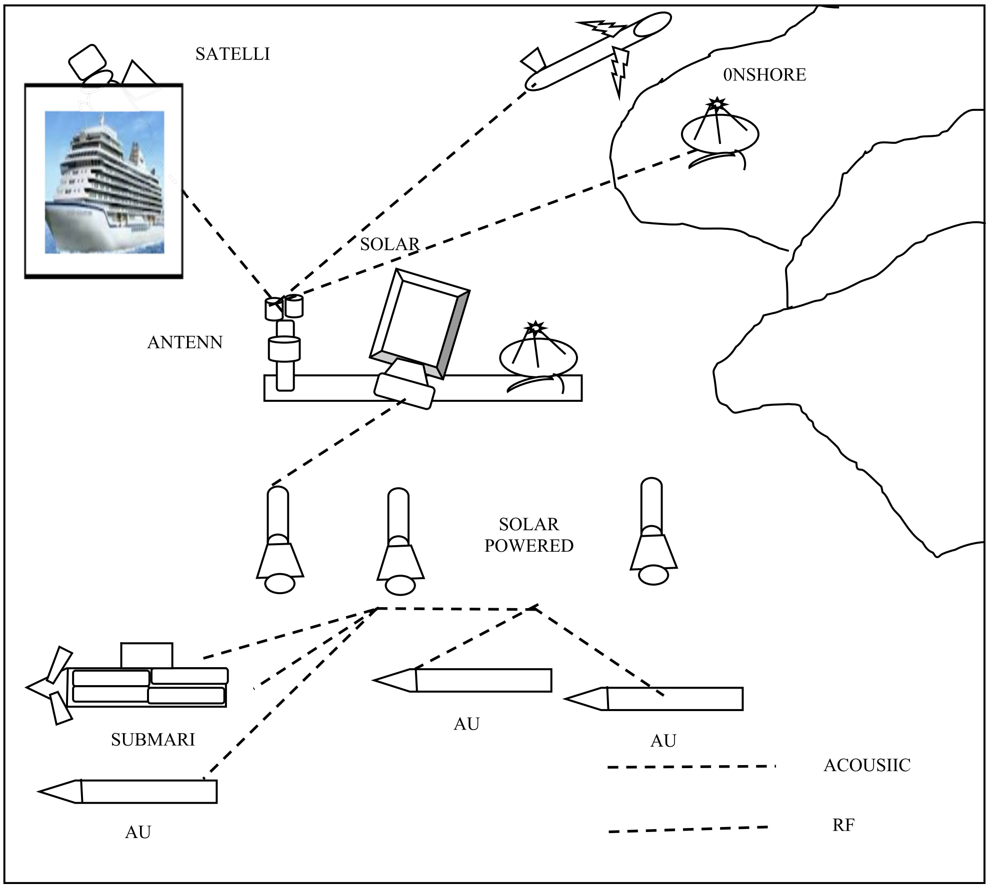

Fig. 7. UAVs directions.

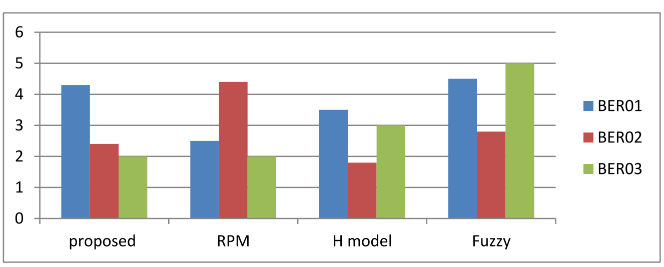

Fig. 8. System error rate analysis.

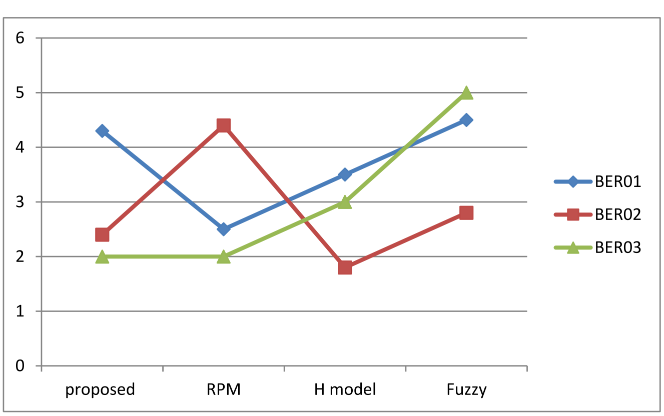

Fig. 9. Graph representation of System error rate analysis.

response channel is necessary in order to enhance the Doppler shift in UAVs. Various UAV channel estimate models work using two methods: a) geometrical and b) measuring shown in Fig. 6.

The pursuit matching with randomized forest computation is expressed by equation (4). This research is connected to the randomized forest process. Because random forest is a machine learning model and pursue matching is a matrix visualizing, we can estimate the channel in an accurate and efficient manner shown in Fig. 7.

Pursue match is often used as a pre-processing phase in communications, however in this paper, adaptable pursue comparing using the random forest approach is investigated. This approach updates the coefficients and refreshes the circumstance at each and every point in time. Because this characteristic isn't available in any approach, the machine learning algorithm with approach finding produces the most reliable data.

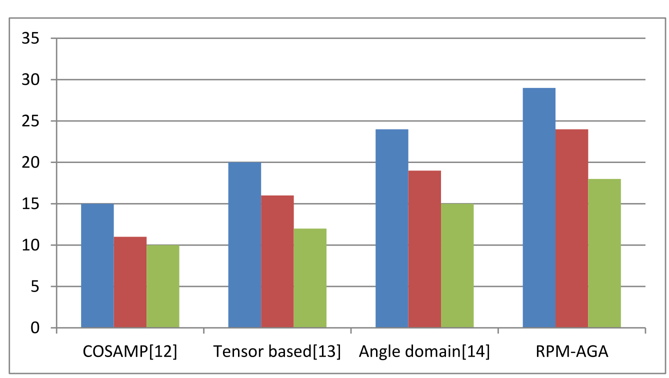

Fig. 10. Graph representation of Bit error rate.

Table 1
Results comparison.

parameter	MMSE	CSE	BER	SER	AVG SNR	SPECTRAL EFFICIENCY	ACCURACY	PRECISION
Pilot base estimation	1.6678	1.12	1.17	1.21	1.141	79.4%	69.1%	1.16
Compressive sensing	1.191	1.19	1.16	1.91	1.142	87.2%	81.2%	1.18
Tensor-Based	1.189	1.187	1.14	1.89	1.129	89.7%	87.4%	1.181
Angle-Domain	1.171	1.172	1.14	1.72	1.126	91.1%	89.4%	1.19
Proposed	**1.121**	**1.144**	**1.11**	**1.12**	**1.122**	**94.2%**	**91.4%**	**1.99**

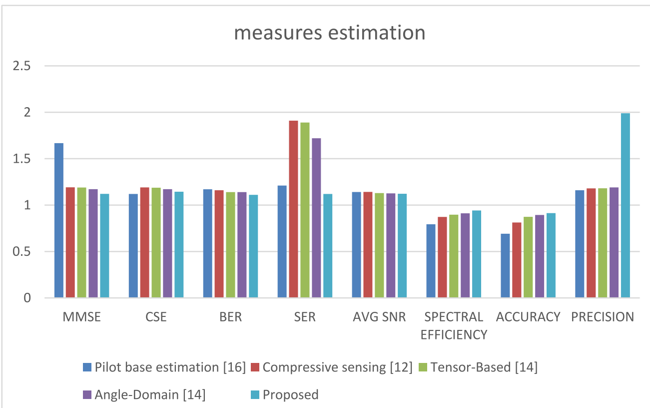

Fig. 11. Comparison of results.

The above Figs. 8 and 9 are clearly explaining about System error rate analysis, this approach may assist underwater communication systems in dealing with the ever-changing character of the channel. The results of these simulations may be seen using the Matlab tool and the Bellhop simulator.

Explains the differences between current approaches and the suggested RPM-ADA model, stating that the MMSE is 0.021, the CSE is 0.043, the accuracy is 91%, and the precision is 0.99. When compared to other approaches, the RPM-ADA is more accurate shown in Fig. 10and Table 1.

Fig. 11 shows the signal to noise ratios vs. system error rate. When contrasted to angle, matrix, and compression essential part channel estimation, the RPA-ADA technique achieves a higher signal to noise ratio and a lowest operating error rate. When compared to the RPM –AGA paradigm, make a positive impression communication is more often used to calculate the channel. In this scenario, technical glitch has more numeric value.

5. Conclusion

The IoT matching optimization approach is developed in bellhop simulator employing 0 to 1500mtr water depth, and an improved UAV has been created using RPM with huge MIMO methodology. For orientation, spherical and cylindrical type channels are used, taking into account multipath propagation at seabed and surface. Find the target with improved channel estimate by altering the number of users and base station angle. For acoustic communication, a random forest pursuit matching algorithm based huge MIMO- OFDM channel is devised in this study. Existing approaches, such as compressed sensing, tensor-based, and angle-based channel estimation, are developed, but they have additional limitations, as discussed above. Along with these challenges, existing models also face time changing and multi path fading. As a result, the suggested technique, i.e. IoT-AGA, accurately resolves all of the aforementioned concerns. Finally, the channel estimation error, bit error, and system failures for the developed model are quite low. As a result, this model is ideal for millimeter wave communications and is a good channel estimate model. When compared with existing approaches, accuracy improved by 21.9% and spectral efficiency improved by 9%. This IoT huge MIMO outperforms modelling findings and puts current technology to the test.In future studies the spectral efficiency is improved by efficient algorithms and complications in the estimation of channel models is reduced by suitable communication system.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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