



UAV-Based Platforms and Networks

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UAVs (Unmanned Aerial Vehicles) are now being used not only in military operations but also for doing a lot of other jobs and easy decisions. They are now being used for various purposes such as parcel delivery, farming, pollution mitigation, disaster management, traffic management, and surveillance. This paper tries to understand how useful it is to use UAVs to carry the Internet of Things (IoT) services and making decisions. UAVs can be equipped with cameras, sensors and communication devices and radio access technologies such as cellular networks. Due to the advancements in wireless communication technologies such as LTE 4G/ 5G, it has become reliable and easy to use these drones to provide such services. For example, UAVs can be used as aerial base stations to collect data from IoT devices on the ground, or they can be used for surveillance using facial recognition abilities. There are some challenges regarding reliability, making decisions and real-time communications, which need to be overcome. If these problems are resolved, the UAVs can be deployed worldwide for providing IoT services easily.

Keywords: Iot; Single-Rotor Helicopters; UAVs (Unmanned Aerial Vehicles); Fixed-Wing Drones; 4G-LTE or 5G; Multi-Rotor or Quad-Copter UAVs

Introduction

Because of technological advancements, all the devices including UAVs are continuously becoming smaller and cheaper and hence becoming useful for making lives easy. It is now much easy to bear the cost of these UAVs and to use them for different applications, such as search, rescue, supplying medical aid, and gathering information secretly, delivering parcels [2] and they can do it in a timely manner, also they can minimize the risk factor in dangerous situations. But these birds cannot fly themselves, and at least one ground-based pilot is required. But in some cases, depending upon the size and technology, more men are required. However, UAVs are still less expensive and they consume less fuel and their maintenance cost is also very low [6]. Their performance and use in different field of life has always been amazingly impressive until now. That's why, this technology has now become very important in military operations and also in other commercial and non-commercial organizations [2,6].

Historical records show that UAVs were used, for the first time, in the First World War [1]. Those UAVs were radio-controlled aircrafts, used as "flying bombs" by the United States (US). Militaries in the world have been building and using such flying devices as targets for training and as decoys. These UAVs, in 1960s, were utilized for reconnaissance purpose. And by the 1970s, for the first time, these UAVs took part in active combat. However, until 1990s, these UAVs had never been used in operations, because reliable communication links were absent [1]. And the use of these devices

in other commercial and non-commercial fields of daily life, such as medical supplies, disaster management, rescue services, and parcel deliveries etc. has just got started [2].

UAVs have picked up distinction among continually developing network of beginners, likewise among expert specialist co-ops. New correspondence advancements, for example, LTE 4G/5G and MEC (versatile edge figuring) will broaden the application territories of UAVs. This paper talks about the capability of UAVs, outfitted with IoT gadgets, in conveying administrations, while flying noticeable all around. Diverse instances of the utilization of these IoT empowered UAVs are talked about all together take a gander at the significance of UAV-based IoT stages.

What is IoT

The improvement of specialized gadgets and remote system advances is continually moving towards new time of the master frameworks in Internet and broadcast communications. Every one of the things, including the specialized gadgets, as well as every single physical item on the Earth will be associated with the Internet, and will be controlled by utilizing remote systems administration guidelines. This idea is known as the "Web of Things (IoT)".

It has pulled in the consideration of the analysts as of late. The idea of IoT is connected with various research zones, for example, body region systems, D2D (Device-to-Device) interchanges systems, home territory systems, UAV (Unmanned Aerial Vehicle) sys-

tems, satellite systems, etc. There are likewise a few various types of utilizations that are made by utilizing IoT advances. It is normal from the idea of IoT that it will incorporate into our general public and will bolster our day by day life.

Types of UAVs in use today

Whenever UAVs are discussed, the first image that comes into one's mind is of that drone which is being used for military purposes. But, there are also available other types, that can be used in different civil, military, commercial and non-commercial operations. For example, those operations that require quad-copters cannot be completed successfully using fixed wing UAVs. It is very necessary to choose suitable UAV type for a job.

Fixed-wing drones

These UAVs are famous for military and defense related applications. They use a wing just like a regular aircraft to fly. They don't have to waste energy in maintaining hovering positions while flying. They only use their energy to move in moving forward. Because of less energy consumption, they can fly for more time, and can be used to map larger areas, and monitor points of interest on the ground. They use gas engines instead of electric engines, which increase their flying limit up to 16 hours [2].

The disadvantage of this type of drones is that they cannot maintain hovering positions, which makes them useless for photography and they become difficult to be launched and landed. There are different processes for launching and landing this type of drones that are chosen according to their size. They can be launched from a human hand or a runway may be needed if the size is so big. They also require higher required skill level and entry point price.

Single-rotor helicopters

These are useful in capturing 3D data from large areas like agricultural lands, cities and forests [2]. It is clear from their name that they have only a single large rotor, but a small tail rotor may also be required to move them forward. Single-rotor wins against multi-rotor drones because of their increased efficiency and they are also capable of long endurance flight missions. They have gas motors and a single rotor which has long blades. They are suitable for aerial laser scanning applications because of their fast forward flight capability and they can also hover in one position. However, because of their perplexing structure and restrictive cost, they are not an appropriate for the normal consistently pilot. Additionally, because of the bigger size of the heli-automaton's rotor edges, there is an expanded hazard for serious damage or even demise. Single-rotor rambles require visit upkeep every now and again, which is an expansion in expense.

Multi-rotor or quad-copter UAVs

These are suitable for short time aerial visuals, because they provide greater control and precision. Quad-copters are good choice for aerial photography. However, their scope of work is limited because of their low-speed, they have less endurance. This

makes them unsuitable for large-scale aerial mapping and long-range monitoring. Their battery life is also very short, and light camera reduces the flight time to 20-30 minutes only [2].

Fixed-wing hybrid VTOL (Vertical Take-Off and Landing drones)

VTOL drones are UAVs which are the latest in distance piloting technology. These drones have successfully combined the abilities of fixed-wing drones with the hovering ability of multi-rotor and single-rotor drones. Also they are able to be launched and landed vertically. They were designed in 1950 and 60s [2], but at that time they failed to do their job successfully, and were cast aside. However, headways in gyrostabilizers, accelerometers and autopilot innovation have made Fixed-wing half and half VTOL flying machines a suitable alternative for remote guiding applications over the globe indeed. Settled wing cross breed VTOL UAVs are currently the flying machine of decision for elevated conveyance administrations.

UAV-Based IoT platform

In spite of the fact that UAVs are playing out their genuine obligations in different fields of life, yet they can be utilized for offering some different administrations, for example, the Internet of Things (IoT) when there are accessible IoT gadgets which can be controlled remotely [17]. This can help UAVs shape an imaginative UAV-based IoT stage operational noticeable all around, and help diminish costs in making novel biological communities. The information can be gathered from remotely controllable IoT gadgets settled on UAVs, turning them on and off at the explicit occasions and situating them in right ways [17]. Keeping in view the energy requirements, the data collected from these IoT devices can also be processed onboard UAVs or it can be sent to the cloud servers on the ground for processing. In order to build an efficient IoT platform using UAVs we have to consider whether the platform will be centralized or distributed, and it will be decided on the basis of very important information regarding the flying routes of the UAVs, IoT equipment mounted on them, and battery power available [17]. For example if a police department needs a video record from a position that is not in the current route of the UAV, it will have to change its route. In such cases, the information regarding the battery status, geographical position becomes very important for decision making. To transmit the data from UAVs, any wireless technology (e.g. Wi-Fi, and cellular networks such as 4G-LTE or 5G etc.). While choosing a wireless technology, there are various factors that must be considered, such as security and reliability. In addition to UAV-to-ground communications, these UAVs may also form flying ad-hoc networks (FANETs) to share resources and data transmission links. For example, a suitable UAV in an FANET can transmit data to ground station on behalf of other UAVs [20]. This clustering of UAVs is very suitable in such cases where the UAVs don't have enough computational power or the energy to complete the task individually. These FANETs are made in such a way that they are self-healing and self configuring, and capable of solving problems regarding diverse policies etc.

UAV potential for advanced mobile communication systems

UAVs have particular and exceptionally helpful highlights that kept an eye on planes don't have. They are dynamic, can be conveyed anyplace effortlessly, they can be given guidelines amid flight effectively, can gauge anything anyplace, and fly in controlled air space self-ruling. These UAVs can be utilized for an immense scope of administrations including non-military personnel, business and legislative administrations. In the event that appropriate IoT gadgets, cameras and specialized gadgets are utilized, these winged creatures can give innumerable administrations. For instance, in the event that we outfit UAVS with high-goals cameras and a decent correspondence framework, for example, LTE, we can take the administrations of group reconnaissance from these UAVs. This can be an extremely helpful administration for security purposes behind distinguishing any dicey action among social occasions of individuals. On the off chance that UAVs are outfitted with proper IoT gadgets, they can gather IoT information from incredible statures. What's more, if the UAVs have enough vitality and assets, the gathered information can likewise be prepared locally, or it very well may be sent in a short measure of time to the ground station for handling. The information can be gathered utilizing any sensor like temperature or dampness noticeable all around or any symbolism gadget like an advanced camera. The information gathered utilizing symbolism gadgets can be utilized for observation, mapping, or demonstrating and so forth.

The greater part of the UAVs as of now being used are equipped for sending information to ground control stations (GCS) continuously, and others have the ability to store the information locally and process it installed. A ton of IoT gadgets settled on UAVs, similar to sensors, cameras and so forth are remotely controllable. Moreover, these UAVs can frame FANETs to convey information to a server/GCS [20]. FANETs expel many structure obstructions connected with the framework based design approach. The issues in regards to correspondence go among UAVs and GCS are evacuated, and solid correspondence joins are shaped utilizing FANETs.

The decision of correspondence innovation that ought to be utilized installed UAVs is additionally an extremely basic choice to make. Since, these UAVs have dynamic and versatility highlights, dependable correspondence (counting great inclusion, stable availability and adequate throughput) ends up vital among them. Present day correspondence frameworks, for example, LTE, 4G and 5G systems will be the benchmarks that help long separation, high elevation and high portability nature of these winged creatures. These innovations will be utilized in UAVs for exchange or trade of information with various IoT gadgets, on the ground in a machine to machine (M2M) way, and also to speak with the ground control stations. Presumably, the LTE 4G frameworks are equipped for expanding system expandability up to a huge number of associations for minimal effort, expanding extent, and lessening the power utilization.

Likewise, 5G systems will be utilized to offer high information speed (in excess of 10 GB/s) and low postponement (1 MS) [21]. These systems will have the capacity to give omnipresent inclusion, even on high heights. They will likewise have the capacity to help 3D network (a trademark that alludes to the ultra-high unwavering quality, ultra-high accessibility and ultra-low dormancy).

These systems will likewise have an imperative trademark, which is the help for extraordinary continuous interchanges, for example, for ongoing portable video reconnaissance and spilling. Additionally they will give broadband access that will make it simple to share superior quality recordings and photographs, even in a thickly populated zone. It is likewise anticipated from these versatile systems, that they will keep away from impacts and bolster remote arranging and change for their flying courses.

Alongside MEC, the limitations of UAVs identified with capacity and figuring can be lifted in these correspondence frameworks, since they can be empowered to offload extraordinary calculations to the edge cloud [22]. Certainly, MEC endeavors to put conventional capacity and processing near the system edge in a versatile system condition. Be that as it may, MEC additionally empowers billions of gadgets to work such applications as are continuous and calculation concentrated specifically at a system edge. MEC can be utilized to do different employments, for example, video investigation, area administrations, IoT, and information reserving and so forth the striking highlights of MEC are its help for administration portability, closeness to the end clients, and the thick geological organization of the MEC servers. These extraordinary highlights will add to organization of UAVs, for example, the Unmanned Aerial Systems (UAS) Traffic Management (UTM) frameworks and are imagined by the NASA (National Aeronautics and Space Administration) [23].

Such wide scope of organization alternatives for these UAVs will bring new plans of action into the real world, when these UAVs can be utilized as a spine for the web on the ground or to supplement the inclusion of 5G innovation. For instance, Google's undertaking "Sky Bender" utilizes UAVs to convey Internet at a speed that is multiple times quicker than 4G frameworks in the Mexico desert [24].

Different applications of drones with IoT capabilities

Use in earthquake

On the off chance that a quake hits a specific region or district, UAVs having been outfitted with appropriate IoT gadgets, similar to cameras and sensors and so on can be offered guidelines to have a trip over that specific area. They may record recordings of the influenced zones for checking the harm done by the seismic tremor. They may likewise detect the parameters, for example, the breeze speed, temperature and the air contamination level. For example, they may gauge the structure of gases, for example, methane if the

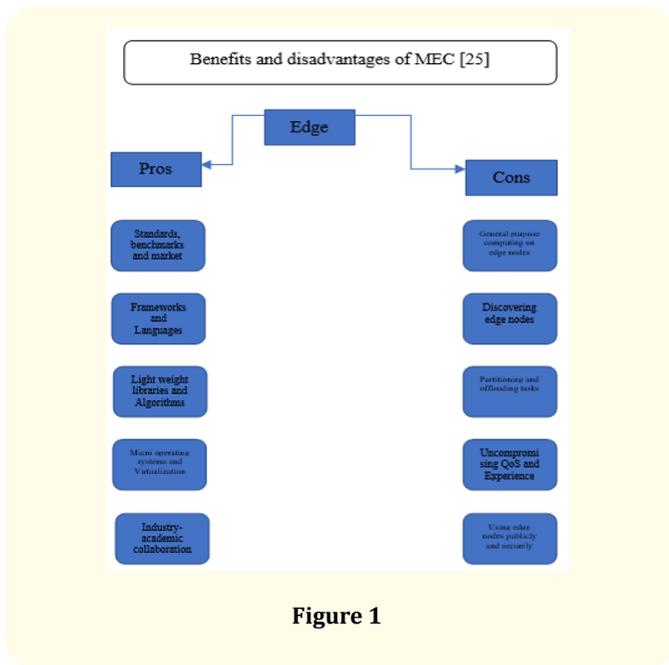


Figure 1

influenced region has production lines or any storage facility that stores such gases.

Data in regards to the piece of gases will help safeguard groups to stay away from dangerous regions, or on the off chance that it ends up essential for them to go into any such zone, they will have the fundamental gear with them. UAVs can likewise associate with one another for asset sharing, coordination and reconnaissance. To think about the territories that have been affected the most, and to realize whether there are individuals who require help, ongoing preparing is required. UAVs can help convey refreshments, nourishment, and prescription to the general population who direly require it, until the entry of protect groups.

UAVs can likewise help the safeguard groups to distinguish the correct geological areas of the general population in issue and guide them about how to reach there. Likewise if the fundamental ground correspondence framework is harmed or pulverized, UAVs can go about as hotspots or BSs to gather short messages that the influenced individuals need to be sent to their loved ones [18].

Little UAVs, for example, nano-UAVs can likewise be utilized to check whether there are any exploited people inside affected structures and give reasonable help later.

Use in crowd surveillance

In broad daylight spots and occasions, for example, sports occasions in arenas or amid processions, it is the obligation of the administration and law requirement divisions to shield the regular citizens from dangers. Insights demonstrate that the rate of wrongdoings in urban zones, for example, road violations [19], vandalism, and fear mongering has expanded incredibly. It is, accordingly, critical way to deal with foresee wrongdoings through discovery and acknowledgment of culprits among hordes of individuals. Cus-

tomary watch frameworks require numerous security protects and a tremendous human exertion to give important wellbeing to the people groups. UAVs can be utilized to help security staff, by shriveling individuals at spots of enthusiasm, from removed areas. They can give invulnerability from any danger, and help not exclusively to control, yet additionally to follow, distinguish and perceive offenders utilizing face acknowledgment strategies.

In the event that the UAVs are outfitted with fitting IoT gadgets (e.g. camcorders), they can offer a productive group observation framework; identify any far-fetched movement and suspicious activity; and perceive countenances of fiendishness individuals [17]. UAVs give a 10,000 foot view or group observation and face acknowledgment. Along these lines, swarm reconnaissance and security of the general population can be improved, while in the meantime, the quantity of security work force sent in the region can be incredibly decreased.

Face acknowledgment process includes numerous means, for example, facial highlights extraction, production of database of known faces, and coordinating caught faces with the put away faces. There are diverse video scientific instruments accessible to this activity. A large number of them are equipped for getting information from UAVs and can accomplish very precise face acknowledgment. Additionally numerous countenances can be perceived in the meantime. The gathered information can be prepared locally and also at remote servers, empowering the face acknowledgment task to be exchanged to MEC [17].

Use in real time monitoring of road traffic conditions and other events

Amid flight, automatons can send constant data with respect to street traffic, which can be put away and prepared in a focal server, and can be utilized by the people on foot and drivers to choose courses [15,16].

UAVs can likewise be utilized in meteorology. Rather than committing an explicit UAV for gathering information identified with climate states of a specific city, any automaton flying around there can carry out the responsibility of gathering climate information (e.g. wind speed, temperature, and stickiness and so forth.), and send it to a focal server. Preparing this information precisely can help making expectations about climate. This is an extremely financially savvy approach and includes incredibly less exertion. Likewise if there should arise an occurrence of mishaps, UAVs can send continuous symbolism to the observation focuses, additionally if an automaton is conveying medicinal unit [15,16], it tends to be exceptionally valuable to give starting help to the harmed, until the point that safeguard groups arrive.

Use in disaster management - applied areas

At the point when a region of the Earth is influenced by a cataclysmic event, it turns out to be imperative to facilitate debacle the executive’s task. Catastrophe the executive’s activities must

be done rapidly and adequately. Debacle the executive's activities help individuals, diminish the quantity of unfortunate casualties and evade financial misfortunes [3]. The compassionate system of UAVs (UAV Viators) [4] gives many use-case models with respect to where and how these UAVs can be utilized for philanthropic purposes and fiasco the board. UAVs can help adequately in the enhancement of the situational mindfulness and appraisal [5]. They can successfully give help with correspondence and coordination of activities, inclusion of territory and pursuit tasks. UAVs can bolster the recognizable proof of gatherings of individuals who are crippled, and help electromagnetic outflows of individual things of the unfortunate casualties covered under demolished structures or covered up in thick backwoods. For instance, rambles were utilized in Japan East incredible tremor. Automaton were utilized there for the accompanying purposes: [6-9].

1. Assisted disaster relief efforts to recover from the earthquake and tsunami.
2. They were also used for capturing the images of the damaged reactors at the Fukushima Daiichi nuclear power plant for site assessments.
3. Used for testing twin-tailed UAV to provide real-time data related to the current radiation level at the nuclear plant.
4. Also used for assessment of the reconstruction and clean up efforts taking place in three different areas in Fukushima prefecture.

UAVs were additionally utilized in another catastrophe case in Port au Prince, Haiti in 2013 for looking over a surface of 45 km², to map urban shantytowns to check the quantity of tents and sorting out an enumeration of the populace [10,11]. Additionally, UAVs were utilized to convey sustenance, prescription and different necessities of life in creating districts and territories that were not available by streets.

UAVs, in addition, were utilized to recuperate from the tremor that hit Nepal in 2015 [12], to contemplate the hazard decrease, explicitly because of surge in Dar-e-Salaam, Tanzania [13], and to protect moving individuals in the Mediterranean [14].

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Conclusion

UAVs, when equipped with suitable IoT devices, can be used from an integrative IoT platform that is operational in the air. This article looks at how the use of communication technologies in the UAV expert systems and the equipment of UAVs with IoT devices can be useful. Different modern technologies and IoT equipment in the UAV systems can help make decision and tasks easy, which

are not easy to do for human beings. Also the cost occurred in the jobs performed by the UAVs is very low as compared to manned aircrafts and the results are also reliable.

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