DIGITAL TRANSFORMATION WITH DRONES – THE UNMANNED AERIAL VEHICLES

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Introduction

The first ever aerial vehicle without a human navigator was innovated by Joseph Michel and Jacques-Étienne Montgolfier in 1783 when they demonstrated flying capabilities of a hot air balloon (HAB). However, its direction of flying was left to be controlled by flow of wind. The place of landing also could not be controlled from ground. In 1849 an Austrian army lieutenant Franz Von Uchatius conceived the idea of a HAB Bomb for war operations. In 1858 Gasper Felix Tournachonthe attempted the first aerial photography from a HAB in Paris. After a long forty years Nikola Tesla could first demonstrate in 1898 that a boat could be controlled by radio signal. Perhaps that is the genesis of all modern unmanned aerial vehicles (UAV) which can be controlled from ground through radio signals.

A UAV is synonymously known as a Drone because it continuously makes dull and monotonous humming sound emanated from its fas rotating wheels fitted with tiny wing type plates. Therefore, in this article these two acronym and word would be used without intending any variation in features of such flying machines. Readers may know more about Drones from the research work of David Daly, a licensed pilot, professional manager and oceanographer[1] about the evolutionary process of UAVs through the 20th century. Birth of the first version of modern drones could be traced in 1935 when a DH.82B Queen Bee aerial vehicle was constructed for hitting aerial targets. A quantum leap in drone technology was achieved in 1973 when Mastiff and IAA Drones were developed by Israel for surveillance and scouting in battlefields. Thus, weaponised raider drones were brought to warzones.

With the advent of more powerful radio technology, sensors, digital cameras, GPS, IoTs, actuators and cognitive technologies, AR, and VR, aeronautical engineers kept on crafting Drones with more capabilities for multivarious applications. In 2008 when the hurricane Katrina caused devastations in the USA Drones were allowed to fly in civilian

air space for disaster management and surveillance. In 2010 Parrot introduced the first of its kind Drone powered by a smart phone and with capabilities for capturing sounds, photography, and videography. Such a Drone is flown by a ground pilot using a remote controller and can feed receiving devices. Such continuous 'innoventive' evolution of UAVs encouraged startups around the world to construct drones for rendering various services for common business organisations, government administration and individual hobbyists.

Objectives

Drone technologists and digital scientists worldwide are relentlessly experimenting for innovative applications of Drones. They are working for digital transformation of VAV based service deliveries and integration with other digital devices like robots and IoT based networks. Keeping that in view the primary objective of this article is to delineate the present state of the UAV ecosystems and related digital technologies excluding those used for defence and military operations. The recent regulatory provisions announced by the government of India will briefly be reviewed to understand how startups and investors will be benefitted in their quest for making India as one of the major drone manufacturing hubs of the world. This article will also bring out certain major applications of drones, including a few dreams, and related solutions and processes for digital transformation of this wonderful UAV technology. A few hurdles and challenges that are to be resolved for faster progress of this multi-purpose technology will also be discussed.

Drone Policy of Government of India

The Ministry of Civil Aviation of Government of India (GoI) first announced the Rules for Unmanned Aviation Systems (UAS, i. e., for UAVs) in March 2021. Policy analysts and stakeholders found those to be riddled with many scope limitations from the perspectives of 'startupians', investors and end users. Manufacturing and flying of Drones were subjected to many permissions and control. Within a few months those Rules were rescinded and the Liberalised Drone Rules, 2021(LDR)[2] was announced by GoI in August 2021. Its predominant objective is to usher in a new era for applications of drones for multivarious services and positioning India as the global manufacturing hub.

The LDR has thirty key enabling features for stakeholders and startups aimed at encouraging all concerned to move ahead with ease at an accelerated pace. These features are based on the foundation of '*Trust and self-certification'*. All these have significantly reduced hurdles for startups and investors to enter this industry sector by decreasing number of approvals as well as compliance requirements for subsequent operations". The provisions of LDR are also expected to accelerate the process of both fundamental and applications research, enhancement of payload carrying capacity and encourage all stakeholders for setting up manufacturing facilities by leveraging innovative/creative minds of India's youth and their strong technological capabilities.

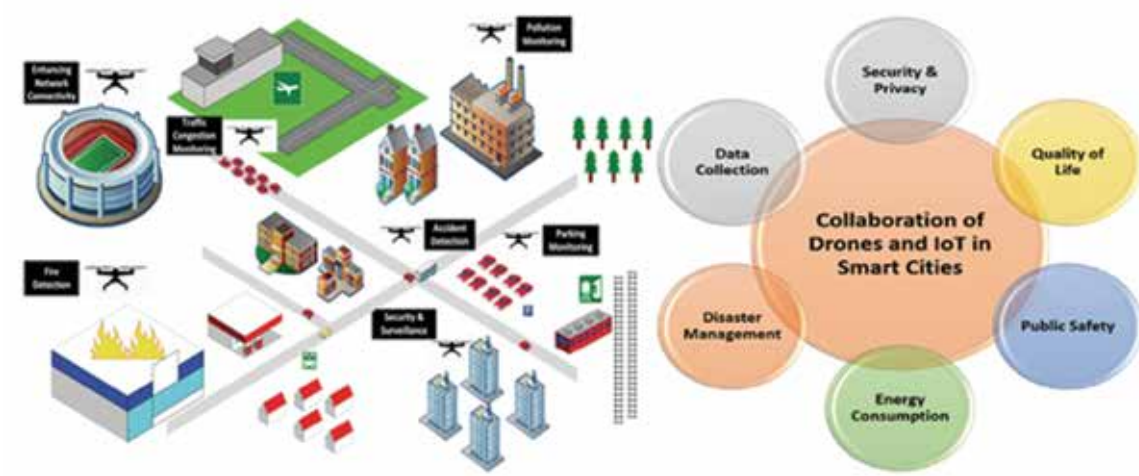
The approval/compliance requirements that have been abolished by the LDR include[3], those for "*… unique authorization number, a prototype identification number, certificate of manufacturing and airworthiness, certificate of conformance, certificate of maintenance, import clearance, acceptance of existing drones, operator permits, authorization of R&D organization, student remote pilot licence, remote pilot instructor authorization and drone port authorization".*

Drones Flying Above Digital Ecosystem

The world is incessantly experiencing accelerated expansion of connected networks with explosion in usage of Internet of Things (IoTs), Industrial Internet of Things, (IIoTs), Internet of Robotic Things (IoRTs) and Internet of Body (IoBs). The author in many of his previous articles, published under this column, has written about applications of all these unique things powered by Microchips, Sensors, Actuators, Bluetooth, and tools for conversion to / display of numeric data. Some of these, which are edible and biodegradable, are used for IoBs for medical service delivery. Several research based predictive analyses have prophesied that by around 2030 an average human being will live life under direct influence of five and indirect influence of twenty internet of things.

Drone technology has joined as an important and unique digitally enabled member for these group of connected networks. More and more integrations of other digital technologies, e.g., like AR, VR AI & ML and edge-computing with Drone technology are enhancing the power of performing localised analytics and faster service delivery. Such combination of technologies helps harnessing the power of social, mobile, analytics and cloud (SMAC).

In its survey-based research paper published in August 2019[4] covering smart Drones and IoTs, IEEE has mentioned that: "*Smart cities contain intelligent things which can intelligently, automatically, and collaboratively enhance life quality, save people's lives, and act as a sustainable resource ecosystem…. advanced collaborative technologies such as drones, robotics, artificial intelligence, and IoTs are required to increase the smartness of smart cities. ….. collaborative drones and IoT play a vital role in supporting a lot of smart-city applications such as those involved in communication, transportation, agriculture, healthcare…."*



Source: https://ieeexplore.ieee.org/document/8795473?denied=

Applications of UAV technology have added the much wanted third dimension to all digital technologies by approaching, viewing, sensing, and sending data/information as well as images and videos of all objects surveyed with minutest level of precision. Several more benefits of using a drone are ease of reaching and accessing with precision of places at a distance and/or at higher altitude with obstructions around. Unlike airplanes and helicopters, drones can glide down much nearer to the objects for capturing improved photographs, video recording and temperature/ moisture sensing, etc. Information about all such surveyed atmospheric conditions, objects, images, and videos can be mapped to a location with the help of GPS coordinates that can further help big data analytics and identifying location specific problems. This in turn helps formulation of strategies and tactics for solution building and service deliveries.

Presently drones are powered by electricity from the built-in battery banks which are to be charged at specific time intervals. Days are not very far when drones will come fitted with highly powerful solar photovoltaic cells for electricity generation while flying in daytime and then store for flying at night or times of cloudy sky. It could be possible that in course of time the rotating blades of UAVs would be able to produce electricity using the kinetic energy created by air in motion. Then a drone will achieve self-sufficiency and no longer be dependent on electric power from any external source.

Global Drone Market

Statista in one of their publications[4] has estimated the global commercial Drone market size in 2021 as USD 27.4 Bln. and predicted its growth to USD 58.4 Bln. by 2026. In another publication they have assessed the following worldwide distribution of services by UAV based service providers, excluding usage for defense activities:

Drone based Services	Percentage
Inspection, maintenance, and monitoring	36
Mapping	25
Photography and Filming	16
Surveying	15
Spraying and Seeding	4
Other Services	4

They have also predicted that by 2023 usage share of cellular connected drone market by regions would be 34% in Asia-Pacific, 29% in North America and 24% in Europe. Rest 13% would be in other regions.

Applications of Drones for Civil Services

Readers by now may be convinced that because of their unique capabilities of flying above the digital ecosystem, as more described in the above section, UAVs have enormous potentials with incredible promises for rendering large number of cost-efficient services to humanity with speed, safety, security, and least possible pollution of environment. In the following segments certain specific services that can be delivered by Drones have been delineated by way of illustrations. Those should not be considered as comprehensive and conclusive.

Services for Defense and Warfronts

UAVs are used by defense personnel of many countries for aerial surveillance, videography, combating flying objects, carrying warheads and precision bombing, etc. Drones are also used for providing logistics management services for reaching arms, ammunition and other goods required by soldiers to border areas/war fronts at higher altitudes which cannot be accessed by surface transports and helicopters. Soon Drones with high payload capacity may be used as air-ambulance for lifting sick/injured personnel.

Health Care Services

Drones are being used for many types of health care related services. The first group of those is speedier and

safe deliveries of medicines, surgical equipment/devices, blood, human organs for transplantation, without the need for any green corridor like in case of surface transport. Days may not very far when Drones will be used as air-ambulances for speedier movement of patients. Drones are also being used for surveillance and monitoring of crowded areas for controlling Covid-19 Pandemic and sanitization of affected areas. Certain municipal corporations are using drones for sprinkling liquid antidotes for mosquito breeding and spreading of diseases. Case in point is Indore Municipal corporation in Madhya Pradesh, India.

Agriculture

In his article of last month, published under this column, the author has written about tiny drones like honeybees which can pollinate flowers over vast agricultural fields. Drones can carry sprayers and sprinklers, with piped link to pressurised containers, for seeding, spreading gases and fertilizers, drizzling water for irrigation, applications of pesticides, insecticides, etc. Such drones can also be used for surveillance and monitoring of crop growth, assessing crop health, and sending clicked images/videos of standing crops affected by diseases, attack of pests/insects, damaged by floods and untimely rain, etc.

Source: https://www.mixerdirect.com/blogs/mixer-direct-blog/how-drones-are-changing-agriculture

In another article the author has recommended integration of such famer friendly Drones with the 'Kishan Blockchain Platform' ideated by him for authorized/supervised use of those and successful collation and use of data and images with segmentation of fields according to GPS coordinates. All these information would help agronomists for further analyses and recommending remedial measures. Insurance companies would be able quickly settle crop insurance claims at reduced costs for survey etc.

Logistics Services

UAVs like any other moving vehicle can carry and drop payloads without much of hassles at pre-programmed locations with almost zero error. Readers may be aware that Drones are presently being built with payload carrying capacity of even 500 Kgs. Small robots can also be placed and made to work inside the closed chamber of a Drone that move deliverable objects within a pre-defined area and return into the Drone. Thus, integration of UAV technology with robotic process automation and Robots have increased versatilities of drones in logistics management of FMCGs and other items in areas with defined peripheries. In course of time Drones would perhaps be used for long hauling of goods with speed and least carbon emission.

Construction Industry

UAVs have started being used by construction industry in very many ways for aerial land surveying and mapping, inspection of project sites, surveillance and safety of workmen and materials, movement of essential items and so on. Irina Jaychenko et. al.[5] in their research paper has concluded that, "*3D models of large areas or objects can be quickly created using drones and combined with laser scanning and standard topographic survey. Usually, the calculation of the volume of excavation requires a lot of time from the engineer-surveyor….. the solution of this problem will require minimal actions from the engineer-to specify the area on the construction plan with the mouse and wait for the completion of the shooting.*"

Fire Fighting Services

Firefighting service professionals use drones for accessing the parts of

high-rise building affected by inferno, jet-spraying water, rescuing human beings, and retrieving valuables.

Photography Videography and Hobbyists

Use of Drones by professionals for aerial photography, videography, cinematography and live telecast of sports events like football matches etc., are now widely known to common people. Young and talented students are also conducting various experiments using drone technology as a matter of their passion and hobby which have potentials for finding many more usage and applications of Drones leading to unique benefits accruing to humanity.

Dream Applications of UAVs

Study of several project summaries by the present author have revealed many ongoing experimentations for unique applications of Drones. Including brief narratives about two of those may not be out of place here.

Garbage Collector from Space

The European Space Agency (ESA) has commissioned a startup for developing a Drone which would be able to fly high into space and catch garbage like dead satellites and rockets which are orbiting the earth after completion of respective missions, or even failing to achieve so. According to a report of ESA[6], "*ClearSpace-1 will be the first space mission to remove an item of debris from orbit, planned for launch in 2025. The mission is being procured as a service contract with a startup-led commercial consortium, to help establish a new market for in-orbit servicing, as well as debris removal.*" David Szondy[7] wrote about such debris stating that, "*These range in size from tiny particles of solid rocket residue to dead satellites the size of a bus. As the 2009 collision between the Iridium 33 and Kosmos 2251 satellites demonstrated, this debris can result in collisions that can create additional thousands of fragments that can cause even more damage in a cascade effect.*"

Hanging Warehouse

Startups in the USA and Europe are also working on projects for positioning large stationary and/or moving UAVs in sky which will operate as hanging warehouses. Large Drones would deliver goods to such warehouses for storage and safe keeping of inventory. Smaller drones will collect packets from such hanging drones for delivering goods to nearby retails shops and other consumers with the help of Robots.

Giant retailers like Amazon and Walmart are already working on pilot projects for managing their large warehouses, on ground with the help of UAVs which would deliver goods to thousands of stores throughout the USA. These UAVs are largely serviced by robots for handling physical inventory of goods at the warehouse and loading onto those flying carriers. The entire process are digitally programmed using RPA technology and run with precision with the help of Artificial Intelligence. Such projects, when implemented throughout the world, would help reducing dependence on surface transport for logistics management.

Hurdles and Challenges for Applications of UAVs

Experimentations for innovative applications of UAVs driven by of overwhelmingly advanced digital technologies are not free from hurdles and challenges. In the present transformation phase of UAV technologies startups are more and more identifying needs for many enablers. They need help and support from different agencies to become successful with pioneering applications and dream-like solutions for delivery of multifarious services with speed and precision at a much lower cost. Their objectives also include energy efficiency and conservation of environment by reducing greenhouse gases. Some of those hurdles and challenges can be listed in the following points:

- Well defined policies and processes for allocation of exclusively defined airspace in terms of altitude, flying path and direction, peripheral boundaries, time slots, management of emergencies, etc.
- Appropriately laid out systems and process, without any ambiguity for collaboration and exchange of information and signals with official Air Traffic Controllers around the pre-designated places from where drones would be flown and their flying path.
- Minimum interference into operations of authorised pilots/controllers at ground for approved purposes and least possible surveillance to monitor their activities by government agencies.
- Extreme precision with technological excellence to ensure near zero instance of failure in operating processes developed with aero-dynamic, mechanical, electrical, electro-magnetic, electronic, and robotic engineering.
- Achieving near zero-error precision/reliability and extreme confidence for navigation through the allotted airspace for averting any collision.
- Uninterrupted participation in and communication with the integrated network of IoTs and the supervising blockchain platform, if so connected,
- Physical safety and security of Drones while flying and resting in hangers.
- Saving the drone from being hacked and hijacked during flight and ground operations.
- Saving of the drone from terrorist activities, sudden deterioration in weather and atmospheric conditions,

collision with birds and high-rise structures, human errors, etc.

- Safety and security of inventory of items being carried while flying.

Continued success of UAV technology in the present Industry 4.0 era is dependent on the success of overcoming these hurdles and challenges. This technology has generated overwhelming excitement and enthusiasm with enormous potentials for value creation. Time is here and now for putting up concerted efforts by all stakeholders for converting the excitement into tangible realities in terms of objectively measurable values.

Conclusion

Much more could have been written about this unique technology and its innovative applications if there would not have been any limitation of writing space under this column. However, readers might have been convinced by this brief article that that humanity needs digitally controlled airborne services which will help minimising value destructions by reducing wastages of time, money, and energy. UAVs would also help conserving the planet. The author is of the view that more empirical research should be done for understanding and appreciating what all 'innoventive' applications are there in the prototype manufacturing laboratories of startups in India and elsewhere in the world. There is an immediate need to understand what the ultimate impacts of UAV technology would be on employment market of a hugely populated country like India, albeit employment opportunities will be there for technicians in manufacturing and flying of Drones. MA

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