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Library Drone Delivery Programme: A Study

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ABSTRACT

There has been a significant paradigm shift in drone applications. Exclusively available only for military missions in the past application of drones has made its way to various platforms and the library is the one such platform that is being examined here. A significant feature of a drone that is its delivery feature can prove immense potential in bringing information to the users in the form of books or other library documents. A study is done on various elements of the drone facility, its payload capacity, the integration of such a facility with the library, the procedure of processing user requests via drone delivery, drone technology and procedure for making delivery, the regulations in India concerning flying of drones and the advantages and limitations of using drone delivery service. It is an emerging technology that has yet to see its full potential in civilian platform. In today's digital era with diminishing demand for physical books caused by electronic documents, drone delivery can breathe fresh air into the library services by bringing back the popularity of books and making them available to the users in the click of a button.

Keywords: Drones; Unmanned aircraft system; GPS; Location delivery; Library service; Drone regulations

1. INTRODUCTION

The idea of drones would generally refer to the remotely controlled military aircrafts used for eliminating terrorist activities. While drones have become a staple in modern warfare, their application to non-military missions has risen dramatically in just the past few years. And despite the rich operational history of several now well-known drone models over the past two decades of conflict, it is a new generation of platforms and technology that have captured the public's attention and interest.[1] Since drones have been commercialised and permitted for civilian uses it is now being used by various individuals and organisations to carry out various tasks and activities which include filming and aerial photography, shipping/ delivery, search and rescue operations, geographic mapping, wildlife monitoring, law enforcement, crop monitoring, pollution and land monitoring, meteorological services, etc. Since drones have found its way to a lot of non-military uses, its usage can also be applied to the library. The most apparent reason for requirement of drones is for document delivery especially books. With the constant rush in the 21st century people don't always have the luxury of time to visit the library whenever they want. In addition to time, location also acts as an added disadvantage. It may be convenient for people living in an area close to the library or have a time saving path free from the usual heavy traffic but not all people in the society have such a privilege. Drones can cut short the time and distance and can deliver books wherever and whenever the patron requires it.

Delivery drones are no longer a sci-fi or a virtual dream. Companies like FlyTrex from Israel have created a fully operational drone delivery service that can deliver food and consumer goods to the people which is currently being used in Iceland. Similarly other companies such as Amazon's Prime Air, DelivAir, etc. have provided promising possibilities for the future.

2. LITERATURE REVIEW

Ida Arlene Joiner in her article titled "Is there a drone in your library's future?" discusses about drones as a resource in the library for the interested people to get firsthand knowledge and experience on drone usage. She mentions various libraries like The Mandel Public Library and Arapahoe Colorado Libraries that are engaged in providing demonstrations and imparting education on new technologies including drone usage.[2]

The American Library Association stresses on the fact that drones will create new opportunities for content creation and research. Thus a piece of valuable technology in the world of information and academics it states that we ought to see it more often in the libraries as a part of its resources. [3]

Various studies and opinions connecting libraries and drones are available that focuses on various aspects of drones in libraries such as — Drone Lending Program i.e. drones as a library resource available for circulation, as a resource for use in maker-spaces, for library tour, etc. But any resource that

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focuses extensively on the usage of drones by libraries for the purpose of delivering documents is unavailable.

3. PURPOSE OF LIBRARY DRONE-DELIVERY SERVICE

In densely populated cities libraries are generally centrally located whether it is a National Library or a District Library. Even though the central location was chosen keeping in mind the factors of visibility and accessibility by the users it has now become inconvenient for many to visit the library because due to rapid expansion of cities the location of such libraries are no longer in a central position. Expansion has also created a larger city population and hence more library users from far-off distances within the city. There are various causes for this inconvenience such as exhaustion from work i.e., for people who can only visit the library after working hours, people who cannot make time to visit the library for various reasons whether personal or official, traffic jams which also is a common problem in big cities or unavailability of transport or direct routes to the library which might lead a library visitor to change cabs or buses multiple times to reach the desired destination leading to a wastage of time, money, etc. Delivery drone's can easily overcome this disadvantage and open new possibilities for both libraries and its patrons by delivering books at the location desired. The idea here is to use delivery drones to deliver books and other documents either to the user's doorsteps or make use of drone GPS technology to deliver it right into the user's hands regardless of the location where the person might be.

4. PAYLOAD CAPACITY

The average weight unmanned aerial vehicles roughly classified as commercial delivery drones can carry is approximately 4.8 lbs (2.2 kg)[4] and it can be anything from food items to medicinal supplies to mechanical equipments, etc. which requires tight packaging to ensure safe and secure delivery. So it is safe to determine that a drone can at a single time deliver 2 to 5 book depending upon the capacity of the drone and weight of the package considering most libraries if not all would issue an average of 5 book per user which is a sufficient capacity to loan out books via drones while heavier books might cut short the quantity.

5. PRICE ESTIMATION

Start-ups have tried to come up with delivery drones for sale. One such start-up is Matternet, which has come up with delivery drones recently and plans to sell them commercially. However, Matternet's delivery drones, called Matternet ONE, are extremely expensive - they cost $ 5000 per unit. There has been so far only one company that has been successful with its delivery drone system and has made its delivery drones available to businesses and the general public, and that company is a small Isreali start-up called Flytrex and the delivery drone introduced by them is called the Flytrex Sky. Flytrex Sky costs about $ 649 and it is the only company that has been successful till date with the drone delivery system and has made it available to businesses and the general public[5]. Many Indian start-ups like Aarav Unmanned Systems, Aero 360, Bubblefly, Drona Aviation, etc. have started creating and experimenting with drones and once a successful product launches from these companies the expenses for purchasing a professional drone can be cut by a large margin.

6. DRONE ELEMENTS

Before exploring the functionalities of using a drone in a library it is important to understand the technicalities that are associated with operating a drone. An over-simplistic view of an unmanned aircraft is that it is an aircraft with its aircrew removed and replaced by a computer system and a radio-link. In reality it is more complex than that, and the aircraft must be properly designed, from the beginning, without aircrew and their accommodation, etc. The aircraft is merely part, albeit an important part, of a total system[6]. A drone is not a complete system in itself but is an element of a larger system known as Unmanned Aircraft System. An Unmanned Aircraft System or UAS comprises of three essential elements.

- Unmanned Aerial Vehicle or UAV
- Communication Data Link
- Ground Control Station[7]

6.1 Unmanned Aerial Vehicle

The Unmanned Aerial Vehicle (UAV) or commonly known as drones is the aircraft responsible for delivering the books either to his/her doorsteps or to their hands irrespective of their location. Delivery Drones is the term commonly used to describe the UAV's used for delivering packages.

6.2 Communication Data Link

A Communication Data link is a term that describes the communications between the Ground Control Station and the UAV. The task of data links is to provide uplinks i.e., communicating information from the GCS to the UAV such as determining flight path, changing altitude, etc. and downlinks i.e., communicating information back from the UAV to the Ground Control Station. These transmissions are usually in the form of radio frequencies.

6.3 Ground Control Station

A Ground Control Station is responsible for man-machine interface. It allows humans to control the unmanned aerial vehicles in air. Responsible for sending and receiving uplinks and downlinks to and from the UAV, the GCS is also usually the place where the pre-flight activities are carried out including flight path determination, height, speed, etc. GCSs vary in physical size and can be as small as a handheld transmitter or as large as a self-contained facility with multiple workstations. Larger military UASs require a GCS with multiple personnel to operating separate aircraft systems[8].

7. IMPLEMENTATION OF LIBRARY DRONE-DELIVERY SERVICE

The first and foremost requirement for this service to work in a library is the availability of a library application software which can either be an extension of the Integrated Library Management Software used by the library or a different software designed specially to connect and communicate with

the library's ILMS interface. This is because most ILMS does not have a smart-phone version of it and an added advantage of it is that the mobile friendly software can make use of the smart-phone's technologies such as the GPS. The user will use the library app to borrow books from the library. He/She will browse through the library collection via the library app, select the document required and set it to borrow. There might be a requirement for a separate circulation section to process requests for drone delivery and return. It may or may not be necessary and depends upon how busy the library is. While this section processes the requests a separate set of staff especially trained for handling drones shall collect the required documents, place it carefully for the drones to make safe delivery and make ready for launch. The staff in the Ground Control Station also known as drone pilots shall be responsible for flying the drones and making safe delivery to the patron. There are two possible ways of using drones to deliver books to users — a) drone delivery to the user address, and b) drone delivery based on real time location via GPS.

7.1 Drone Delivery to the User Address

The simplest way of drone delivery of books can be done is by delivering it to the patron's doorsteps. This will require a drone with camera, a launch pad and the Ground Control Station in the library as mentioned above where the trained staff shall remote control the drones. The camera will provide the navigation system which is to show real time video feed on the computers in the control station similar to a car driver watching the road or a helicopter pilot except controlling from a remote location i.e., the library.

7.2 Drone Delivery Based on Real Time Location via GPS.

This system of drone delivery is similar to the one explained above except it will make the delivery right into the user's hands. The user will be required to keep his GPS turned on before the library initiates the delivery process. A notification via the library app can be used to alert the user about the initiation of the delivery process and that he/she is required to turn on the GPS and keep it turned on until the delivery process is completed. Once connection is made with the user's smart-phone GPS the delivery can be then initiated. While the delivery is still in the air it can also periodically request the user for secure location updates until it arrives because safe delivery might be a little problematic or even impossible in locations such as a busy street or inside a public bus, etc.

Drone GPS can also be used in a similar way to (Fig. 1) to make delivery to the user's doorsteps. Advanced GPS drones makes use of a technology known as GPS Drone Waypoint Navigation System that allows the drone to fly on its own without any manual intervention. This is because GPS Drone Waypoint Navigation System allows setting of destination or pre-planned points that can be configured into the drone remote control navigation software. The drone can be instructed as to where to fly, at what height and also the speed of the flight. The drone even remembers the spot from where it was launched and at the press of a button it can automatically fly back to where it started from.

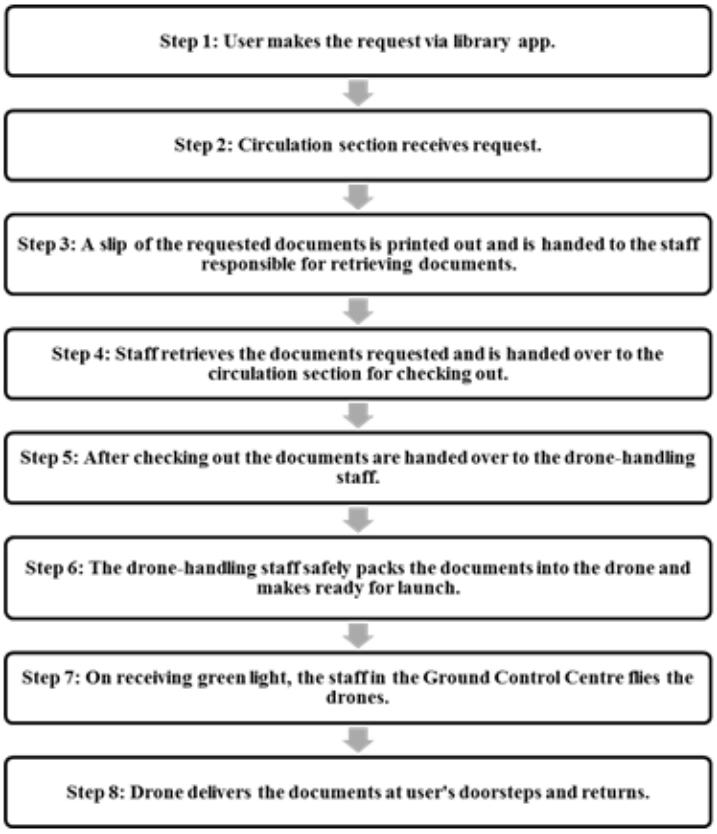

Figure 1. A step by step visualization of circulating documents with the integration of drone tech.

8. BEST PRACTICES OF LIBRARY DRONE-DELIVERY PROGRAM

These are the essential points to consider for a successful implementation of an UAS in the library.

8.1 Analysing Requirements

Analyse the requirements of an UAS in the library. "Why is it necessary?", "What does it plan to achieve?" etc. are some of the important points that needs to be evaluated.

8.2 Documenting Requirements

It is important to document the requirements that arise after evaluation of various issues such as regulatory compliance, security analysis, type of drones, data storage (operational data), UAS maintenance, etc.

8.3 Site and Airspace Analysis

Evaluation of the site in question is required to identify issues such as whether there are wireless routers or other signal emitting devices nearby that may interfere with signal transmission. Airspace evaluation such as flying over busy traffic, private/government properties, nearby airports, etc. is required.

8.4 Drone Technology

Even though the drones in question here are delivery drones it is essential to further evaluate it based on its payload capacity, battery power, number of propellers, etc.

8.5 Data Storage

Where and how to store important data such as operations data, flight log data, etc. is an essential aspect to consider.

8.6 Project Testing

Testing the UAV under various environment/weather conditions, distance, traffic, population, etc. and every other aspect of the facility.

8.6 Finalisation

Evaluation of all the conditions stated above and the results yielded thereafter whether favourable/unfavourable shall determine the project finalisation.

9. DRONE REGULATIONS IN INDIA

There have been several notifications by the Office of the Director General of Civil Aviation regarding the use of Unmanned Aircraft System for civilian purposes but they were only draft policies and nothing has been finalised as of yet.

One of the first notifications issued by the Office of the Director General of Civil Aviation on civilian drone operation was in October 7, 2014 which required drone operators to acquire approval from Airport Authority of India, Ministry of Home Affairs and other concerned agencies besides Director General of Civil Aviation. On 21 April, 2016 Director General of Civil Aviation released a set of draft guidelines on operating drones for civilian purposes. In October, 2017 Director General of Civil Aviation released again a new set of guidelines with the aim of finalising it by December 31, 2017[9].

All the draft policies and guidelines that have been issued so far are strict with the civilian operators mainly for safety and security issues. These guidelines contain various requirements such as proper training of drone operators, proper maintenance of the Unmanned Aircraft System, flying limits, payload limits, etc. These guidelines also contain other requirements that might limit the flexibility of operating drones from a library such as — drones can only operate within Visual Line of Sight which would limit the area it can cover, restrictions on flying over densely populated areas without prior approval, etc[10].

10. ADVANTAGES

- As compared to the traditional walking-to-the-library there will be a faster mode of returning and retrieving documents to and from the library. It will also serve as an emergency option if a user requires a document right at the moment or to return a document on due date to avoid paying fines
- It is a time saving option as a patron does not have to deal with unusual traffic to get to the library.
- Home delivery or location delivery have the possibility of boosting circulation as the user do not have to worry about stock piling in his/her room and borrow/return books as per their requirement without having to physically be there
- Through drone delivery the library can also act as a mobile library by bringing books to people living in far off distances, residents of retirement homes, etc. It will be a form of fuel efficient, effortless, time saving as well as environment friendly mobile library service
- An advantage in itself, drone delivery may also be branded as a premium subscription service. A monthly or a yearly subscription option should be made available to users with subsequent discount in an annual subscription plan compared to a monthly. This will facilitate revenue generation that can be utilised for periodical maintenance, upgradation, etc. of the Unmanned Aircraft System
- With the increasing popularity of e-documents and diminishing interest of today's youth in physical books drone delivery will be a breath of fresh air by bringing back the popularity of physical books. If real books are delivered with just a touch on the smart-phone like e-books then it can definitely give the electronic documents a run for its money.

11. LIMITATIONS

- Weather issues such as rain or strong wind may delay delivery
- Possibility of malfunctioning mid-air over a busy street cannot be ruled out
- Package security issues due to human intervention such as theft by doing harm to the drones
- Legal issues such as trespassing or night time delivery, etc.

12. PRESENT SCENARIO OF DRONE DELIVERY

Zookal, an Australian based platform for purchasing and renting textbooks have partnered with Flirtey, a transportation/delivery company in 2013 to deliver books by drones. The company conducted a world-first drone delivery test back in October 2013 and to date has conducted over a hundred successful test deliveries of textbooks[11]. Amazon Prime Air is currently under development for making drone delivery all over the world. It has been dealing with the regulatory bodies of various countries to grant permission for making drone delivery a reality. The Amazon Prime Air webpage says, "We will deploy when and where we have the regulatory support needed to safely realise our vision. We're excited about this technology and one day using it to deliver packages to customers around the world in 30 minutes or less." On February 9, 2018 Drone Delivery Canada received the Compliant UAV Operator Special Flight Operations Certificate (SFOC) that allowed the company to operate drones Beyond Visual Line of Sight (BVLOS)[12]. This is a milestone achievement as regulatory bodies currently have not allowed BVLOS operation of drones. On March 28, 2018 the East China Regional Administration of the Civil Aviation Administration of China (CAAC) granted operating (pilot) license to a subsidiary of China's leading courier company, SF Express, in Jiangxi province[13]. Companies such as Apple, FedEx, Google's Project Wing, etc. are some of the important players testing drone delivery and negotiating drone laws with regulatory bodies to implement more flexibility. Currently there have been no implementation of drone technology for document delivery in libraries and the major reason for this is because regulatory bodies have not provided the required flexibility till date. However the strictness of the laws has

toned down to considerable extent to allow e-commerce giants to conduct test deliveries and results have been fruitful. These tests have allowed the regulatory bodies to reform the laws in favour of implementing the technology and libraries should be ready to adopt it as such a reality is not very far.

13. CONCLUSIONS

Assessment has been made on the drone structure and the elements of the Unmanned Aircraft System facility and its integration with the library. It yields possible results but calls for a big investment. However it is only a one-time investment and with subscription options there is also the possibility of revenue generation which can be utilised for self-sustenance of the facility.

Drone-delivery service directly fulfils four out of the five laws of library science as given by Dr. S. R. Ranganathan — (a) books are for use; (b) every reader his/her book; (c) every book it's reader and (d) save the time of the reader. Drone-delivery for civilian purposes is an emerging technology and is still in its nascent stage. There are various advantages in using drone deliveries as well as limitations. But these limitations should be viewed as mere challenges to overcome. Drone-delivery in libraries is not a widespread concept but we have studied what it can achieve owing to its advantages as well as frequent technological advancement. The regulatory bodies and policy makers have already reviewed and revised the guidelines multiple times which have just been favourable for civilian purposes and to hope for a final implementation that favours more flexibility in drone operations is the way to go.

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