A review and technical perspective towards the role of UAV as a mode of transport in healthcare sector in India

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Abstract **- This paper describes the technical and legal sides of Unmanned Aerial Vehicle and its operations for emergency medical situations like accidents, emergency hospitalization etc. in India. It highlights the details about mode of operations like flight aerodynamics, types of payloads, aircraft launching and landing system, payload dropping mechanisms, powerplant selection, etc. In 2018, The Director General of Civil Aviation of Government of India announces new policies for Remotely Piloted Unmanned Systems. According to these policies, designing and operating the Unmanned Aerial Vehicle in Indian air space becomes somewhat easier than before. Although, these regulations cannot give complete freedom of what designer and operator wants in their Unmanned Aerial Systems but, it helps to design the Unmanned Aerial System with systematic approach from the foundation stage. India is the 2nd most populated country in the world with poor health sector. Because of this high densely population, it is difficult to treat every needful person. Many accident cases are registered daily in India and maximum of them lost their lives just because of lack of treatment at early stages. Even ambulance takes 20 to 40 minutes of time to reach at accidental place by road (In rural area that too is not possible). If we can be able to provide the necessary treatments like first aid treatment, medicines, living organs, blood etc. by Aerial route (within 5-7 minutes) then it is possible to save the life of many peoples across the country. This project is trying to mention the details about unmanned aerial system which can solve this problem and help provide the treatment in medical emergencies.**

keywords **- Unmanned Aerial Vehicle, Unmanned Aerial System, Medical emergency, DGCA, RPAS.**

I.INTRODUCTION

The term Unmanned Aerial Vehicle (UAV) was first introduced in the 1980s which defines, an autonomous or remotely piloted, multirole aircraft which can carry a payload or performing any task like surveillance without direct interference of humans. This definition makes UAV different from other aerial vehicles such as airplanes, helicopters, missiles, gliders, balloons etc. The UAS, refers to the system in which one or more unmanned aerial vehicles in combination with payloads, a navigations and control system, sensors, instruments and data linkages working together to operate the vehicle without pilot. Other term used to refer UAS is remotely piloted aircraft system (RPAS). From recent years, implementation of UAS was seen widely in land survey, urban planning and development, mapping, mining industry, archaeology, environment protection, disaster management, aerial photography, construction etc. Because of affordable in cost, great performance and time saving ability, UAVs are highly demanded in market. UAVs was utilized for military purposes at their initial period. The first successful radio control aircraft took-off in 1924. Through the development of software and electronics and the mass production of processors, sensors, and batteries produced for electronic devices, UAV designs have become easier, more affordable and more accessible and hence this began to utilize UAVs for commercial world. Currently, plenty of nations like USA, European union, Israel, India, China and so on are utilizing UAVs in their military and civil operations.

This review article aims to highlight the importance and applications regarding the use of small UAVs to transport blood and medicines from blood banks/medical stores to critical access hospitals, accidental place in times of critical and emergency situation. This technology has the potential to benefit peoples in distant areas. Just like other sectors, health sector also has the best usage of UAVs to improve their services. Transportation is huge barrier in delivery of medicines and vaccines in distant or high densely populated areas in countries like India. UAVs can be the best alternative in case of any emergencies for the transportation of medicines in such areas. It may be a quick means of transportation of medicines and other facilities. This system will be affordable cost of transportation for medical facilities. The contribution of UAVs for caring of patients, accident victims in the manner to provide immediate medicines, blood in less time for assess can save someone's life.

Some hospitals in Switzerland started using rotor wing UAVs (Figure-1) to deliver the blood samples and other medicines. This step helps many peoples in Switzerland to save their lives. This UAVs are capable of carrying payloads up to 2 kg and move at velocity up to 57.6 km/h at an altitude of 110 m and the range up to 20 km. This UAVs are equipped with parachute so that in case of any damage occurs in air, the UAVs are able to land safely without harming others as well as cargo inside it.

The medicine delivery start-up Zipline from African country – Rwanda, uses fixed wing UAVs (Figure-2) to deliver the blood and medicines. Its UAVs has operating range of 80 km and move at speed of 100 km/h making it one of the innovative and

successful Unmanned Aerial System. The medicines are dropped at delivery location with the help of parachutes. The UAV can carry 1.75 kg of payload. It was in service from the year 2016.

Fig-1 Rotor wing UAV by Swiss post [1]

Fig-2 Fixed wing UAV by Zipline [2]

At present, medical supplies in the United States of America (USA) are delivered by conventional road transport as well as airplanes and helicopters. The availability of blood and other medicines is limited during emergencies at critical access hospitals, due to this, conventional mode of transportation may become disrupted.

II. METHODOLOGY

A research study was conducted on available scientific papers and journals related to this topic. Some information was collected from official website of drone companies which are working in this field with successful results. Since research into the implementation of UAVs in health sector around the globe is at initial stage, literature survey was conducting on limited available sources.

Design

Tushar et.al (2020) discussed about Aerodynamic characterization of Albatross Inspired wing for UAVs [3]. In the paper author elaborated detailed design analysis on the aerodynamics of wing which can bear high lift to weight ratio. UAVs having High payload fraction are eligible to carry more payloads. Wing is most important part of fixed wing aircraft for their contribution of generating the lift. According to requirements and applications of UAV, its wing shape and other characteristics differs. Similarly, for the stability, empennage plays an important role. The software which was used for design and simulations was XFLR5. It uses 3D panel and Vortex Lattice Method (VLM) for analysis and results. By considering all aerodynamic geometries of designed UAV like wing span, aspect ratio and wing area for main wing, horizontal tail and vertical tail at constant flight speed, the aerodynamic analysis was performed. The design objective is accomplished by obtaining the graph of lift coefficient versus angle of attack, lift coefficient versus drag coefficient and ratio of Lift to Drag coefficient versus angle of attack which defines the lift characteristics of wing in order to obtain the maximum lift enhancing design requirement carrying highest payload. Fuselage which satisfies the condition to hold and release the cargo by launch and drop mechanism. Also, fuselage should not make big disturbance on wing to act against lift. Some more bio-inspired wing designs were discussed by Dwivedi et al [4] [5].

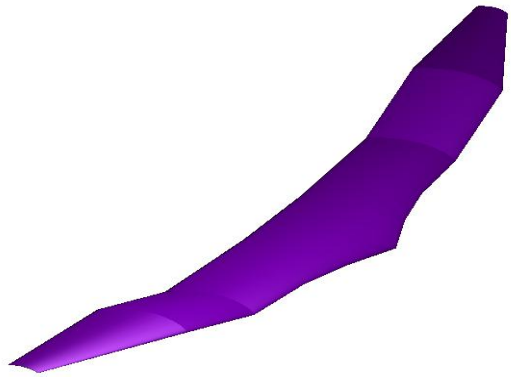

Fig-3 Albatross inspired wing design by Tushar [3]

Safety & Accuracy

In a country like India, where peoples are living in dense areas, safety of their lives from flying object above their head is very important. The UAV should be equipped with all safety instruments for cargo inside it as well as protect the UAV and surrounding environment from crash landing. This problem can be solved by attaching efficient parachute system to UAV in case of emergency landing and good navigation and control system which keeps UAV away from dense areas. Use of Artificial Intelligence and IoT can increase the controllability, accessibility and accuracy of an UAV. Many UAVs in the world are improving their performance by the implementing AI & IoT in their flight program. It can also help to identify and solve the problems like change the flight path automatically if any buildings, air obstacles or wind gusts are making disturbance in current

fight path without human interaction. Using this, UAV will complete its operation in less time and accurately without compromising the safety.

Launch of fixed wing UAV

Apart from the micro and mini UAVs (take-off weight up to 3 kg) that can be launched by hand, UAVs need to accelerate up to require velocity to take-off. Conventionally, a runway is used as a platform from where the UAVs are accelerates and airborne by its own propulsion system. But this launching method is not suitable at every place. Because somewhere the space is too limited to accelerate the plane for take-off. In this type of scenario, UAVs can be takes off with the help of launch assist. This can achieve in different ways and here the four most common categories used for launch by today's UAV industry. 1. Rocket assisted take-off, 2. Bungee cord, 3. Hydraulic launchers and 4. Pneumatic launchers.

Fig-4 Bungee cord take-off (credit- unmannedsystemtechnology.com)

Cargo delivery system

To deliver cargo at exact location, fixed wing UAV has to make a struggle as its difficult to land and take-off at unknown place also it is unable to hover at same place like rotor wing UAV. Hance, fixed wing UAV can drop/release the cargo while on flight path by decreasing UAV's velocity so that cargo can be land smoothly on the surface with the help of parachute. Another option is, the UAV has to equipped with hovering mechanism to be constantly hover at same place so that it can release the cargo at exact location with the help of rope or parachute.

Fig-5 Drop while hovering (credit- crossblade.com)

Fig-6 Drop with rope (credit- wish.com)

Landing/Recovery of fixed wing UAV

The simplest and most cost-efficient way to land/recover a fixed-wing UAV is the same as the full-sized manned aircrafts land on a runway by the conventional way. But similar with launch system, it takes more space for runway. In this scenario there is a requirement of very small or near zero-length runway landing/recovery system [6] . Above there are some methods used to land/recover UAVs within short distance. 1. Net recovery, 2. Parachute recovery, 3. Sky hook, 4. Arresting line.

Fig-7 Sky hook Recovery (credit- commons.wikimedia.org)

III. INDIA DRONE/UAV REGULATIONS

According to India's national aviation authority, the Ministry of Civil Aviation, manufacturing and flying a UAV is legal in India, but it is recommend being aware with the drone regulations. India's Directorate General of Civil Aviation announced the country's first Civil Aviation Requirements (CAR) for drones/UAVs on August 27, 2018 which was in effect from December 1, 2018 in the country. In this rules & regulations, the word UAV is sometimes referred as drone or RPA (Remotely piloted aircraft) [7].

Drone Categories in India

- Nano: Less than or equal to 250 grams (0.55 pounds)
- Micro: From 250 grams (0.55 pounds) to 2kg (4.4 pounds)
- Small: From 2kg (4.4 pounds) to 25kg (55 pounds)
- Medium: From 25kg (55 pounds) to 150kg (330 pounds)
- Large: Greater than 150kg (33 pounds)

General Rules for Flying a Drone in India

- All drones except those in the Nano category must be registered and issued a Unique Identification Number (UIN).
- Drone pilot must be certified and license holder from flight training schools in India.
- A permit is required for commercial drone operations (except for those in the Nano category flown below 50 feet and those in the Micro category flown below 200 feet).
- Drone pilots must maintain a direct visual line of sight at all times while flying.
- Drones cannot be flown more than 400 feet vertically.
- Drones cannot be flown in areas specified as "No Fly Zones", which include areas near airports, international borders, Vijay Chowk in Delhi, State Secretariat Complex in State Capitals, strategic locations, and military installations.
- Permission to fly in controlled airspace can be obtained by filing a flight plan and obtaining a unique Air Defense Clearance (ADC)/Flight Information Center (FIC) number.
- Foreigners are currently not allowed to fly drones in India. For commercial purposes, they need to lease the drone to an Indian entity who in-turn will obtain Unique Identification Number (UIN) and UAOP from DGCA.

Also, it is highlighted that India has specific requirements regarding the types of features a drone must have to be flown in Indian Airspace (excluding those in the Nano category). These mandatory requirements are:

- GPS
- Return-to-home (RTH)
- Anti-collision light
- ID plate
- A flight controller with flight data logging capability
- RF ID and SIM/No Permission No Takeoff (NPNT)

IV. APPLICATIONS

The UAVs or drones are being emerged as a resource in many fields which are still ghost for most of the population, especially in India. The main purpose of drones as per India is Military and Civil purpose which includes Aerial photography, Surveillance, Border patrol, resuscitation, Forensic investigation and what not, including Crisis management, epidemiology, and telecommunication. The application of UAVs in healthcare sector is a novel and emerging concept. Today, with the advancing technology rapidly, their applications are increasing worldwide, including adoption in healthcare sector, which can benefit from of technical capabilities of UAVs. The UAVs also made their place in the defence sector by being a surveillance resource. But as the increasing difficulties in the healthcare sector in recent times, UAVs can perform much more efficiently in healthcare sector also. UAVs are into force in western countries as health care delivery system to improve the medical facility for most of the people. Previously people do not get the access to medicines due to its limited transport facilities. But now it is not available due to its transportation. The increase in the pandemic situation made many new inventions and improvisations, to that increasing the use of UAVs can make a difference.

UAVs can act as delivery agents of medicines in areas where the transportation through automobiles is slightly risky, that is in red zone areas, hilly regions, and some of the tribal areas. UAVs are much versatile than how they are being used. UAVs can act as transportation source for many blood banks, and to provide vaccines in emergencies in minimum time possible. UAVs can delivery medicines faster to farer areas. UAVs can be used utmost to their efficiency in medical and health sector in normal and even in pandemic situations. Other applications include search and rescue, public health surveillance tools, small package delivery to communities affected by major disasters, and communication hotspots for surgeons operating in rural areas.

V. FUTURE DIRECTIONS & POSSIBILITIES

UAVs can be our future reliable transportations in medical and health care sector. In future one can rely on UAVs for delivery of medicines, blood for needed ones easily and quickly, as it is featured for and even for the distribution of COVID-19 vaccines using small and quick response UAVs. The UAV operators have to improve the technology which meets all the expectations and requirements in health care sector. Although, it not possible without support of government, so the government must investigate the usage and operations of UAVs in health sector. Government also has to improve their rules and regulations time to time with updating technology.

Government of India planning to make a separate air traffic control network for UAVs similar to air traffic control for manned flying vehicles. Whenever this thing come on ground, the implementation of UAVs in health sector become more reliable, worthy and more accessible for many citizens.

VI. CONCLUSION

UAVs are going to be assets to the health care industry in upcoming years as studied and referred by many authors across the globe. The usage of UAVs in the healthcare industry will be more appreciable due to its time of response which is very required in the case of emergencies especially in country like India. The flexibility factor of UAV allows them to travel over high lands, water bodies like rivers and lakes, mountains, dense forests as well as over bridges, multi storey buildings etc. The travel time taken by a UAV is quite less than other transportation facilities used for delivering healthcare products. This feature is very required in emergency medical situations to avoid trauma attacks and serious medical situations.

UAV, combination of all efficient roles is quite hard to manage the network. As UAV comes along with dependence on many sectors to produce it in the market and they are RDT and E (Research and Development, Technology and Engineering) including operation (radar and navigation systems, operating stations, take-off and landing stations, air traffic control) and maintenance. The personnel required to perform RDT and E must be also trained. To make all this happen Finances are required which can be obtained from Investors from Private and Government sectors. Therefore, the process of production of UAV must be carried out safely and surely as referred by many authors. The ground Pilot controlling the UAV must also be trained. Use of Artificial Intelligence and IoT can add up to extra functional features like anti-collision, sense and avoid, terrain following, automatic homecoming, etc. to UAV to operate the network perfectly in the region without any disturbance or any safety related issue. Considering all the above the Government has put Rules and Regulation for the production and usage of UAVs in the country for medical purposes, which must be followed by organizations for safe production and functioning of UAVs.

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