Drones- Characteristics & Development Needs

Utkarsh Mittal

Abstract— Drones or 'Unmanned Aerial Vehicles' (UAVs) is an aircraft without a human pilot on board. Its Flight is either controlled autonomously by onboard computers or by remote control. This domain has seen rapid developments in recent years and there is more to come. The main characteristics of a drone depend upon its degree of autonomy and the endurance. A number of factors affect these characteristics. There is a crutial need for advancements in the filed of Drones and to keep up with these advancemets, changes in the rules and regulations are required. Various government agencies in different countries decide the rules and regulations for the use of drones in their respective jurisdrictions.

Index Terms— Drones, Unmanned Aerial Vehicles, Autonomus Aircrafts, FAA, DGCA, Drone Autonomy, Drone Endurance

————————————— ◆ —————————————

1 INTRODUCTION

DRONES or the 'Unmanned Aerial Vehicles' (UAV) are aircrafts with no pilot on board. A pilot at ground can remotely control them. Drones have become an important addition to military's operational environment. In addition to military purposes, today these drones are being used for various scientific, commercial and public purposes. Also according to the ongoing trends, drones will become a regular part of life, used in research, transportation, law enforcement, surveillance and entertainment. Up until recently, most drones have been used for surveillance, reconnaissance, security, or in warfare [1]. Pilots on ground can control drones remotely or autonomously by systems built into vehicle; they provide an option for flight and exploration in places that might normally be too dangerous or difficult. Commercial use of drones became a point of particular interest in 2014 after Amazon announced it's plan for Amazon Prime Air, a service to deliver goods by drone- and several other companies have also announced similar plans [2].

The U.S. Federal Aviation Administration (FAA) however, currently bans the commercial use of drones without a waiver, though hobbyists in US can fly drones within certain restrictions by FAA (away from airports, under 400feets, and within the operator's sight) [3]. India's Directorate General of Civil Aviation (DGCA) also bans the commercial use of drones in India. The FAA and DGCA are framing guidelines for the commercial use of drones in their respective jurisdictions. As individuals and businesses wait for regulations to respond to new demand and interest, manufacturing of drones has increased, with over 1500 different kinds of drones being manufactured with capabilities for multiple different endeavors [4].

2 CHARACTERISTICS

2.1 Degree of Autonomy

The early drones are no more sophisticated than a simple radio controlled aircraft being controlled by a human pilot at all times. More sophisticated versions may have built in control and/ or guidance systems to perform low level human pilot duties such as speed and flight path stabilization. From this perspective, most early drones are not autonomous at all. Compared to the manufacturing of drones' flight hardware,

the market for autonomy technology is fairly immature and underdeveloped [5]. Because of this, autonomy has been and may continue to be the bottleneck for future drone developments.

Autonomy is commonly defined as the ability to make decisions without human intervention. To that end, goal of autonomy is to teach machines to be "smart" and act more like humans. The mode of technological development in the field of autonomy has mostly followed a bottom-up approach, and the practitioners in the field of control science have largely driven recent advances. Similarly, autonomy has been and probably will continue to be an extension of the controls field.

Autonomy technology that will become important to future drones' development falls under the following categories:

1. Sensor Fusion- Combining information from different sensors for use on board vehicle.
2. Communications- Handling communication and coordination between multiple agents in the presence of incomplete and imperfect information.
3. Motion Planning- Determining an optimal path for vehicle to go while meeting certain objectives and constraints, such as obstacles.
4. Trajectory generation- Determining an optimal control manever to take to follow a given path or to go from one location to another.
5. Co-operative tactics- Formulationg an optimal sequence and spatial distribution of activities btween agents in order to maximize chances of success in any given mission scenario.

2.2 Drone Endurance

All drones- commercial or recreational, military or civilian, have one thing in common: the need for power. Power to the engines, power to the computer brain, power to the cameras and systems: the drone requires power to do its job and transmit its input and output. Most drones by nature are wireless, and so must either generate their own power or draw from onboard battery. The maximum flight duration of drones varies widely. Internal combustion engine aircraft endurance depends strongly on the percentage of fuel burned as a fraction of total weight of the drone. Here lies the weakness of the

drone: the time it can operate- its endurance.

Many solutions for increased drone endurance have been forwarded, but each has drawbacks. Solar panel work poorly below clouds, batteries have limited lifetimes, internal combustion engines are loud and unreliable, and "beaming" the power to drone via lasers requires line of sight to a base. However fuel-cell technology has advanced to a point where it can address many unmanned system requirements, without the noise, weight, and reliability issues of a combustion engine. The U.S. Navy's Ion Tiger can fly for over 24 hours.

3 NEED OF DEVELOPMENT AND CONCERNS

Need of development in any field is always welcomed for its betterment. Same is in the filed of drones. With betterment in the field we could improve a variety of things, such as:

1. Drones could help improve outreach efforts, delivering resources to the geographically isolated or homebound, providing deposit collections to areas affected by disasters [6].
2. They could help improve Internet access in unreservedareas. Google has included drones along with balloons and low orbit satellites as possible means of providing Internet access, especially in remote places [7].
3. As drones will provide new opportunities for content creation and research, users may expect drones to be part of the technology resources available from libraries. Aditionally, video or survey content produced by drones may become content collected and managed by libraries.

Even as drones open opportunities for creativity, research, and production, they also raise concerns for privacy and safety. Those concerns for safety are especially apparent in regions where drones are used for surveillance and warfare, where people live unaware if drones are used for surveillance or as part of an offensive [4]. Privacy concerns may only increase as drones become smarter and more autonomous, through the improvement on onboard systems, and smaller and cheaper, allowing them to proliferate through society and escape notice as they enter smaller space [8].

These are the reasons that the FAA and the DGCA have banned the use of drones commercially for the time being, as they make rules and regulations that can overcome these problems. Along with these government agencies, various researchers are also continuously developing countermeasures to overcome the security problems that arise with the use of drones. Latest entry in the list of the countermeasures is by South Korea [9]. A research project by the Korea Advanced Institute of Science and Technology (KAIST) uses sound to disable the internal gyroscopes that balance drones. The sound targets Micro-Electro-Mechanical Systems (MEMS) gyroscopes, the tiny sensors used by the drones to stay level in flight. The researchers found that if enough deliberate, hostile external vibration could disturb the smooth flight of the drone. It turns out that the resonant frequencies, or sounds that vibrate at the same frequencies as the targeted object, of many of the gyroscopes used in small drones are within audible range and can effect the drones. There are various other defenses on hand already being used by the military.

4 GOVERNING BODIES AND REGULATIONS

Currently the various governing bodies like FAA and DGCA have banned the commercial use of drones. Although the FAA does make exceptions for hobbyists where the drone stays in sight of human operator. Over the past several years, a growing number of people and organizations have found a way to get around the ban on commercial use by setting up a nonprofit organization or by classifying themselves as hobbyists. This way they can operate their drones in a non-commercial way and collect payments as donations. The FAA has divided the use of drones into three major categories as follows: Governmental, Non-Governmental, and Hobby.

4.1 Summary of rules of FAA on use of drones [10]

1. Unmanned aircraft must weigh less than 25kg.
2. The aircraft must remain within visual line-of-sight of the operator at all times.
3. Daylight only operations are to be conducted.
4. Maximum air speed of 100mph.
5. Maximum altitude of 500 feet above ground level.
6. Requires preflight inspection by the operator.
7. No careless or reckless operations.
8. The operator must be at least 17 years of age.
9. Pilot of the drone would be considered as operator and would require to pass an initial aeronautical knowledge test at an FAA approved test centre.

4.2 DGCA (India)

In 2014, DGCA banned the use of drones across the country irrespective of anything [11]. According to the circular: UAV has large number of civil applications. However, its use besides being a safety issue, also poses security threat. The airspace over cities in India has a high density on manned air traffic. Due to lack of regulation, operating standards and uncertainty of technology, UAV pose threat for air collision and accidents. The civil operation of UAV will require approval from the Air Navigation Service provider, Defense, Ministry of Home Affairs and DGCA.

DGCA is in the process of formulating the regulations for certification and operations use of UAV in the Indian Civil Airspace [12]. Till such regulations are issued, no non-government agency, organization, or an individual can launch a UAV in Indian Civil Airspace legally.

Across the world, rules for drone are either published or under process. The base of these rules will be similar to that of FAA's rules.

5 CONCLUSION

In this study, an outline of basics of drones is presented. The

various characteristics, the need of development and the rules and regulations, which guide the use of drones, are briefly shown. The intended audience is the researchers new to this domain. With this study, new researchers will be able to quickly get acquainted with characteristics of drones and the trends in the field.

Most technologies currently embedded in our daily lives followed a specific pattern of evolution. First phase is the conceptualization. Second phase consists of development of core and supporting technologies. Technology acceptance among common population is the next step. Finally, the technology phases out as it is replaced by newer technologies. A similar evolution is being observed in the drones' domain. Currently, it can be said that the drones' domain is between the phases of technology development and technology acceptance.

- *Utkarsh Mittal is currently pursuing Master's degree in Electronics and Communication Engineering from Vaish College of Engineering, M.D.U, India. Mail id- utkarshmittal05@gmail.com*

REFERENCES

[1] Hazel Davis, "Drones: The Good, the Bad and the Future" Virgin Unite, September 8,2014. http://www.virgin.com/unite/business-innovation/drones-the-good-the-bad-the-future

[2] David Robson, "The Biggest Test for Drones" BBC Future, October 8, 2014. http://www.bbc.com/future/story/20141008-the-biggest-test-for-drones

[3] Jeff Beckham,"Drones Will Transform Sports Photography- Once the FAA Gets Out of the Way." Wired, September 23, 2014. http://www.wired.com/2014/09/drones-will-transform-sports-photographyonce-faa-gets-way/

[4] Benjamin Wallace-Wells," Drones and Everything After", New York Magazine, October 5, 2014. http://nymag.com/daily/intelligencer/2014/10/drones-the-next-smartphone.html

[5] The UAV website, http://www.theuav.com/index.html .

[6] Thomas Frey."192 Future Uses for Flying Drones", Futurist Speaker, September 2, 2014. http://www.futuristspeaker.com/2014/09/192-future-uses-for-flying-drones/

[7] John Brodkin," Google testing drones that could provide Internet access to remote lands", ArsTechnica, September 15, 2014. http://arstechnica.com/information-technology/2014/09/google-testing-drones-that-could-provide-internet-access-to-remote-lands/

[8] Peter Diamandis," Top 10 Reasond=s Drnes Are Disruptive", Forbes, August 11, 2014. http://www.forbes.com/sites/peterdiamandis/2014/08/11/top-10-reasons-drones-are-disruptive/

[9] Kelsey D. Atherton," Korean Researchers Knock Drones out of Air with Sound", Popular Science, August 7, 2015. http://www.popsci.com/korean-researchers-knock-drones-out-air-sound

[10] FAA's Website. http://www.faa.gov/regulations_policies/rulemaking/media/021515_sUAS_Summary.pdf

[11] DGCA's website, file no. 15-13/2014-AED, October 7, 2014. http://dgca.nic.in/public_notice/PN_UAS.pdf

[12] Archit Gupta," Upcoming UAV rules of India", Aviator Flight, May 17, 2015. http://aviatorflight.com/upcoming-uav-rules-of-india/