Cinematography Drone with Automated Ability for Self-flight and Maneuverability: A Review

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ABSTRACT

Unmanned Aerial Vehicles or UAVs are an amazing piece of machinery that have proven their usefulness in various industries like construction, military, logistics, filmmaking, etc. They're either operated remotely by a human controller from the ground or have automated capabilities to control its own flight. But due to several technological and environmental restrictions there are many models that can guarantee complete autonomous behavior of the drone. For being truly autonomous, UAVs will need to get far better at sensing its surroundings and obstacles to decide its own path and react in time to avoid collisions.

This project specifically aims at enhancing the drones used in the tourism sector for the betterment of traveling experience of people by automating the process of capturing their experience along with autonomous flight capabilities. ML enabled cinematography drones to tackle the gap in the market where good camera drones are unavailable at a lower price point with an added benefit of hands-free automated flight patterns to capture cinematic shots.

We have tried to achieve this milestone by using sensors that can detect the surrounding obstacles in real-time and manipulate its flight path to capture cinematic shots of the target object. Through the project we're also automating various shots like hover, 360 degree view, follow at focus,etc that the drone will include into its flight path on the go.

Operating an unmanned flying machine is very challenging especially when you're flying the drone out of your line of sight and detecting objects using just one FPV camera or monitoring several cameras at the same time is not humanly possible. Hence, through this project we're not only allowing travellers to enjoy their journey but also take videos of places they can't reach without having to worry about losing or crashing their drones. There can be further research on this flying model to inculcate it for various industries as the flying pattern and requirement changes in each sector.

Keywords—UAV(Unmanned Aerial Vehicle), Drone, Cinematography, ML, FPV, Automated flight.

I. INTRODUCTION

The rise of Machine Learning has led to great advancements in the field of automation across all domains of computer applications, especially vehicular automation. There are numerous research activities ongoing in the field of Autonomous Navigation of UAVs which has achieved various milestones in the last decade or so with drones rapidly moving towards achieving complete autonomy.

However, where there has been significant visible growth in the area, the main focus of these research projects are binding to specific tasks like path finding, obstacle detection and avoidance. The contributions of these systems to the overall autonomous development of a particular UAV system is not assessed, hence, a detailed study is required that finds the implications of inculcating all the technological advancements when applied to a single piece of machinery.

With recent developments in the field related to hardware and software components, Machine Learning and Deep Learning has advanced a lot with numerous papers published involving its application to autonomous flight. Various advancements like precision GPS,image processing, lidar and computer vision have projected that the drones will be capable of achieving autonomy in the upcoming years, but these solutions have a very high cost of implementation, are not robust and sometimes require important subsystems to be present for optimal operation.

The focus of this paper is to perform an in-depth analysis of various published papers that utilize Deep Learning or similar

learning-based solutions as a basis for implementation of navigation tasks towards drone autonomy.

II. LITERATURE REVIEW

a) Inner workings of a Drone:

1. Multi-rotor aircraft are controlled by adjusting the speed of the motor and in turn the speed at which the aircraft's propellers spin. The height at which the drone is flying can be controlled by manipulating the rotational speed of the motors. Increase the rotational speed to go up and decrease it to come down. The drone moves forward by increasing the speed of the rear propellers and comes back when the speed of the forward propellers are increased. It goes left by running the right hand propellers faster whereas it moves towards right by running the left hand propellers faster. Clockwise and anticlockwise turns are achieved by taking advantage of the fact that two motors spin clockwise and two counter-clockwise, and then precisely adjusting the speed of each individual motor to turn left or right. The maneuverability of the drone is handled by the aircraft's flight controller which receives the instructions from the pilot through radio waves, then translates them into digital commands and sends them to the ESC. The ESC in turns interprets these instructions and increases or decreases the voltage to each individual motor.

b) The Challenges to Developing Fully Autonomous Drone: When we say Autonomous drone, we mean an aerial machine that can map its own path without the help of any human behind a controller, to an extent, we've already been able to achieve this. In the aerospace industry there are 5 levels of autonomy. They can be defined using the following levels:

2. Level 0: Machines that do not have any autonomy and require a human behind the controller to fly it. An example for this are small short-range airplanes which are hand flown like the Cessna.

3. Level 1: The machines under this category have basic autonomous systems, like altitude control, but the pilot is in control. Helicopters are an example.

4. Level 2: Under this category there are various autonomous systems that are running simultaneously, but the pilot is in control.

5. Level 3: The aircrafts in level three are capable of flying autonomously but the pilot must monitor the systems and be ready to take over if certain dynamics change. The autopilots in commercial aircrafts come under this category.

6. Level 4: In this level, the aircraft is completely autonomous in most situations; the pilot can take over but generally doesn't have to.

7. Level 5: In this level, The drone is completely autonomous.

8. In the current Aerospace sector, the technology until level 4 has been implemented in actively flying machines, where the aircraft can make certain decisions and control, but human supervision is necessary at all times. Research is still ongoing in developing the first

completely autonomous drone.

In order to make drones completely autonomous, a few challenges have to be overcome to ensure that the drones are safe to fly and meet all local laws, regulations, and safety standards. These challenges include:

9. The technologies enabling autonomous flight like LiDAR, sensors, FPV and 360 cameras have to be chosen that best suits the project requirements.

10. Designing and testing the drone around these components such that they are able to observe its environment carefully and make changes quickly by processing multiple streams of data at the same time – particularly in adverse weather conditions.

Configuring the various system design and properties in order to improve aerodynamics, reducing weight and increasing the performance of the power source which would lead to an increase in travel distance, carrying capacity and operational duration.

Simulations have to be run in order to verify the proper working of each individual component and optimize them to improve overall performance.

c) Keeping Airspace Safe: With autonomous drones the safety risks increase as there is a long way for these machines to achieve complete autonomicity and gain our trust. The onset of autonomous UAVs will require new rules, laws, regulations, air traffic control systems and other intricate aspects.

11. In order to keep the airspace safe, we must abide by a few guidelines that allow us to build a safe environment to test the capabilities of our system without any imminent danger to life and property.

12. Firstly, the sensors must be able to clearly sense their environments without being fooled by fog or lighting conditions, such as glare or shadows. These sensors must be affordable and light to maximize the UAVs'

carrying capacity or maneuverability.

13. The sensors should be capable of monitoring the airspace in every direction. Transponders allow modern aircrafts to monitor other aircrafts in its vicinity but the model is too sophisticated for a drone. Hence, UV and IR sensors can be used in drones to monitor its surroundings and avoid air traffic conflict and detect other obstacles and avoid them like trees, houses and sometimes even things thrown at it. The system should be sophisticated enough to detect the speed and direction of the object and correct its path to avoid collision.

Next, the data collected from these sensors will be processed by an ML enabled chipset that can perform complex image processing in real-time. Using this data, the system will make decisions and using simulations these systems will be tested and trained in various scenarios to ensure that they will make the safest choice in every situation.

14. Finally, UAVs are likely to use electricity as a power source to keep down emissions and also have a constant weight throughout the flight as aircrafts to support its small build.

These steps will ensure that the aircraft is truly autonomous and a better addition to the aerospace industry.

d) When Will We Get Autonomous Drones? This question can be better framed as how autonomous do we want the system to be. As mentioned earlier, there are various systems already available that provide some sort of autonomicity to the aircrafts.

Building a UAV that can fly safely on its own over a city between two predefined points is possible with even the current technologies. But our ultimate aim here is to build a drone which can, for example, deliver pizza to your front door in an urban environment without anyone piloting it remotely. That would be a fully autonomous system that is capable of performing the task on its own.

15. As the drone can fly high up in the sky avoiding ground obstacles, hence, the most important part of

the flight is the approach, landing and takeoff. In an urban area, the drone will need to perform these actions while avoiding houses, pets, people, clothes lines, weather, birds and other objects in the sky. Until an autonomous craft can perform these actions reliably in an urban setting, we haven't achieved complete autonomicity yet.

16. The current automation technologies available in aerospace has a lot of limitations, for example, the system isn't capable or trusted to –

17. Manage complex, unpredictable situations

18. Handle adverse weather

19. Fly without restrictions in populated areas

20. Hence, an expert is always supervising the flight, ready to take control.

21. Currently drones are already being incorporated to perform remote asset inspections, 3D image rendering, deliveries, security, cinematography and for emergency use in hazardous situations. Once there is sustainable proof that they are viable and ensure commercial success of the technology, fully autonomous drones capable of transporting humans will start becoming a reality. There is still a long way to go before this becomes a reality and we are ready to give up the ultimate safety feature – a pilot.

III. OVERVIEW

From the above literature review we can draw the following findings –

Autonomicity is a vision for a distant future which seems achievable if humans are convinced enough to give complete control to a machine and not the pilot.

Autonomous systems have existed for a long time but the level of complexity in these systems aren't enough to call it fully autonomous.

UAVs are smaller versions of aircrafts and hence, not all systems have the same capabilities to carry heavy duty navigation systems, environment sensors and transponders under the hood.

Smaller drones can use IR sensors to perform object detention but the process is slow and hence, the reaction time of systems to an obstruction in the environment is slow too.

IV. CONCLUSION

After performing this intensive review of various literatures we have reached a point where we have a complete understanding of the drone infrastructure and what is needed to make a better technology as compared to what is available in the industry.

To build our drone with autonomous capabilities powered by Machine Learning we'll be using a combination of IR Sensors to detect the various obstacles in the environment, and also the speed and direction of the object if it's moving. We'll have to program the firmware to process information from the sensors in real-time and to the best of its capabilities, try to avoid them by moving in a different direction with enough speed to avoid them.

We are also trying to keep the budget under INR30,0000 so that we don't build something that is not affordable by a majority of the target market.

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