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Distant Mission UAV capability with on-path charging to Increase Endurance, On-board Obstacle Avoidance and Route Re-planning facility

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Abstract :UAVs (Unmanned Aerial Vehicles), especially Quad copters is facing challenges in their mission due to its lower endurance. As such, the missions having long distances are not achievable through Quad copters.

The performance of any vehicle, while testing, is one of the most important factors. This performance is based on range, endurance, altitude, attitude control, VTOL (Vertical Take-Off and Landing), battery life, and other autonomous functionalities. The major problem we are facing in the field of UAVs is battery life. The use of higher mAh battery is not a perfect solution as the weight also increases with the size of the battery and that will then require once level higher mAh battery and this may not end soon.

Several different techniques can be applied to eliminate or reduce the above drawback. One can be, in the mission path itself, take the drone down to the ground, change its battery and continue the mission, which is a kind of out of logic things. The other solution which we can find is the use of a charging dock. In this case, no need to follow the vehicle, everything can be automatic with the help of a sensor and communication system.

The above solution ends the endurance problem but, if the endurance is higher and mission is longer, it necessary to put on necessary sensors for the safety of the vehicle.

Keywords: UAV, charging facility, endurance, collision avoidance, route re-plan.

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1. Introduction

Drone technology is the fastest growing and the most emerging future technology, increasing its demand across the World, in each and every field of operation, from using it as goods carrier to structure health monitoring, from surveillance application for using it in the battlefield and in the battlefield too, it varies from an attacker to an ambulance, depending on the circumstances. The ideas related to designing, materials, manufacturing, assembling, application, controlling, etc. keeps on changing this technology and for this reason. In spite of getting many up gradations year by year, even today, some drawbacks are required to overcome with the wise implementation and usage of advanced technologies. Also, some additional sensors are important for long flights and distant mission for the vehicle's safety.

2. On path charging facility

Currently, what is going on in the field of UAV is, flying, changing the battery, flying, and keeps going on. The new technology advancement can be used to avoid the problem by changing the battery again and again. And what if the drone is half the way of accomplishing the mission? It can neither go further, finish the work nor come back. So, what we have come up with is, a charging dock1. This charging dock will be placed on several distances on buildings. The passerby drones will be able to identify that in the nearby region charging dock is available. After the signal of detecting the charging dock, it will check its battery level. If it is 50% or below, it will go to the dock, get it charged and will take-off again to continue its mission. If not, it will continue flying. Here, we can set the cut-off percentage level according to our requirement and the distance between two consecutive charging docks can be preprogrammed into the vehicles, so that it can check that after how much distance the next dock is, when it is checking its battery percentage level near a dock.

Three Steps of Operation: -

Step – 1 – Drone lands on the charging platform

Step – 2 – Drone wireless charging and monitoring (2.4G Wi-Fi communication) [1]

Step– 3 – Drone takes-off and continues its motion on the prescribed mission path

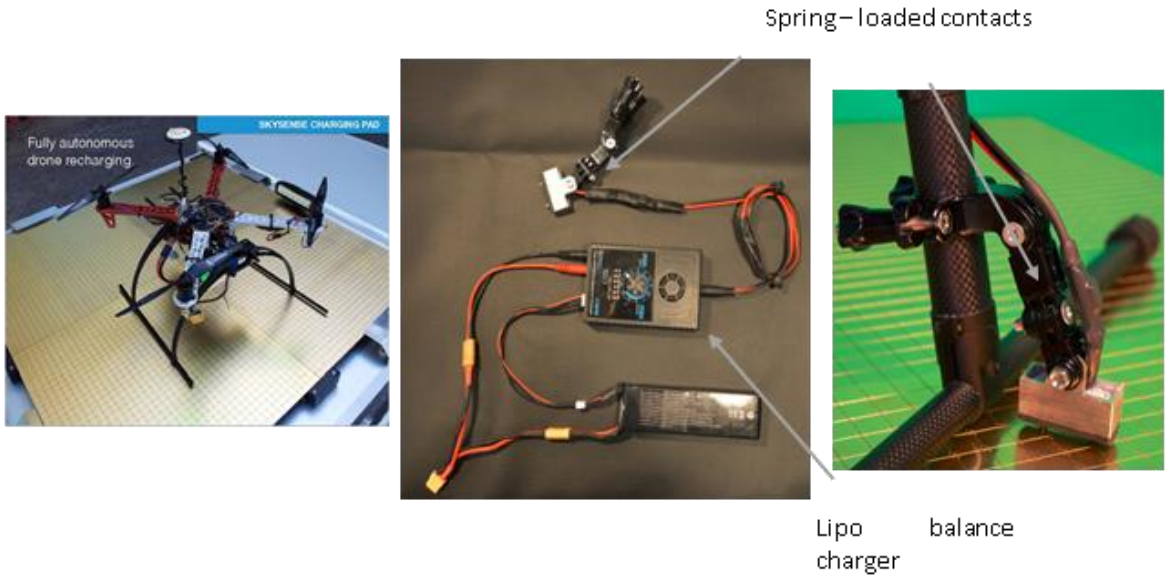

Figure 1 – Skysense charging pad connections[6]

Many companies are coming with their new techniques in charging pads as an option for increasing endurance which can be used until we get the hydrogen fuel cells regular to use.

3. Obstacle Avoidance System

Safety first. When a UAV is being assigned a mission with a prescribed path to follow to reach the destination, it is necessary to have some sensor on-board to protect itself from getting collided. The UAV which is fully autonomous should be able to detect these obstacles and avoid them by using sensors and an algorithm. The most widely used sensor for this application is the ultrasonic sensor. While, now even Laser sensors are available with the variation in the rays which can help detecting an obstacle. For a quad copter, it is necessary to monitor the whole 360 degree area around the UAV, so, at least four or even more can be used as per the requirement. Some of the pioneers in autonomous navigation for helicopters worked at NASA Ames Research Center. In 1980 and 1990 decades they have published a series of papers highlighting some techniques developed for automatic Nap-Of-the-Earth flights such as computer vision, integration of active and passive sensors, design of control strategies tested in 3D

computer simulations. In the beginning, the authors developed 2D models of the environment and later on they extended the path search techniques to 3D in order to obtain a low-altitude guidance system for military helicopters [2].

The capabilities of laser based sensors are much higher to the capabilities of ultrasonic sensors, nevertheless ultrasonic sensors are highly capable of giving a precise reading when they are perpendicular or almost perpendicular to the surface, becoming a practical solution to measure the distance with objects over and under the quadcopter, being one of these objects the floor, meaning this that the sensor can be used to measure the flight altitude when approaching the landing zone as well as the maximum flight altitude when flying on roofed areas.[7]

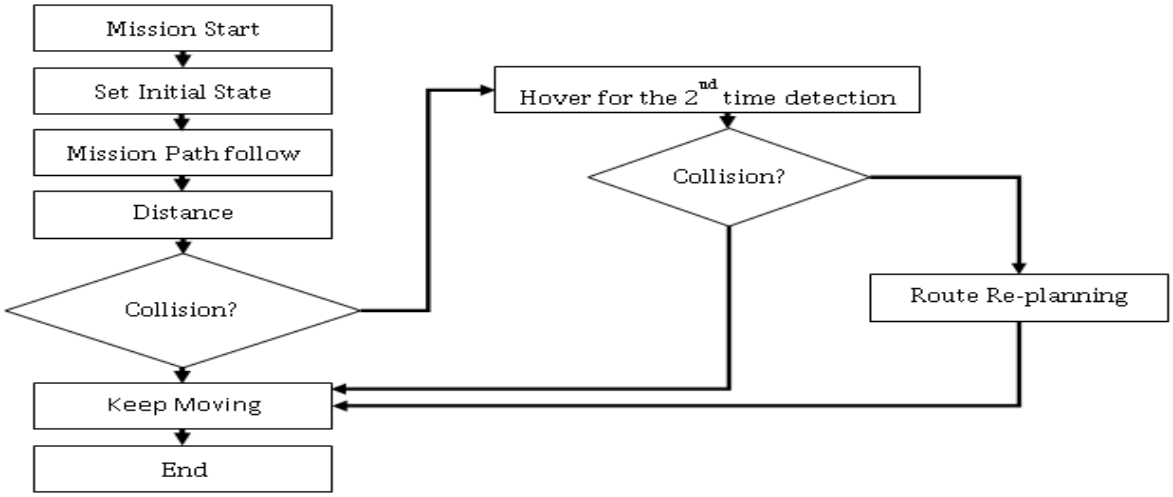

Figure 2 – Flow chart of Obstacle Avoidance

4. UAV with autonomous level 4

Autonomous system is one of the system which describes the difference between a drone and a UAV. A drone can be semi-autonomous or mostly a Remotely Piloted Vehicle (RPV) be called a UAV, until and unless it can fly without RC or with an automatic control. There are 10 levels of autonomous flight,which describes the capability of the computer to control a flight automatically without any input from the human. The levels are described here, below, from 1 to 10. [4]

Level – 1 – Remotely Piloted Vehicle. Here, the 100% input is required from the human.

Level – 2, 3 – High level of human input is required in this level. It can be operated in simple environmental condition. Example – Predator, Global Hawk, etc.

Level – 4 – On-board route re-plan. It has the capability to change its path when needed and come back to its original flying path, without the interference or input from the human.

Level – 5, 6, 7 – Group co-ordination, tactical re-plan and goal. These all requires medium level of human input. All of these can work in the moderate environment and can operate multifunction missions. Example – UCAV-N.

Level – 8, 9 – Distributed controls and group strategic goals. Low level human input is enough for this level. Moreover, a big mission can be achieved with the help of group planning on air, without the input from the human. Example – UCAR.

Level – 10 – Fully autonomous. This is an extremely high level operation, where the computer will not take input from the human. It has no environmental limitation and can be used in any kind of missions. [4]

Up to level 9 some research is in process but, considering the regular flying purpose, we are near to the level 4. So, including the level – 4 of autonomous system in which the UAV will change the route accordingly, when needed. As, the path charging facility is being used here and the obstacle avoidance system, route re-planning becomes a necessary part to be carried out. Because, it will

change its path to avoid collision or for charging itself, it has to come back to its original mission path to accomplish the mission. The same follows in the charging operation.

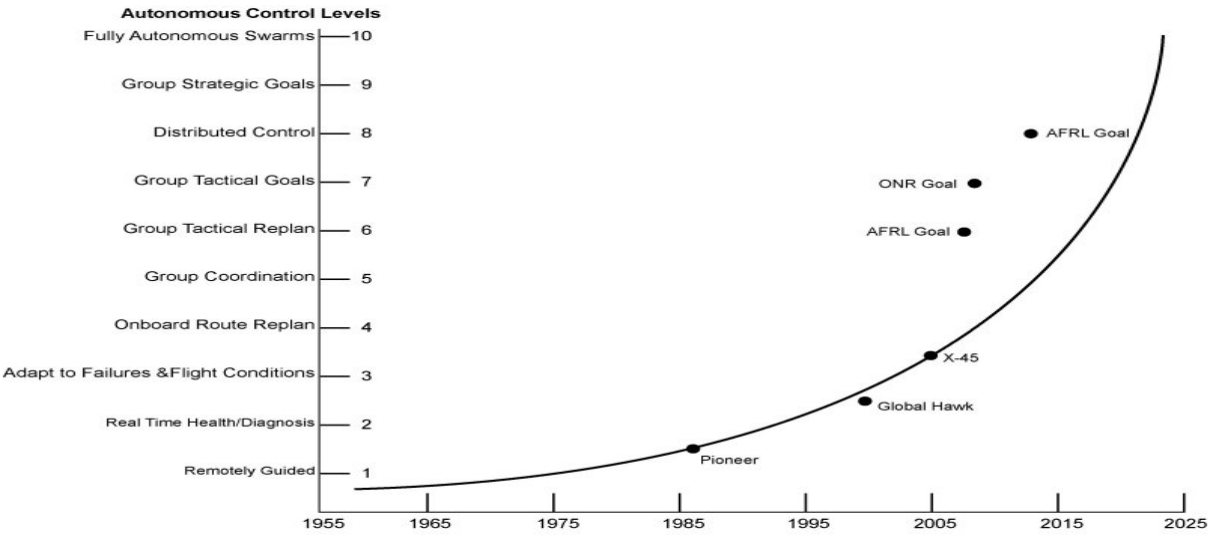

Figure 3 – Autonomous level chart 3

The characteristics of the vehicle will be: -

1. The autopilot on board the drone is to be designed in such a way that it can autonomously fly from one location to another.

2. The drone have take-off, landing and collision avoidance methods implemented on board. [5]

This function is not so easy to perform,but the on board should be that efficient that it can perform the route re-plan functionality.

5. Conclusion

Some UAV functionalities which are observing difficulties in fulfilling the aim of longer mission have been presented here with some new techniques and technologies that can overcome the drawbacks. Focusing on the safety first as a research parameter, the concept for high endurance with accidental safety will play a significant role in real time application. The reason behind adding all the important features is to increase its capability in long duration flight without facing any problem on a path and with which an assigned mission can easily be accomplished.

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