Background of Path Planning to Aviation Engineering

Path planning is an essential technology in aviation industry especially in the rapid urbanization. Skyscrapers and mountains may create a more complex terrain, which is also obstacles to aircrafts or flying machines. Path planning is required to avoid dangers and find the best route for flying. Aviation engineering integrate both path planning technology and aviation technology in order to let the aircraft operate efficiently and safely.

In commercial flight, path planning is one of the most important elements in aircraft avionics. The navigation system relies on the result of path planning to guide the aircraft to the destination. In aviation engineering, the aircraft data is combined with the path planning system. By inputting different constrains regard to the particular aircraft type, and also other factors such as geographical condition between two places and the weather, the computer can then compute the best route for the flight, with the lowest cost as well as fulfilling different regulations. The results mostly depend on the aircraft type and the weather on that day when flying the same route. For example, flying an A350 and A320 between two places may come out with an different route since their Extra-time Operation Standard (ETOPS) is different. A320 has a lower ETOPS (within 180 minutes with flying by one engine)[1], which means it has to fly a route that have more airport nearby compared to A350, which have a higher ETOPS (within 370 minutes with flying by one engine)[2]. More checkpoints needed to be set for A320 in order to fulfill the ETOPS. The planned route for A320 is more complex and indirect compare to A350. With the path planning system, the result can be calculated by striking a balance between cost, time and restrictions and a best outcome will then be generated. The aircraft navigation system may then set different checkpoint on the map based on the path planning result, then form a possible route to guide the aircraft to the destination accordingly. Without an accurate planned path, the navigation system. This allow the aircraft fly effectively with the lowest cost and adequate safety.

The significant of path planning is also shown when flight route is changed suddenly due to different factors such as delay due to heavy traffic jam, poor weather condition. It will be extremely complicated and time consuming to recalculate the route with different variable and parameters by hand. For example, when the flight faced a poor weather, to determine if the flight should follow the original path or deviate to avoid danger, it consist of many factor that affect every variable according, like the cost (fuel usage, time usage), tolerance of the aircraft structure under poor weather condition. All of them have to be calculated in order to ensure the safety of the flight. With a path planning system, result can be generated quickly and allow the aircraft navigation system to follow the path. Error can also be reduced by eliminating the human factors. This increase the accuracy of calculation in aviation engineering and provided a efficient and safe method to due with any possible change in commercial flight

In Unmanned aerial vehicle (UAV) area, path planning system is used to coordinate the flying route of the UAV and avoid collisions. In daily life, there is an increasing trend of using UAV in different area such as agriculture, delivery and surveying. Path planning system is required in order to allow multiple UAVs operate in same airspace safely without collision among themselves and also obstacles in urban such as buildings and cars. In the past, UAVs mainly rely on the GPS localization. However, signals will be interfered when UAVs fly in urban and obstacles may reflect and deflect the signal transmission, thus affect the accuracy of the localization of the aircraft and may affect the safety of flying UAVs. By adopting path planning, setting cost map, obstacles, constrains and terrain can be input into path planning system. With the aid of sensors and camera, a real time environment can be captured during the operation [3]. With the path planning approach to fly UAVs, less error is committed due to the inaccurate localization and more UAVs can be flown in the same airspace as less space are needed to reserve for the errors of localization. Also, with a prior path planning aid with sensor and camera to transfer real-time image and data, the UAVs can fly safely in urban area with the monitor by the controller.

The path planning system also facilitate the automation of UVAs. Auto robotics is becoming much more popular and so do the UAVs. In the past, UAVs are required to fly by a controller with remote and monitoring the real time scenario with camera. [4] With the latest path planning technology, a real-time path planning can be done and allow UAVs to fly in environment with uncertainties. Instead of prior input of environment and terrain of a place and generate the a route before take-off, the system can generate two path, a rough path with lager grids in map (global path) and an exact path with smaller grids (local path). The UAV will first use the rough path to determine the destination, then fly with the exact route. With this technology, the UAV can fly smoothly in a rather complicated area as the path can generated according to a specific environment. This increase the flexibility of flying an automated UAV as it can adapt to changes and react correspondingly.

Reference

[1] Airbus, “Airbus A320 Family approved for 180 minute ETOPS by the FAA”

<https://www.airbus.com/newsroom/press-releases/en/2006/05/airbus-a320-family-approved-for-180-minute-etops-by-the-faa.html>

[2] EASA, “EASA certifies Airbus A350 XWB for up to 370 minute ETOPS”

<https://www.easa.europa.eu/newsroom-and-events/news/easa-certifies-airbus-a350-xwb-370-minute-etops>

[3] Guohao Zhang and Li-Ta Hsu, “ A New Path Planning Algorithm Using a GNSS Localization Error Map for UAVs in an Urban Area” pp2-4

<http://ira.lib.polyu.edu.hk/bitstream/10397/81261/3/Zhang_New_Path_GNSS.pdf>

[4] Han Chen, Peng Lu and Chenxi Xiao, “Dynamic Obstacle Avoidance for UAVs Using a Fast Trajectory Planning Approach”, pp1-2

<https://www.polyu.edu.hk/researchgrp/arclab/files/Robio2019-chenhan%20lupeng%20xiaochenxi.pdf>