UAV Route Planning On A Dynamically Changing Waypoint Based Map For Exploration Purposes.

Georgios P. Kladis †, John T. Economou †, Antonios Tsourdos §,
Brian A. White § and Kevin Knowles †
Aeromechanical Systems Group
Department of Engineering Systems and Management †,
Autonomous Systems Group
Department of Informatics and Sensors §,
Cranfield University, Shrivenham,
Swindon SN6 8LA, United Kingdom

I. Extended Abstract

In general,on board guidance and control systems are used to monitor flight performance. Apart from the time of arrival and endurance of flight they are also utilized to maintain updated fuel reserves. Presently overall flight planning is performed on ground dispatch computers. However it is crucial to be able to estimate, real-time, the fuel profile on board in order to increase automation and performance of the preflight planning when disturbances occur. In other words wasting fuel during unforecast unknown disturbances can degrade the performance of the preflight planning mechanism. At the same end, if the time of arrival is available by a particular strategy then a fuel optimal trajectory can be possibly generated on-line with manipulation of flight parameters like speed, propulsion magnitude, angle of turn etc. In the included work the UAV mission is represented by energy graphs motivated by the analysis in [1]. The problem of the shortest path routing is revisited when a dynamically changing environment is considered. It is assumed that information about the map is received while on flight due to events. Determining all possible routes and choosing the optimum, prior to a mission, from a minimum cost sense is not sufficient for the solution of the problem. In fact, additional information should be accounted for the embedded decision process. Consequently for such a stochastic system the best solution can be a rather deterministic approach. In addition Unmanned Aerial Vehicles are required, while on mission, to "*scout*" areas of interest within the map. Particularly UAV reconnaissance missions over a totally unknown or partially known environment are concerned with two important tasks. Firstly they involve extracting as much intelligence as possible and traversing the area of interest in the most safe flyable means. Hence based on data gathered real-time during mission the UAV should be capable of integrating knowledge from a variety of sources and re-plan its mission accordingly in order to fulfil objectives. Motivated by the previous, depending on the decision making process, the notion of a "*temporary*" optimum path can be of physical and functional sense. In essence, the problem can be modeled as a multistage decision making process, where each stage is triggered by an event and is characterized by a current starting point and the same goal. Hence given the current availability between paths, the objective is to devise a policy that leads from an origin or current known location to a destination node while traversing the unknown region of interest with the minimal energy demand. In the included work mathematical formulation of a dynamically waypoint based map is illustrated and its relevance is stated through properties. In addition physical and functional limitations are included for the UAV application.

Index Terms

Dynamically changing environment, Reconnaissance mission, uncertainty region, Graph theory, adjacency energy matrix, waypoint based guidance, energy conservation, shortest path.

REFERENCES

[1] J. Economou, G. P. Kladis, A. Tsourdos, and B. White, "A node-to-node composite graph and pseudo-boolean modeling: A uav energy application." *In Journal of Aerospace Engineering. Proceedings of the Institution of Mechanical Engineering*, vol. 221, no. 5, pp. 815–830, October 2007.