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Trajectory Generation Procedure for Unmanned Aerial Vehicles

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Abstract : One of the most constraining problems facing the development of autonomous vehicles is the limitations of current technologies. Guidance and navigation controllers need to be faster and more robust. Communication data links need to be more reliable and secure. For an Unmanned Aerial Vehicles (UAV) to be useful, and fully autonomous, one important feature that needs to be an integral part of the navigation system is autonomous trajectory planning. The work discussed in this paper presents a method for on-line trajectory planning for UAV's. This method takes into account various constraints of different types including specific vectors of approach close to target points, multiple objectives, and other constraints related to speed, altitude, and obstacle avoidance. The trajectory produced by the proposed method ensures a smooth transition between different segments, satisfies the minimum curvature imposed by the dynamics of the UAV, and finds the optimum velocity based on available atmospheric conditions. Given a set of objective points and waypoints a skeleton of the trajectory is constructed first by linking all waypoints with straight segments based on the order in which they are encountered in the path. Secondly, vectors of approach (VoA) are assigned to objective waypoints and their preceding transitional waypoint if any. Thirdly, the straight segments are replaced by 3D curvilinear trajectories taking into account the aircraft dynamics. In summary, this work presents a method for on-line 3D trajectory generation (TG) of Unmanned Aerial Vehicles (UAVs). The method takes as inputs a series of waypoints and an optional vector of approach for each of the waypoints. Using a dynamic model based on the performance equations of fixed wing aircrafts, the TG computes a set of 3D parametric curves establishing a course between every pair of waypoints, and assembling these sets of curves to construct a complete trajectory. The algorithm ensures geometric continuity at each connection point between two sets of curves. The geometry of the trajectory is optimized according to the dynamic characteristics of the aircraft such that the result translates into a series of dynamically feasible maneuvers. In summary, this work presents a method for on-line 3D trajectory generation (TG) of Unmanned Aerial Vehicles (UAVs). The method takes as inputs a series of waypoints and an optional vector of approach for each of the waypoints. Using a dynamic model based on the performance equations of fixed wing aircraft, the TG computes a set of 3D parametric curves establishing a course between every pair of waypoints, and assembling these sets of curves to construct a complete trajectory. The algorithm ensures geometric continuity at each connection point between two sets of curves. The geometry of the trajectory is optimized according to the dynamic characteristics of the aircraft such that the result translates into a series of dynamically feasible maneuvers.

Keywords : trajectory planning, unmanned autonomous air vehicle, vector of approach, waypoints
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