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Application of Rapidly Exploring Random Tree Star-Smart and G2 Quintic Pythagorean Hodograph Curves to the UAV Path Planning Problem

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Abstract : This work approaches the automatic planning of paths for Unmanned Aerial Vehicles (UAVs) through the application of the Rapidly Exploring Random Tree Star-Smart (RRT*-Smart) algorithm. RRT*-Smart is a sampling process of positions of a navigation environment through a tree-type graph. The algorithm consists of randomly expanding a tree from an initial position (root node) until one of its branches reaches the final position of the path to be planned. The algorithm ensures the planning of the shortest path, considering the number of iterations tending to infinity. When a new node is inserted into the tree, each neighbor node of the new node is connected to it, if and only if the extension of the path between the root node and that neighbor node, with this new connection, is less than the current extension of the path between those two nodes. RRT*-smart uses an intelligent sampling strategy to plan less extensive routes by spending a smaller number of iterations. This strategy is based on the creation of samples/nodes near to the convex vertices of the navigation environment obstacles. The planned paths are smoothed through the application of the method called quintic pythagorean hodograph curves. The smoothing process converts a route into a dynamically-viable one based on the kinematic constraints of the vehicle. This smoothing method models the hodograph components of a curve with polynomials that obey the Pythagorean Theorem. Its advantage is that the obtained structure allows computation of the curve length in an exact way, without the need for quadratural techniques for the resolution of integrals.

Keywords : path planning, path smoothing, Pythagorean hodograph curve, RRT*-Smart
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