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Drone On-Time Obstacle Avoidance for Static and Dynamic Obstacles

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Abstract : Path planning for on-time obstacle avoidance is an essential and challenging task that enables drones to achieve safe operation in any application domain. The level of challenge increases significantly on the obstacle avoidance technique when the drone is following a ground mobile entity (GME). This is mainly due to the change in direction and magnitude of the GME's velocity in dynamic and unstructured environments. Force field techniques are the most widely used obstacle avoidance methods due to their simplicity, ease of use, and potential to be adopted for three-dimensional dynamic environments. However, the existing force field obstacle avoidance techniques suffer many drawbacks, including their tendency to generate longer routes when the obstacles are sideways of the drone's route, poor ability to find the shortest flyable path, propensity to fall into local minima, producing a non-smooth path, and high failure rate in the presence of symmetrical obstacles. To overcome these shortcomings, this paper proposes an on-time three-dimensional obstacle avoidance method for drones to effectively and efficiently avoid dynamic and static obstacles in unknown environments while pursuing a GME. This on-time obstacle avoidance technique generates velocity waypoints for its obstacle-free and efficient path based on the shape of the encountered obstacles. This method can be utilized on most types of drones that have basic distance measurement sensors and autopilot-supported flight controllers. The proposed obstacle avoidance technique is validated and evaluated against existing force field methods for different simulation scenarios in Gazebo and ROS-supported PX4-SITL. The simulation results show that the proposed obstacle avoidance technique outperforms the existing force field techniques and is better suited for real-world applications.

Keywords : drones, force field methods, obstacle avoidance, path planning
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