FASTER: Fast and Safe Trajectory Planner for navigation in unknown environments

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Abstract-

Planning high-speed trajectories for UAVs in unknown environments requires algorithmic techniques that enable fast reaction times to guarantee safety as more information about the environment becomes available. The standard approaches that ensure safety by enforcing a “stop” condition in the free-known space can severely limit the speed of the vehicle, especially in situations where much of the world is unknown. Moreover, the ad-hoc time and interval allocation scheme usually imposed on the trajectory also leads to conservative and slower trajectories. This work proposes FASTER (Fast and Safe Trajectory Planner) to ensure safety without sacrificing speed. FASTER obtains high-speed trajectories by enabling the local planner to optimize in both the free-known and unknown spaces. Safety is ensured by always having a safe back-up trajectory in the free-known space. The MIQP formulation proposed also allows the solver to choose the trajectory interval allocation. FASTER is tested extensively in simulation and in real hardware, showing flights in unknown cluttered environments with velocities up to 7.8 m/s, and experiments at the maximum speed of a skid-steer ground robot (2 m/s).

Index Terms- Convex decomposition, path planning, trajectory optimization, UAV.

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