Robotics and Autonomous Systems Thesis Defense

Simultaneous Navigation And Mapping (SNAM) Using Collision Resilient UAV

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Abstract

Navigation and mapping in GPS-denied environments, such as coal mines or dilapidated buildings filled with smog or particulate matter, pose a significant challenge due to the limitations of conventional LiDAR or vision systems. It is crucial for first responders and cave explorers to have a navigation algorithm and mapping strategy to safely enter such territories.

This thesis presents the design of a collision-resilient Unmanned Aerial Vehicle (UAV), XPLORER that utilizes a novel navigation algorithm for exploration and simultaneous mapping of the environment. The real-time navigation algorithm uses the onboard Inertial Measurement Units (IMUs) and arm bending angles for contact estimation and employs an Explore and Exploit strategy. Additionally, the quadrotor design is discussed, highlighting its improved stability over the previous design.

The generated map of the environment can be utilized by the same UAV or other autonomous vehicles to navigate the environment. The navigation algorithm is validated in multiple real-time experiments in different scenarios. Furthermore, the developed mapping framework can serve as a supplementary input for map generation along with conventional LiDAR or vision-based mapping algorithms.

Both the navigation and mapping algorithms are designed to be modular, making them compatible with conventional UAVs. This research contributes to the development of navigation and mapping techniques for GPS-denied environments, enabling safer and more efficient exploration of challenging territories.

June 7, 2023; 11 AM; ECG G305;

Zoom Link: https://asu.zoom.us/j/87414446992