Robust Autonomous Micro Aerial Vehicle (MAV) Navigation with Onboard, Environment-Agnostic, Multi-Sensor SLAM

Krishna, Parthiv (School: Minnetonka High School)

This project involved the development of autonomous Micro Aerial Vehicles (MAVs) that use a multi-sensorial localization system to navigate and deliver payloads. As a continuation project, it leveraged past work in the development of indoor-only MAVs and extend it to work in multiple environments, including indoors and outdoors. A quadrotor MAV was designed, built, programmed, and tested. The MAV was designed with a maximum takeoff weight (MTOW) of approximately 4 kg to allow for greater lifting ability. Increased robustness through software combination of multiple sensing, localization, and mapping methods were a primary focus of this project. Two primary programmable processors were used: an ARM Cortex M4 for motor control and an Nvidia Jetson TX2 for high-level processing. These two processors are supported by other smaller co-processors for sensor data translation. Sensing methods such as GPS, Optical Flow, LIDAR, and Visual-Inertial Odometry were combined to navigate indoors and outdoors, and to transition between long-range outdoor flight and targeted indoor flight. The increased efficiency and speed of navigation abilities, with waypoint- and targetpoint-based guidance, were another key improvement. Currently, the MAV successfully navigates indoor and outdoors in lighted and low-light conditions. The MAV is able to fly outdoors with a speed of 9 m/s and indoors with a speed of 2.5 m/s. The MAV is guided to target positions from a remote laptop, and it intelligently plans paths to reach the desired locations. Potential applications of this project include search and rescue, surveillance, and package delivery.

Awards Won:

National Aeronautics and Space Administration: Honorable Mention

International Council on Systems Engineering - INCOSE: Certificate of Honorable Mention