Development of Autonomous Unmanned Aerial Systems for Semi-Dense Point Cloud Generation in Disaster Scenarios

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The primary objective of this project is to develop autonomous Unmanned Aerial Systems (UAS) to generate semi-dense point clouds of the interior of buildings. These point clouds can be used to aid first responders in disaster scenarios such as earthquakes, fires, or school shootings, where there is a high risk associated with searching through buildings for victims. Through the implementation of this project, search and rescue efforts can be accelerated, in effect removing the responsibility of “searching” from first responders. A single quadrotor UAS has been designed and assembled, with approximate physical dimensions of a 450mm diagonal wingspan and 1250g takeoff weight. Control circuitry consisting of a high-level flight computer and a low-level flight controller was designed using two programmable processors -- the former uses a Broadcom BCM2835 SoC and the latter uses an ARM Cortex M4 microcontroller. The flight computer, programmed in Python 2.7, generates point clouds by using a digital webcam while also creating real-time flight paths. The flight controller, programmed in C, uses a BNO055 Inertial Measurement Unit (IMU) and a software implementation of a Kalman filter to predict absolute orientation. Based on orientation and flight paths from the flight computer, the flight controller controls the four brushless DC motors. Photogrammetry software has been tested in outdoor and indoor environments with image data collected on the UAS. Planned developments include improving the photogrammetry software to work in real-time, and building more UASs. Connecting more UASs with a decentralized Wireless Mesh Network will allow for collaborative mapping.

Awards Won:

Fourth Award of $500