Development of a Photogrammetry-Enabled Quadcopter With LiDAR Collision Avoidance and Real-time Detection for Optimized Hurricane Disaster Response and Mapping

Goel, Abhigya (School: Academies of Loudoun)

The 113 billion dollars of damages from Hurricane Ian prompted two needs: rapid first response and efficient reconstruction. However, first-response efforts were prolonged by the lack of effective real-time detection capabilities, and traditional GIS mapping yielded 2D environment maps that made rebuilding disaster zones both challenging and inefficient. Furthermore, existing commercial drones for emergency response are inefficient and expensive, costing at least $10,000. An advanced GIS approach, leveraging photogrammetry-based 3D modeling and real-time detection, is essential for increasing spatial awareness and search capabilities, expediting the disaster response process by significantly reducing manual labor through providing crucial 3D data and efficient detection. A collision-avoiding aerial search and analysis quadcopter was developed, powered by a Raspberry Pi 4B, Navio2, LiDAR sensor, and a camera. Five minutes of drone video footage was spliced into a dataset of 300 images, which was then processed through a custom photogrammetry pipeline in AliceVision Meshroom to create 3D models that accurately reconstructed the surface geometry of the captured environment. These reconstructions are viable for use by developers in planning environment reconstruction after a hurricane. A TF-Lite detection model assisted by an Edge TPU was then integrated with onboard camera systems to provide fast and accurate detection of human presence. To ensure vehicle safety, LiDAR sensing and obstacle avoidance capabilities were developed for smart navigation in dynamic environments. While the preliminary prototype features a successful integration of all required subsystems, future development into autonomous function would serve to further increase operational efficiency.

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