Decentralized, Autonomous Drone Swarms for Real-Time Mapping Applications and Natural Disaster Relief

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Current drone swarm technology is oftentimes not fully autonomous nor connected by a reliable network, and therefore cannot efficiently map large natural disaster environments to identify severely damaged areas in real-time. Our research proposes combining a robust decentralized drone swarm and follow the leader flight formation. A fleet of custom-designed and off-the-shelf drones was used for testing. First, in the decentralized swarm, the autonomous swarm algorithm finds nearby teammate drones and dynamically creates network routes between drones, eliminating the reliance on a central drone and single-point-of-failure errors. If a drone detects an error state, it leaves the network, and another drone is autonomously added to the fleet while existing drones continue with disaster mapping. Moreover, the follow-the-leader flight algorithm enables the swarm to fly through an environment in a coordinated manner following the path of a leader drone to maximize the terrain covered, whereas current swarms are limited in the total terrain covered since each drone is assigned to a predefined flying area, although longer drone flight is possible. Drones use LiDAR sensors to fuse point clouds of an environment into a 3D terrain map, which is advantageous over traditional photogrammetry due to its higher accuracy in darker and densely vegetated settings. Using drone imaging data collected from a real natural disaster environment, a region-based convolutional neural network is developed to identify disaster-struck areas and natural disaster severity with a 92% accuracy. The results demonstrate the application of a low-cost and efficient decentralized drone swarm that maximizes the amount of terrain mapped, and real-time 3D mapping with natural disaster identification capabilities.

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