Title: Planar Surface Detection for Small Unmanned Aerial Vehicles using Structure from Motion

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Unmanned Aerial Vehicles (UAVs), or drones, are being used in more and more diverse ways. They are being used in agriculture, transportation, real-estate, archaeology, security, and site or building inspections. Military applications such as surveillance and reconnaissance, though, account for much of their uses, and the military's research sector is responsible for many innovations in UAV technology. One example is a small UAV, referred to as a Nano. According to the U.S. Army Roadmap for Unmanned Aircraft Systems (UAS) Roadmap 2010-2035, Nanos are expected to coordinate with one another to create swarms that fly in groups, adjust positions, and crawl on surfaces. The ability of the swarms to detect the planar surfaces of buildings is essential since buildings are one of the most common architectural characteristics in a physical environment.

Structure From Motion (SFM), which is a photogrammetric technique for estimating the three-dimensional (3D) structure of a scene or object from a series of two-dimensional images, can provide more detail of a scene or object in a 3D model while costing much less compared to Simultaneous Localization and Mapping (SLAM). This is the reason we choose the Structure from Motion technique for our comparative research. An SFM pipeline can be made of multiple steps: extracting and matching features, detecting a planar surface, estimating camera poses, triangulation, transformation, and reconstruction. More specifically, we plan to have one virtual drone successfully detect a wall of a building with Random Sample Consensus (RANSAC) in a virtual space first then compare it with variant algorithms: Progressive Sample Consensus (PROSAC) and Adaptive Real-Time Random Sample Consensus (ARRSAC). In our first phase, we aim to compare the efficiency of these different algorithms in each SFM pipeline and report the comparison results in the context of our foundational task of detecting a wall of a building with one drone in a virtual space. Then, we plan to increase the number of UAVs and have them face toward the same planar surface of a building after identifying that it is the same surface using three different SFM pipelines. Finally, we will compare the results of the performance of multiple UAVs from one pipeline with the results from another.

While there have been attempts to improve the efficiency of the standard RANSAC algorithm, there is relatively less effort being made to compare it with its variant algorithms via a task-oriented approach for small UAVs. The contributions of our work are two-fold: first, we offer a comparative analysis of RANSAC algorithms using SFM pipelines; and second, in the context of achieving a critical task that has the potential for use in various fields, our work will provide valuable insight that can help promote more cost-effective and efficient applications that will improve UAVs' autonomous operation in the near future.