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Comparison between Photogrammetric and Structure from Motion Techniques in Processing Unmanned Aerial Vehicles Imageries

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Abstract : Over the last few years, significant progresses have been made and new approaches have been proposed for efficient collection of 3D spatial data from Unmanned aerial vehicles (UAVs) with reduced costs compared to imagery from satellite or manned aircraft. In these systems, a low-cost GPS unit provides the position, velocity of the vehicle, a low-quality inertial measurement unit (IMU) determines its orientation, and off-the-shelf cameras capture the images. Structure from Motion (SfM) and photogrammetry are the main tools for 3D surface reconstruction from images collected by these systems. Unlike traditional techniques, SfM allows the computation of calibration parameters using point correspondences across images without performing a rigorous laboratory or field calibration process and it is more flexible in that it does not require consistent image overlap or same rotation angles between successive photos. These benefits make SfM ideal for UAVs aerial mapping. In this paper, a direct comparison between SfM Digital Elevation Models (DEM) and those generated through traditional photogrammetric techniques was performed. Data was collected by a 3DR IRIS+ Quadcopter with a Canon PowerShot S100 digital camera. Twenty ground control points were randomly distributed on the ground and surveyed with a total station in a local coordinate system. Images were collected from an altitude of 30 meters with a ground resolution of nine mm/pixel. Data was processed with PhotoScan, VisualSFM, Imagine Photogrammetry, and a photogrammetric algorithm developed by the author. The algorithm starts with performing a laboratory camera calibration then the acquired imagery undergoes an orientation procedure to determine the cameras' positions and orientations. After the orientation is attained, correlation based image matching is conducted to automatically generate three-dimensional surface models followed by a refining step using sub-pixel image information for high matching accuracy. Tests with different number and configurations of the control points were conducted. Camera calibration parameters estimated from commercial software and those obtained with laboratory procedures were comparable. Exposure station positions were within less than few centimeters and insignificant differences, within less than three seconds, among orientation angles were found. DEM differencing was performed between generated DEMs and few centimeters vertical shifts were found.

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