Title: Accuracy analysis of webcam photogrammetry for indoor mapping applications

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Abstract:

Photogrammetry via webcams may serve as an inexpensive alternative to lidar and structured light for measuring indoor spaces in the development of three-dimensional indoor maps. Low-priced commodity webcams can be acquired in large numbers and installed indoors in such a way as to enable multi-view 3D reconstruction of an enclosed space, such as an office or hallway. Statically mounted webcams can also provide persistent measurements over time which may improve accuracy with repeated measurements. However, these measurements can contain errors due to poor camera calibration, image distortions from low-grade optics and sensors, inaccuracies in the photogrammetric process, and methodological error during plane and surface feature extraction.

This study serves as an initial investigation into the feasibility and accuracy of webcam photogrammetry for measuring indoor spaces. An indoor office space measuring 4 meters x 6 meters served as the platform for the 3D measurements. Multi-view images of this office space were acquired using several webcam and digital camera platforms to investigate the performance of current and future webcam-like devices, which can include high-resolution surveillance cameras. These images were then processed using Agisoft PhotoScan, a commercial photogrammetry software package, to produce point cloud measurements of the study area. To provide two independent sources of higher accuracy and fidelity for accuracy testing, a baseline dataset was collected using a Riegl LMS-Z420i laser scanner to produce a reference lidar point cloud and another baseline dataset was developed using a manually operated laser distance measurer.

Accuracy assessments include statistical analyses of fixed point target locations, various planar surfaces, and surface textures using variograms. We believe that the results show that alternative low cost cameras can provide 3D interior mapping capabilities with acceptable levels of accuracy, and so may offer a means for simpler acquisition of "as built" 3D models of interior spaces such as offices, underground complexes, airport terminals, shopping centers, and caves.