Photogrammetrically Enhanced Plane Sweep for Point Cloud Densification with UAV Imagery

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ABSTRACT

The existing photogrammetry and computer vision workflow in structure from motion (SFM) software entails a digital surface model (DSM) process that can be enhanced by implementing a higher level of photogrammetric constraint. I am using photogrammetrically enhanced plane sweeping to reinforce the DSM workflow, specifically for cleaning up edges and corners in the final DSM using imagery from unmanned aerial vehicles (UAV). The entire DSM workflow consists of starting with a sparse point cloud derived from stereo reconstruction, densifying it via the plane sweep method, and from there a DSM can be formed with meshing and texturizing techniques. The novelty I will present is in the densification of the sparse point cloud. Each sparse point is seen by n-photos and a plane is placed near the sparse point at a location needing densification to test the neighborhood of that location in the n-photos. As the planes are swept above and below that location, similarity measures are developed by projecting the n-photos onto the planes and comparing intensities. One new point is established from the center of the plane with the highest similarity measure, provided the similarity measure is above a minimum threshold. This process is repeated in all areas that are deemed too sparse. The plane sweep method is heuristic by itself but can be significantly enhanced by using the a-priori photogrammetric information and constraints to optimize how the similarity at each plane is calculated and aggregated. This resulting dense point cloud will aid in reconstructing edges and corners in the meshing stage of the DSM workflow, giving the final product a higher level of interpretability.

Key words: Structure from motion, Digital surface model, Stereo reconstruction, Unmanned aerial vehicle