Title
Error Detection, Factorization and Correction for Multi-View Scene Reconstruction from Aerial Imagery

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Abstract

Sequential scene reconstruction from video sequences has become a prominent computer vision research area in recent years, due to its large number of applications in fields such as security, robotics and virtual reality. Despite a lot of recent progress in this field, there are still a number of issues that manifest as incomplete, incorrect or computationally-expensive reconstructions. The engine behind achieving reconstruction is the matching of features between images, where common conditions such as occlusions, lighting changes and texture-less regions can all affect matching accuracy. Subsequent processes that rely on matching accuracy, such as camera pose estimation, structure computation and non-linear parameter optimization, are also vulnerable to additional sources of error, such as degeneracies and mathematical instability. Detection and correction of errors, along with robustness in parameter solvers, are a must in order to achieve a very accurate final scene reconstruction. However, detection of errors is in general difficult due to the lack of ground-truth information about the given scene, such as the absolute position of scene points or GPS/IMU coordinates for the camera(s) viewing the scene.

In this dissertation, algorithms are presented for the detection, factorization and correction of error sources present in all stages of a scene reconstruction pipeline, and in the absence of ground-truth knowledge. Three algorithms make use of feedback after the pose and structure estimation process to unmask and factorize errors related to the feature matching process and also errors in camera parameters, all of which ultimately affect structural accuracy. It is shown how the different types of errors are corrected, as evidenced by more-accurate pose estimates and lower reprojection errors. Additionally, another algorithm is presented that improves robustness in multi-view reconstruction by removing frames that may lead to inaccurate feature matches, pose estimation degeneracies and mathematical instability in structure computation. In general, the presented algorithms are optimized for the specific application of aerial video, but have been proven to work across different scene types and camera motions, and for both real and synthetic scenes.

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