Stability Analysis of a Multi-Camera Photogrammetric System Used for Structural Health Monitoring

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SUMMARY

Multi-camera photogrammetric systems are becoming more and more widespread due to the off-the-shelf availability of inexpensive digital cameras. Such systems are employed in a variety of metric applications including mobile mapping, vision-aided navigation, biomedical engineering, and structural deformation monitoring. In order to meet desired precision specifications these systems should be calibrated on a regular basis. The calibration parameters to be solved for include both the interior orientation parameters of each camera, and the mounting parameters of each camera with respect to a reference camera. The frequency of such system calibration depends on the build quality of the system components and on any external forces related to the environment in which the system is being used. Since stability over time has been recognized as a major factor for metric quality in sensors used for photogrammetric work, it is necessary to investigate how often a particular system should be calibrated. This could be achieved through a system stability analysis where the impact on the photogrammetric reconstruction of any changes in the calibration parameters can be quantified.

A numerical tool for checking the variations of both the internal geometry and the mounting parameter of each camera in a system was developed. This paper presents three methods that could be used for the system stability analysis of a multi-camera photogrammetric system. All methods are based on an image space synthetic grid, and provide measures of (in)stability in terms of image space units. The methods were tested with both simulated and real world data. Based on the simulation, the best of the three methods was chosen in the most general case. Given the real system calibration data for two particular system setups in a structural laboratory, the developed system stability tool could be used to either make recommendations on the frequency of calibration and/or identify the sources of instability.