Standardized Measures for the Stability Analysis of Low-Cost Digital Cameras and Potential Applications

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SUMMARY

Increasing resolution and lower costs of off-the-shelf digital cameras are giving rise to their utilization in traditional and new photogrammetric activities, such as transportation, surveillance, archaeological, industrial, and medical applications. This progress is allowing amateur users to generate high-quality photogrammetric products using such cameras. For most, if not all photogrammetric applications, the internal metric characteristics, usually known as the Interior Orientation Parameters – IOP, of the implemented camera need to be determined and analyzed. The derivation of these parameters is usually achieved by implementing a bundle adjustment with self-calibration procedure.

The issue of camera stability has been rarely addressed when dealing with analog metric cameras since they have been carefully designed and built to assure the utmost stability of their internal characteristics. However, the stability of digital cameras needs to be investigated since these cameras are not built with photogrammetric applications in mind. This paper introduces three quantitative methods for testing camera stability, where the degree of similarity between reconstructed bundles from two sets of IOP is evaluated. One method assumes that the image coordinate systems associated with the two reconstructed bundles are parallel and that they share the same perspective center. The second method allows the two bundles to rotate relative to each other until the best coincidence is achieved, and the third method allows both spatial and rotational offsets between the two bundles while observing their quality of fit at a given object space.

In this research, the stability of five amateur and professional digital cameras has been checked over a period of thirteen months. The experimental results demonstrate the stability of the majority of these cameras. Some potential applications involving the generation of 3D CAD models, measurement of facial features and medical imaging, will also be discussed in the context of their need for camera calibration and stability analysis.