

A versatile photogrammetric camera automatic calibration suite for multi-spectral fusion and optical helmet tracking

Jason de Villiers, Robert Jermy and Fred Nicolls

Abstract:

This paper presents a system to determine the photogrammetric parameters of a camera. The lens distortion, focal length and camera six degree of freedom (DOF) position are calculated. The system caters for cameras of different sensitivity spectra and fields of view without any mechanical modifications. The distortion characterisation, a variant of Brown's classic plumb line method, allows many radial and tangential distortion coefficients and finds the optimal principal point. Typical values are radial and tangential coefficients. These parameters are determined stably and demonstrably produce superior results to low order models despite popular and prevalent misconceptions to the contrary. The system produces coefficients to model both the distorted to undistorted pixel coordinate transformation (e.g. for target designation) and the inverse transformation (e.g. for image stitching and fusion) allowing deterministic rates far exceeding real time. The focal length is determined to minimise the error in absolute photogrammetric positional measurement for both multi camera systems or monocular (e.g. helmet tracker) systems. The system determines the 6 DOF position of the camera in a chosen coordinate system. It can also determine the 6 DOF offset of the camera relative to its mechanical mount. This allows faulty cameras to be replaced without requiring a recalibration of the entire system (such as an aircraft cockpit). Results from two simple applications of the calibration results are presented: stitching and fusion of the images from a dual-band visual/LWIR camera array, and a simple laboratory optical helmet tracker.

Keywords: Camera calibration, distortion correction, helmet tracking, stitching, multi-spectral fusion