Camera Calibration for Band-registration and Ortho-rectification of MiniMCA Imagery Acquired by a Fixed-Wing UAV

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ABSTRACT: The purpose of this research is to establish a prototype of environmental observation network that can rapidly and accurately assess the conditions of ecosystems in great details over a vast region in the era of global change. However, an optical remote sensor requires a good weather condition with direct sunlight and minimum amount of cloud cover. The window of opportunity is usually short (e.g. 1-2hrs), thus a flexible data collection is the key for the application and a fixed-wing UAV equipped with MiniMCA and a single frequency GPS antenna is adopted. The MiniMCA-12 is a multi-spectral (12 channels), multi-lens, and frame-based optical sensor. Each band of image is acquired by its individual center perspective camera. The bandwidth for each spectral band is 10 nm that covers 400 nm (blue) to 950 nm (near infrared) wavelength ranges with close regard to known biophysical indices suitable for environmental observation purposes. Conventionally, a precise ortho-rectification procedure requires tie-point image coordinates measurements, with/without GPS/IMU observations, and bundle adjustment with ground controls. In this study, those twelve lenses are calibrated through an indoor calibration field including their interior orientation parameters (IOPs) and relative orientation parameters (ROPs). Since a feature-based tie-point image matching scheme may not work for all channels due to their spectral responses are different, we choose one channel as reference image and perform aerial triangulation with ground control points to obtain all images' exterior orientation parameters (EOPs). Based on the pre-calibrated ROPs we can estimate the images' EOPs of the other 11 channels and perform ortho-rectification separately. Since the ROPs are adopted, a precise band-registered multi-spectral image can be obtained as well. The experimental results show that the except for buildings where no height model is available for relief displacement correction, the band registration problem can be solved through the proposed calibration and ortho-rectification scheme.

KEY WORDS: Camera Calibration, Multi-Spectral Images, Ortho-rectification, UAV