Monitoring surface deformation using automated digital photogrammetry and Particle Image Velocimetry technique

Rou-Fei Chen, Jian-Cheng Lee, Kou-Jen Chang, Yu-Chang Chan
Institute of Earth Sciences, Academia Sinica

Abstract

Aerial photographs acquired using a high-resolution digital images and ground survey has been to monitor changes in topographic features and surface deformation, and to obtain the digital elevation models (DEMs). To rectify the image data, it is necessary to obtain geometrical parameters including camera type, frame focus, and aerial height. Furthermore, it is important to achieve a reasonable accuracy without a great number of ground control points (GCPs) when dealing with large-scale imagery. In order to obtain better ground controls for geometric calibration, we carried out RTK-GPS measurements at each ground points with a resolution of a few centimeters in horizontal and vertical components. Therefore, GCPs provide strong geometrical constraints for triangulation and orthorectification of images. This measurement is crucial because otherwise it is almost impossible to obtain orthorectified photographs with a precision in pixel level as good as 10-20 cm. The particle image velocimetry (PIV) method is an application of an optical image (e.g., aerial photographs and SPOT images) correlation technique, in which the horizontal displacement field is measured by comparison of images acquired at two different times. This method is based on a sub-pixel correlation of orthorectified images, using sliding windows. Each image is divided into several small areas (windows). The corresponding windows from the two images are then cross-correlated. The cross-correlation function is a pattern-matching routine that determines the relative displacement between images, which are shifted according to the best overlap. The residual offsets of image pairs are computed from the phase shift of the Fast Fourier Transform of the sliding window. This value corresponds to the horizontal displacement vector of the window. The correlation between two images can be efficiently performed as long as their texture is similar. The creation of DEMs from oblique and non-metric imagery using automated digital photogrammetry can be difficult. Recently, technology provided increasing variety of methods, especially seamless DEMs are generated for entire blocks or for any sub-block or polygon area. In this study, we focused to put forward a survey method to monitoring morphological change through reconstruct the high precision DEMs and measure surface displacement.