# Accuracy Analyses of a Fixed-wing UAV Equipped with SPAN CPT for Direct Georeferencing and DSM Generation

Jiann-Yeou Rau[2], Chih-Yang Chen[1], Jyun-Ping Jhan[3], Kircheis Liu[4] & William Lee[5]

[1]Associate Professor, [2]Master student, [3]Ph.D Student,
Department of Geomatics, National Cheng Kung University
No.1, University Rd., Tainan City 701, Taiwan (R.O.C.); Tel: + 886-6-2757575#63839;
E-mail: luvismagik@gmail.com, jyrau@mail.ncku.edu.tw

[4]Vice Director of Technical Developer, GEOSAT Aerospace Co., Ltd.
4F, No.931, Sec. 4, Bade Rd., Nangang Dist., Taipei City 115, Taiwan (R.O.C.)
E-mail: geosataero.l@gmail.com

[5]General Manager, Aeroland UAV Inc.
No. 112-23, Su-Lin Village, An-Din Township, Tainan City 745, Taiwan (R.O.C.)
E-mail: aeroland.lee@gmail.com

**ABSTRACT:** Comparing with manned airplane an Unmanned Aerial Vehicle (UAV) is a more flexible with lower cost platform for aerial photo acquisition. However, its payload, endurance time, and flight height is comparably lower and generally only small format consumer grade digital camera can be carried out. That means, its footprint coverage will be smaller, more images are necessary to cover the same area, and may contain only forest within one image when flying over the mountainous area. By these characteristics, it is a difficult to utilize the conventional aerial triangulation (AT) procedure to obtain the images' exterior orientation parameters (EOPs) that requires uniform distributed tie-points within the images. Because, it is difficult to match tie-points automatically due to the image context has repetitive pattern, shadow, and homogeneous area. It is thus suggested to utilize a tactical grade IMU together with a dual-frequency GPS antenna for direct georeferencing (DG) particularly when fast response for hazard investigation is required. Generally, the accuracy of DG is not enough for stereo matching and digital surface model (DSM) generation. Thus, in case landslide volume estimation is required after disaster a non-control GPS-supported AT can be considered. In this paper, a fixed-wing UAV equipped with a SPAN-CPT and a Canon EOS 5D Mark II DSLR camera are used for aerial image acquisition. An in-door camera calibration field is designed for the calibration of interior orientation parameters (IOPs). A two-step boresight and lever-arm calibration procedure is used for system calibration. The performance of the whole system will be evaluated including bundle block adjustment through different AT software, the precision of system calibration, the accuracy of DG, and the accuracy of the generate DSM. Experimental results show that the RMS errors of the generated DSMs by non-control and controlled AT are 1-m and 0.4 meters, respectively. It proves that the elevation accuracy is high for landslide volume estimation after disaster even control points are not available and the use of DSLR camera for aerial mapping is promising. In the meantime, the RMS errors of DG in planimetric and vertical directions are both less than 1-m and 4-m, respectively. This is acceptable for a flight height of 1200-m and for the purpose of fast hazard investigation.

**KEY WORDS:** UAV, Aerial Triangulation, System Calibration, Direct Georeferencing, Digital Surface Model.