**Orientation Determination of UAV Images  
Using Point and Line Control**

Ching-Hui Hung1 and Liang-Chien Chen2

*1 Master Student, Center for Space and Remote Sensing Research,* *National Central University,   
No.300, Jhongda Rd., Jhongli City, Taoyuan County 32001, Taiwan,*

*E-mail:* [*higirl.hui5781@gmail.com*](mailto:higirl.hui5781@gmail.com)

*2 Professor, Center for Space and Remote Sensing Research, National Central University,   
No.300, Jhongda Rd., Jhongli City, Taoyuan County 32001,Taiwan,  
E-mail:* [*lcchen@csrsr.ncu.edu.tw*](mailto:lcchen@csrsr.ncu.edu.tw)

**Abstract:**

Compared to traditional aircrafts, unmanned aerial vehicles (UAV) practice lower cost of operation with higher flexibility in photogrammetry measurements. However, the exterior orientation parameters (EOPs) of many UAV cameras may not be precise enough for direct georeferencing without ground control. This study is to adjust the EOPs of an UAV by the combination of point and line control. In addition to the ground control points (GCPs), control lines are also employed in the orientation modeling.

Based on the colllinearity condition equations, GCPs and ground control lines (GCLs) are integrated in the orientation modeling. Line-based collinearity condition equations are formulated, where each GCL is expressed in parametric form, which means the extracted feature lines are represented by parametric equations. The proposed model takes those parameters into consideration instead of the start and end point of the linear features.

This study comprises four parts, (1) feature extraction, (2) feature correspondence, (3) orientation determination, and (4) validation. In addition to GCP marking, linear features are extracted by Canny edge detector followed by a Hough Transform. Then the points and lines are interactively corresponded to their counterparts in a topographic database for the acquisition of object coordinates. The GCPs and GCLs are then employed in the orientation modeling using space resection. The experimental results of this study were validated using a Canon EOS Mark 5D II camera on a Microdrones MD4-1000 UAV. The contribution of GCPs and GCLs were analyzed.

**Keywords:** Unmanned Aerial Vehicle (UAV), Exterior Orientation, Line Control

**Suggested Topic:** GPS & Photogrammetry: Digital Photogrammetry

**Presentation Preference:** Poster