CONTACT: ipm@innovatecalgary.com • (403) 284-6400

Bundle™ - Self Calibrating Photogrammetric Software Package

TECH ID #:524.1

Background

Bundle™ is a software package that performs self-calibrating photogrammetric adjustments and terrestrial network adjustments. It has been developed by the Multi-Sensor Systems research group in the Department of Geomatics Engineering at the University of Calgary.

Bundle™ is primarily intended for close-range terrestrial applications where the normal matrix may not have a banded structure. Therefore, special procedures for solving the system of normal equations have not been implemented (i.e., the normal matrix is not re-ordered to reduce the computational load when it is inverted). Bundle™ has a number of powerful and flexible options that should satisfy most users, including:

- Self-Calibration: Supported interior orientation parameters including focal length, principal point offset, radial lens distortion (k_1, k_2, k_3), tangential distortion (p_1, p_2) and affinity and shear.
- Incorporation of terrestrial network observations: Supported additional observations include 3D Distances – including distances between exposure stations, zenith angles, horizontal angles and azimuths.
- Weighted parameter observations: This is useful when estimates of parameters are known – for example, when GPS or INS is used to determine exposure station position. Supported parameter observations include exposure station position, exposure station orientation, camera interior orientation and weighted control point co-ordinates.
- Relative orientation constraint observations: This is useful in stereovision systems where the orientation of one camera is known relative to another camera.
- Automatic Generation of approximates: use of DLT to generate exterior orientation approximates when 6 or more control points are visible in an image, space intersection to generate tie point approximates, inner constraints, constraints applied to exposure station positions or control point co-ordinates and automatic elimination of constraints as datum defects are eliminated by additional information.
- Residual Calculation and goodness-of-fit test.
- Input Options: single or multiple input text files, automatic rejection of invalid observations, full input error reporting, use of omega/phi/kappa rotation angles, or roll/pitch/yaw angles and use of additional body to camera rotation matrices (for integration in other systems)
- Output Options: text and HTML output files.

Areas of Application

- GPS Assisted Aerial Triangulation
- Integrated Sensor Orientation for airborne mapping systems
- Georeferencing of multi sensor and mobile mapping systems
- Calibration of cameras
- Adjustment of terrestrial networks.

Competitive Advantages

- Bundle™ is primarily intended for system developers requiring Bundle™-adjustment source code. However, it is also available as either a stand-alone console or Windows™ application. Educational discounts for both the source code and the executables are available.
- Bundle™ has been programmed in C/C++ using Microsoft Visual C++™. Compilation using other environments has not been tested and is not supported. However, neither compiler nor platform specific code has been used and porting to other compilers should not be difficult. The code is has extensive internal documentation (including details of the algorithms) and object-oriented techniques have been used. Additionally, the Standard Template Library (STL) has been widely used.
- The code has three primary modules: Bundle™ Adjustment engine, Text input andText and HTML Output.
- The input and output modules are completely separate from the Bundle™ adjustment algorithms and code – allowing purchasers of the software to easily incorporate a Bundle™ adjustment into their own custom graphical user interface (GUI).

Publications

- Ellum, C., "Integration of Raw GPS Measurements into a Bundle Adjustment", ISPRS Commission IV Symposium, 12-23 Jully 2004, Istanbul, Turkey.

- Ellum, C.M. N. El-Sheimy, N., "New strategies for integrating photogrammetric and GNSS data", ISPRS Commission V Symposium, Image Engineering and Vision Metrology, 25.-27. September 2006, Dresden, Germany.

- Hassan T., Ellum C., and El-Sheimy N. (2006). Photogrammetric Bridging of GPS/INS in Urban Centers for Mobile Mapping Applications. ION GNSS 2006, Fort Worth, Texas, USA, Sep. 26-29, 2006.