Best Practices for Managing Aerial and UAS Frame Imagery

Cody Benkelman, Jie Zhang
Objectives

- Manage and share collections of imagery from aerial frame cameras
  - Professional digital cameras
    - Metric lens, precise positioning with GPS & IMU
  - Uncalibrated frame cameras on unmanned aerial systems (UAS) or drones
  - Intent is to manage & process single, unprocessed images from the sensor; Preprocessed Orthophotos from a data provider are a different use case...
Image Management Workflow Using Mosaic Datasets
Highly Scalable, From Small to Massive Volumes of Imagery

Create Catalog of Imagery
- Reference Sources
- Ingest & Define Metadata
- Define Processing to be Applied

Apply:
- On-the-fly Processing
- Dynamic Mosaicking

Access as Image or Catalog
Support for Aerial and UAV/UAS Imagery data

• Use Mosaic Dataset to manage both film and digital frame camera data

• A generic solution to support thousands of different cameras

• Required information:
  - Interior orientation (camera parameters)
  - Exterior orientation (unique frame parameters)
Basic workflow in ArcGIS

- Create Mosaic Dataset
- Use the appropriate Raster Type to ingest data from different sensors
  - Applanix
  - Match-AT
  - Frame Camera  *(added at 10.3.1)*
- Populate integrated metadata into Mosaic Dataset
  - Sensor location (x,y,z) and orientation (o,p,k)
  - Other metadata may be added to facilitate management & analysis
- Share as image service (optional)
Two approaches

- **Images with complete orientation parameters**
  - LeadAir
  - UltraCam
  - etc.
  ➔ Generate Frames and/or Cameras table from calibration report, etc.

- **Orientation parameters generated by software**
  - Drone2Map for ArcGIS
  - Pix4d Mapper™
  - Harris/Icaros OneButton™
  - etc.
  ➔ Generate Frames and/or Cameras table from exported project report.
Prepare inputs for *Frame Camera* Raster Type

- Consolidate exterior/interior orientation parameters
  - GPS file
  - Camera file
  - Frame parameters file (*.txt, *.csv, or *.xml)

- Create Frames and/or Cameras table
  - Format the orientation parameters to *Frame Camera* Raster Type schema
  - Supports radial distortion correction
  - Works for any camera
  - Input format can be csv/txt/feature class/GDB table

See in ArcGIS Help System:
http://esriurl.com/FrameSchema
http://esriurl.com/CameraSchema
Demo
Mosaic dataset workflow
Frame Camera Raster Type – Exterior orientation

Frame table

- Required: PerspectiveX/Y/Z and image path (relative or absolute)
- Omega/Phi/Kappa
- Add raster info fields to speed up ingest process
  - NCols, NRows, NBands, PixelType, SRS

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Frame Camera Raster Type – Interior orientation

Camera table

- Focal length (microns)
- Principal point (microns)
- Image to camera affine transformation
- AverageZ or DSM
- Radial/Konrady correction

\[ x' = x \cdot (K_0 + K_1 \cdot r^2 + K_2 \cdot r^4 + K_3 \cdot r^6 + K_4 \cdot r^8) \]
\[ y' = y \cdot (K_0 + K_1 \cdot r^2 + K_2 \cdot r^4 + K_3 \cdot r^6 + K_4 \cdot r^8) \]

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\[ C = ((\text{cols}/2) \cdot 0.5) \times \text{PS} \]
\[ R = ((\text{rows}/2) \cdot 0.5) \times \text{PS} \]

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where PS is camera’s film pixel size in microns.

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Convert Drone2Map project to Mosaic Dataset

- Drone2Map project contains calibrated interior/exterior orientation parameters

- Custom python tool to convert Drone2Map project to mosaic dataset

- Provide mosaic view of the drone image collection without generating single ortho mosaic image
Oblique Image support

- Frame camera mosaic dataset is oblique aware
  - Sensor Azimuth - indicate camera horizontal direction (0 ~ 360)
  - Sensor Elevation – indicate camera vertical direction (0 ~ 90)

- Query these value to determine
  - Whether a image is oblique
  - The image’s look angle

- New Web Appbuilder “Oblique Viewer” widget
  - Create comprehensive web app to view oblique images from frame camera image service
  - Perform mensuration
Alternative workflow for UAV projects

Data Management of single frame images as well as orthomosaics and DSMs
Imaging modes and data: UAV data collection

- **Single image frames**
  - Geotagged, or may include full orientation metadata
  - May be nadir or oblique (low / high)

- **Aerial video**
  - Typically geotagged (GPS only)
  - May have MISB (orientation) metadata
Data Products from UAV data collection (imagery based)

- Orthorectified mosaic
- Digital Surface Model (DSM)
- Orientation metadata (nadir/oblique)
  - Multiple view angles
- 3D point clouds
- 3D models
Automated workflow for Drone2Map (and similar) projects

- Organize Orthorectified Mosaic, Digital Surface Model, and Oriented Frames into Mosaic Datasets (single project)

- Compile multiple projects into a managed collection

- Based on the Image Management Workflows
Demo
Automated workflow for management of Drone2Map products
For full motion video from UAV (drone)

- Refer to another presentation at UC 2016:

**Drones in ArcGIS**

Thu 30, 1:30 PM – 2:45 PM

Room 14 A
Summary – and links to further information

**Best Practice Workflows for Image Management**

Our focus was on creating the mosaic dataset for a single data collection using the *Frame Camera Raster Type*...

For more info re: data management & automation:

- Resource Center landing page [http://esriurl.com/6005](http://esriurl.com/6005)
- ArcGIS Online Group [http://esriurl.com/6539](http://esriurl.com/6539)
- Downloadable scripts & sample data
- Recorded webinar: [http://esriurl.com/LTSImgMgmt](http://esriurl.com/LTSImgMgmt)