Working with Historical Scanned Film Imagery

Cody Benkelman
Cristelle D’Souza
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Objectives

- Manage & Share collections of scanned film imagery

- View & use
  - By geography
  - By date, other attributes

- Initial product is mosaic dataset or image service with approximate georeferencing

- Accuracy may be improved, depending on metadata and priority
Historical Imagery

- Film imagery from archives
  - Rolls of aerial film (9”, other)
  - Single frames
  - Panchromatic, True Color, Color IR
  - 1930’s – 2000’s

- Value
  - Water rights
  - Property Boundaries
  - Finding unexploded ordnance (UXO)
Data Sources

• Typically scanned by
  - Photogrammetric scanner
  - Table top scanner
• Scan quality sometimes poor
• Often Panchromatic, sometimes color (RGB or CIR)
• Orientation & Metadata
  1. Excellent – Output from AT
  2. Good – Digital Index from navigation data (> 1990)
  3. Poor – Just Index Map
  4. None

Increasingly accurate metadata results in simpler workflows and more accurate results (see next slide)
Limited/No orientation data: highly manual, small # of images

- Scan

- Use Georeferencing Tools
  - Details on following slide
  - Accuracy will be limited

- Manage using Mosaic Dataset
  - Raster Dataset Raster Type

- Use directly in ArcGIS Pro
- (and/or) Publish as Image Service
Georeferencing Tools - Details

- Set TIF images to ReadOnly

- Use ArcGIS Georeferencing Tool
  - Manually position
  - Manually add **Tie Points** using imagery base map
  - 5 to 8 are sufficient to begin, distributed across image
  - Start with 1st order transformation
  - Automated tie point **may** work (if similar base imagery is available)
  - Spline transformation will be necessary to fit terrain
  - **Accuracy will be limited!**

- Use “Save” to save transform to apply to the original image
  - “Save As New” (rectify and output) is NOT typically recommended
Georeferencing Tools

Historical color infrared photography courtesy of USDA
Metadata about image orientation drives the workflow

- **Excellent** – Output from AT software (*Match-AT, ISAT*)
  - Use mosaic datasets w/ proper raster type → this *Historical* workflow not required

- **Good** – Digital Index from navigation data (> 1990), camera calibration report
  - Proceed directly to *Frame Camera* raster type workflow

- **Poor** – e.g. Index Map
- **None**

Continue with this *Historical* workflow, unless a small # of images and Georeferencing tools are adequate.
Scanned Film (Historical) Imagery

Ortho Mapping

• Build Frames & Cameras tables with estimated values

• Run Ortho Mapping workflow –
  - Compute fiducials
    - Aerial triangulation, block adjustment
    - Add ground control (as possible, e.g. *ad hoc* tie points from basemap)
    - Apply DTM, optional Color Correction, Seamlines

• Mosaic dataset to orthorectify images on-the-fly
  - Use directly, or create outputs if desired: Orthomosaic, Digital Surface Model (DSM)

For more detail on the *Historical Imagery workflow*, see Demo Theater 1 @ 1:15 Wednesday
High Level Workflow (large/multiple projects → automation)

1. Scan
2. Compile metadata, create feature class with approximate photo centers
3. Calculate approximate orientation
   Many steps involved; See GP Tools available for download: [http://www.esriurl.com/HistoricalTools](http://www.esriurl.com/HistoricalTools)

4. Mosaic Dataset
   *Frame Camera* Raster Type

5. Aerial Triangulation & Block Adjustment: Ortho Mapping workflow
   Increased accuracy – orthorectified products

6. Use directly in ArcGIS for Desktop and/or Publish as Image Service
(1) Scanning & Optimum Format

- Scan at about 20 microns
- Record scan direction →
- Optimize Compression
  - TIF with JPEG compression (Q80 ~ 5x)
  - If color use JPEG_YCbCr (Q80 ~ 8x)
- No need to generate statistics
- Generate Pyramids
  - Often Internal (GDALaddo)
- To optimize format use CopyRaster or Optimize Rasters

http://esriurl.com/OptimizeRasters
(2) Compilation of Metadata & Digitization of Approximate Photo Centers

- **Photo Index or Print Laydown**
  - Digitize locations and frame numbers by run & film number
  - Build feature class \( (x,y) \) point for approximate photo center
  - “How??” will depend on your data. Easiest method typically to:
    - Scan & georeference the Photo Index/Print Laydown
    - Manually create points for photo centers
  - Populate “Key Historic Imagery Parameters” Table (next slide)

- **Film Report**
  - Include other metadata about the flight – date, type of film, etc.
(2) continued: Build “Key Historic Imagery Parameters” Table
For “Historical Imagery.pyt” - Required fields

Approximate X,Y (Geometry)

COG (course over ground) – this will be calculated

‘Raster’ field: path and file name to each scanned file

PhotoScaleF – Scale factor e.g. 5000 for 1:5000

FocalLength - In microns; e.g. 152400 for 6 inch

ScanDirection – per previous diagram

ScanResolution – in microns. If not known, can be estimated as \(0.24/\min(Cols,Rows)\)

FrameSize – in microns e.g. 180000 for 18cm. If undefined then assumed to be 23cm

Frame – As a 4 digit string, e.g. 0023 (not stored as an integer)

Run – As a string

Film – As a string
For “Historical Imagery.pyt” - Optional fields

Cols,Rows – Number of Cols and Rows of the image.
   Will be obtained from Image if not defined; caution about performance

OffsetC, OffsetR - in microns. This is the offset of the camera center from the center of the scan. If undefined then assumed to be 0.

Fiducials (coordinates in camera coordinate system)

Other parameters optional – from Film Report
   e.g. AcquisitionDate, ScanDate, ScannerModel, FilmType, etc.
   Frame Camera Raster Type will add to attribute table

New at Pro 2.2, not yet included in the sample workflow
(3) Calculate Approximate Orientation

- Geoprocessing Tools in “Historical Imagery.pyt”

- Will build table(s) required as input to the *Frame Camera Raster Type*
  - *Frames Table and Cameras Table* corresponding to Exterior orientation and Interior orientation
  - Can be separate tables, or combined into one

- Details re: *Frame Camera Raster Type* in Demo Theater 1 Wednesday @ 4:00 “Workflows for Aerial Frame Cameras”

See in ArcGIS Help System:
- http://esriurl.com/FrameSchema
- http://esriurl.com/CameraSchema
(3) Continued - Calculate Approximate Orientation

- Run *EstimateCOG* → Input KHIP table
  - This populates Course Over Ground field

- Run *Check Estimate Orientation Parameters*
  - This verifies required data is populated before beginning a lengthy run

- Run *Estimate Orientation Parameters*
  - This builds single Frame & Camera Table required as input to *Frame Camera* Raster Type (workflow step 4)
Approximate Orientation

Historical Imagery Tools
(4) (Optional) Create Mosaic Dataset

- Use *Frame Camera* Raster Type
  - Input Frame+Camera table as input
- Calculate footprints by Geometry, shrink ~200 m, clip to footprints
- Set Mosaic Method = Closest to Center

*Alternative*: Proceed directly to Ortho Mapping, and input Frames and Cameras tables
(Workflow step 5) Ortho Mapping workflow

- Calculate fiducials (if in cameras table for this camera)
- Aerial Triangulation (AT) & Block Adjustment
  - Estimates for interior and exterior orientation parameters
- Uses best available DEM
- Input ground control points, if available
- Output
  - Refined interior & exterior orientation

New at Pro 2.2, not yet included in the sample workflow
Ortho Mapping

Compute Fiducials, Run Aerial Triangulation & Block Adjustment
Publishing (Workflow step 6)

• As Image Services
  - Highest Image Quality (No data loss)
  - Provide Metadata
  - Access to All Overlapping data
  - Clip to Footprints

• As Raster Tile Cache (*not* generally recommended)
  - Generate in Desktop or Server
  - Publish through Server or to ArcGIS Online
  - Provides Static Backdrop
Imagery Workflows

Best Practice Workflows for Image Management, Analysis, & Use

- Landing page
  - http://esriurl.com/ImageryWorkflows

- ArcGIS Online Group
  - Downloadable scripts & sample data

**NOTE**: The Historical Imagery workflow has not yet been migrated to the current Workflows site, and is found on an older help site at http://www.esriurl.com/HistoricalTools. See discussion included in this download.