ArcGIS Full Motion Video

Raster Development Team

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ArcGIS Full Motion Video

Agenda

• What is Full Motion Video (FMV)?
• Getting started with Esri FMV
• Esri Full Motion Video Products
• What’s New!
• Demos
ArcGIS Full Motion Video

What is full motion video (FMV)?

• A sequence of images captured at a rate of 1hz (one frame per second) or higher
• The lead standards board for Full Motion Video is the “Motion Imagery Standards Board” or MISB

Full Motion Video is often abbreviated “FMV”
ArcGIS Full Motion Video
Concepts – Space, Time, and Video

• “When” and “Where”: Full Motion Video captures images in time and space
  - Time: Each frame in a video is captured at an instant in time. *By displaying the frames in sequence, at the rate captured, we see motion and change*
  - Space: The sensor is oriented in a particular direction, capturing imagery of a location. *By using direct georeferencing information, we can establish the location of the imagery*

• Synchronous vs. Asynchronous Metadata
  - Asynchronous metadata is acquired without regard to a particular frame
ArcGIS Full Motion Video
Concepts – Maps and FMV

• We can register a Full Motion Video to a map
  - Shared time and coordinate system
  - Map and FMV are synchronized as time passes
  - Features and events are captured using ArcMap
ArcGIS Full Motion Video
Concepts – Where does FMV data come from?

- Unmanned Aerial Vehicles (UAV’s)
- Orbital sensors (overhead sensors)
- Fixed Wing and Helicopter
- Vehicle mounted cameras
- Hand-held mobile devices and cameras
- Stationary (persistent surveillance)
Concepts – Where does FMV data come from?

L3 Wescam MX-15HDi
ArcGIS Full Motion Video
Concepts – How is FMV data captured?

- Sensors
  - Location (X,Y,Z) of a sensor may be fixed or dynamic
  - Orientation of the sensor may be controlled independently of the platform
  - Sensor may be rotated or elevated
Motion Industry Standards Board

Who is MISB?

• The MISB was established for the DoD, intelligence community (IC), and National System for Geospatial-Intelligence (NSG).
  - “To formulate, review, and recommend standards for motion imagery, associated metadata, audio, and other related systems for the DoD, IC, and NSG.”
  - “The goal of the MISB is to promote technologies that are standards-based in order to ensure interoperable solutions…”

http://www.gwg.nga.mil/  
 Courtesy of http://www.gwg.nga.mil/misb
ArcGIS Full Motion Video
MISB Supported Motion Imagery Types

- Panchromatic/Electro Optical (EO)
- Multispectral (MSI)
- Infrared (IR)
- Hyperspectral (HSI)
Motion Industry Standards Board (MISB)
What does MISB video metadata look like?

A “shopping list” of your required FMV metadata.

http://www.gwg.nga.mil/misb

Courtesy of http://www.gwg.nga.mil/misb
Motion Industry Standards Board (MISB)

MISB Approved Compression Types

- **H.264**
  - Best quality for low bandwidth
  - 2 to 1 performance advantage over MPEG-2
  - Higher cost (less of a factor than it used to be)
- **MPEG-2**
  - Mature technology
  - Widely supported
  - Lower cost
- **JPEG 2000**
  - 2-3 times the bandwidth of H.264 and MPEG-2
  - Very useful with large frame images
To be MISB compliant, any new motion imagery system must:

1) Be digital
2) Produce a compliant MPEG-2 Transport Stream (TS)
3) Use MPEG-2, MPEG-4 Part 10 (H.264/AVC), or JPEG 2000 image compression
4) Produce non-destructive (not “burned in”) metadata
5) Comply with MISB Standards 0601, 0102, and 0604

http://www.gwg.nga.mil/misb
Motion Industry Standards Board (MISB)

I’m building a new motion imagery system. What I should avoid doing?

Do not build:

1) Analog systems
2) Digital systems that use interlaced scanning
3) “Burned in” metadata
4) MISB EG 0104 (deprecated)
5) Systems that utilize file formats not covered by the MISB.
6) Systems that utilize proprietary file formats, metadata encodings or compression algorithms

http://www.gwg.nga.mil/misb

Courtesy of http://www.gwg.nga.mil/misb
“Metadata is collected, processed, and then distributed to a flight computer through the most appropriate interface.” – Standard060105.pdf
Motion Industry Standards Board (MISB)
MISB Minimum Guidelines

- Record digitally, no analog
- Use MPEG-2, H.264, or JPEG 2000 compression
- Comply with the MISB minimum metadata set 0902
- Add metadata elements as needed for the task
- Do not “burn in” your metadata
- Do not use proprietary formats

http://www.gwg.nga.mil/misb

Courtesy of http://www.gwg.nga.mil/misb
ArcGIS Full Motion Video
Capabilities – Esri Supported FMV Formats

- PS, MPEG-2 Program Stream
- TS, MPEG-2 Transport Stream
- MPG, MPEG File
- MPEG, MPEG File
- MP2, MPEG-2 File
- MPG2, MPEG-2 File
- MPEG2, MPEG-2 File
- MP4, MPEG-4 File
- MPG4, MPEG-4 File
- MPEG4, MPEG-4 File
- H264, H.264 Video File
- VOB, ESD File
- MT2S, MT2S

* Important step in the installation process
ArcGIS Full Motion Video

FMV Geoprocessing Tools

- Extract Metadata from Video
- Extract Video Extent
- Mosaic Video
- Video Multiplexer (Coming soon!)
ArcGIS Full Motion Video
What’s new!

• Live stream recording
• Pan and zoom for live streams
• Video Clip and Ship
• Measure distances directly on a video
• Improved performance…and more!
ArcGIS Full Motion Video
What’s new in FMV 1.2.1!

• Pan and Zoom
• Easily export new video clips
• Live stream Recording
• Slow motion playback
• Measure distances directly on a video
• Accuracy option, uses DEM/DTED information to increase video-to-map and map-to-video accuracy
• One-click PowerPoint integration – easily create reports from FMV data
• Performance improvements
  - Hardware acceleration and software only modes
  - Linear resampling and high resolution modes
ArcGIS Full Motion Video
Esri FMV Today and the road ahead!

• Currently Released Products
  - FMV Add-in for ArcGIS Desktop 10.1, 10.2, 10.3
  - FMV Geoprocessing Tools for 10.2, 10.3

• Upcoming Products
  - New FMV Add-in and GP Tools
    - Very large file support, Video Multiplexer, and more!
  - FMV support for ArcGIS 10.4 (2015)
  - FMV for ArcGIS Pro (February of 2016)

Non-MISB metadata support
Video Multiplexer

Preparing your videos and metadata for the ArcGIS Full Motion Video Add-in
What is the problem?

Non-MISB Metadata Support

- FMV reads geo-referencing information from a video file
  - Encoded using MISB specifications
- Not all video files have this information encoded
  - Metadata may...be stored in external file
  - Metadata may...not include all relevant fields
  - Metadata may...have non-MISB headings
- Need a workflow for preparing videos for full FMV functionality

Input video and metadata file...

MISB compliant metadata
Video Multiplexer
Typical Video Metadata Files

- Comma Separated Values (.csv) file.
- Headings may or may not follow MISB guidelines.
- Each entry must have a time reference.
- Time values must be Unix-based UTC timestamps *.

* microseconds that have elapsed since midnight (00:00:00), January 1, 1970

1433429777800780 = GMT: Thu, 04 Jun 2015 14:56:17 GMT

http://www.epochconverter.com/
Video Multiplexer
Non-MISB Metadata Support

- Metadata File
- Output Video
- File Mapping File
- Calculate Corners?
- Time Shift Observations

Input video and metadata file...

Video Multiplexer GP Tool
MISB compliant metadata and video
Use the MISB field-mapping template to specify your field names

Non-MISB Metadata Support

- Put metadata field names into the third column to match MISB fields.
- FMV uses red fields for geo-referencing
- **If yellow fields are set, image corners can be calculated.**

<table>
<thead>
<tr>
<th>MISB Tag</th>
<th>MISB Tag Name</th>
<th>My column headings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>UNIX Time Stamp</td>
<td>TimeStamp</td>
</tr>
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<td>5</td>
<td>Platform Heading Angle</td>
<td>PlatformHeading</td>
</tr>
<tr>
<td>6</td>
<td>Platform Pitch Angle</td>
<td>PlatformPitch</td>
</tr>
<tr>
<td>7</td>
<td>Platform Roll Angle</td>
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<td>13</td>
<td>Sensor Latitude</td>
<td>SensorLatitude</td>
</tr>
<tr>
<td>14</td>
<td>Sensor Longitude</td>
<td>SensorLongitude</td>
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<tr>
<td>15</td>
<td>Sensor True Altitude</td>
<td>SensorAltitude</td>
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<tr>
<td>16</td>
<td>Sensor Horizontal Field of View</td>
<td>HorizontalFOV</td>
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<tr>
<td>17</td>
<td>Sensor Vertical Field of View</td>
<td>VerticalFOV</td>
</tr>
<tr>
<td>18</td>
<td>Sensor Relative Azimuth Angle</td>
<td>SensorRelativeAzimuth</td>
</tr>
<tr>
<td>19</td>
<td>Sensor Relative Elevation Angle</td>
<td>SensorRelativeElevation</td>
</tr>
<tr>
<td>20</td>
<td>Sensor Relative Roll Angle</td>
<td>SensorRelativeRoll</td>
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<td>21</td>
<td>Slant Range</td>
<td></td>
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<td>Frame Center Latitude</td>
<td>FrameCenterLatitude</td>
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<tr>
<td>24</td>
<td>Frame Center Longitude</td>
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<td>25</td>
<td>Frame Center Elevation</td>
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<td>Offset Corner Latitude Point 1</td>
<td>OffsetCornerLatitudePoint1</td>
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<tr>
<td>27</td>
<td>Offset Corner Longitude Point 1</td>
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<td>Offset Corner Latitude Point 2</td>
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<tr>
<td>33</td>
<td>Offset Corner Longitude Point 4</td>
<td>OffsetCornerLongitudePoint4</td>
</tr>
</tbody>
</table>
After multiplexing the video contains MISB-compliant metadata

Non-MISB Metadata Support

- Sensor location is present
- Frame corners are missing
- Minimum sensor and platform fields are present, so frame corners can be calculated…
The calculate corners option: The video is now fully geo-referenced!

Non-MISB Metadata Support

- Video and metadata are now MISB compliant and prepared for the FMV Add-in
- Frame corners and center are now added to the metadata
Time Synchronization Issues
Non-MISB Metadata Support

• At 0:13 seconds the frame crosses the road, but the road is not seen in the video.
• At 0:18 seconds the video crosses the road. Digitized points reflect the time shift.
Time Synchronization
Non-MISB Metadata Support

- Time shift observations can be recorded in a CSV file
- Enter one observation for a consistent shift
- Enter multiple observations for a differential linear shift
Time Synchronization
Non-MISB Metadata Support

• The workflow…
  - Make multiple time-adjusted videos.
  - Pause each video while observing a common feature (e.g. a road)

• The results
  - Red is the original video
  - Green is a 5 second consistent time shift
  - Blue is a 5-9 second differential time shift.
Time Synchronization – Testing the results of the time-shift

Non-MISB Metadata Support

- Do the time warp again and pause all videos near the end.
- Footprints show differences in geo-referencing
- Blue has the best results
Video Multiplexer in Summary
Why we’re so excited about it!

- Works with non-MISB metadata to make your videos MISB-compliant (Ready for the FMV Add-in)
- Calculates frame center and corner data *automatically*
- Fixes time synchronization issues
Where can my organization get the Esri FMV software?

FMV 1.2.1 and GP Tools 1.1 are both downloaded from my.esri.com.

1. Open your Organization account in My.Esri.com (Got to https://my.esri.com/welcome)
2. Click the Downloads tab
3. Click the "View Downloads" button that corresponds the version of ArcGIS Desktop you're using (i.e. 10.3)
4. Select "Additional Product" drop down towards the bottom of the page
5. The FMV tools are on that list. Click the Download button to begin downloading the software.
ArcGIS FMV

Demos
esri

Understanding our world.