CASI Processing at the NERC
Airborne Remote Sensing Facility

CASI-SWIR Workshop
2002 Flight Campaign

Andrew K. Wilson
Section for Earth Observation
Centre for Ecology & Hydrology
CASI-SWIR Workshop

- Presentation Outline
  - Airborne Remote Sensing Facility
  - Data Processing Strategy
  - Level 1b Processing
  - Level 3a Processing
  - Case Studies (UK & Belgium)
  - Summary / Conclusions
Airborne Remote Sensing Facility

• **Aircraft Platform**
• **Instrument Suite**
  - ATM & CASI-2
  - RC-10 camera
  - Terrain mapping LiDAR
• **Integrated Data System**
  - Navigation
• **Data Processing Strategy**
  - Data and software
Airborne Thematic Mapper – Multi-spectral

- Visible
- NIR
- SWIR
- TIR
Compact Airborne Spectrographic Imager - Hyperspectral

Deciduous Woodland (Spectral)
Coniferous Woodland (Spectral)
Coniferous (Spatial Bands)
Deciduous (Spatial Bands)

Wavelength (nm)
Radiance
Terrain Mapping LiDAR - (Unit for Landscape Modelling)
Integrated Data System

- Sensor time synchronisation
- GPS Position
  - Latitude / Longitude / Height @ 20Hz
- GPS Attitude
  - Roll / Pitch / Heading @ 20Hz
- Inertial Attitude
  - Roll / Pitch / Heading @ 64Hz → 200Hz
Data Processing Strategy

• NASA Standard Data Products
  - Level 0 - Raw Sensor Data
  - Level 1b - Calibrated Data + Navigation
  - Level 2 - Geophysical Data
  - Level 3a - Geo-corrected Data
  - Level 4 - Multi-temporal, Multi-sensor Data

• Hierarchical Data Format (HDF)
  - Image data in HDF Scientific Data Sets
  - Metadata in HDF VGroups
Level 1b Data Processing

• Radiometric Calibration
  - Calibration to ‘at-sensor’ radiance

• Navigation Processing
  - Differential GPS correction of position
  - GPS / Sensor ‘level arm’ offset
  - Sensor boresight misalignment calibration
  - Integration of GPS / inertial attitude
  - Interpolation to ATM / CASI scan sync time
GPS / Sensor ‘level-arm’ offset
Geometric Targets for Boresight Misalignment Calibration
Geometric Targets for Boresight Misalignment Calibration
## GPS/INS Attitude Integration

<table>
<thead>
<tr>
<th>GPS</th>
<th>Advantages</th>
<th>Disadvantages</th>
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|     | • Absolute attitude for each epoch  
     | • Independent measurement for each epoch | • Low sampling frequency  
     |                           | • Measures airframe motion  
     |                           | • Moderate accuracy |
|     | • High sampling frequency  
     | • Measures sensor motion  
     | • High relative accuracy | • Drift problems, random walk  
     |                           | • Dependency between epochs |
GPS/INS Attitude Integration

- Options for GPS / INS attitude integration
  - Simple linear or polynomial regression
  - Kalman filtering

- Smoothing of GPS only attitude

- Interpolation of attitude & position to scan time
Level 3a Data Processing

- L1b sensor position $\rightarrow$ L3a pixel location
  - Sensor position and attitude
  - Sensor geometric model
  - WGS84 spheroid $\rightarrow$ Earth geoid transformation
  - Pixel view angle intersection with Earth’s surface
Surface Elevation (metres a.s.l.)

OS mean sea level (geoid datum)

WGS84 spheroid (GPS datum)

Pixel view angle intersection with Earth’s surface
a) Flat terrain model  
Digital Elevation Model (DEM)  
b) Terrain model with building heights  
Digital Surface Model (DSM)
Level 3a Data Processing

- Resampling of output pixel value
  - Resampling algorithm(s)
  - Output pixel spatial resolution
  - Output product control

- 'azgcorr' software provided to NERC funded users

- Future implementation of Level 2 & 4 algorithms
- Future generic sensor processing
• ATM and CASI-2 Data (2003)
  - CEH Monks Wood
  - Processed with ARSF IDS and azgcorr
  - 1.0 metre spatial resolution
  - Bicubic spline resampling
  - UK British National Grid
  - Radiance data
ATM & CASI-2
ATM & CASI + vectors
Co-registration of 1 metre ATM & CASI data

ATM – true colour

CASI – false colour
Case Studies – UK

• CASI – SWIR (SASI) (2002)
  - CEH Monks Wood
  - Processed by ITRES software
  - 0.7 metre spatial resolution
  - Nearest Neighbour (NN) resampling
  - UTM projection
  - Radiance and Reflectance data
SASI radiance spectra

Monks Wood SASI spectra

- Coniferous Wood
- Deciduous Wood
- Crop
- Bare Soil
- Tarmac/Roof
- Grass

Radiance Units vs. Band #
SASI radiance spectra
Case Studies - Belgium

  - Rural scene
  - Processed by ITRES software
  - Radiance data (geometrically uncorrected)
  - Reflectance data (geometrically corrected)
SASI Radiance (un-geocorrected)
SASI radiance spectra
SASI radiance spectra
SASI reflectance spectra
Summary / Conclusions

• Potential of imaging spectroscopy (SWIR)
  - Biosphere
  - Geosphere
  - Cryosphere
  - Atmosphere
Summary / Conclusions

• Potential of imaging spectroscopy (SWIR)

• Availability of hyperspectral sensors (SWIR)
  - Hymap, CASI-SWIR, AISA Hawk
Summary / Conclusions

• Potential of imaging spectroscopy (SWIR)

• Availability of hyperspectral sensors (SWIR)

• Attention to calibration and pre-processing
  - Spectral and Radiometric calibration
  - Atmospheric and Geometric correction
Summary / Conclusions

• Potential of imaging spectroscopy (SWIR)
• Availability of hyperspectral sensors (SWIR)
• Attention to calibration and pre-processing
• Retrieval of bio-, geo-physical parameters
  - Underlying physical principles
  - Robust algorithms
Summary / Conclusions

• Potential of imaging spectroscopy (SWIR)
• Availability of hyperspectral sensors (SWIR)
• Attention to calibration and pre-processing
• Retrieval of bio-, geo-physical parameters

• Development of appropriate techniques
  - Absorption feature extraction
  - Spectral unmixing
  - Spectral matching
Summary / Conclusions

• Potential of imaging spectroscopy (SWIR)
• Availability of hyperspectral sensors (SWIR)
• Attention to calibration and pre-processing
• Retrieval of bio-, geo-physical parameters
• Development of appropriate techniques
End of Presentation

ARSF:  http://www.nerc.ac.uk/ARSF/home.html

Email:  akw@ceh.ac.uk