ASD FieldSpec FR Calibration

Setup and Techniques

Prepared by
Dan Olive

Commercial Remote Sensing Directorate
Lockheed Martin Space Operations – Stennis Programs
John C. Stennis Space Center

October 23, 2001
ASD FieldSpec FR Spectroradiometer

- Designed for collection of spectral data in the field
- Range is 350 to 2500 nanometers
- Measures spectral reflectance, radiance, and irradiance
- Fiber optic bundle carries light to three internal spectrometers

- UV/VIS/NIR silicon array covers about 350 to 950 nm with ~1.4 nm sample interval

- Two NIR/MWIR spectrometers cover 900 to 1850 nm and 1700 to 2500 nm with a sampling interval of about 2 to 3 nm

- Control and data storage with laptop computer
- Interchangeable foreoptics provide flexibility in field of view
Components of Calibration

- Spectral: Intrinsic wavelength standards
  - Lasers
  - Discharge lamps
- Radiometric: NIST secondary standard
- Linearity
- Field of View (FOV)
<table>
<thead>
<tr>
<th>Equipment List</th>
</tr>
</thead>
<tbody>
<tr>
<td>- NIST calibrated integrating sphere</td>
</tr>
<tr>
<td>- NIST sphere is equivalent to a secondary radiance standard</td>
</tr>
<tr>
<td>- Multiple HeNe lasers</td>
</tr>
<tr>
<td>- Sphere controller</td>
</tr>
<tr>
<td>- ASD FieldSpec FR spectroradiometer</td>
</tr>
<tr>
<td>- Portable laptop computer</td>
</tr>
<tr>
<td>- Precision 3-axis positioner</td>
</tr>
<tr>
<td>- MATLAB® software</td>
</tr>
</tbody>
</table>
Spectral Setup

- Use intrinsic spectral sources
- Six different wavelengths
- All HeNe lasers
- Beams directed into sphere
- No beams directly on baffle
• Take raw DN data with laser input to sphere
• Determine wavelength ASD measures for each intrinsic standard
• Locally generated MATLAB code fits Gaussian to peaks and provides center wavelength and FWHM
• Calculate ASD deviations from accepted standard wavelengths
Radiometric and Linearity Setup

- ASD powered up for 1.5 hours before taking data
- Sphere port set to open away from operator
- Probe with appropriate foreoptic positioned normal to port and centered
- Room lights off for minimum stray light
- No reflective surfaces near output port
Radiometric Setup

- Entrance aperture of probe close to but not inside port output plane
- Probe is well centered
- Note edge of internal baffle
- Field of view should be considerably less than 40° to ensure total area seen is fully on the baffle surface
Datasets Required

- NIST calibration at 30.0 mW/cm²*sr
- Equivalent to about 50% of maximum output from sphere
- Linearity requires data collection at 100%, 75%, 50%, 25%, and 10% of max
- Least squares linear fit to these points
- Use data from 50% for radiometric calibration coefficient calculation
Data Files

- All data recorded as raw data files
- Each has the format HEADER.XXXX, where HEADER is created by the operator and XXXX is a number auto-incremented by the FR
- Each file has wavelength scale in one column, DN in a second column
- Files converted to text files (*.txt) with the ViewSpecPro software before analysis
- Calibration Work Instruction details entries so that each experimental data sequence produces a spectrum that is the average of 25 separate readouts
- A total of 30 of these saved spectra is generated for each experimental setup
- First step in analysis is to average these 30 files at each wavelength
Data Files (continued)

- Averaging 25 readouts for one spectrum reduces noise
- Saving 30 spectra enables statistical calculation of SNR and further reduces noise
- Spectral calibration files of laser lines are analyzed to yield center wavelength and FWHM as measured by the ASD
- Corrections (offsets) are calculated from differences between standard wavelengths and those measured by the ASD
- Spectral radiance calibration coefficients are produced from raw digital numbers recorded and NIST file of spectral radiance from the sphere
- For verification of linearity, the raw spectra are first converted to spectral radiance via the calibration coefficients
- The resultant spectral radiance file is then integrated to yield total integrated radiance, which is used to derive a least squares fit to a line
Field of View Measurement

- Precision, automated three-axis positioner moves small grain of wheat bulb through field of view
- Room darkened
- ASD takes spectrum at each position
- Spectrum is integrated to yield overall intensity and plotted as function of position in the X,Z plane
- Angular FOV reconstructed from geometry
• Field portable spectroradiometers play key role in validation and verification
  – Ground truth data collection
  – Radiometer transfer for internal laboratory use
• Calibration required under ISO9000
• Vendor calibrations not traceable
• In-house calibration highly desirable
  – Traceability ensured
  – Equipment not subject to hazards of shipping
• Instruments serve multiple purposes
The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY)  25-10-2001
2. REPORT TYPE
3. DATES COVERED (From - To)

4. TITLE AND SUBTITLE
ASD FieldSpec Calibration Setup and Techniques

5a. CONTRACT NUMBER
NAS13-650
5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Dan Olive

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
LMSO- Stennis Program

8. PERFORMING ORGANIZATION REPORT NUMBER
SE-2001-10-00063-SSC

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Earth Science Applications Directorate

10. SPONSORING/MONITOR'S ACRONYM(S)

11. SPONSORING/MONITORING REPORT NUMBER

12. DISTRIBUTION/AVAILABILITY STATEMENT
Publicly Available STI per form 1676

13. SUPPLEMENTARY NOTES
Conference - Presentation at National Council of Standards Laboratories - Regional Chapter Meeting, SSC

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:

a. REPORT
b. ABSTRACT
c. THIS PAGE

U U U

17. LIMITATION OF ABSTRACT

UU

18. NUMBER OF PAGES
13

19b. NAME OF RESPONSIBLE PERSON
Dan Olive

19b. TELEPHONE NUMBER (Include area code)
(228) 688-1803

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18