Application of hyperspectral imaging camera to remote sensing studies

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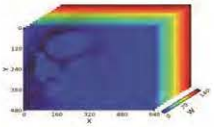
What is a Hyperspectral Camera ?

- Recent development of camera technology has made it possible to produce **Hyperspectral Cameras** that can measure **hundreds of narrow wavebands in a megapixel image .**

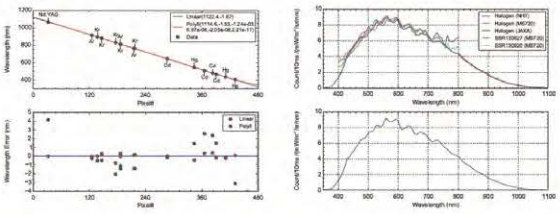
EBA JAPAN
NH-2

Specifications

	NH-2	NH-7
Sensor type	CMOS	CMOS
Image size	752×480	1280×1024
Color depth (bit)	10	10
Wavelength (nm)	350~1100	350~1100
Spectral Res. (nm)	5 (151ch)	5 (151 ch)
Capture rate (sec)	4.0(VGA)	1.6 (VGA) 7.0 (SXGA)
Dimension (mm)	76×62×193	76×62×193
Weight (g)	850	850



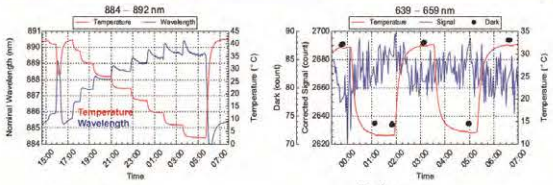
Wavelength / radiometric calibration



- Wavelength calibration
  Discharge Lamp Hg, Ar, Cd, Kr) and Nd:YAG Laser
- 14 emission liness are used to obtain 5th order polynomial
- Fitting error: 0.29 nm

- Radiance calibration
  - Skylight
  - Integrating Sphere
- Peak sensitivity @550 nm
- Sensitivity range 350 – 1100 nm

Temperature dependence

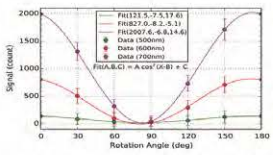


- Wavelength
  - Xenon Lamp
- Wavelength shift:
  - -1 nm – 1 nm (< 30°C)
  - 2 nm (< 40°C)
- Fitting error: 0.1 nm

- Radiance
  - Halogen Lamp
- Correction factor:
  - 5% (500 nm – 900 nm)
  - 30% (other wavelengths)
- Fitting error:
  - 0.2% (< 40°C)

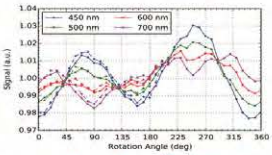
Comparison of polarization properties of spectral imagers

LCTF



LCTF scales linearly with $\cos^2\vartheta$ (polarization sensitive)

Hyperspectral camera



Almost no polarization dependece (<±1-2%)

Applications of hyperspectral camera

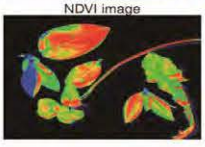
- Hyperspectral camera is a device to **visualize spectral features.**

Example

- Medical care
  - Lesion detection
- Food
  - Freshness check
- Land-cover classification
- Vegetation remote sensing
  - Crop monitoring
  - Tree species classification
- Ocean remote sensing
  - Oil spill detection
- Atmospheric remote sensing
  - Pollution monitoring

RGB image

NDVI image



Application of hyperspectral camera for aerosol research

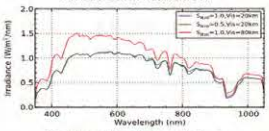
- Hyperspectral camera is suitable for **measuring functions of space x,y and wavelength λ.**

Solar radiation

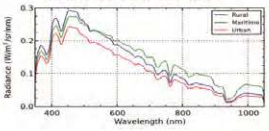
- Direct solar radiation (λ)
  - Optical depth
  - Molecular column amount
- Scattered solar radiation (x, y, λ)
  - Phase function
  - Single scattering albedo
- Aureole (x, y, λ)
  - Forward scattering

- These spectra contains info. about molecules and aerosols in the optical path.

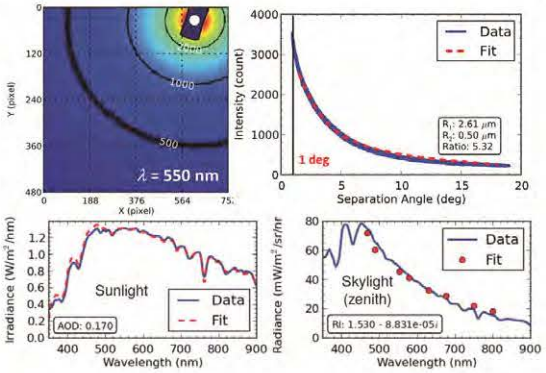
Direct solar radiation



Scattered solar radiation

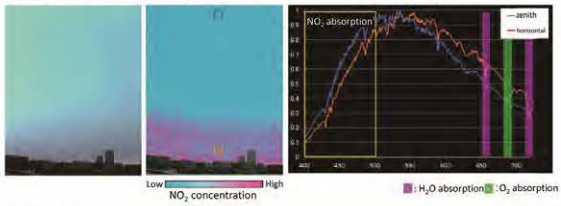


Results of aureole observation

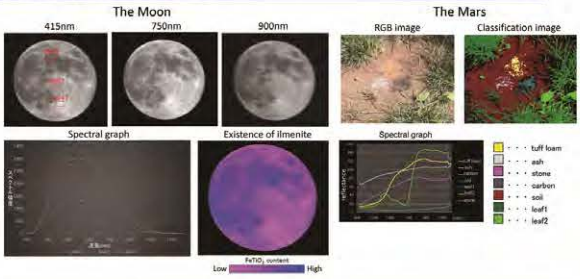


Observation of air molecules

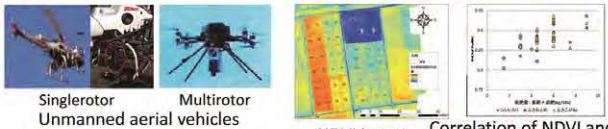
RGB composition image NO_2 distribution Spectral graph



Planetary resources survey



Precision Agriculture



Singlerotor
Multirotor
Unmanned aerial vehicles (UAVs)

NDVI image

Correlation of NDVI and the amount of fertilizer

Hyperspectral data →Band selection

Summary

- NH hyperspectral camera is a portable stand-alone hyperspectral imager with internal scanning system.
- We have demonstrated usage of NH for atmospheric measurement and other various applications.
- With the advance in IT technology and robotics, application of hyperspectral imaging will be further expanded.