Remote sensing applications with hyperspectral portable video camera

Y Takara[1], F Ando[1], T Fujimori[1], N Manago[2], K Kajiwara[2], Y Honda[2], A Kondoh[2], H Kuze[2], N Noro[1]

[1] EBA Japan Co., Ltd., [2] CEReS/Chiba Univ.

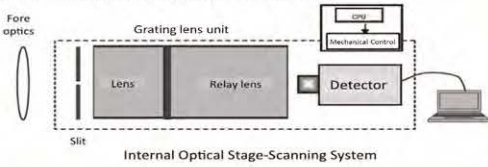## What is a Hyperspectral Camera ?

- Recent development of camera technology has made it possible to produce **Hyperspectral Cameras** that can measure **hundreds of narrow wavebands in a megapixel image**.
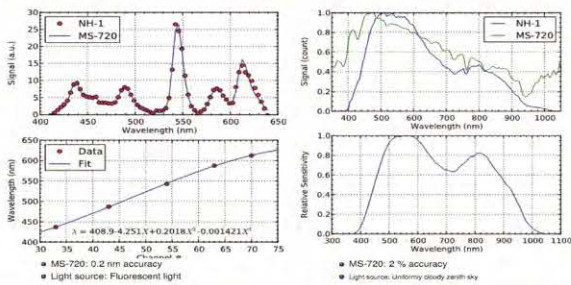
EBA JAPAN NH-1

Specifications

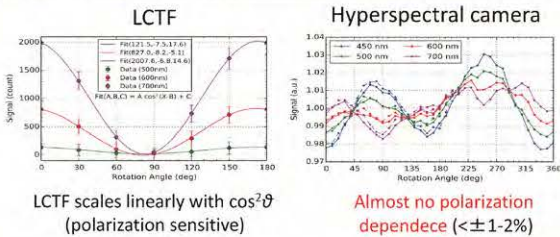|	NH-1	NH-7
Sensor type	CCD	CMOS
Image size	640×480	1280×1024
Color depth (bit)	8	10
Wavelength (nm)	350~1050	350~1100
Spectral Res. (nm)	5 (141ch)	5 (151 ch)
Capture rate (sec)	16 (VGA)	1.6 (VGA) 7.0 (SXGA)
Dimension (mm)	76×62×204	76×62×193
Weight (g)	1000	850
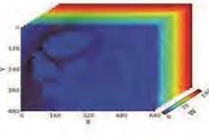
- NH hyperspectral camera is a **compact portable device with built-in scanning system** and can take hyperspectral images, **with no need for translation devices**.

- Both line sensor and area sensor mode are available and can be easily switched by software.

Internal Optical Stage-Scanning System

Results of wavelength/radiometric calibration

$\lambda = 408.9 + 4.251X + 0.2018X^3 - 0.001421X^4$

- MS-720: 0.2 nm accuracy
- Light source: Fluorescent light
- MS-720: 2 % accuracy
- Light source: Uniformly cloudy zenith sky

Comparison of polarization properties of spectral imagers

LCTF

Hyperspectral camera

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

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
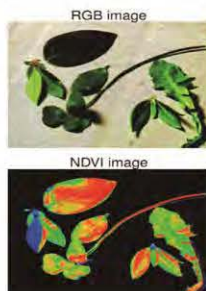
Application of hyperspectral camera for aerosol research

- 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

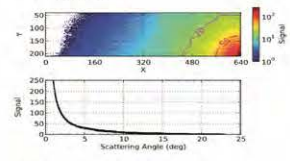- These spectra contains info. about molecules and aerosols in the optical path.

Direct solar radiation
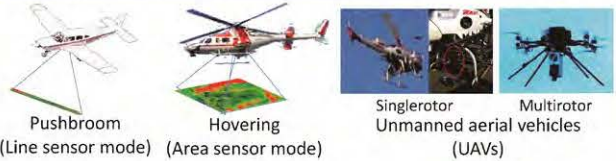
Scattered solar radiation
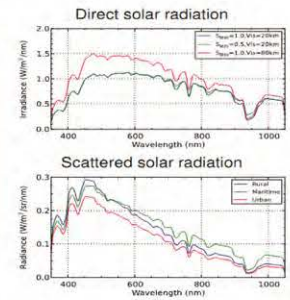
Results of aureole observation
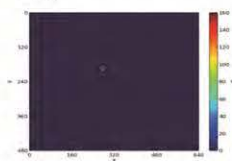
- Sun
- Aureole
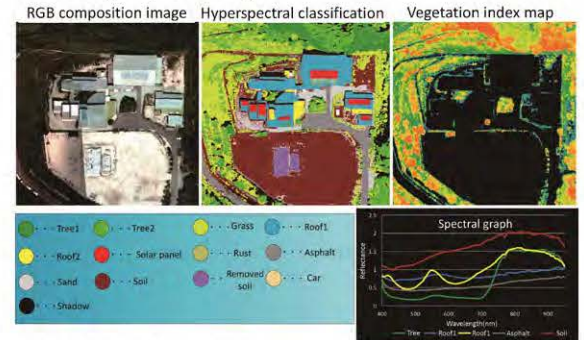

- Observation date: Oct. 16, 2012
- Observation time: 15:18 ~ 16:12
- **Field of view: 0.035°/pixel**
- ⇒ 640×480 pixels = 22.4°×16.8°
- Apparent solar size: 15 pixels
- Observation time: 14:55
- **Minimum scattering angle: 1°**
- **Angular resolution: 0.1°**

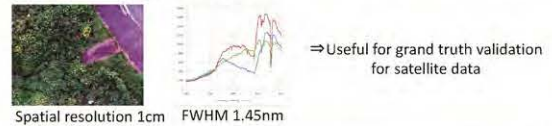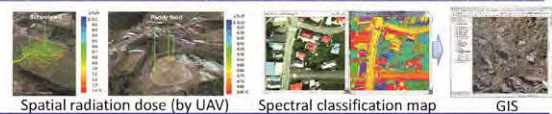## Hyperspectral imaging for airborne applications

Pushbroom (Line sensor mode)

Hovering (Area sensor mode)

Singlerotor   Multirotor
Unmanned aerial vehicles (UAVs)

- Airborne hyperspectral image

RGB composition image   Hyperspectral classification   Vegetation index map

- Tree1 - Tree2 - Grass - Roof1
- Roof2 - Solar panel - Rust - Asphalt
- Sand - Soil - Removed soil - Car
- Shadow

Spectral graph

High spatial and spectral resolution

⇒Useful for grand truth validation for satellite data

Spatial resolution 1cm   FWHM 1.45nm

Integration with other categorical data into GIS (FUKUSHIMA project)

Spatial radiation dose (by UAV)   Spectral classification map   GIS

Summary

- NH hyperspectral camera is a portable stand-alone hyperspectral imager with internal scanning system.
- We have demonstrated various usage of NH for atmospheric measurement and various applications.
- With its highly flexible configuration for any environment, NH hyperspectral camera is widely applicable in remote sensing field.