

# Imaging evaluation of photosynthesis using newly-developed hyperspectral portable video camera

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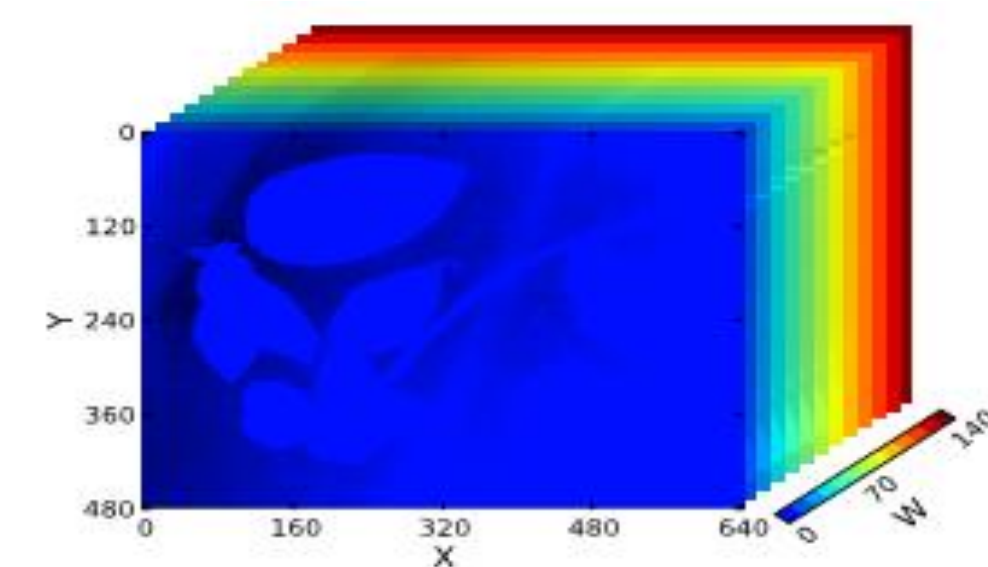
## What is a Hyperspectral Camera ?

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



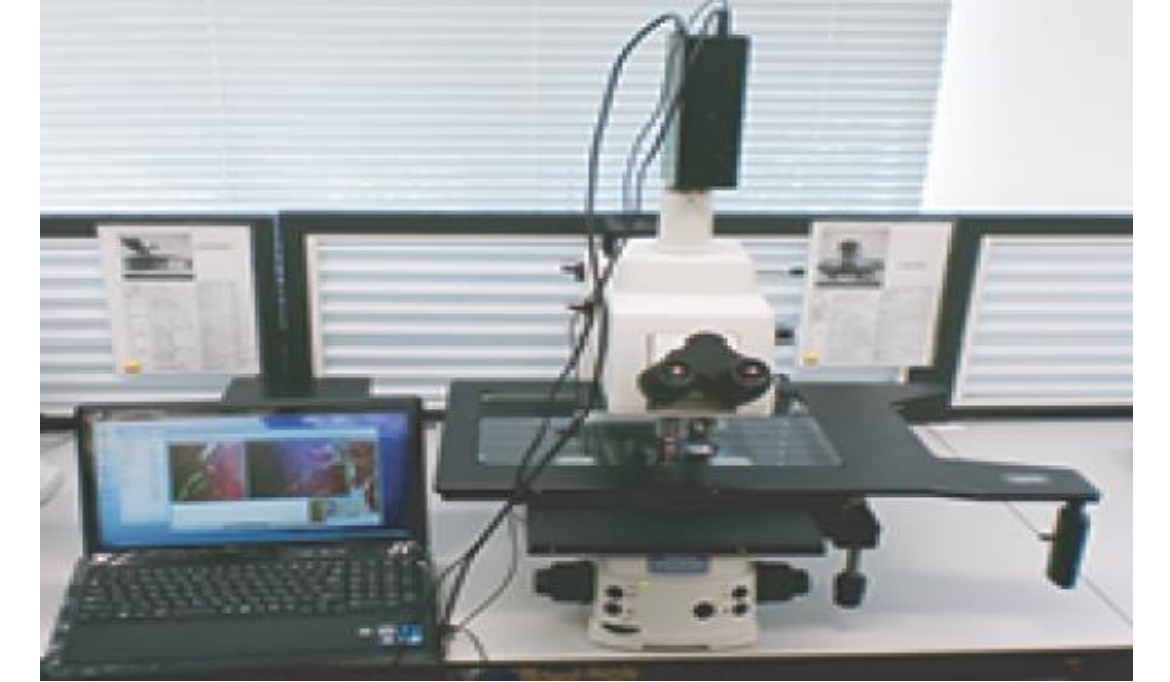
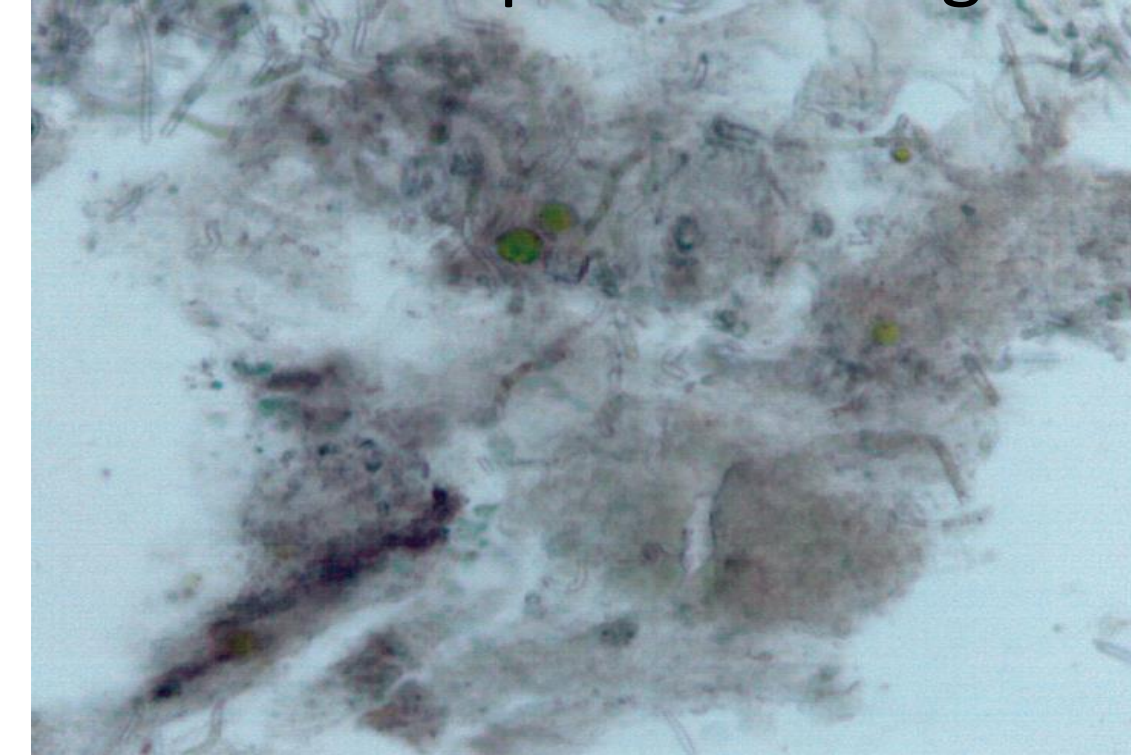
### Specifications

	NH-1	NH-7
Sensor type	CCD	CMOS
Image size	640×480	1280×1024
Color depth (bit)	8	10
Wavelength (nm)	350~1050	400~1000
Sampling (nm)	5 (141ch)	5 (121ch)
Capture rate (sec)	16 (VGA)	1.6 (VGA) 7.0 (SXGA)
Dimension (mm)	76×62×204	76×62×193
Weight (g)	1000	850



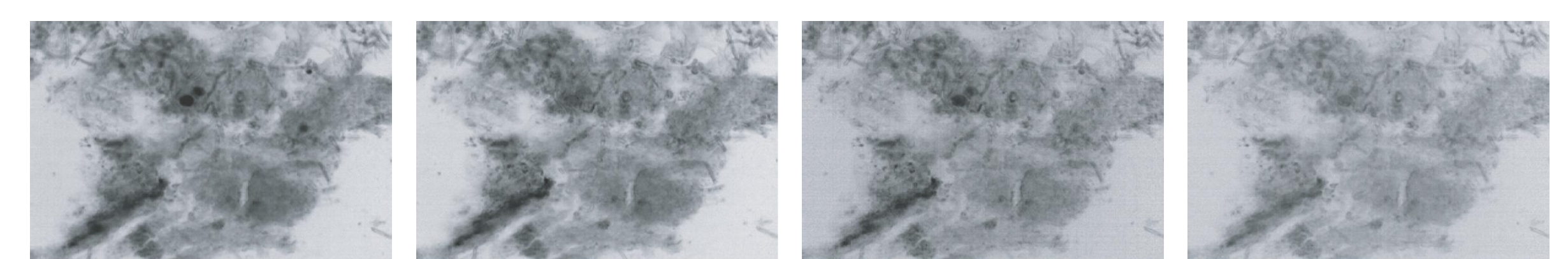
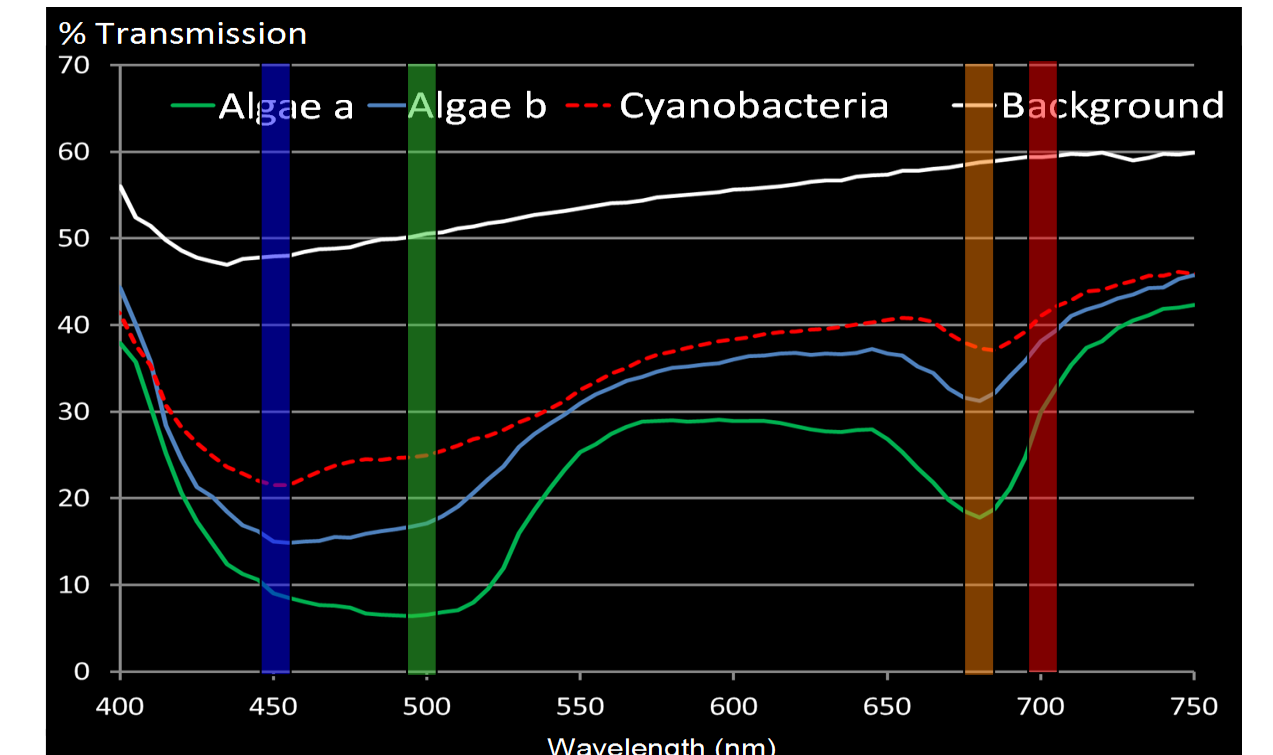
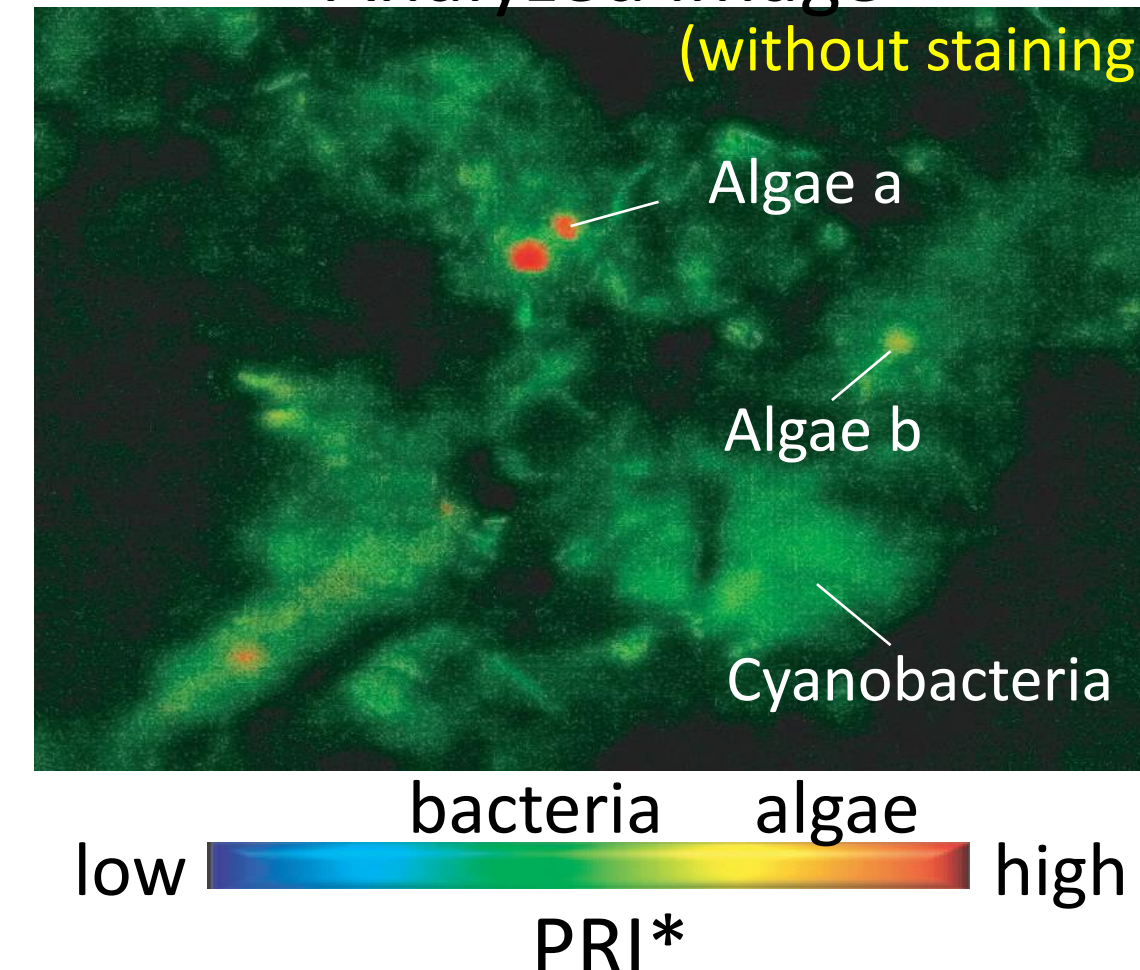
## Hyperspectral imaging for microscopic inspection

RGB composition image



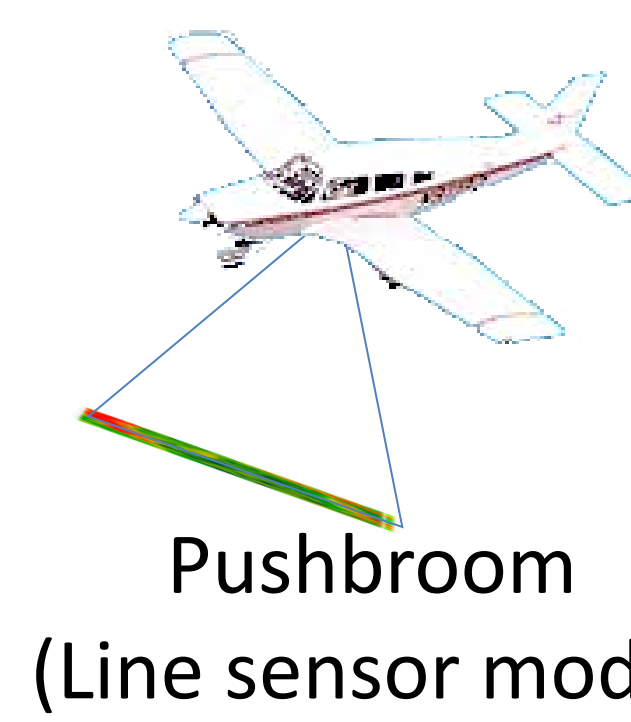
Hyperspectral microscope

Analyzed image

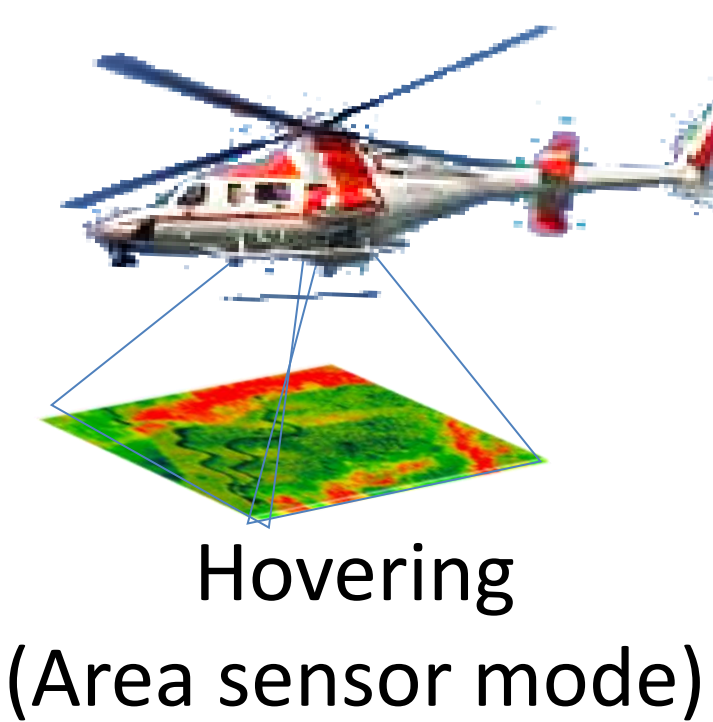


\* PRI: photochemical reflectance index, used as an indicator of photosynthetic light use efficiency

## Hyperspectral imaging for airborne applications



Pushbroom  
(Line sensor mode)



Hovering  
(Area sensor mode)

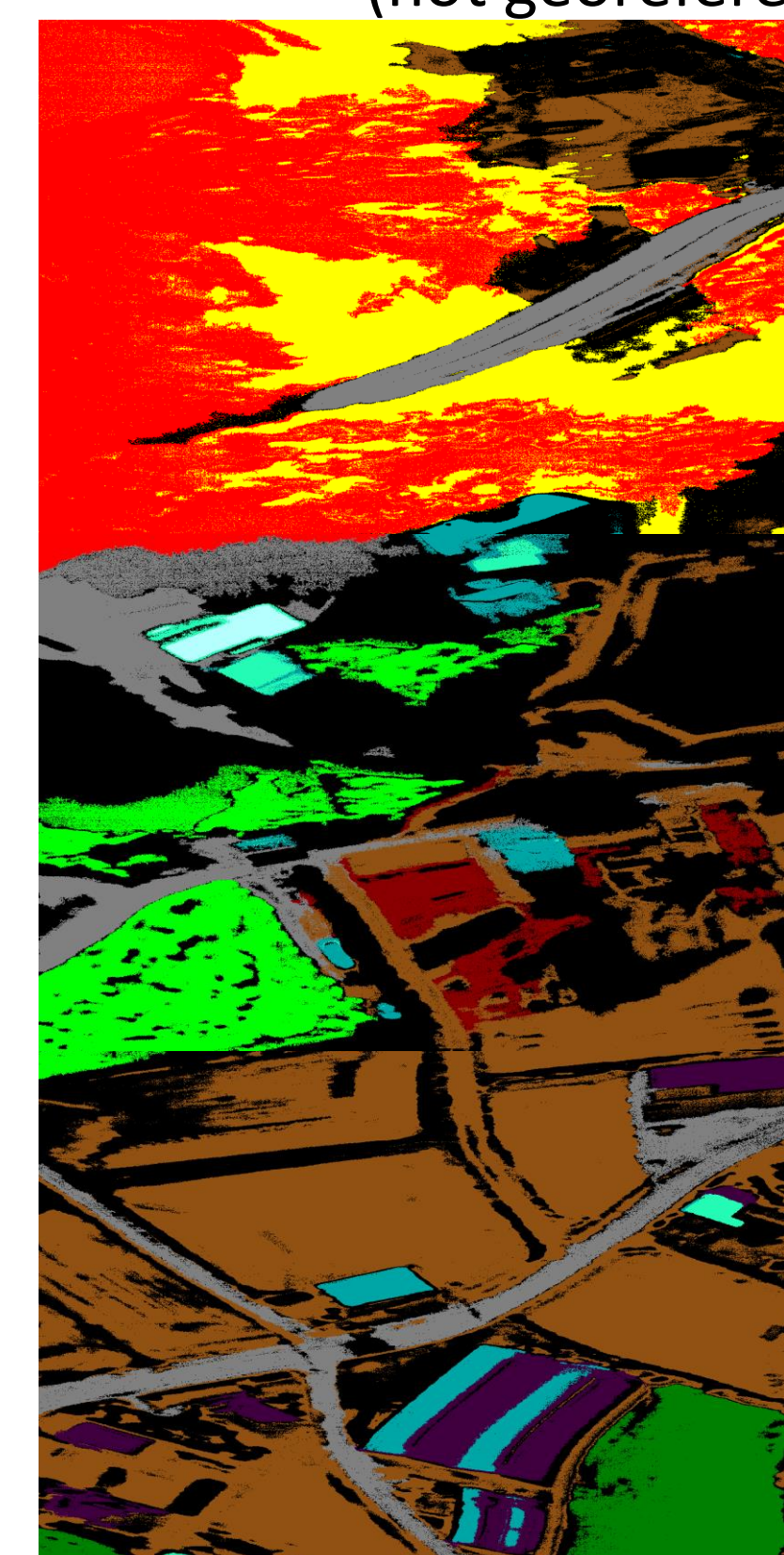


Unmanned aerial vehicle  
(UAV)

- Airborne (pushbroom) hyperspectral image (not georeferenced)

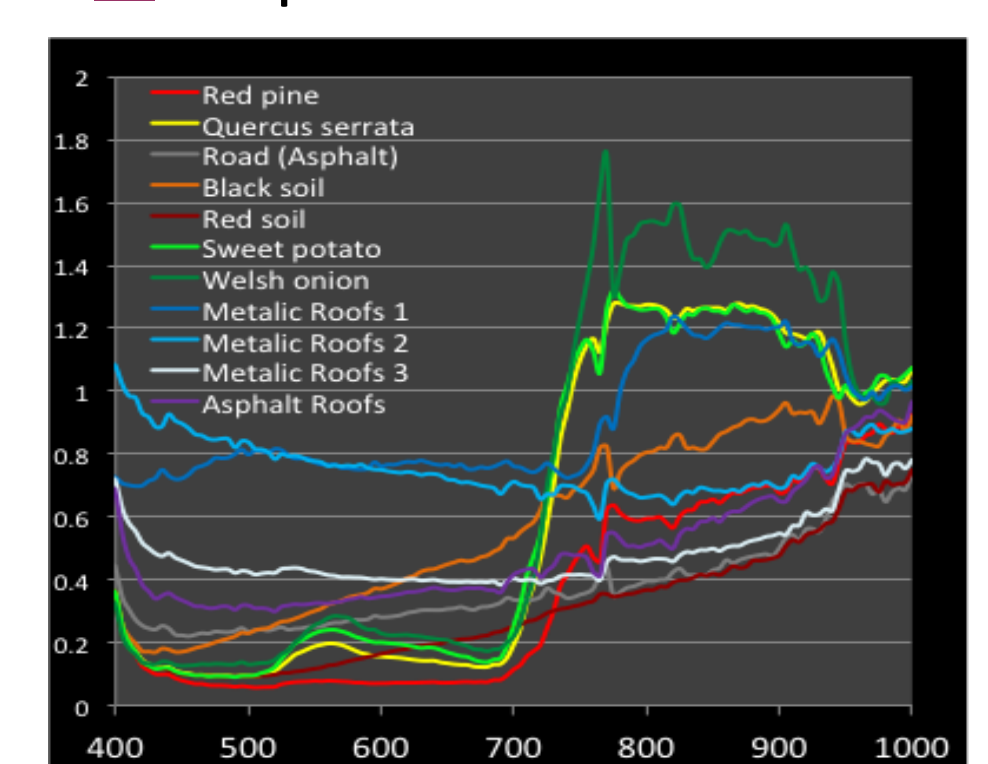


RGB composition  
image

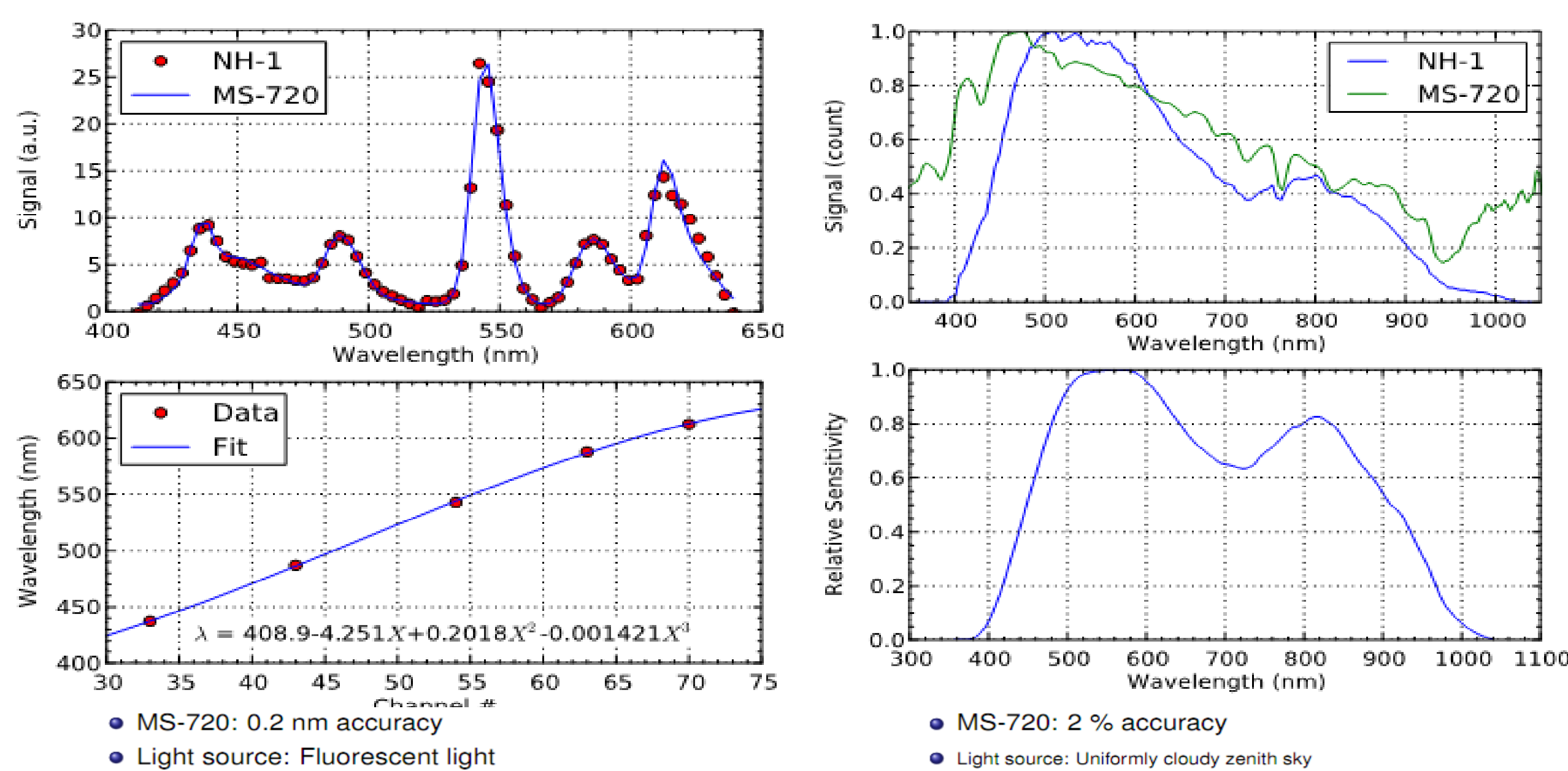


Hyperspectral  
classification image

- Red pine
- Quercus serrata
- (Konara oak)
- Sweet potato
- Welsh onion
- Red soil
- Black soil
- Road (Asphalt)
- Metalic Roofs
- Asphalt Roofs

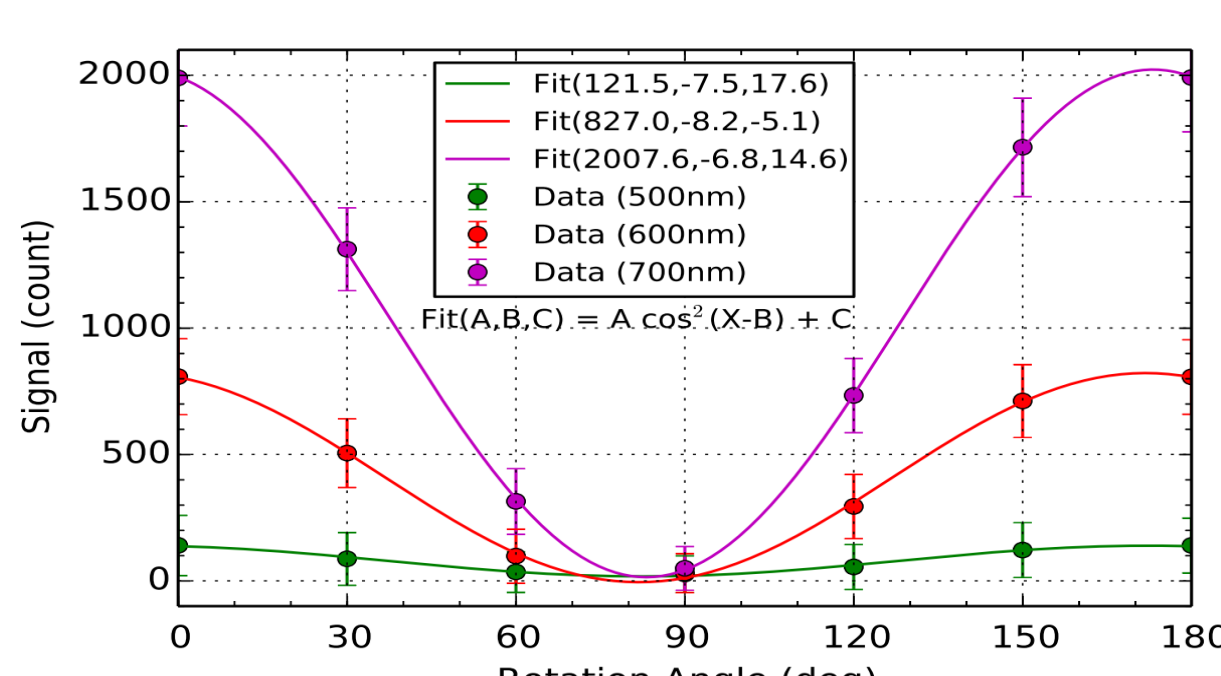


## Results of wavelength/radiometric calibration



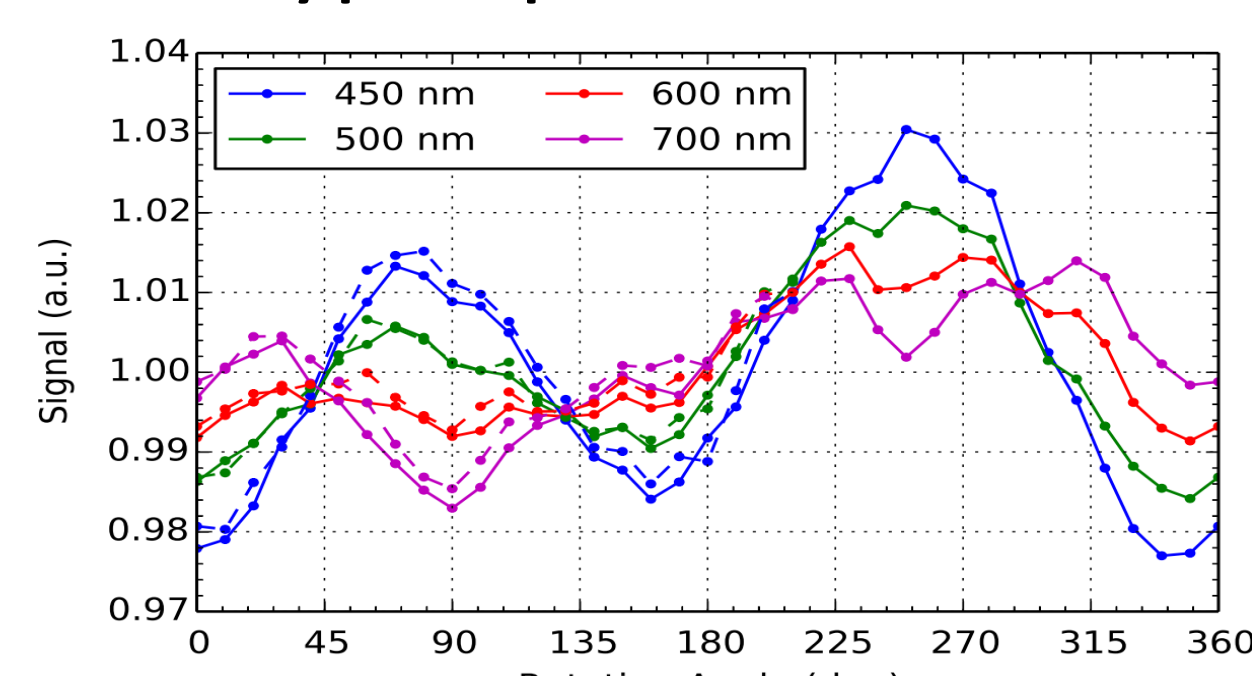
## Comparison of polarization properties of spectral imagers

### LCTF



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

### Hyperspectral camera



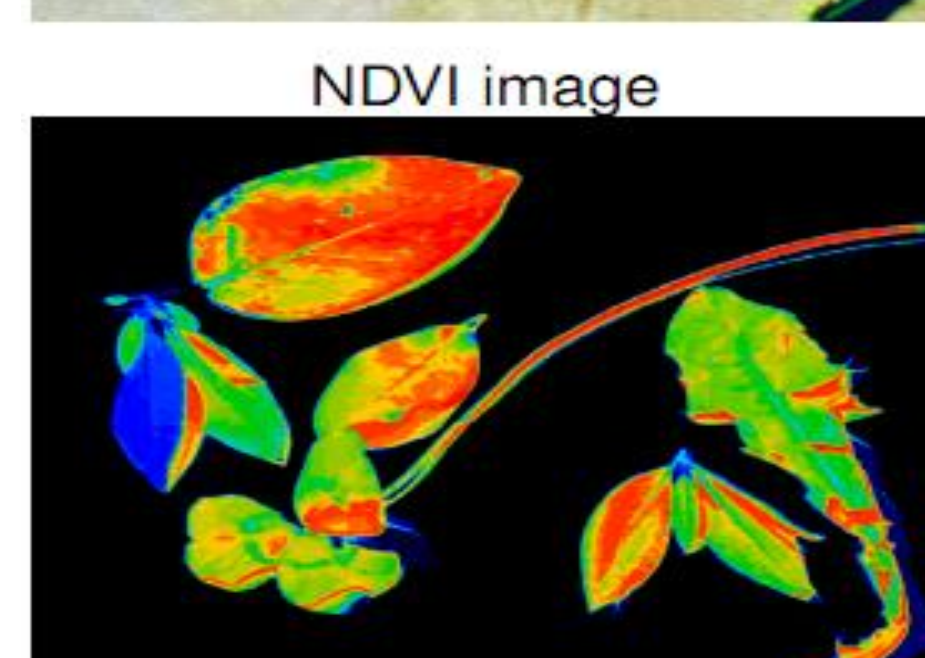
Almost no polarization  
dependence ( $\pm 1-2\%$ )

## 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



## Summary

- NH hyperspectral camera is a portable stand-alone hyperspectral imager with internal scanning system.
- We have demonstrated novel usage of NH for photosynthetic estimation and various applications.
- Hyperspectral imaging measurement with high spatial and spectral resolution is advantageous for evaluating structural and physiological heterogeneity within the object.
- This can also be an efficient tool for evaluating spatial uniformity and spectral response of solar cells.