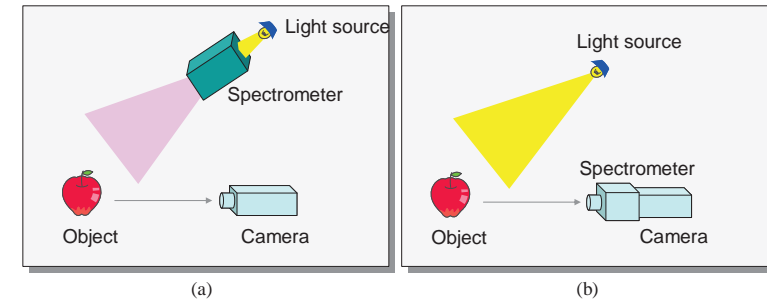


光画像工学

Optical imaging and image processing (XI)

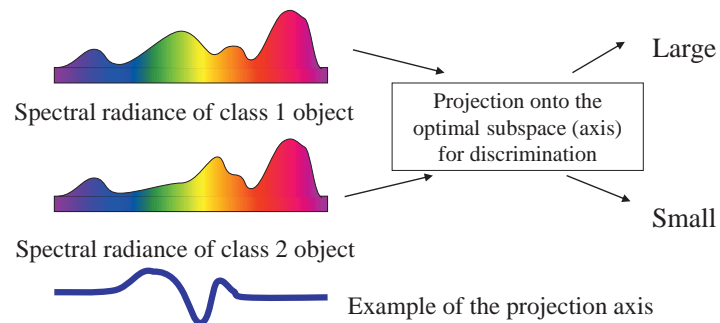
5.2 Methods for spectral imaging

Location of dispersive element or spectral filter	Bandwidth	Acquisition methods	Optical device
Between object and sensor	•Narrow	•Point sequential •Line sequential •Band sequential •Mozaic filter •Others	•Diffraction grating •Interference filter •Absorption filter •Dichroic prism •Fourier transform spectroscopy •Emission •Others
Between illuminant and object	•Wide		

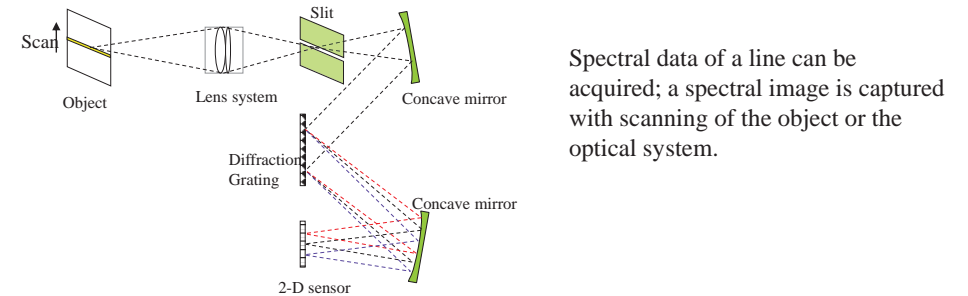


Object recognition using multispectral images

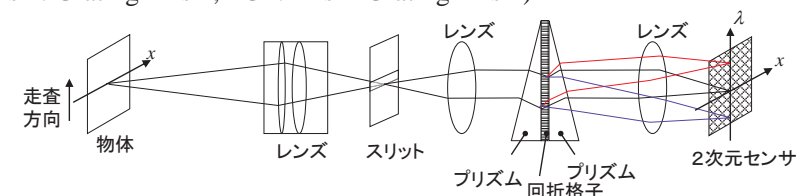
- Multispectral image acquisition
- Statistical classification of spectral data
 - Linear classification, PCA, ICA (independent component analysis), Canonical discriminant analysis
- Optimal design of the spectral sensitivities of imaging systems
 - Color imaging can be considered as the projection in the spectral space



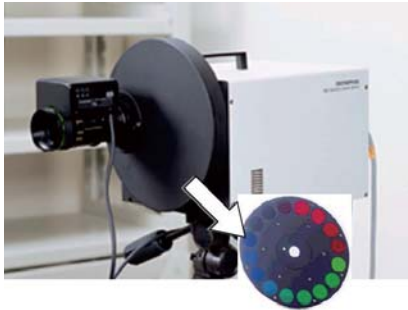
Spectral imaging device using diffraction grating



The optical system for direct vision spectral imaging (Grism: Grating-Prism, PGP: Prism-Grating-Prism)

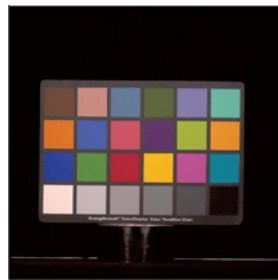


Spectral imaging device using interference filter

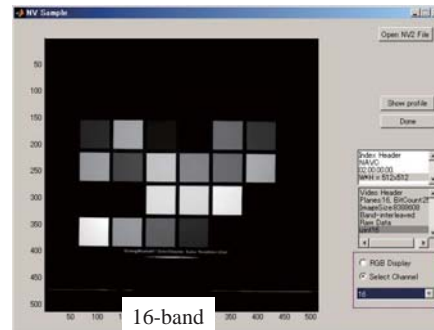


16-band filter-wheel multispectral camera (TAO/NICT, Japan)

16-band image



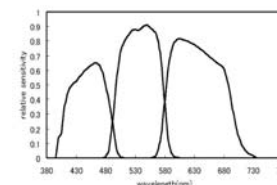
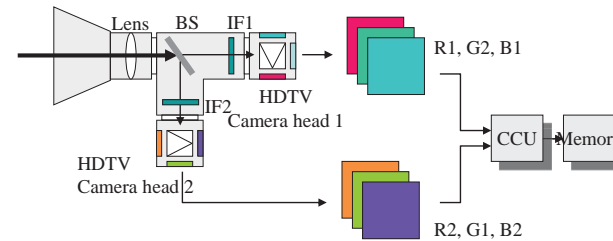
Color reproduction



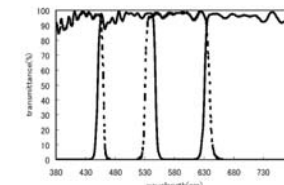
16-band

Spectral imaging device using hybrid method

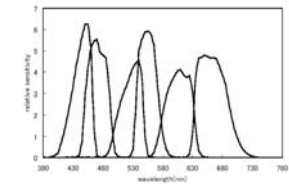
- 6-band HDTV camera (NICT)



Spectral sensitivity of 3-and camera



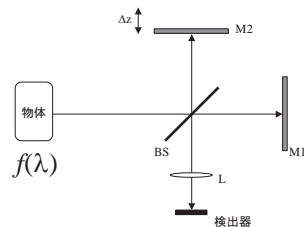
Spectral transmittance of filters IF1 and IF2



Spectral sensitivity of 6-band camera

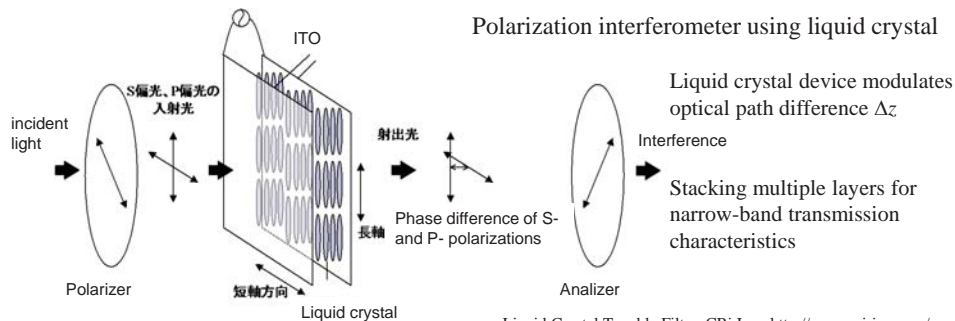
Ref. K. Ohsawa, T. Ajito, et. al., J. Imag. Sci. and Tech., Vol.48, No.2; pp.85-92 (2004)

Spectral imaging device using Fourier transform spectroscopy



Michelson interferometer

$$\text{Sensor output} \propto \int \frac{f(\lambda)}{2} \left\{ 1 + \cos\left(\frac{2\pi}{\lambda} \Delta z\right) \right\} d\lambda$$



Polarization interferometer using liquid crystal

Liquid crystal device modulates optical path difference Δz

Stacking multiple layers for narrow-band transmission characteristics

Liquid Crystal Tunable Filter: CRI Inc., <http://www.cri-inc.com/>

5.3 Multispectral imaging for color reproduction Why RGB Imaging is not enough?

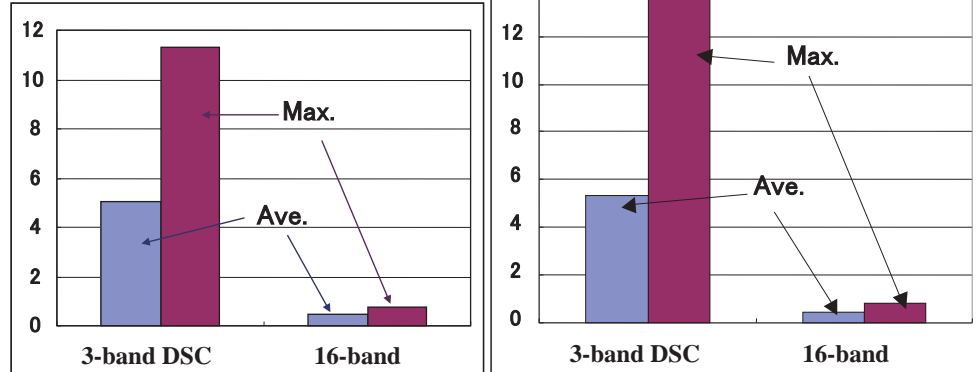
- RGB does not represent the color attribute of an object.
- Spectral sensitivity of conventional color imaging device is not equivalent to human vision
- Color reproduction under different illumination environment
- Is not "Quantitative" information for image analysis
- The color gamut of display does not cover all the existent colors
- Observer Metamerism: Color matching for different observers

Accuracy of color estimation

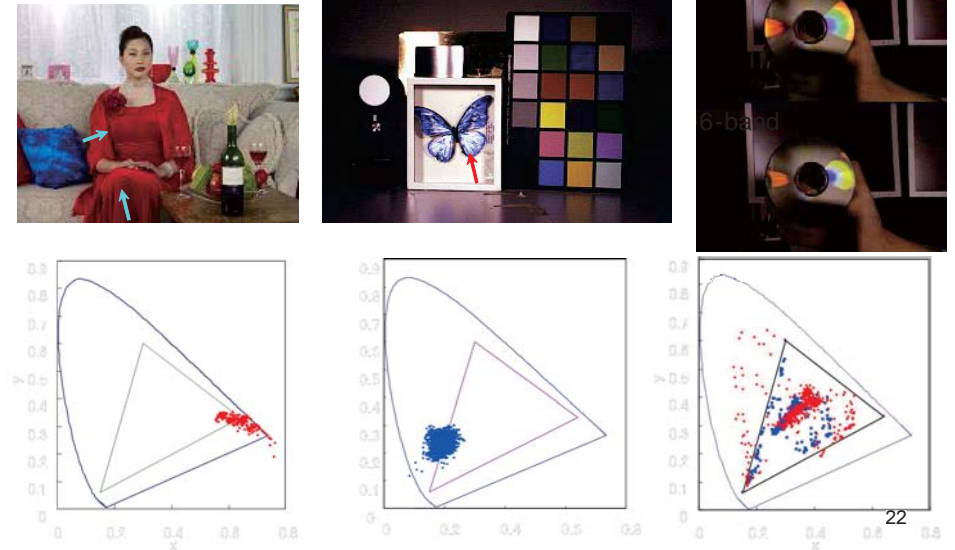
- CIELAB color difference of GretagMacbeth ColorChecker (24 color patches) - Experimental results

Illuminant:

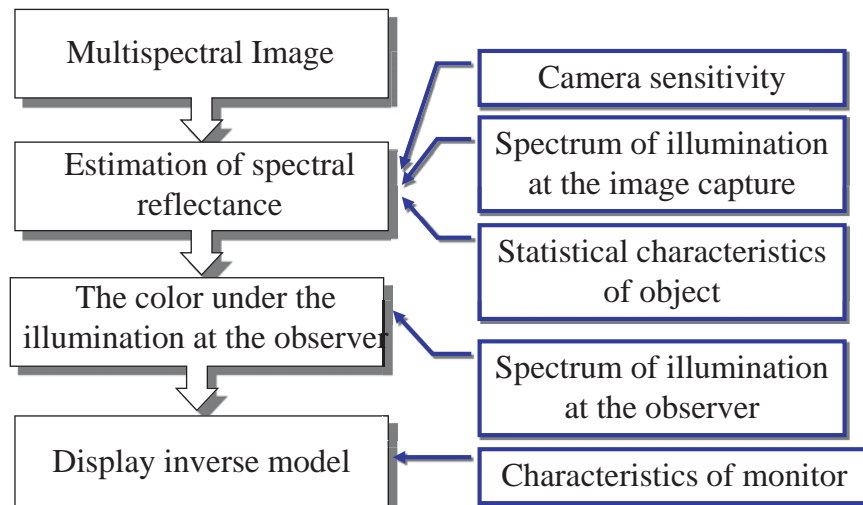
Capture=D65, Reproduction=F2 →
Capture = Reproduction = D65↓



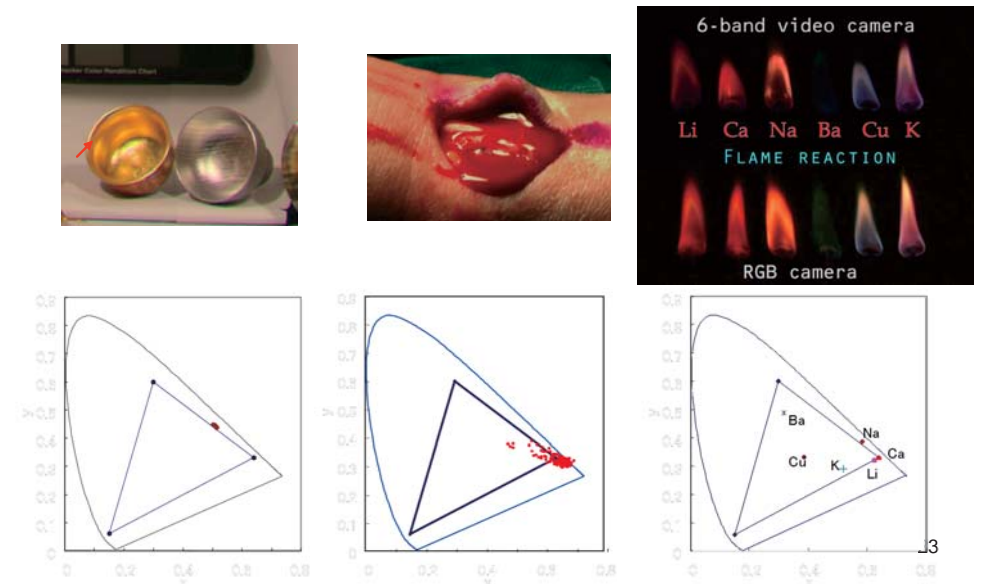
High chroma colors captured by 6-band camera



Spectrum-based Color Reproduction Algorithm



High chroma colors captured by 6-band camera



5.4 Applications of multispectral imaging

- Medicine
 - Dermatology, Pathology, Endoscopy (ex. Narrow band imaging),
 - Dentistry, Telemedicine, Surgery, Ophthalmology
- Printing
 - Image acquisition for merchandize catalog printing
- Electronic commerce
 - Textile: Hi-fi color reproduction, expanded color gamut
 - Virtual prototyping by multispectral BRDF measurement and multispectral rendering
- Digital archive, digital museum
 - Multispectral image archive of artworks and cultural heritage
 - Reproduction of woodprints by Shiko Munakata
 - Capture and reproduction of natural scene, ex., Aurora
- CG
 - New expression in computer graphics
 - Spectral rendering