Medical Application of Multispectral Imaging

Masahiro Nishibori
mn@iuhw.ac.jp
International University of Health and Welfare
What is multispectral imaging?

• Multispectral imaging provides pictures include **spectral reflectance** information for each pixel.

• Spectral reflectance of objects usually requires a multi-band camera to be captured, there has been few practical equipment for clinical application yet.
Spectral Reflectance vs. Wavelength
Promising Applications

1. Spectral Color Pictures - a digital image each pixel of which has spectral reflectance

2. Real Color Appearance Pictures - a digital image that has very precise color reproduction of real objects independent of both devices and illumination (very precise appearance of real objects = absolute appearance)
Spectral Color Pictures (1)

• Current imaging systems record only a small part of this reflectance, and do so inaccurately.

• Therefore, a variety of new morphological diagnostic methods based on information not detectable by human sensation may be developed.
Spectral Color Pictures (2)

• The spectral reflectance of each pixel of a skin picture will be used to calculate and visualize the distribution of three major skin pigments.

• The spectral reflectance of skin will be estimated by observation from a picture taken using a current three-band digital camera because the three principal components are sufficient to approximate it.
Estimating Skin Pigments from Reflectance
(modified from a Prof. Tsumura’s presentation)

Monte Carlo Simulation of the Photon Propagation

Skin model
- Depth
- Scattering
- Absorption

Hemoglobin density
Melanin density
Oxygen density

Repeat until Convergence

Modify to Reduce Errors

Spectral Reflectance

Wavelength

Measured

Estimated

Reflectance

Repeat until Convergence
Estimation of Spectral Reflectance using Pictures Taken by a 3 Band Camera

Visualization of Skin Metabolism
Prospect of Predictive Medicine
Color Problems in Medicine (1)

In a physical examination:

fever  normal  anemia

Wrong color reproduction causes wrong diagnosis.
Color Problems in Medicine (2)

In a laboratory examination, we need:

effort to reach the right color appearance

(source: the survey web)
Color Problems in Medicine (3)

In microscopic pathology:

intentionally changed colors cause only little difference in diagnosis

(source: the survey web)
Color Problems in Medicine (4)

In macroscopic pathology:

intentionally changed colors cause severe difference in diagnosis

(source: the survey web)
Color Problems in Medicine (5)

In dermatology:

different digital media cause different color appearance

(T. NUMAHARA, Digital Color Imaging in Biomedicine, 2001)
Real Color Appearance Pictures

Real color appearance of skin can be:

1. estimated using a common digital camera because the three principal components are sufficient to approximate it

2. displayed using a common display with precise colors because the three primary colors will reproduce most colors of skin with good accuracy.
spectral reflectance

→

principle components
1
2
3

RGB values

→

estimated reflectance

[(matrix calculation)]

(mucosa)


Estimation of Spectral Reflectance using Pictures Taken by a 3 Band Camera
Calculation of Color Appearance under Different Illumination
Spectral Radiance of Various Illuminants

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Real Color Appearance under Various Illuminants

Flash: off
White Balance: fixed

Flash: on
Calibrated with a Color Chart
Application to Telemedicine, etc.
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b Dermatology, Musashino Red Cross Hospital, Tokyo, Japan
c Environmental Immunodermatology, Tokyo Medical and Dental University, Tokyo, Japan
d Operating Center, Tokyo Medical and Dental University Hospital, Tokyo, Japan
e Section of Periodontology, Tokyo Medical and Dental University Hospital, Tokyo, Japan
f Gerontological Nursing and Health Care System, Tokyo Medical and Dental University, Tokyo, Japan
g Department of Bioinformatics Medical Research Institute, Tokyo Medical and Dental University, Tokyo, Japan
h Department of Information and Image Sciences, Chiba University, Chiba, Japan
i Research Center for Frontier Medical Engineering, Chiba University, Chiba, Japan
j Konica Minolta Technology Center Inc., Osaka/Hachioji, Japan
k Eizo Nanao Corporation, Ishikawa, Japan