

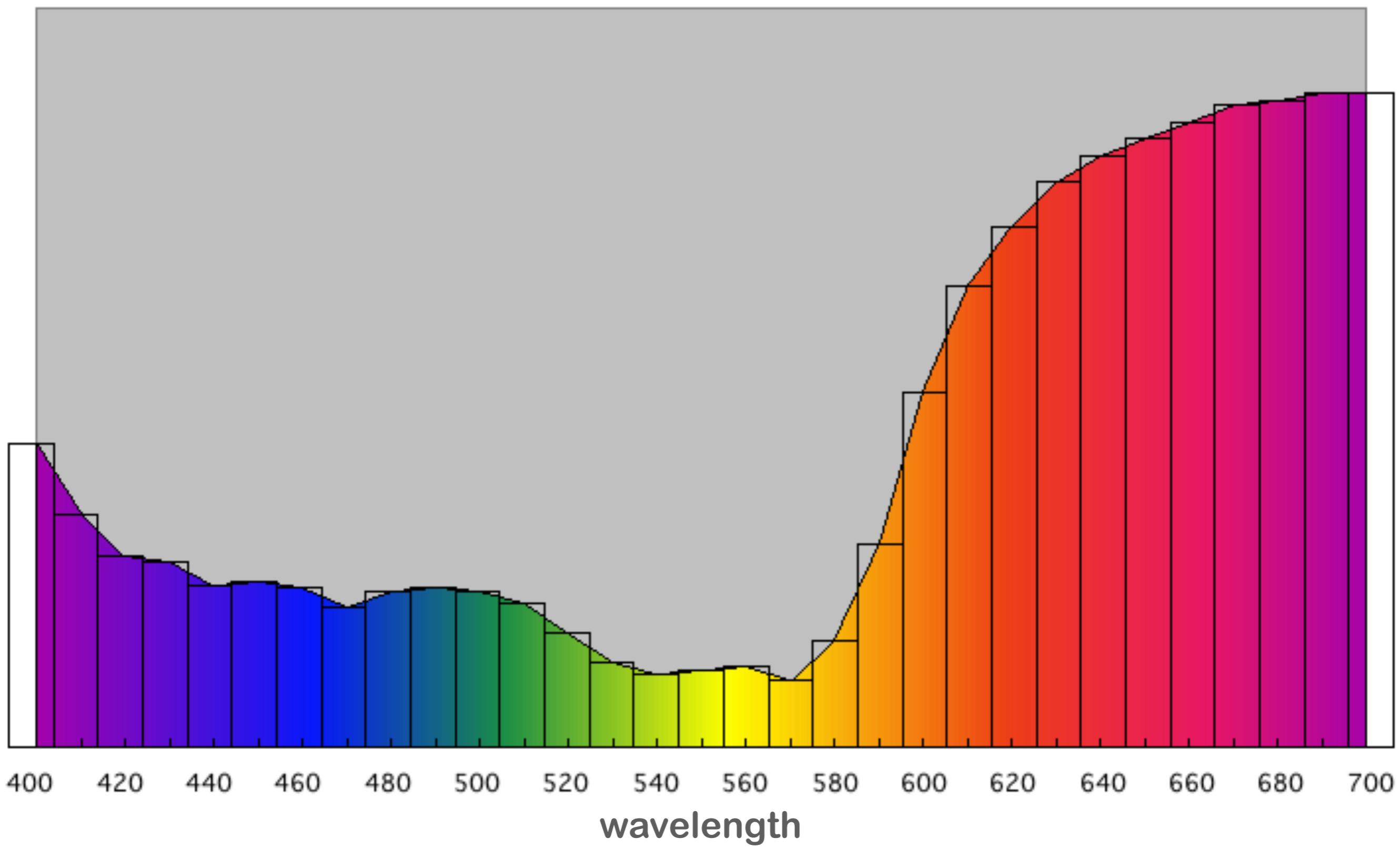
AROB Workshop
International Workshop on Artificial Life and Robotics in Busan
September 7, 2017

**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

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.

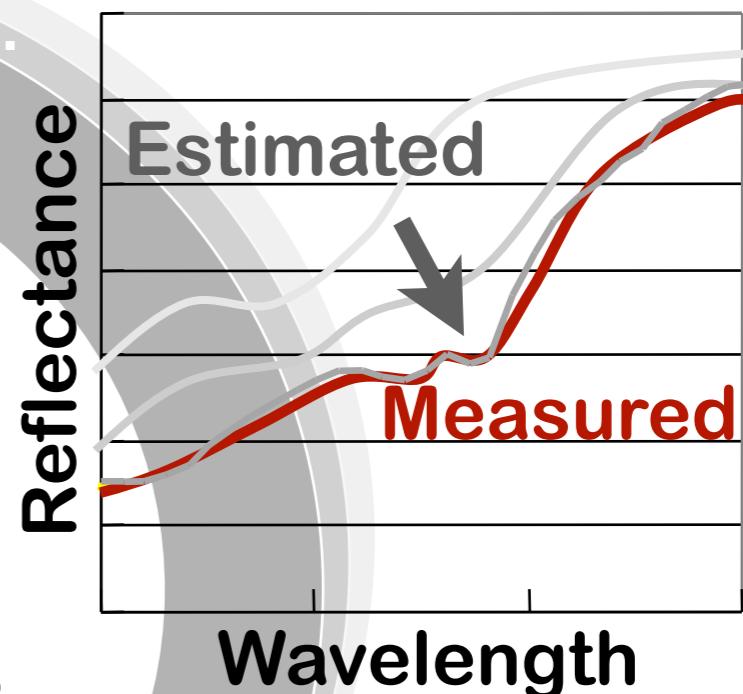
Monte Carlo Simulation of the Photon Propagation

Skin model
• Depth
• Scattering
• Absorption

Repeat
until
Convergence

Hemoglobin density
Melanin density
Oxygen density

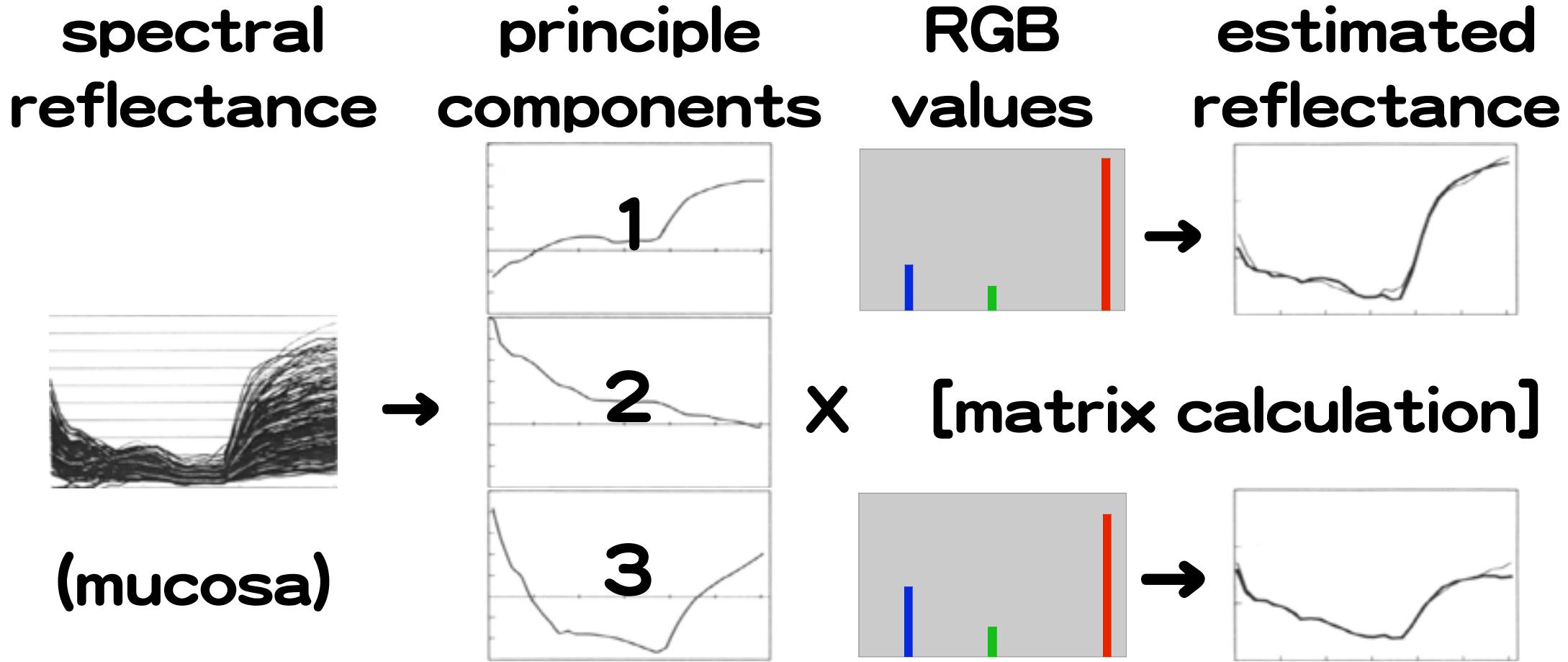
Spectral Reflectance



Modify to
Reduce Errors

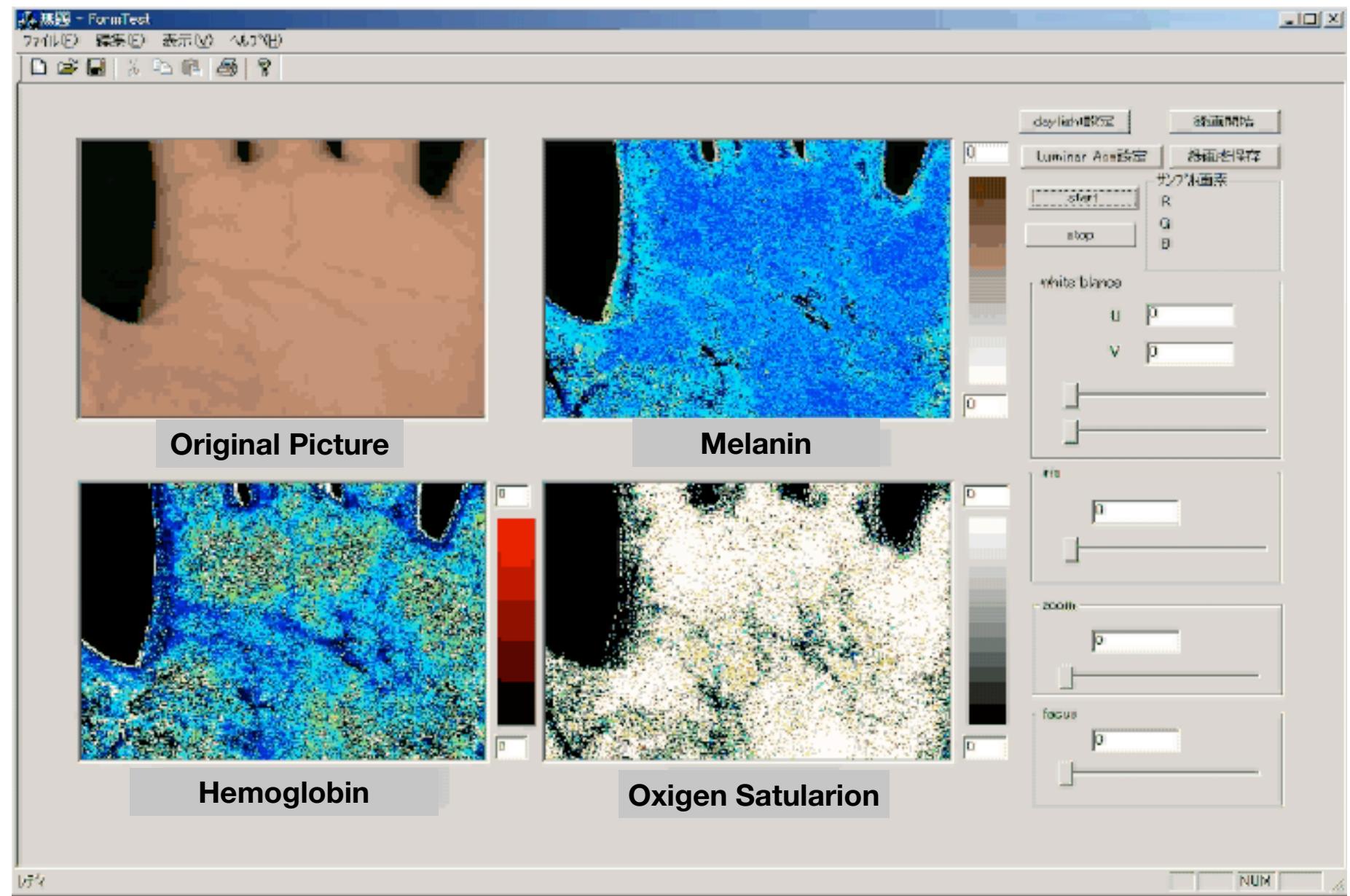
Estimating Skin Pigments from Reflectance

(modified from a Prof. Tsumura's presentation)



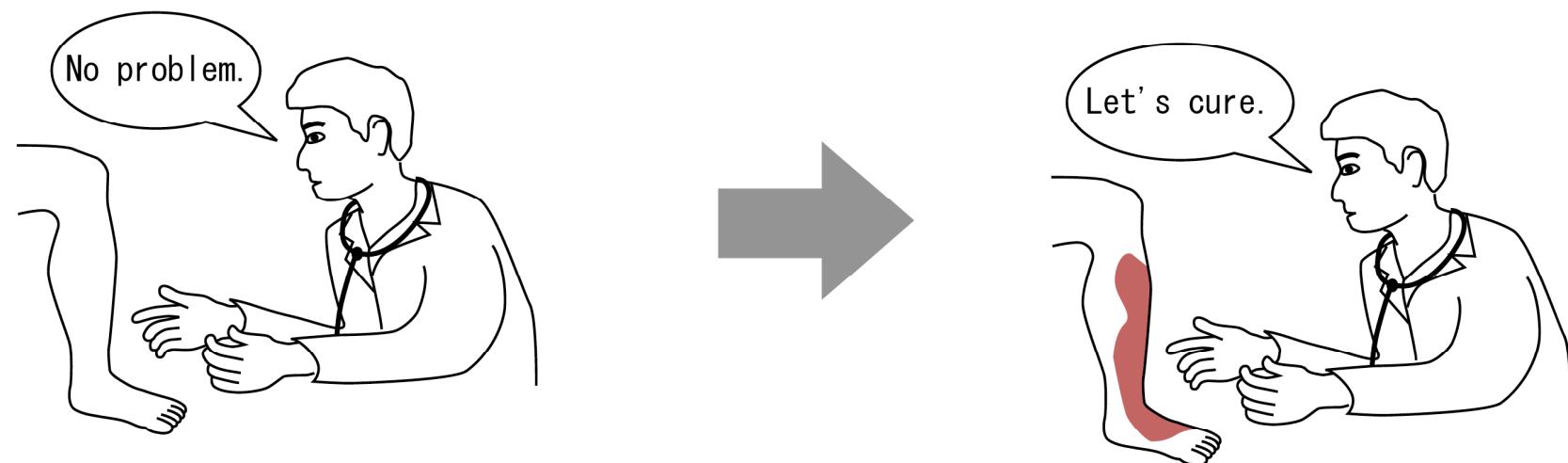
【source】 Yoichi Miyake : Analysis and Evaluation in Digital Color Imaging, University of Tokyo Press, 2000.

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

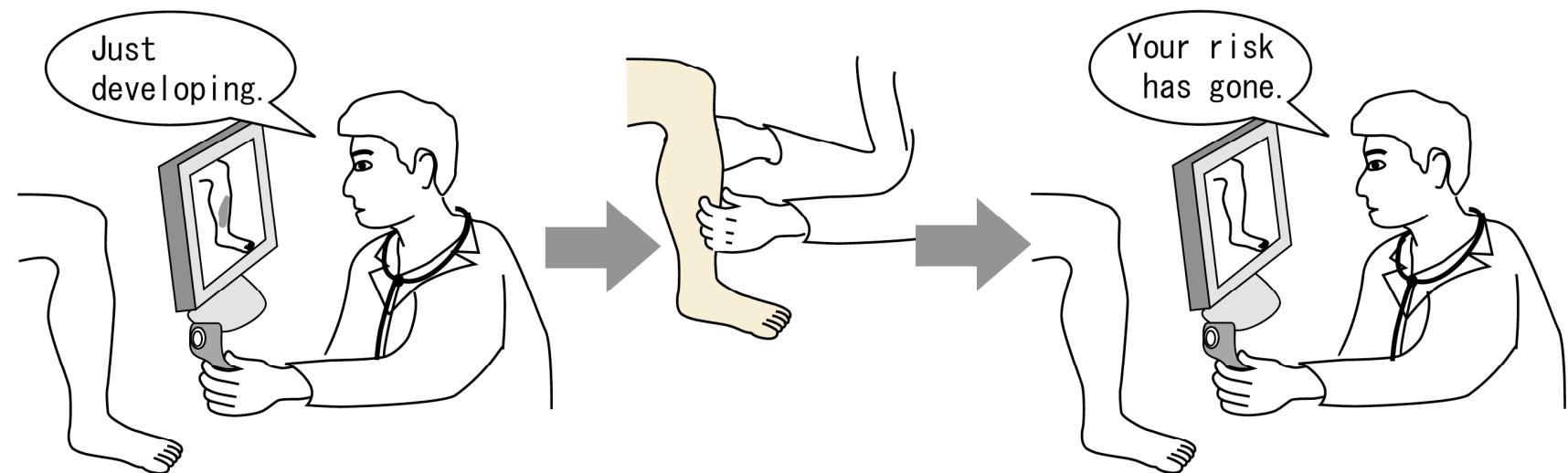


Visualization of Skin Metabolism

Physical Exam (Before)	Observation	Complication
------------------------	-------------	--------------



Physical Exam (After)	Prevention	Successfully Prevented
-----------------------	------------	------------------------



@M.Nishibori 2004

Prospect of Predictive Medicine

Color Problems in Medicine (1)

In a physical examination :



fever



normal

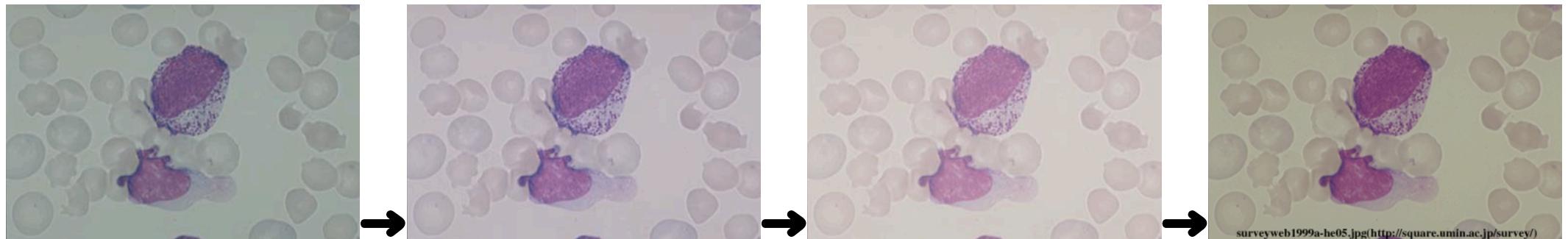


anemia

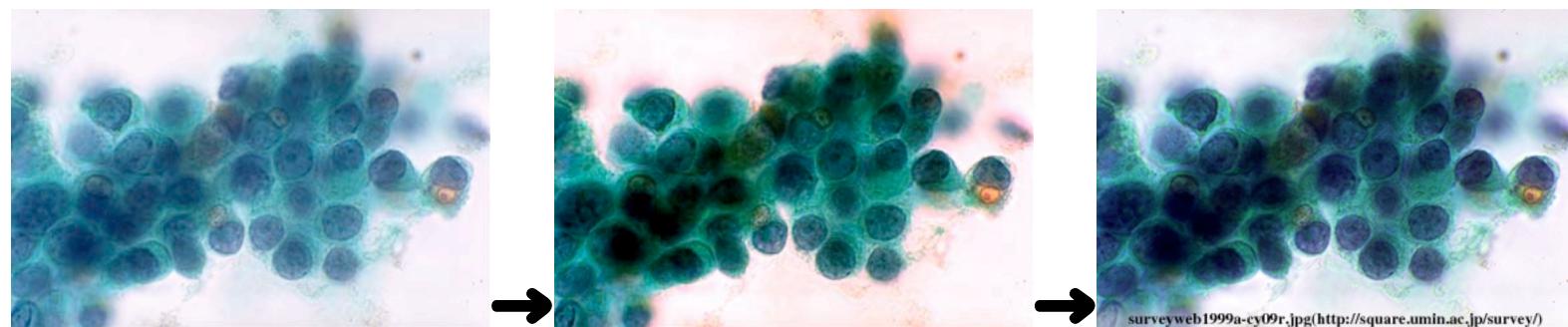
**Wrong color reproduction causes
wrong diagnosis.**

Color Problems in Medicine (2)

In a laboratory examination, we need :



surveyweb1999a-he05.jpg(<http://square.umin.ac.jp/survey/>)



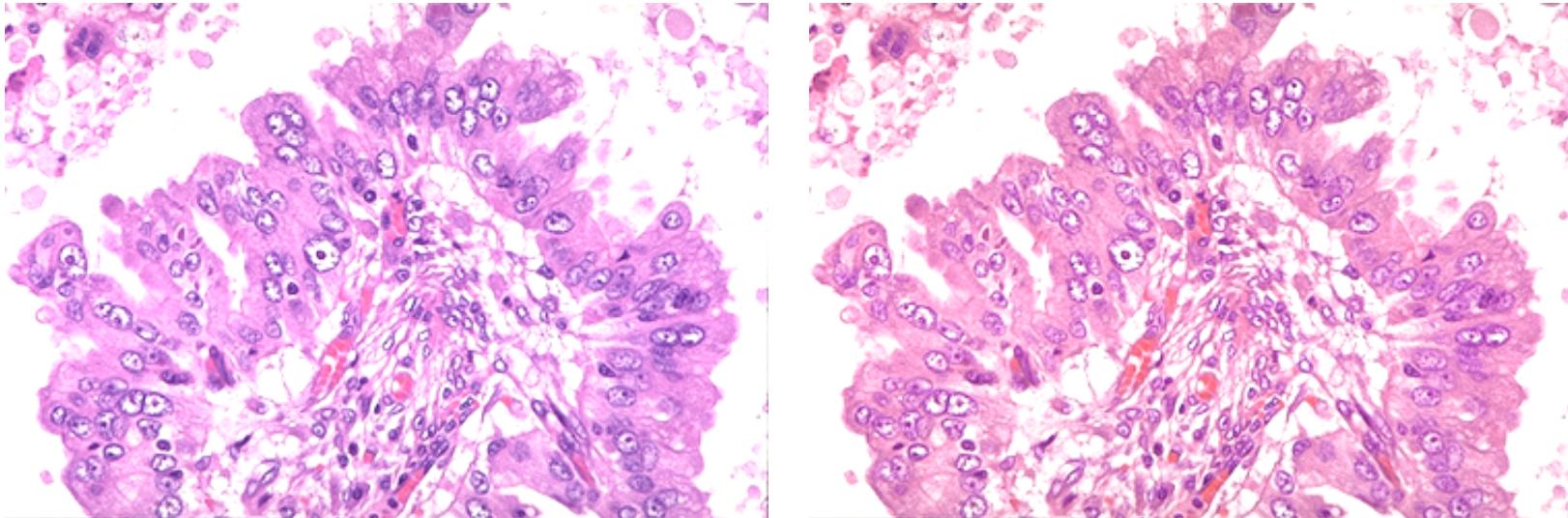
surveyweb1999a-cy09r.jpg(<http://square.umin.ac.jp/survey/>)

effort to reach the right color appearance

(source : the survey web)

Color Problems in Medicine (3)

In microscopic pathology :

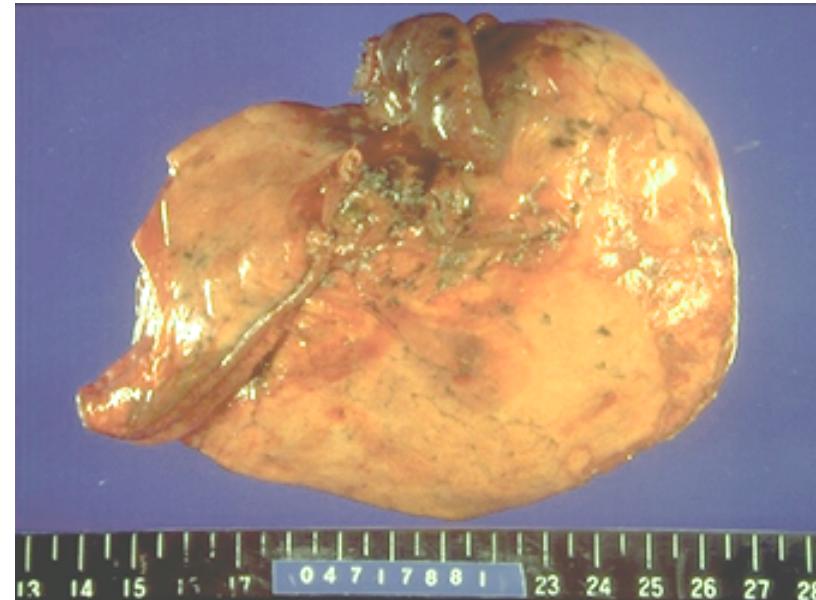
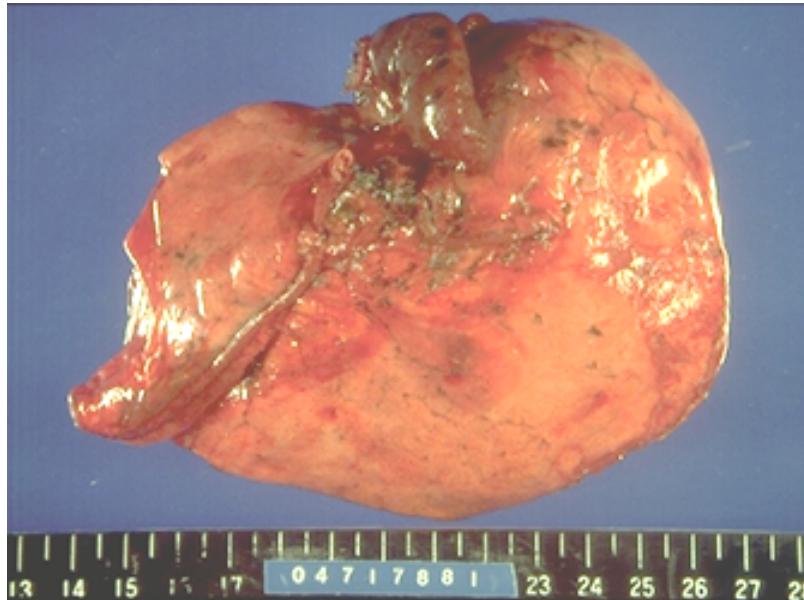


**intentionally changed colors cause
only little difference in diagnosis**

(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 :



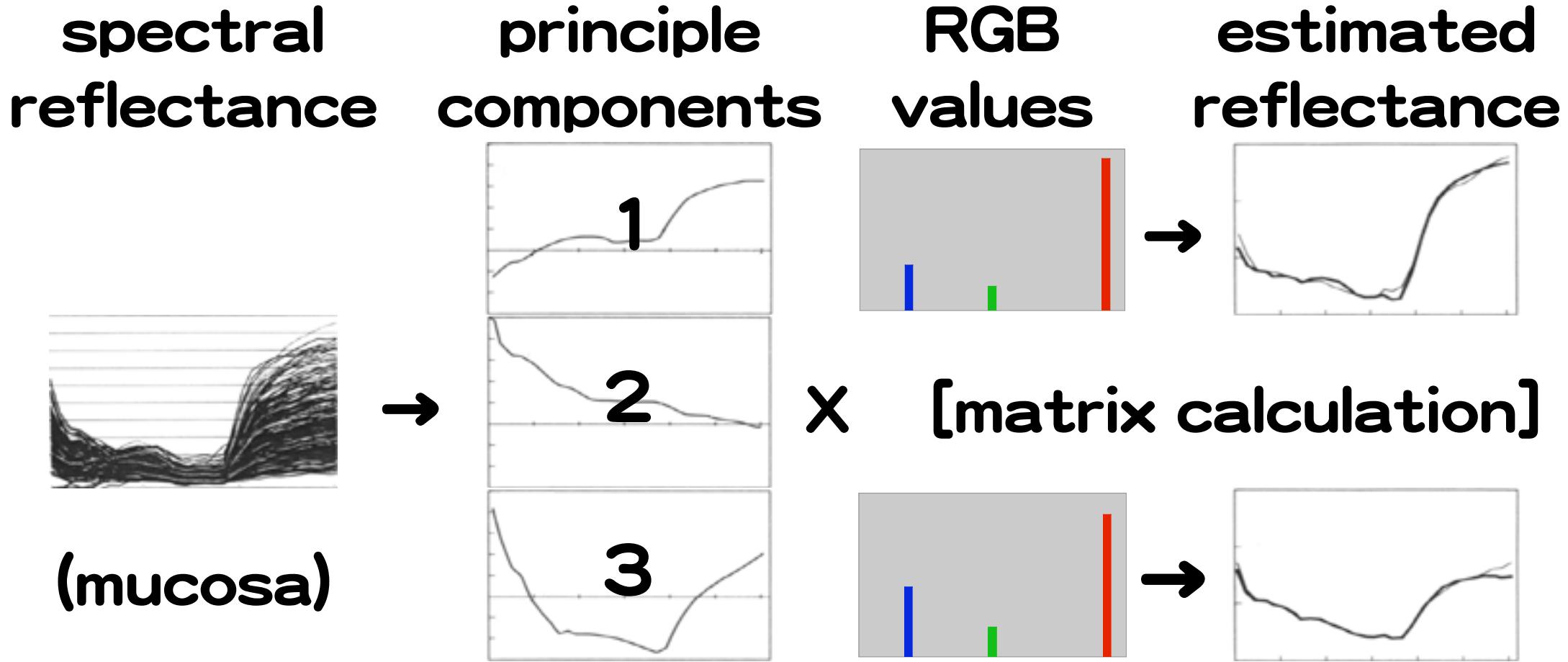
**different digital media cause
different color appearance**

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

Real Color Appearance Pictures

Real color appearance of skin can be :

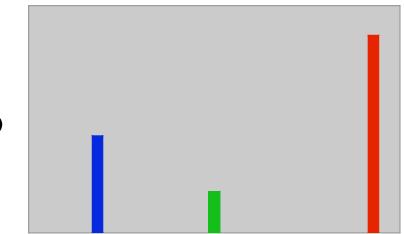
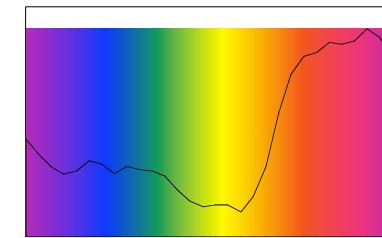
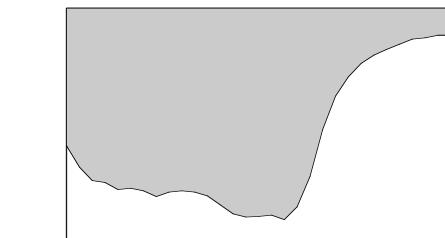
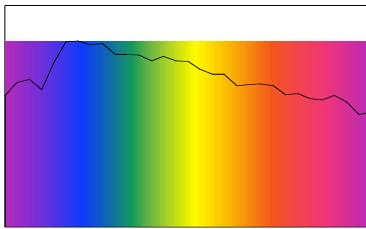
1. estimated using a common digital camera because the three principal components are sufficient to approximate it
2. displayed using a common display with precise colors because the three primary colors will reproduce most colors of skin with good accuracy.



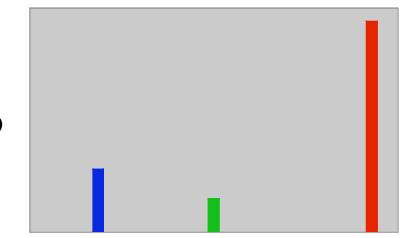
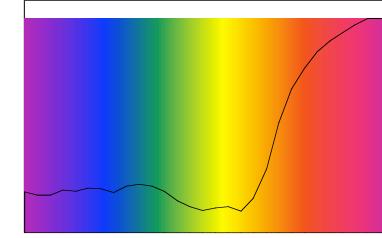
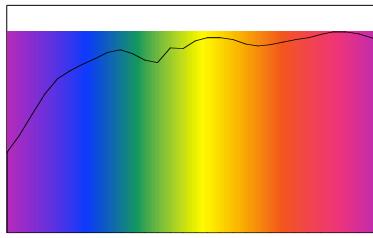
【source】 Yoichi Miyake : Analysis and Evaluation in Digital Color Imaging, University of Tokyo Press, 2000.

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

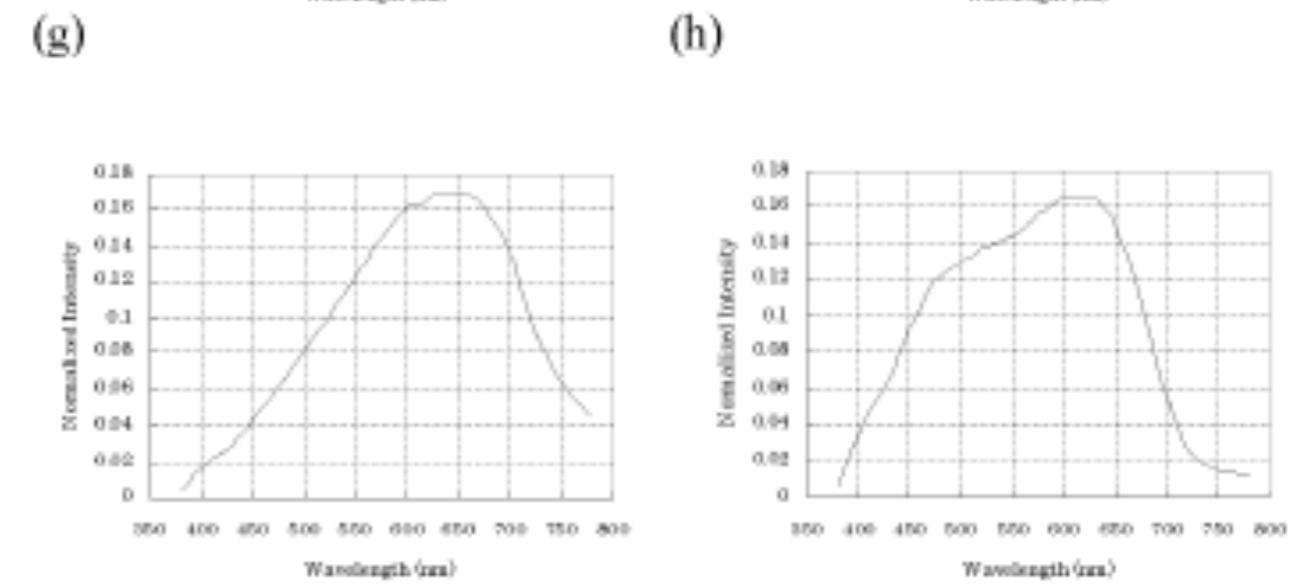
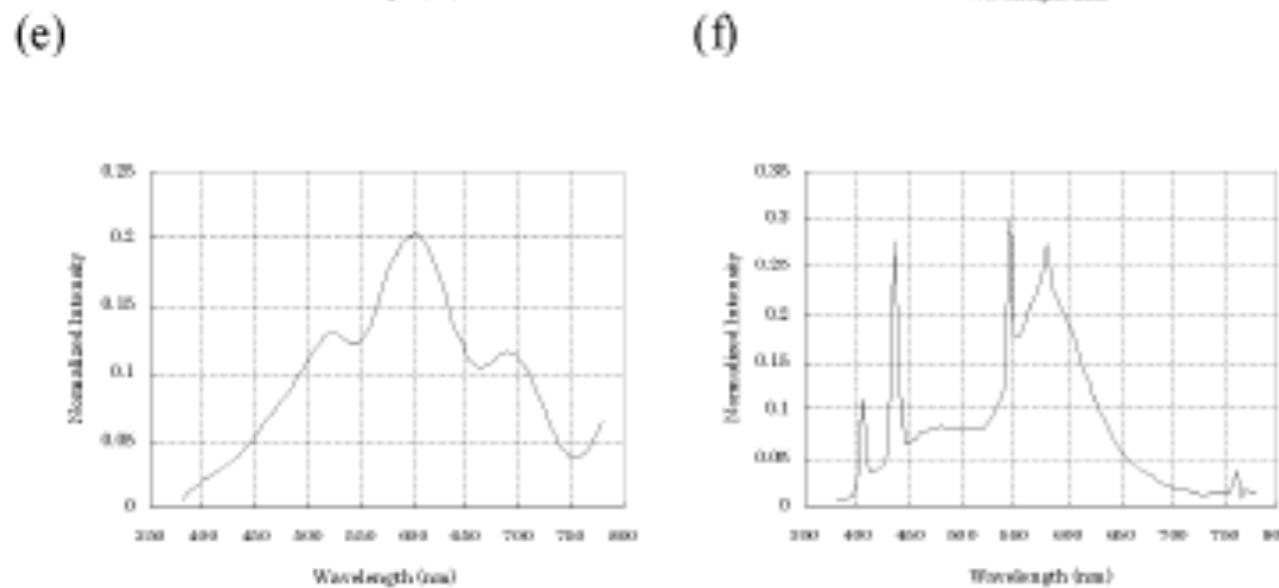
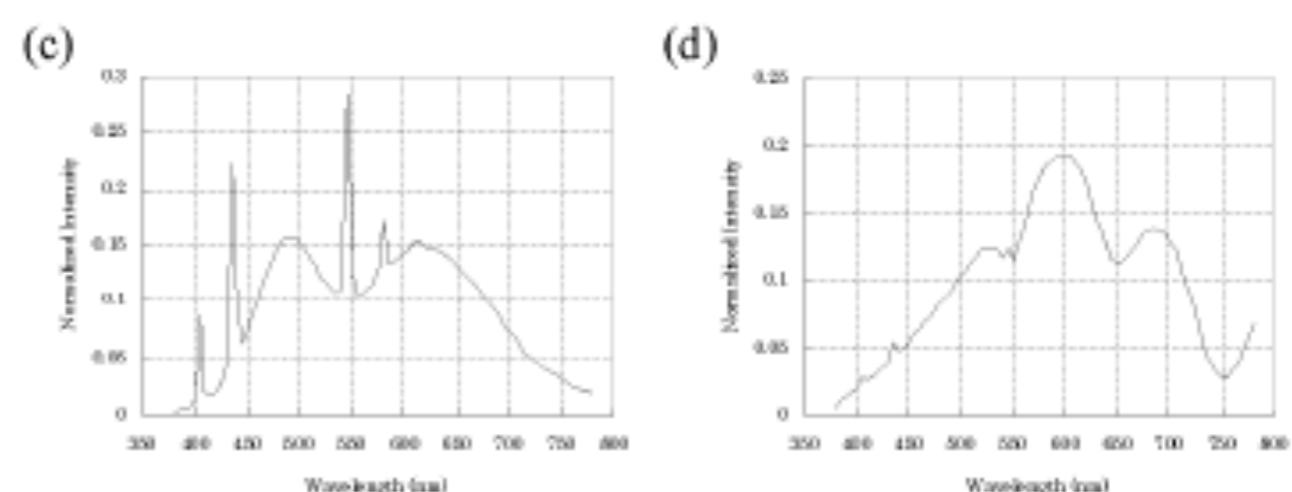
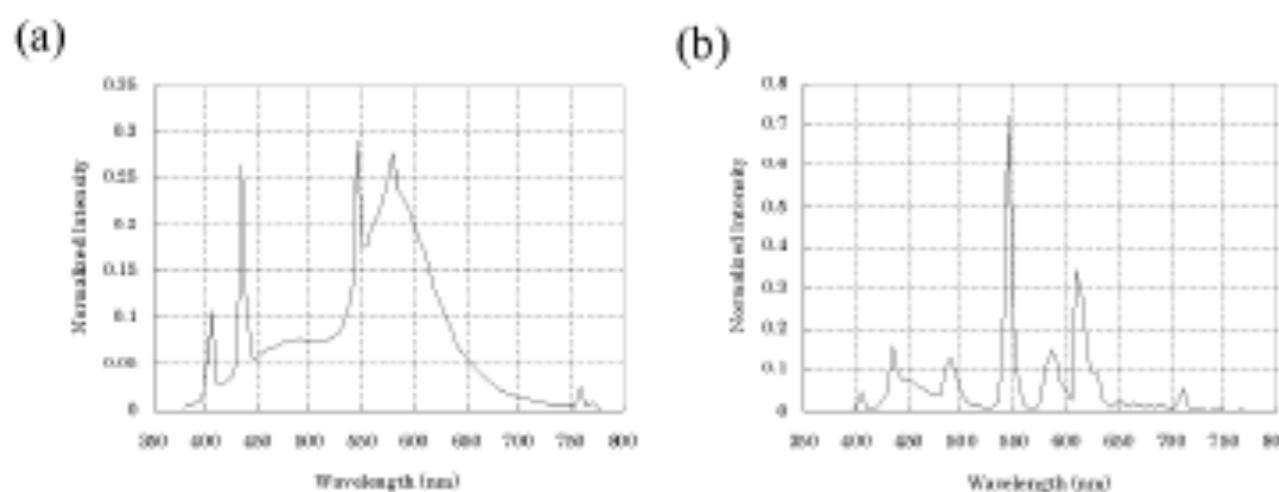
spectral radiance of illumination spectral reflectance of an object spectrum of reflected light RGB values



↓↑ [integration]

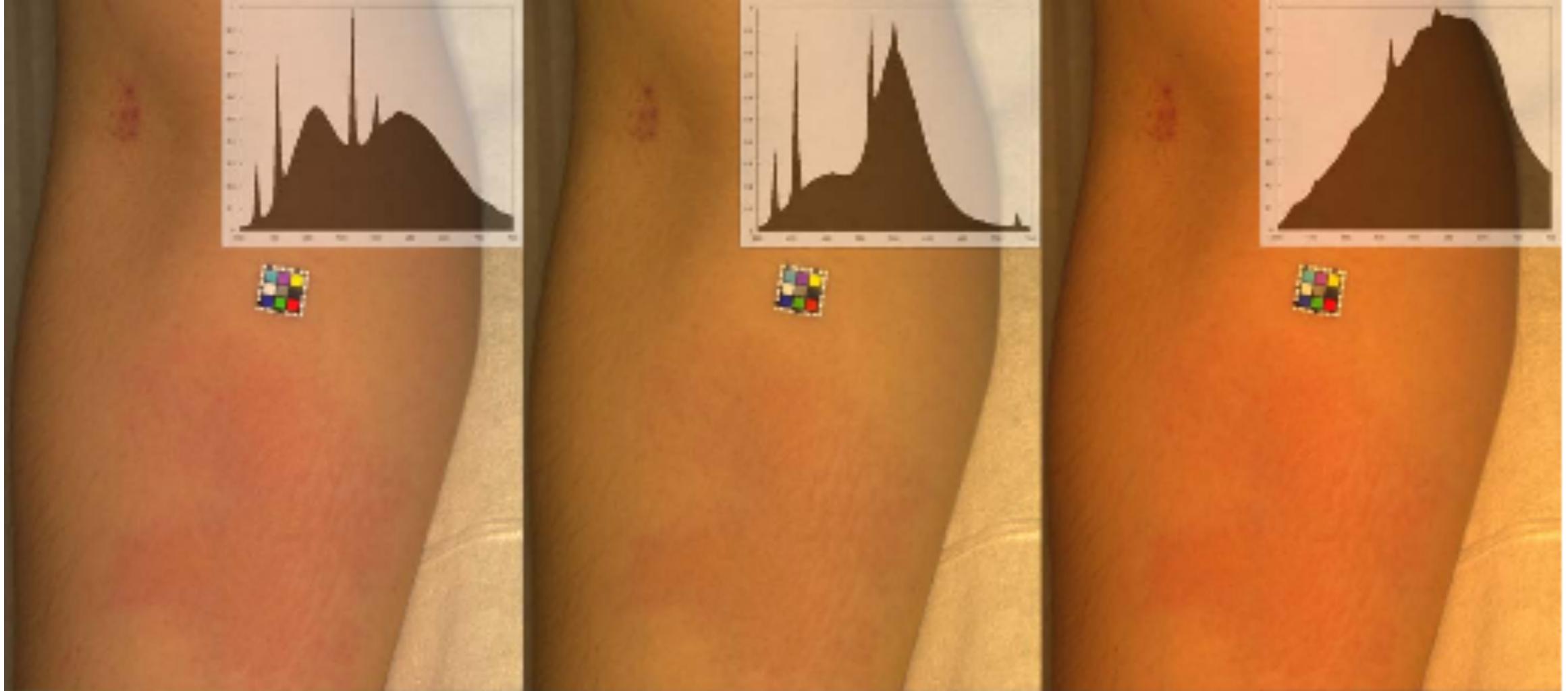


Calculation of Color Appearance
under Different Illumination



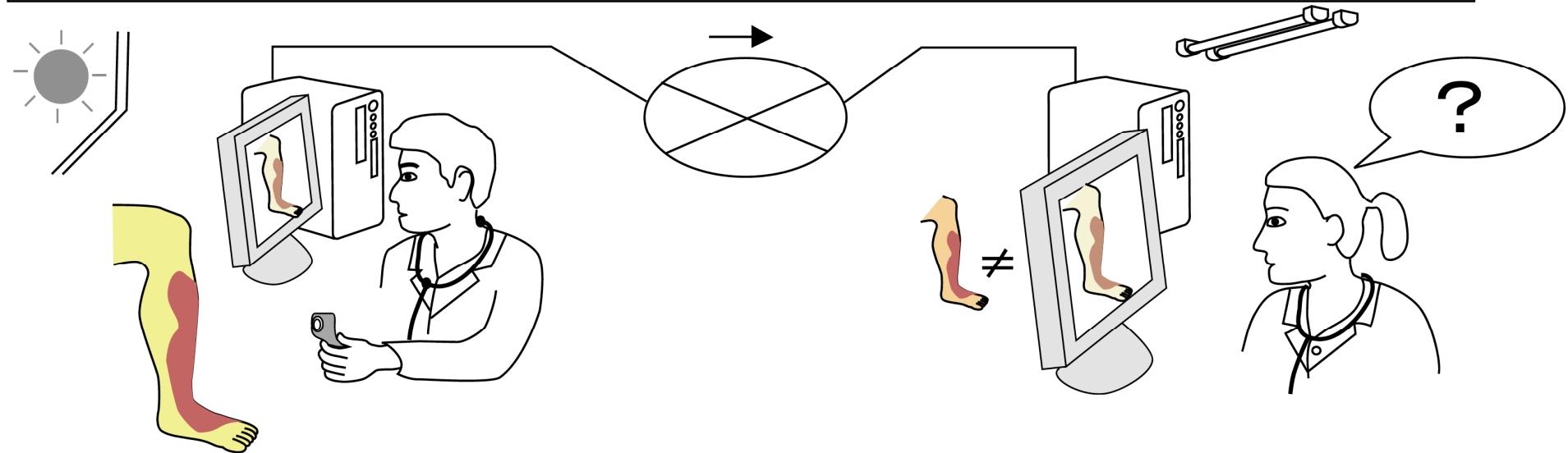
Index	Place	Angles of measured plane	Ceiling light	Other lighting sources
(a)	An emergency outpatient unit	45° to the horizontal	on	none
(b)	A treatment room of a dermatology ward	45° to the horizontal	on	none
(c)	An outpatient booth of dermatology	45° to the horizontal	on	windows aside
(d)	A dental chair by the window	horizontal	on	an adjustable lamp
(e)	A dental chair apart from the window	horizontal	off	an adjustable lamp
(f)	A dental chair by the window	horizontal	on	windows aside
(g)	A surgical bed in an operating room A	horizontal	off	surgical lights
(h)	A surgical bed in an operating room B	horizontal	off	surgical lights

Spectral Radiance of ~~Vari~~erious Illuminants

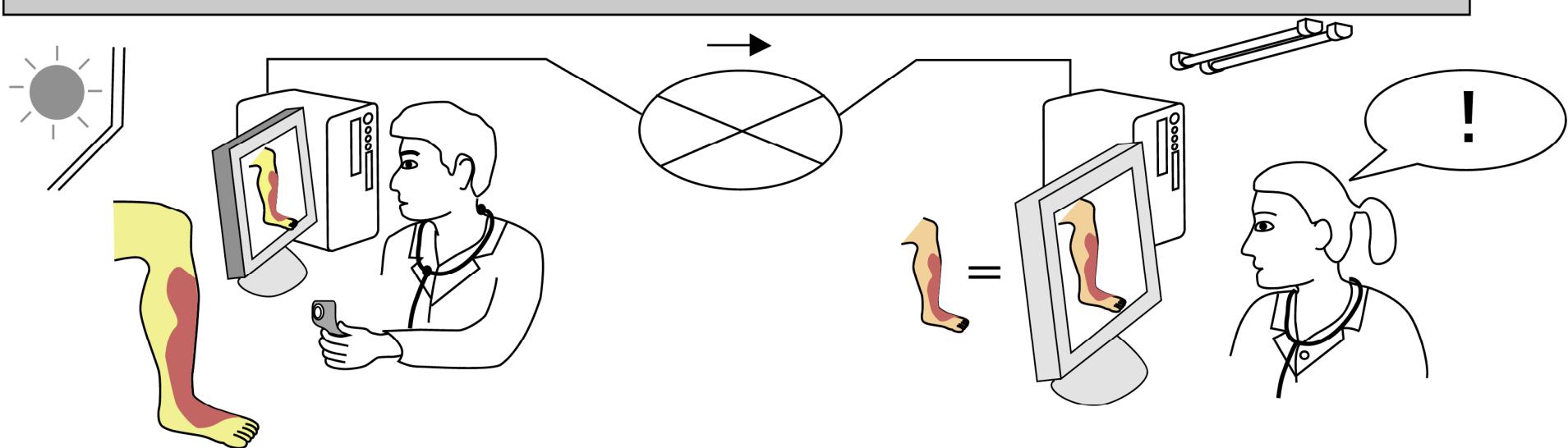


Real Color Appearance under Varierious Illuminants

Before



After



@M.Nishibori 2004

Application to Telemedicine, etc.

Acknowledgments

**Ken Watanabe^b, Yasuhiro Miyazaki^c, Naofumi Tanaka^d,
Shinichi Arakawa^e, Yumi Chiba^f, Kumiko Ohashi^g,
Hirosi Tanaka^g, Masahiro Okuyama^h, Kenji Kamimura^h,
Norimichi Tsumura^h, Yoichi Miyakeⁱ, Fumiko Uchino^j,
Hirosi Yamato^j, Po-Chieh Hung^j, Noriyuki Hashimoto^k**

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