

# THE HUMAN SKIN COLORIMETRIC AND EVALUATION WAY APPLIED SPECTRAL IMAGING WITH 3-DIMENSIONAL SCANNING AND LAPLACIAN FILTER IMAGE PROCESSING

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## ABSTRACT

The human skin measuring way was applied non-contact spectral imaging. And system was composed by White LED Illumination, Liquid Crystalline Tunable Filter, Peltier cooled monochromatic CCD sensor, Laser projector for 3-Dimensional metric to compensate curvature of image measuring area which related optics geometry of illumination and detection.

Subjects were males and females medial surface of lower arm and measured 420 to 700nm each 10 nm images. Each wavelength images, XYZ, and L\*a\*b\* images were applied Laplacian filter calculation and analyzed correlation between calculated value and each subject age. The results of correlation about human age, Laplacian filter value, wavelength were shown in this study. This colorimetric way was useful and high possibility for evaluation of the human skin and characterizes condition.

## INTRODUCTION

The human skin is one of the difficult objects to get high accurate measuring result by ordinary contact type spectrophotometer. As the reason, the human skin surface has extremely complex structure and half-transparency phenomenon. Ideally, non-contact type colorimetric measuring way is necessary. Especially, spectral imaging is useful to measure and evaluate of human skin. On the other hands, human body has curvature and need 3-Dimensional metric to compensate optics geometry. In this study, combined spectral imaging way and lattice pattern projection for measuring part to compensate optics dimension, and applied Laplacian filter calculation to evaluate skin surface.

## EXPERIMENT

A gonio-photometric spectral imaging system was applied to measure spectral reflectance and texture of human skin. It was composed of white LED illuminates, a liquid crystalline tunable filter (LCTF), and CCD imaging device with Peltier cooling unit. Illuminates direction were 20 degrees from normal direction, and detect direction was normal against sample, and the CCD device captures the images via the LCTF. And laser projector was applied to get 3-Dimension human skin object by lattice pattern projection to compensate optics geometry and schematic diagram is shown in Figure 1. Left side is optics geometry of measuring system, and right side is captured image of lattice pattern projection on human lower arms. Measuring area was around 10cm by 7.5cm and pixel resolution is 772 by 580 pixels in this area, and resolution is 192 dpi. Measured part of human skin was middle part of lower arm and measured 5 people male and female, ages were around twenties to seventies. Measurement time was need 2 minutes, and arm was fixed during measuring.

Each wavelength and synthetic Color image under D65 illuminate were shown in Figure 2. There were various textures in each wave length image. Especially long wavelength images see brad tube , and surface texture was very smooth.

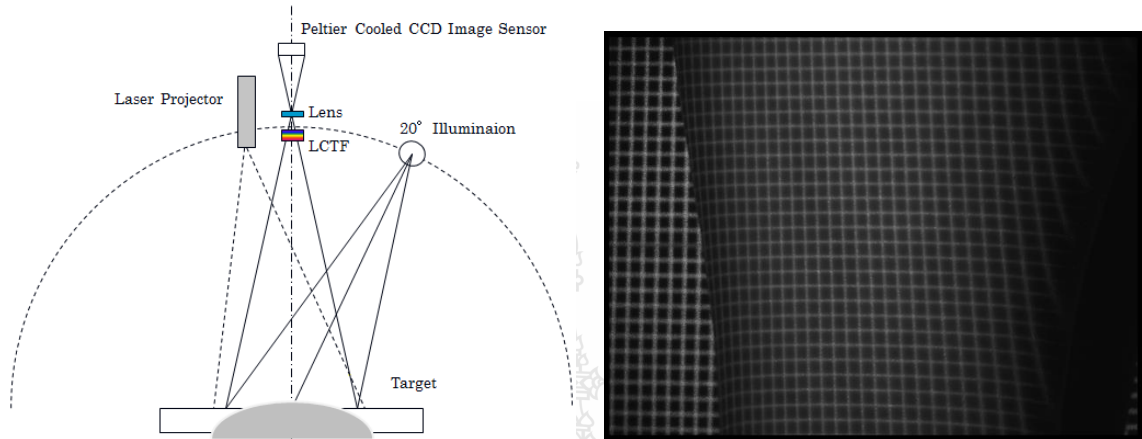


Figure 1. Schematic diagram of measuring system and lattice pattern projection image



Figure 2. Spectral imaging measuring result

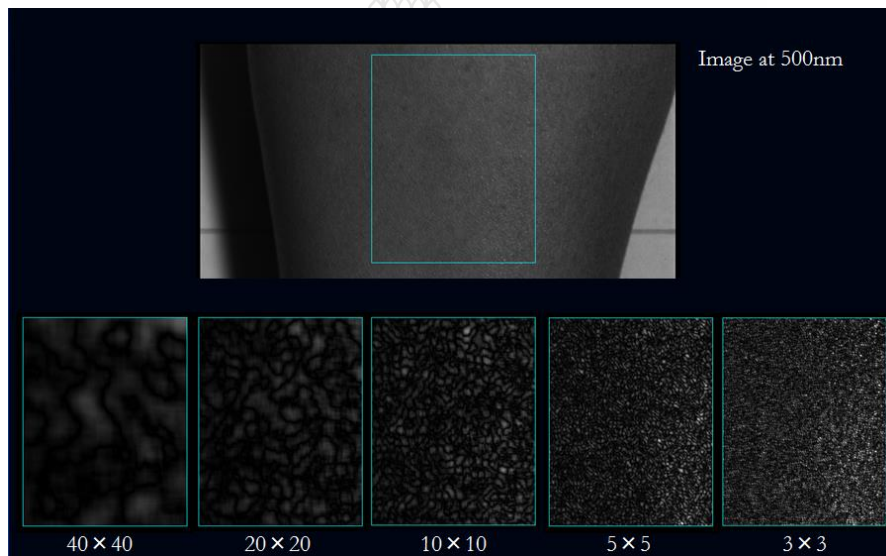
After measuring,  $L^*a^*b^*$ , XYZ value were calculated from each pixel spectral imaging data under illuminant D65, F10, and A. Each wavelength image,  $L^*$ ,  $a^*$ ,  $b^*$  image, and XYZ image was applied Laplacian Filter calculated by equation 1.

$$\nabla^2 f(x,y) = \frac{\partial^2 f(x,y)}{\partial x^2} + \frac{\partial^2 f(x,y)}{\partial y^2} = f_{xx}(x,y) + f_{yy}(x,y) \quad (1)$$

The Laplacian filter calculation way of L\*a\*b\* color image under D65, F10, and A illuminate was applied color difference calculation. Delta E\*<sub>ab</sub> between two beside pixel is same as deviation. The Laplacian filter calculation way of colour image was applied summation of Delta E\*<sub>ab</sub> between center and up and down, left and right, total 4 direction pixels.

### RESULT

The single wavelength image of 500nm applied Laplacian filter was shown in Figure 3. In this figure, Laplacian filter calculated averaged of 5 different size of area and each size were 3 by 3, 5 by 5, 10 by 10, 20 by 20, and 40 by 40 pixels.



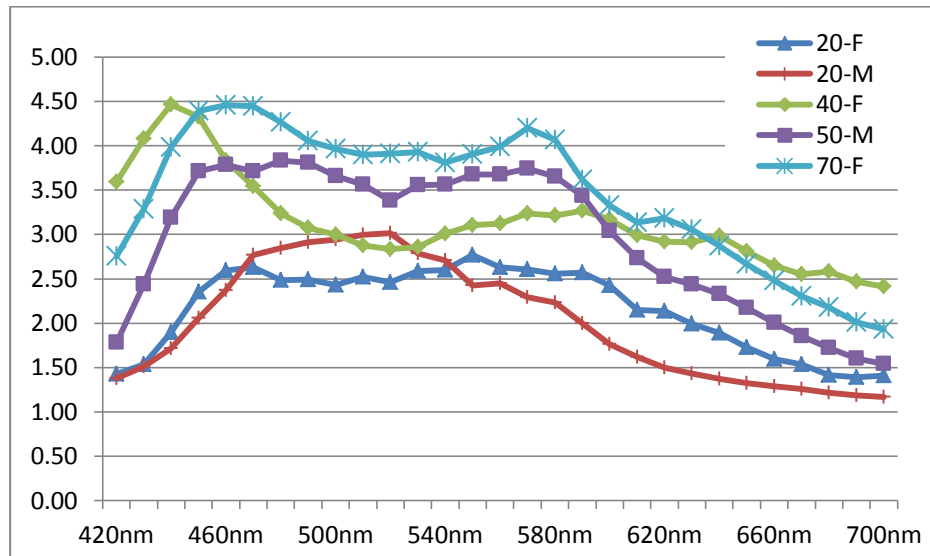
**Figure 3. Laplacian filter applied image**

The Laplacian value of colour image based on CIELAB coordinate under D65, F10, and A illuminate, average value of each wavelength image were shown in Table 1. Yong age value was smaller than old age, and these Laplacian filter value were correlated with age.

Table 1: Laplacian filter values

Age	20	20	40	50	70
Gender	Female	Male	Female	Male	Female
D65	2.0	3.1	3.2	3.0	4.9
F10	2.6	3.1	3.8	3.2	4.8
A	2.1	2.8	3.6	2.9	4.7
Average of each wavelength	2.2	2.0	3.1	3.0	3.5

Each wavelength image Laplacian filter values are shown in Figure 4. In this figure, horizontal axis is wavelength and vertical axis is filter value. The filter values were depending on wavelength. The long wavelengths between 600nm to 700nm values were smaller than 460nm to 600nm values. Also Laplacian filter values of colour image were depending on illuminate. Especially, in the case of young age and illuminant F10 value was higher than the other illuminant values. These results were indicated human skin image appearance is different under illuminant spectral type.



**Figure 4. Laplacian filter calculation result of each wavelength of spectral imaging**

### CONCLUSION

1. Gonio-photometric spectral imaging way with 3-Dimension scanning was useful for human skin color measuring. It is possible to compensate human body coverage and high accurate measuring with non-contact way.
2. There were correlation between Laplacian filter value and age. Laplacian filter value is increase with age.
3. Laplacian value was depending on type of illuminant. That is the human skin image is different under different type of illuminate.

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