Prediction of Color and Appearance of Textiles

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ABSTRACT

Color of textiles is usually measured by integrating sphere method or sample rotating method, but this method gives only average color of textiles, and does not give the characteristics or visual appearance of textiles. In this study, to characterize the appearance of textiles, three dimensional color measurements was made and analysed. For this experiment, gonio-spectrophotometric color measurement system was used, and three dimensional spectral reflectance factor distributions of reflected light from textile samples were obtained. Spectral reflectance factor change in latitude or longitude direction was analysed in statistical way. Textiles are composed of warp and woof, then spectral reflectance factor of textile for any direction is also composed from two component. Principal component score for wavelength relates to ratio of observed area of warp and woof. Using these relations, spectral reflectance factor distribution and color of textile, observed from one direction, were predicted.

1. INTRODUCTION

For many years, color of textiles were measured by the integrating sphere method, i.e. diffuse incident and near normal viewing or near normal incident and diffuse viewing, or sample rotating method. In other word, average color of textiles was measured, in spite of color of textiles changes with viewing direction. On the other hand, for measurement of gloss or lustre of textiles, goniometric measurement was proposed.

In this study, samples of mixed yearn textiles were measured by gonio-spectrophotometric color measurement system, and three dimensional distribution of spectral reflectance factor were obtained. As mixed yearn textile is composed from two kinds of thread, color of these textiles are to be mixture of two kinds color. Three dimensional spectral reflectance factor was analysed statistically, using principal component analysis, principal components, proportion, principal component score and eigenvector were calculated. From the relation between these values, spectral reflectance factor distribution, when the sample is viewed from one geometric condition, is predicted.

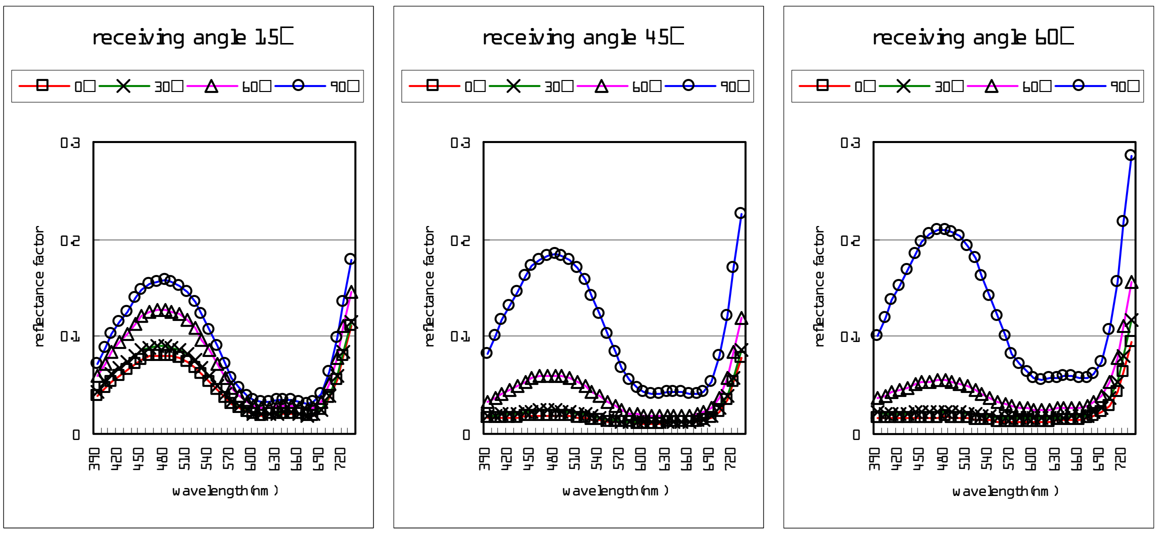

Fig.1 : Spectral reflectance factor distribution of sample A, incident angle : 0° , receiving angle : 15° , 45° , 60° , azimuthal angle : 0° , 30° , 60° , 90°

2. SAMPLES AND INSTRUMENT

For this study, six kinds of mixed yearn textile samples were used. These samples were measured by Murakami Model GCMS-3B Gonio-Spectrophotometric color measurement system, of which geometric and spectral conditions are as follows;

Geometric condition: incident angle: 0° (normal)
receiving angle: 15°, 30°, 45°, 60° from normal
azimuthal angle: 0° to 345°, 15° interval

Spectral condition: wavelength range: from 390nm to 730nm, 10nm interval
bandpass: ca. 10nm

3. MEASUREMENT AND ANALYSIS

Spectral reflectance factor distributions for above mentioned geometric conditions were measured by gonio-spectrophotometric color measurement system. Typical examples of spectral reflectance factor distribution of sample A are shown in Fig. 1. From these spectral reflectance factor distributions, tristimulus and colorimetric values (XYZ, xy, L*a*b*, L*C*h) were calculated for CIE standard illuminant D65 and CIE 1931 (2°) colorimetric standard observer.

On the other hand, these spectral reflectance factor distributions were statistically analysed. Variance-covariance matrix of spectral reflectance factor and azimuthal angle were treated by principal component analysis. Eigenvalue, proportion and cumulative proportion for each principal component of sample A are shown in Table 1. Principal component score and eigenvector for receiving angle 15°, 30°, 45° and 60° of sample A are shown in Fig. 2. In this way, statistical results of all samples were obtained.

receiving angle 15°

	eigenvalue	proportion	cumulative prop.
principal component 1	0.0323	0.9979	0.9979
principal component 2	0.0001	0.0020	0.9999
principal component 3	0.0000	0.0001	1.0000

receiving angle 30°

	eigenvalue	proportion	cumulative prop.
principal component 1	0.0181	0.9658	0.9658
principal component 2	0.0006	0.0341	0.9999
principal component 3	0.0000	0.0001	1.0000

receiving angle 45°

	eigenvalue	proportion	cumulative prop.
principal component 1	0.0163	0.9109	0.9109
principal component 2	0.0016	0.0889	0.9998
principal component 3	0.0000	0.0001	1.0000

receiving angle 60°

	eigenvalue	proportion	cumulative prop.
principal component 1	0.0192	0.8571	0.8571
principal component 2	0.0032	0.1427	0.9998
principal component 3	0.0000	0.0002	1.0000

Table 1 : Eigenvalue, proportion and cumulative proportion of principal component 1, 2, 3 of sample A

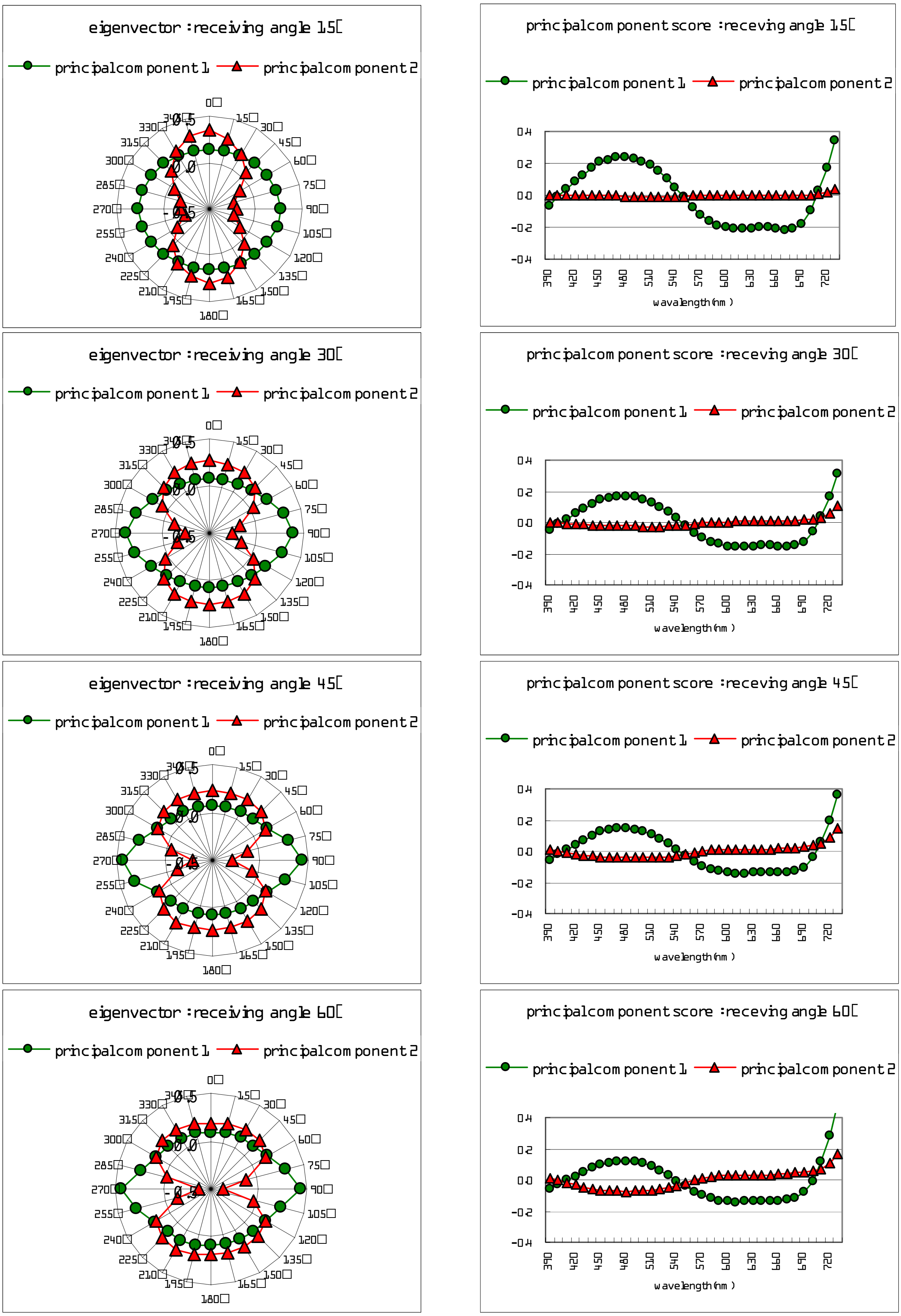

Fig.2 : Principal component score and eigenvector for receiving angle: 15° , 30° , 45° , 60° of sample A

4. CONSIDERATIONS

As shown in Table 1, spectral reflectance factor distributions of samples for any viewing direction are composed from two component, in case of sample A, blue and black. And the proportion of two components, which relates ratio of viewing area of two threads, warp and woof, from viewing direction, is predicted from eigenvector of two components, which are calculated by three dimensional spectral reflectance factor distributions. In this method, color of textile from any viewing direction is predicted.

5. CONCLUSION

Color of mixed yarn textile is composed of color of warp and woof, and ratio of two component depends on relative area of warp and woof from the viewing direction. Spectral reflectance factor distributions of reflected light from six kinds of textile samples were measured by gonio-spectrophotometer three dimensionally, when the sample was illuminated from the normal and viewed from one direction, for example from 60 degree from normal, changing the azimuthal angle from 0° to 345° by 15° step. Then spectral reflectance factor distributions on the same latitude were obtained. Using variance-covariance matrix of spectral reflectance factor and viewing azimuthal angle, principal component score, eigenvector and factor loading of the first and the second principal components were calculated by principal component analysis. By the interpolation of these results, we can predict spectral reflectance factor for the optional azimuthal angle on the same latitude. By the same manner, from spectral reflectance factor distributions for one reflected angle from the normal, for example 15°, 30° or 45°, we can predict spectral reflectance factor for the optional azimuthal angle on each latitude. In the same way, spectral reflectance factor for the optional reflected angle on the same azimuthal angle, in other word on the same longitude, can be predicted. From the predicted spectral reflectance factor distributions, tristimulus and colorimetric values were calculated and compared with the measured values.