Analysis of Painting Materials of Dancheong on Korean Traditional Wooden Building using Hyperspectral Imaging Technique

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I. Introduction

1. Background

- What is DANCHEONG?
  - Polychromatic surface of traditional Korean wooden buildings.
  - Consisted with 5 principle colors, it has unique, restricted hues and patterns.
  - The materials, recipes and painting techniques that were used for Dancheong are rarely variable, and have been changed along with time.
  - In 20th century, most of the traditional materials and recipes for Dancheong have been lost or replaced with modern, industrial materials.
  - Although contemporary Dancheong after 1980’s have national standard specifications, it is hard to know what materials were used as they are variable by operators and circumstance.

- Why GREEN COLORS?
  - Green colors take largest area, as they are also used as background color.
  - Green colors in Dancheong are basically divided into 3 different phases along with their relative tones and locations.
  - They are named differently as Noirok (middle tone), Yangrook (brightest tone), Hayeop (darkest tone).
  - The green colors have the most broad variation in materials, recipes and uses.

2. Objective

- Hyperspectral imaging technology can provide a solution to issues that current analysis methods are containing, since it is a non-contact analyzing tool that can also perform over a long distance.
- With reflectance spectra acquired from Hyperspectral, it will be possible to identify what materials were used in green colors of Dancheong.
- Hyperspectral technique can be a complement for current methods.

II. Methods

1. Experimental Process

- Post-study
  - Standard specimens of different pigments and materials
  - Practical use
    - Colors
    - Materials

- Reference samples
  - Single pigment-based/Unrefined oyster shell white (UW)
  - Mixtures of pigments and materials

- Experimental samples
  - Pigment combinations of modern paintings
  - Pigment combinations of traditional Dancheong

- Other samples
  - Modern paints
  - Pigments: Oxide yellow, Oxide red, Oxide black

2. Experimental Methods

- To study the applicability of Hyperspectral technique, Hyperspectral camera with spectrum range of 370–1000nm was used.
- For cross-validation, conventional pigment analysis methods were applied on the same samples in and sites.

2.1. Materials

- Based on the standard specification and practical recipes, some pigment candidates were selected.
- Diluted acrylic emulsion (PolySi 506, 20% in D.W.) was used as binder.
- Pigment mixtures were applied on the Wooden Panel.

2.2. Samples

- Can Hyperspectral distinguish different pigments?
  - Noirok vs. Yangrook
  - Noirok vs. Hayeop

2.3. Pseudo samples

- Can actual greens be distinguished by Hyperspectral data?
  - Experimental samples
  - Experimental samples

2.3.1. Conventional analysis

- Chemical component
  - X-ray Fluorescence spectroscopy
    - 15kV, 100sec, 400kV, 20sec (X-300, Sciapsys, USA)
  - Particle observation
    - Digital Video Microscope
    - Digital Microscope

- Analytical Methods and Conditions

- Reflectance
  - Hyperspectral camera
  - Spectral range 370–1000nm (PS-V10E, Specim, Finland)

3. Site Application

3.1. Conventional analysis

- XRF, Microscopy

- Noirok, Yangrook, Hayeop
  - Green
  - Yellow
  - Blue/Black

- Samples
  - Mixture of pigments
  - Mixture of materials
  - Modern paints
  - Pigments: Oxide yellow, Oxide red, Oxide black

3.2. Hyperspectral analysis

- Reflectance
  - Hyperspectral camera
  - Spectral range 370–1000nm (PS-V10E, Specim, Finland)

- Experimental samples
  - Pigment combinations of modern paintings
  - Pigment combinations of traditional Dancheong

4. Study on the cause

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- This research is a first attempt to analyze Dancheong in Korea by using Hyperspectral technique, which will contribute to the development in characterization methods for pigments in Korean Dancheong with safe experimental environment and fast measurement procedure.

- The Hyperspectral data interpretation process model was established for green pigments used in contemporary Dancheong through samples that were produced in diverse variation.

- By applying Hyperspectral data interpretation process, it was confirmed that it not only identifies what pigments used for green, but also enables having prior knowledge about pigment mixture in Dancheong.

- Hyperspectral would be applicable for practical Dancheong investigation in field when the DB is built, which includes samples with various material and mixture ratio reflecting the characteristics of Korean Dancheong.

IV. Conclusion

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