Application of Human Color Information Processing to the Analysis of Artworks

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1. Object

Artwork analysis requires a macroscopic framework and methodology, reflecting both art historical approach and scientific technique. Yet majority of artwork analysis relies heavily on either historical evidence or highly subjective appraisal, and many limitations have been addressed in appreciating artworks with conventional analytical methods. To solve this problem, we combined the traditional method of art appraisal with biologically-motivated image processing technique that reflects visual information processing mechanisms of human vision [1].

2. The Art-Historical Analysis of artworks

Fig. 1. Complementary colors in the artworks

(From left, Johannes Vermeer, Pieter de hooch, Gabriel Metsu)

We studied on influential relationships between Johannes Vermeer and his contemporary artists, including Nicolas Maes, Pieter de hooch, Gerard Ter Borch, and Gabriel Metsu. Our study is based on two art historical background of Vermeer and other artists. First, Vermeer and other artists influenced each other’s painting, and second, Vermeer and other artists used complementary colors to emphasize the effect of light in their paintings. In particular, complementary pairings of yellow ocher and cobalt blue were the most representative characteristic of Vermeer and other artists. Moreover, many artists used the cobalt blue in their artworks because cobalt blue that is called Delft Blue has been renowned in the city of Delft since the 17th century. We accordingly focused on the study of the art historical background of Vermeer and other artists and provided a practical solution by introducing quantitative analysis of artists’ painting styles through image processing techniques.

3. The Quantitative Analysis of artworks

In this study, the color analysis exhibits and compares cobalt blue and yellow ocher in the artworks of Vermeer and other artists. For this analysis, RGB-coded images are transformed into the CIE L*a*b color space format because the CIE L*a*b corresponds very well to the perceptual differences of their appearances [2]. To discriminate the characteristic colors of artists’ works quantitatively, colors were analyzed in terms of complementary color differences based on the Euclidean distance (ΔE), which has been used when simulating configurations of opponent coding information processing in research on human color perception. Because the Euclidean distance is generally regarded as equal in terms of color within $\Delta E = 0.5-1.2$, the analysis is judged by this criteria.

$$\Delta E = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2 + \cdots + (p_n - q_n)^2} = \sqrt{\sum_{i=1}^{n} (p_i - q_i)^2}$$

4. Result & Implication

Our previous study showed that Vermeer’s complementary color is most similar to that of Gerard Ter Borch [3]. However, the previous study did not include Vermeer’s contemporary artists because it deals with limited number of artists for ‘uncovering a mentor to Vermeer.’ Thus, this study broadens the scope of research on Vermeer, encompassing the whole Delft school. This study offers important implications and gives a new direction to future research on Vermeer and the Delft School. Also, this study suggests a new vision for art history and offers a great potential to be applied for quantifying information on drawing styles into a database. Furthermore, an interdisciplinary approach of engineering, cognitive science, and art history adopted here by utilizing biologically-motivated image processing techniques is believed to contribute to a systematic analysis of artworks and would be very informative for future studies.

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Reference