Matière of Painting Analyzed by Wavelet Transform

Toshihiro Bando, Masamichi Kobayashi, Yuri Sakurai
Department of Intelligent Information Engineering and Sciences
Doshisha University
Tatara Miyakodani 1-3
Kyotanabe, Kyoto 610-0321, Japan
Email: tbando@mail.doshisha.ac.jp

Abstract

"Matière" plays an important role in paintings to create an atmosphere to tableaux. We investigated "matière" or texture features of Paul Klee's paintings because he seems to have tried to use many painting techniques and materials intending to produce variety of textures that create respective atmosphere in each painting. As a first step to know texture feature of color images of his paintings we analyzed grayscaled images of paintings in seven composition categories by 2-D wavelet transform. Then we calculate an image characteristic amount from the result of wavelet multi-resolution analysis of the painting images to clarify their texture feature quantitatively. As a result, the image characteristic amounts of painting images we calculated actually indicate that Klee created many different textures by using many kinds of painting techniques and materials. This result indicates that we can use the image characteristic amounts as objective index of texture feature or "matière" of paintings.

Introduction

As brushwork of the painters and materials they use determine texture of paintings, "matière" reflect the characteristics of painters and style of paintings. Texture analysis has been used to characterize each painting, and also used to indentify[1]. In this study we intend to make it clear whether wavelet multi-resolution analysis of the picture images effective to understand the structure of painting images.

Methods

We analyzed the images of paintings by wavelet multi-resolution analysis using the Haar function as the mother wavelet function to see spectral feature of brightness distribution of painting images. Grayscaled painting images were decomposed into seven subband levels and the data of each subband reflects the feature of different spatial frequency and the directional features of the image.

As an indicator of texture feature we calculate an image characteristic amount *RMS* (Root Mean Square) of wavelet coefficient values of HH components in each subband from the result of two-dimensional discrete wavelet transform of the painting image. Wavelet coefficient values of each subband of multi-resolution analysis indicate contribution of each spatial-frequency component to whole image. So a set of *RMS* value from each subband is able to be considered as an indicator of size of image components or granularity of whole image, and then it is also one of important texture features or "matière".

We used Paul Klee's painting images downloaded from the image database in the website of the Paul Klee Center for multi-resolution analysis. From the downloaded images of Klee's typical paintings we chose 31 sample images consisting of three to six images in each seven categories of Paul Klee's paintings classified by H. Nishida according to brushwork. Seven categories of Paul Klee's paintings we used for analysis are 1) Step-by-step transition of color, 2) Composition with parallel lines, 3) Composition with square and magic square, 4) Expression by symbol and thin line, 5) Sputterings, 6) Pointillism paintings, and 7) Paintings with heavy black line. Sizes of the images are from about 210,000 to 260,000 pixels and original color images are grayscaled for the analysis of brightness distributions.

Results and Discussion

Paintings of brushwork category "Pointillism" (see Figure 1(a)) indicate the *RMS* distributions that have a peak at relatively small subband region and the *RMS* value increases again as the subband become larger (Figure 1(c)). The peak of the *RMS* distribution at the small subband reflects the average size of the element points painted in oil that construct whole paintings and are the origin of the painting style name "Pointillism". Whereas the increase of the *RMS* value at large subband region seems to reflects the fact that the motifs of these paintings that consist mainly of many elemental small points with almost similar color and size have relatively large areas. Paintings of brushwork category "Expression by symbol and thin line" indicate the *RMS* distributions that have one peak at small subband region and become relatively small in large subbsnd region (Figure 1(c)). The peak of *RMS* distribution at relatively small subband corresponds to the fact that these paintings consist of fine structures of many kinds of symbols, letters and detailed lines drawn by pen and pastel on the smooth background painted in watercolors.

In contrast to the category "Pointillism", paintings of brushwork category "Step-by-step transition on color plane" (see Figure 1(b)) indicate the *RMS* distributions of almost monotonic increase as the number of subband increase (Figure 1(c)). This distribution reflects the fact that the paintings of this category consist of relatively large components of smooth color surface.

(a) (b) (c)
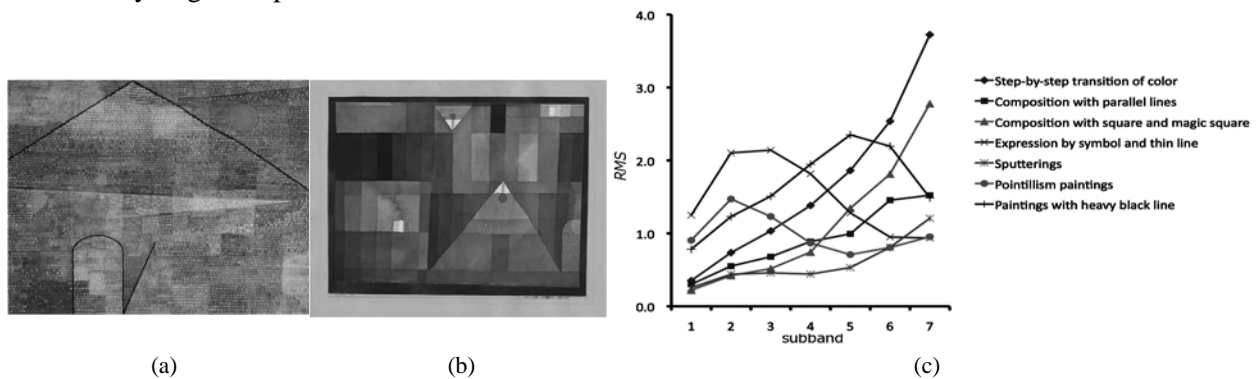
Figure 1: *(a) Sample painting of brushwork categories "Pointillism". (b) Sample painting of brushwork categories "Step-by-step transition on color plane". (c) Averaged RMS value distributions of the paintings in seven brushwork categories.*

Our results showed that the *RMS* value is one of the statistical values that indicates texture feature of the image objectively. In the case of painting image this value reflect texture feature of paintings or "matier" as a result of paints and materials used in each paintings and of brushwork. Paul Klee paid so much attention to the "matier" and tried to make various kinds of "matier" in his paintings using many types of paints and materials like oil, watercolor, gouache, tempera, pastel, chalk, pen, etching or using them together and also using painting technique like pointillism and collage. Our analysis of his painting images indicate that he succeeded in giving each of his paintings diverse atmospheres suited for the motif combining various kinds of paints and materials, and using many kinds of brushwork techniques to make specific "matier" in his paintings. The results of our present study also suggest that the image characteristic amounts calculated from the wavelet coefficient value like *RMS* is one of the useful indicators to understand the structure of painting images as well as to know "matier" of paintings. This type of index is not only useful for identification of painter from brushwork feature, but we can also utilize it as a powerful tool to understand and compare individual characteristics of each painting.

References

[1] C.R. Johnson, E. Hendriks, I.J. Berezhnoy, E. Brevdo, S.M. Hughes, I. Daubechies, Jia Li, E. Postma, Z. Wang, *Image Processing for Artist Identification - Computerized Analysis of Vincent van Gogh's Painting Brushstrokes*, IEEE Signal Processing Magazine, Vol. 25, No. 4, pp.37-48, 2008.