Image Color Transfer Approach by Analogy with Taylor Expansion

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ABSTRACT

The Taylor expansion has shown in many fields to be an extremely powerful tool. In this paper, the authors investigated image features and their relationships by analogy with Taylor expansion. The kind of expansion could be helpful for analyzing image feature and engraftment, such as transferring color between images. By analogy with Taylor expansion, the image color transfer algorithm is designed by the first and second-order information. The luminance histogram represents the first-order information of image, and the co-occurrence matrix represents the second-order information of image. Some results illustrate the proposed algorithm is effective. In this study, each polynomial in the Taylor analogy expansion of images is considered as one of image features which help in re-understanding images and its features. By using the proposed technique, the features of image, such as color, texture, dimension, time series, would be not isolated but mutual relational based on image expansion.

Keywords: Co-Occurrence Matrix, Image Color Transfer, Image Feature Analysis, Luminance Histogram, Taylor Expansion

1. INTRODUCTION

Image analysis, understanding, compression and extracting have been very active in information technology. Many features of images, such as color, texture, dimension, time series, were explored. They seemed to be isolated in those researches. During our matching and rendering image study, we firstly only used luminance information, the first-order information of image, to find the match color. When the texture is complex and variant, it is very difficult to make a success of matching by using the first-order information of images. And then we introduced the co-occurrence matrix (Alparone, Argenti, & Benelli, 1990), which represents the second-order

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information of images. We get a best match criterion, which is similar surprisingly to Taylor expansion. At it happens, the Taylor expansion has shown - in many fields - to be an extremely powerful tool (Dyer & Ip, 2012; Engelbrecht, 2000). The fact is so interesting for us that we investigate a kind of expansion will be used to positions of image feature analysis and engraftment, such as transferring color between images (Reinhard, Adhikhmin, Gooch, & Shirley, 2001; Welsh, Ashikhmin, & Mueller, 2002). By analogy with Taylor expansion, we re-design image color transfer algorithm to match the color between the source image and destination by first and second-order information (Liu, Ji, & Wang, 2004).

The rest of this paper is organized as follows: Related works are presented in Section 2. Section 3 describes color, texture and Taylor expansion. Section 4 presents our analogy expansion of images and color transfer algorithm. The experimental results are illustrated in Section 5, and finally conclusions are given in Section 6.

2. RELATED WORKS

In previous published work, Reinhard et al. introduced a method (Reinhard, Adhikhmin, Gooch, & Shirley, 2001), in which colors from a source image were transferred to a second colored image using a simple but surprisingly successful procedure. The basic method matched the three-dimensional distribution of color values between the images and then transforms the color distribution of the destination image to match the distribution of the source image. Welsh et al. transferred color to grayscale images (Welsh, Ashikhmin, & Mueller, 2002), in which the greyscale image was represented by a one dimensional distribution, hence only the luminance channels can be matched between the two images. We pay attention to not only luminance but also texture factor on rendering technique between pictures. Texture analysis and synthesis has had a long history in psychology, statistics and computer vision. Gibson pointed out the importance of texture for visual perception (Engelbrecht, 2000). Julesz had done some pioneering work on texture discrimination that paved the way for the development of the field (Julesz, 1962). Efros et al. studied image quilting for texture synthesis and transfer (Efros & Leung, 1999; Efros & Freeman, 2001). Nealen and Alexa described improved methods, hybrid texture synthesis technique for texture synthesis and show how these methods can also be used for texture transfer (Nealen & Alexa, 2003). Hertzmann et al. described a new framework for processing images by example, called “image analogies” which generalizes texture synthesis for the case of two corresponding image pairs (Hertzmann, Jacobs, Oliver, Curless, & Salesin, 2003). Pitie et al. propose a kind color transfer technique for the image processing (Pitie, Kokaram, & Dahyot, 2007). Chung and Wen develop an algorithm for colorizing a grayscale image. In their approach, a block-based vector quantization of luminance mapping technique are used to automatically colorize the grayscale image to improve the quality of the colorized grayscale image (Chung & Chen, 2009). Quang et al. propose a reproducing kernel Hilbert space framework for image and video colorization (Quang, Kang, & Le, 2010). Pouli and Reinhard present a kind of histogram reshaping technique which allows significantly better control and transfers the color palette between images of arbitrary dynamic range (Pouli & Reinhard, 2010). Image analogies are applied in several disparate areas, including machine learning, texture synthesis, nonphotorealistic rendering, and image-based rendering (Ruderman, Cronin, & Chiao, 1998; Ji, Liu, Wang, & Tang, 2004; Ji & Chen, 2008).
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