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An Objective Metric for Quality Assessment of Color Quantized Images

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In this paper we present a novel objective image quality metric for quality assessment of color quantized images. The proposed metric models any color quantization distortion as a combination of three similarities: color similarity, edge similarity and structural similarity. We validate the performance of the proposed metric with an extensive subjective study involving 875 color quantized images and show that the new metric outperforms recent state-of-the-art image quality metrics in the quality assessment of color quantization distortion.

Keywords : Color Quantization, Objective Image Quality Assessment, Subjective Image Quality Assessment.

1. INTRODUCTION

Image quality assessment is an important tool in image processing systems. Image quality assessment methods can be classified into two categories: subjective and objective. The subjective image quality assessment methods are accurate in estimating the visual quality of an image because they are carried out by human subjects but are costly process which requires a large number of observers and takes a significant time. On the other hand the objective image quality assessment methods are computer based methods that can automatically predict the perceived image quality. Hence the objective image quality assessment methods gained more popularity.

Originally, color quantization has been used to satisfy the display hardware constraints that allow a limited number of colors to be displayed simultaneously. Today the original motivation of color quantization has changed due to availability of inexpensive full color displays. However, color quantization is still an important problem in the fields of image processing and computer graphics, it can be used in mobile and hand-held devices where memory is usually small [1], it can be used in low-cost color display and printing devices where only a small number of colors can be displayed or printed simultaneously [2], it also can be used in lossy compression techniques [3]. Another aspect of importance of color quantization is that the human visual system can't perceive more than 20,000 different colors at any given time [4] while a full color image may contain up to 16 million different colors, this large number of colors makes it difficult to handle a variety of color-based tasks such as computing histograms or other useful statistics.

Many researchers have contributed significant research in the design of objective image quality methods starting from the widely used Mean Square Error (MSE) metric and its correlated Peak Signal to Noise Ratio (PSNR). The Weighted Signal to Noise Ratio (WSNR) [5] simulates the human visual system properties by filtering both the reference and distorted images with contrast sensitivity function and then compute the SNR. Miyahara [6] proposed a Picture Quality Scale (PQS) based on three distortion factors: the amount, location and structure of error. The perceptual color fidelity metric (S-CIELAB)[7] is a spatial extension to the CIELAB metric for measuring color reproduction errors of digital images. It simulates the spatial sensitivity of the human visual

image. Our proposed metric models any image distortion as combination of three similarities: color similarity, edge similarity and structural similarity. The performance of the proposed metric was validated with an extensive subjective study involving 875 color quantized images and the results show that the proposed metric outperforms the recent state-of-the-art image quality assessment metrics in terms of prediction accuracy, monotonicity, and consistency. Future work includes using this new application-specific image quality metric to guide the process of color quantization in a color quantization algorithm in order to improve the perceptual quality of the delivered color quantized images.

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