Chapter 59
Analysis of SSIM Based Quality Assessment across Color Channels of Images

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ABSTRACT

Advances in imaging and computing hardware have led to an explosion in the use of color images in image processing, graphics and computer vision applications across various domains such as medical imaging, satellite imagery, document analysis and biometrics to name a few. However, these images are subjected to a wide variety of distortions during its acquisition, subsequent compression, transmission, processing and then reproduction, which degrade their visual quality. Hence objective quality assessment of color images has emerged as one of the essential operations in image processing. During the last two decades, efforts have been put to design such an image quality metric which can be calculated simply but can accurately reflect subjective quality of human perception. In this paper, the authors evaluated the quality assessment of color images using SSIM (structural similarity index) metric across various color spaces. They experimented to study the effect of color spaces in metric based and distance based quality assessment. The authors proposed a metric using CIE Lab color space and SSIM, which has better correlation to the subjective assessment in a benchmark dataset.

1. INTRODUCTION

Quality evaluation of digital images is an essential operation with applications across various domains. During each stage of digital image processing like capture, storing, compression, and enhancement, certain distortions are introduced in the images. The amount of distortion can sometimes affect the way an image is perceived by an observer, which is referred to as image quality. Hence it is necessary to measure the overall perceived quality of an image to maintain, control, or to enhance it. One of the essential requirements of an image quality measure is that it should have

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strong correlation to the human perception. Many efforts have been directed during the last two decades to design such an image quality metric which can be calculated simply but can accurately reflect subjective quality of human perception (Bovik, 2010a; Bovik, 2010b; Lee et al., 2011). The choice of an adequate metric usually depends on the requirements of the considered application.

Due to the wide application of color images in the recent past, color image quality assessment (IQA) is gaining momentum. Color images can be represented using the three attributes (brightness, hue, and saturation), which form basis of human perception of color. Hence various trichromatic spaces have been proposed for color image processing. At present, most of color image quality assessment methods convert a color image to one of the color spaces like HSV, XYZ etc. and then adopt the gray scale image quality assessment for each channel (Thakur et al., 2011; Toet et al., 2003; Le Callet et al., 2003). However, this kind of conversion cannot completely describe the nonlinear perception of brightness, hue, and saturation in a color image. It is well known that color image quality assessment results depend on the features of color space and how closely it can characterize visual perception. Thus, it is highly desirable to convert color image to a color space which can reflect the subjective visual characteristics more properly in order to obtain a better quality metric.

In this paper, we evaluated quality assessment for color images using SSIM for RGB, HSV and Lab images. We have also calculated Euclidean distance for RGB, HSV and Lab images and compared SSIM with Euclidean distance. Section 2 describes the previous work done in image quality assessment. Sections 3 and 4 describe the color spaces and our experiments of using SSIM across various color channels. Section 5 describes about the proposed work of using Lab color space in SSIM (Lab based SSIM). Section 6 explains the experimental results.

2. PREVIOUS WORK

Identifying the image quality measures that have highest sensitivity to distortions would help systematic design of coding, communication and imaging systems and of improving or optimizing the picture quality for a desired quality of service at a minimum cost. Image quality measurement basically consists of two approaches: Subjective measurements and Objective measurements.

Figure 1 shows the classification of IQA measures. Subjective measurements are the result of human experts providing their opinion of the image quality and objective measurements are performed with mathematical algorithms. The goal of research in objective image quality assessment is to develop quantitative measures that can automatically predict perceived image quality (VQEG, 2000). An objective image quality metric can play a variety of roles in image processing applications. It can be used to dynamically monitor and adjust image quality. It can be used to optimize algorithms and parameter settings of image processing systems. It can be used to benchmark image processing systems and algorithms (Pappas et al.,2000).

In full-reference image quality assessment methods, the quality of a reproduced image is evaluated by comparing it with the original image that is assumed to have perfect quality. In reduced-reference image quality assessment methods, limited information are available for both reproduced image and original image to evaluate the quality of the test images. No-reference metrics try to assess the quality of an image without any reference to the original one.

2.1. Metric Based IQA

Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) were traditionally used metrics based on error sensitivity. However they are