

IMAGE QUALITY ASSESSMENT BASED ON CONTOUR AND REGION *

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Abstract

Image Quality Assessment (IQA) is a fundamental problem in image processing. It is a common principle that human vision is hierarchical: we first perceive global structural information such as contours then focus on local regional details if necessary. Following this principle, we propose a novel framework for IQA by quantifying the degenerations of structural information and region content separately, and mapping both to obtain the objective score. The structural information can be obtained as contours by contour detection techniques. Experiments are conducted to demonstrate its performance in comparison with multiple state-of-the-art methods on two large scale datasets.

Mathematics subject classification: 68U10, 94A08.

Key words: Image quality assessment, Contour detection, Image segmentation.

1. Introduction

With the coming of information era, multimedia has become the primary carrier of information in our daily life. Digital images, as an important part, attracts tremendous attention. However, digital images are subject to a wide variety of distortions during the procedure such as acquisition, processing, compression, storage, transmission, and display. Image Quality Assessment as one of the fundamental problems attracts tremendous interest in recent years.

Generally IQA methods are classified into two categories: one is subjective assessment by humans and the other is objective assessment by human-designed algorithms. Image quality depends on its ultimate receiver, therefore subjective evaluation by humans is a correct criterion. Nevertheless, it's time-consuming, expensive and unable to be implemented in a real-time system. The objective assessment aims to develop computational models to automatically predict the image quality in consistent with subjective assessment.

* Received February 1, 2016 / Revised version received October 27, 2016 / Accepted November 11, 2016 /
Published online December 16, 2016 /

According to the availability of reference source, objective assessment is classified as full-reference, reduced-reference and no-reference. In this paper, we only focus on full-reference methods. The interested readers are referred to the book of Wang and Bovik [1] for more details.

Due to the availability of datasets with human-labeled groundtruth, a variety of full-reference IQA methods are proposed in last decade. Existing approaches could roughly be divided into the following categories: the statistic of errors based model (e.g. Mean Squared Error (MSE), Peak Signal to Noise Ratio (PSNR)), Human Visual System (HVS) based model [2-4], structural similarity based model [5, 6], information theory based model [7, 8], and visual saliency based model [9-11]. Most approaches evaluate local quality at pixels based on patches, and generate a quality map after all pixel evaluation is finished.

In our opinion, a pixel as a low level representation unit is too fine to assess image quality. Human visual perception is adapted for extracting structural information such as contour and segmentation. The perceptual process of images is hierarchical: human first perceive global structural information such as contours and further focus on local regional details such as texture. In this paper, we propose a contour and region based framework for full-reference IQA. Our model separates an image into structure part and local regions. We detect the contour for representing structure, and use local descriptors for representing local region content. Existing models weight each pixel by information content in a low level. As opposed to this, we assess image quality in a higher level: on the one hand, we consider the contour as a whole and try to quantify the degeneration of the contour, on the other hand, we measure the degeneration of the region content. Finally we map both to obtain the objective score.

To evaluate the performance, we test our model on two large-scale benchmark datasets, LIVE2 [12] and TID2013 [13]. We demonstrate its promise through the comparison with multiple state-of-the-art objective methods.

The remainder of this paper is as follows. In Section 2, we review the related works. Next, we introduce our model in detail in Section 3. Section 4 covers the algorithms of two modules. We present experiments in Section 5, and discuss in Section 6.

2. Related Works

In this section, we first cover the review of full-reference IQA, contour detection and image segmentation, then introduce the most related work to our model.

2.1. Full-reference Image Quality Assessment

Traditional full-reference methods, including MSE, PSNR, base on the statistic of errors. They have been the dominant quantitative metrics in image quality assessment for decades due to “their simplicity to calculate, clear physical meanings, and mathematical convenience in the context of optimization” [5]. But these methods focus on the difference on single pixel independently, ignoring the fact that neighbouring pixels in an image are not independent but highly correlated. Furthermore, spatial structure in an image contains abundant visual information. So it’s inevitable these metrics don’t correlate well with perceptual image quality.

To solve above problems, researchers make great efforts to take the characteristics of HVS into account. Representative work are referred to Just Noticeable Difference (JND) model [2], Noise Quality Measure (NQM) [3], Visual Signal-to-Noise Ratio (VSNR) [4] and so on. JND penalizes the errors in accordance with visibility, considering the spatial contrast sensitivity