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A Haar Wavelet-Based Perceptual Similarity Index for Image Quality Assessment

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Abstract

In most practical situations, the compression or transmission of images and videos creates distortions that will eventually be perceived by a human observer. Vice versa, image and video restoration techniques, such as inpainting or denoising, aim to enhance the quality of experience of human viewers. Correctly assessing the similarity between an image and an undistorted reference image as subjectively experienced by a human viewer can thus lead to significant improvements in any transmission, compression, or restoration system. This paper introduces the Haar wavelet-based perceptual similarity index (HaarPSI), a novel and computationally inexpensive similarity measure for full reference image quality assessment. The HaarPSI utilizes the coefficients obtained from a Haar wavelet decomposition to assess local similarities between two images, as well as the relative importance of image areas. The consistency of the HaarPSI with the human quality of experience was validated on four large benchmark databases containing thousands of differently distorted images. On these databases, the HaarPSI achieves higher correlations with human opinion scores than state-of-the-art full reference similarity measures like the structural similarity index (SSIM), the feature similarity index (FSIM), and the visual saliency-based index (VSI). Along with the simple computational structure and the short execution time, these experimental results suggest a high applicability of the HaarPSI in real world tasks.

1 Introduction

Digital images and videos are omnipresent in daily life and the importance of visual data is still growing: According to [1], by 2020, nearly a million minutes of video content is estimated to cross the internet every second.

Typically, video and image signals are intended to be ultimately viewed by humans. For transmission or storage, most signals are compressed in order to meet today's channel and/or storage demands. Compression as well as transmission errors can introduce distortions to video or image signals that are visible to human viewers. For evaluating or optimizing a transmission system or parts of it, e.g. by controlling the rate-distortion trade-off of a video encoder, it is crucial to measure the severity of distortions in a perceptually meaningful way. Quality 'in a perceptually meaningful way' can only be measured reliably in psychometric tests. In such tests, participants are asked to rate the subjectively perceived quality of images or videos that have previously been subject to some kind

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