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ORIGINAL ARTICLE

Full-reference image quality metric for blurry images and compressed images using hybrid dictionary learning

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Abstract

The image quality degradation due to the loss of high-frequency components of images is often seen in real scenarios, such as artifacts caused by image compression and image blur caused by camera shake or out of focus. Quantifying such degradation is very useful for many tasks that are related to image quality. In this paper, an effective approach is proposed for the image quality assessment on images with blur as well as images with compression artifacts. Based on the relation between the dictionaries of the degraded image and the reference image, we build up a hybrid dictionary learning model to characterize the space of patches of the reference image as well as that of the degraded image. The image quality is then measured by the difference between the two resulting dictionaries. Combined with a simple sparse-coding-based metric, the proposed method shows competitive performance on five benchmark datasets, which demonstrates its effectiveness.

Keywords Image quality assessment · Dictionary learning · Sparse coding · Image blur · Image compression

1 Introduction

Image degradation is a common phenomenon in the real world during the acquisition, transmission and processing of images. In many scenarios, the image degradation is caused by the loss of components of high frequency. For instance, the image blur caused by camera shake or defocus can be considered passing the image to a low-pass filter which kills and decays the Fourier coefficients in the high-frequency domain. Image compression algorithms often reduce the storage requirement or shorten the transmission time of an image by removing the image details which correspond to global or local high-frequency components. See Fig. 1 for some examples.

An effective metric that can accurately quantify the changes on images caused by such degradations is certainly welcomed in many applications. Take image processing for example. Such a metric can be used for guiding the processing algorithms or for automatically determining the parameters of an algorithm [30]. Similarly, for image compression, the metric can be used to indicate whether the compression is overdone. Not limited to processing natural images [41], the metric also has important applications in the processing of images from different fields, such as borehole images [39], hyper-spectral images [4, 5] and SAR images [3].

Developing such a metric for computers using some computational models is one goal of objective image quality assessment (IQA). In general, the IQA metrics can be classified into full-reference (FR), reduced-reference (RR) and no-reference (NR), according to the amount of information known from the reference image. A reference image indicates the image with ultra-high quality corresponding to the degraded one, i.e., the reference image has the same content as the degraded one but with very high quality. The reference image or most of its features are fully known in the FR metrics (e.g., [8, 29, 32, 37, 43, 46, 53]) while totally inaccessible in the NR metrics

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