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Deblocking filtering method using a perceptual map

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ABSTRACT

A new method of deblocking is proposed. It aims to reduce the blocking artifacts in the compressed image by analyzing their visibility. A perceptual map is obtained using some Human Visual System (HVS) characteristics. This perceptual map is used as input to a recursive filter to reduce the blocking effect. The obtained results have been compared with a very recent efficient method.

1. Introduction

To account for the non-stationarity of the image signal and the computational constraints, the image is often analyzed and processed on a block-by-block basis. There are other motivations behind the use of block-based image treatments such as real-time applications, parallel architectures and the limited channel bandwidth. However, block-based image-processing techniques may result in some annoying artifacts, such as blocking effects that may affect the image quality.

For low bit rate, block-based coding methods produce a noticeable blocking effect. This is mainly due to the fact that the blocks are transformed and quantized independently. This annoying artefact appears as horizontal and vertical artificial contours and its visibility depends highly on the spatial intensity distribution in the image. Moreover, the Human Visual System (HVS) increases the perceived contrast between two adjacent regions. This is mainly due to inhibitory neural connections in the retina known as Mach effect [1]. Therefore, the visibility of the blocking effect is more amplified due to the pronounced horizontal and vertical sensitivity of the HVS.

Blocking effect has been widely studied and many ad hoc methods for measuring and reducing it have been proposed in the literature. In [2], a blocking effect measure based on boundary blocks analysis is proposed. To compute the blocking effect visibility vertically, the first step consists of computing the difference between each adjacent row (the same process is applied to obtain the visibility of the blocking effect horizontally). Then, a summation of the information of the boundaries and the information contained in the adjacent blocks of the boundaries is performed. Finally, after applying a zero crossing detection, the global measure is obtained by weighting the values achieved at the previous steps.

In [3], a similar approach is proposed with some improvements. The masking effect is considered by taking into account only the maximum between the boundaries blocking effect measure and the zero crossing detection only if the computed visibility is superior to the Just Noticeable Distortion (JND). In [4], an iterative algorithm is applied for reducing the blocking effect artefact in the block transform-coded images by using a minimum mean square error filter.

In [5], the blocking artefacts are modelled as 2D signals in the DCT-coded images. By taking into account some HVS properties, a visual parameter in the vicinity of the

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inter-block boundary is used to remove the blocking effect. In [6], after forming a new block from two adjacent blocks 8 × 8, a zero masking is applied in the DCT domain to modify some particular DCT coefficients. In [7], Nosratinia proposed a method for blocking reduction where the processed image is obtained by averaging the shifted and JPEG-recompressed versions of the original compressed image. The bit rate recompression is obtained by reading the header file.

In [8], a new technique based on a frequency analysis is proposed for reducing the blocking effects. The artefacts are modelled as 2-D step function between the neighbouring blocks. The blocks are classified into smooth and textured regions. Depending on the region type, an appropriate filter is applied. In [9], an artificial neural network is used in the DCT domain to reduce the blocking effect by removing some DCT coefficients of each intermediary block. Several other interesting methods for reducing the blocking effect have been also developed in [10,11].

In this work, we propose a different approach for reducing the visibility of the blocking effects without a prior information on the compression method. Indeed, the previous methods are based either on the size of blocks or on the compression type, which can be a disadvantage. Here, we compute a visibility map obtained by analyzing the visibility of the frontiers of adjacent regions by using some HVS characteristics namely Contrast Sensitivity Function (CSF), Cortex transform and masking effect. This visibility map is then used to control the blocking effect filtering by adapting, for each pixel, the filtering strength according to the associated visibility value. This paper is organized as follows: Section 2 presents the method to obtain the visibility map and how to exploit it in the filtering process. Section 3 is dedicated to the results and the performance evaluation of our method. In this section we present some results obtained using different images. Finally, the last section contains some conclusions and perspectives.

2. The proposed method

The main idea developed here is to reduce the blocking effect using perceptual information about the visibility of blocking effect. The first step is to extract from the distorted image a visibility map of the blocking effect. This visibility map is obtained using some well known HVS models, to analyze the visibility region by region in the degraded image. Once the visibility map computed, the following step consists in adapting for each pixel the filter parameter according to this visibility map. Therefore, the importance of each pixel becomes different according to its visibility. This perceptually adaptive filtering scheme is summarized in Fig. 1.

2.1. The blocking visibility map

As explained above, the most annoying artifact induced by blocking effects is the increase of the boundary visibility between adjacent regions. To quantify this artefact, we propose using some HVS models to analyze the visibilities between all adjacent regions in a segmented image.

The compressed image is first segmented into different regions. This segmentation produces two classes of

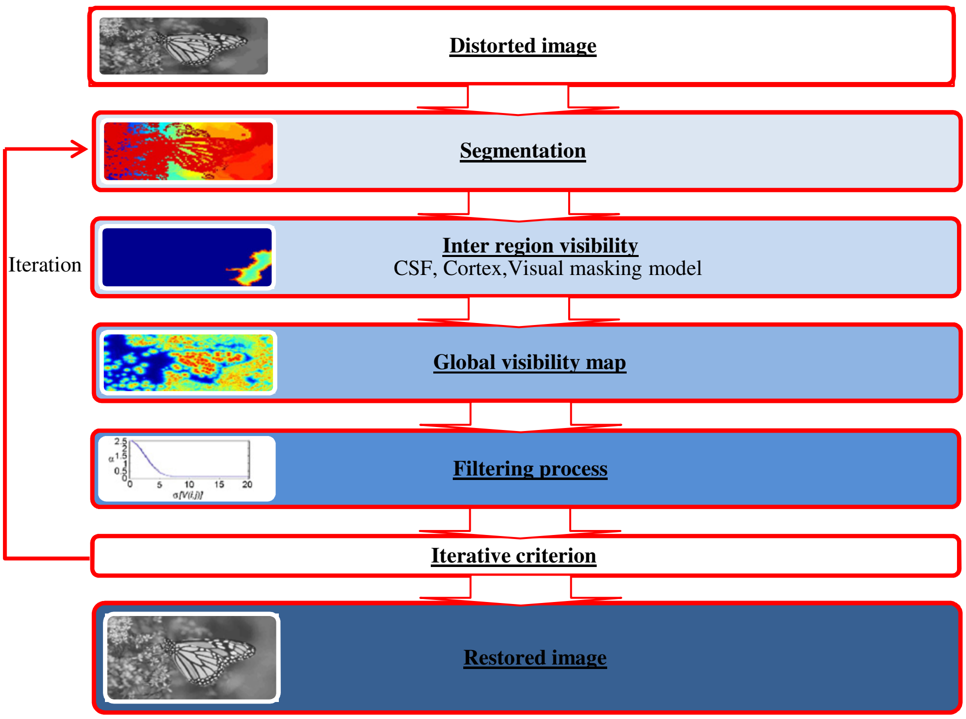

Fig. 1. Method flowchart.