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Studies on Properties of HVS for Ring Detection

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Abstract: *In this paper, I observed the properties of HVS for Ring Detection. The automatic detection of regions visually impaired by ringing artifacts in compressed images, it is a no-reference approach, taking into account the specific physical structure of ringing artifacts combined with properties of the human visual system (HVS). The approach is validated with the results of a psycho visual experiment, and its performance is compared to existing alternatives in literature for ringing region detection. Experimental results show that our method is appropriate in terms of both reliability and computational efficiency.*

I. Introduction

The occurrence of the compression induced artifacts depends on the data source, target bit rate, and underlying compression scheme and their visibility can range from imperceptible to very annoying, thus affecting perceived quality. Research on the design of blockiness metric has shown that an efficient no-reference approach intrinsically exists of two steps: 1) the detection of regions in an image where blockiness might occur, and 2) the determination of the blocking annoyance in these regions. We use a similar two-step approach for the design of a no-reference ringing metric. This paper only discusses the first step: the detection of regions in the image, in which visible ringing occurs. This, however, does not always reflect human visual perception of ringing, because of the absence of spatial masking as typically present in the HVS.

This issue is taken into account by incorporating properties of the HVS into the detection method. Obviously, the optimal performance in terms of reducing the number of required computations, while maintaining the reliable detection of perceived ringing, can be achieved by optimizing two aspects: 1) the detection accuracy of relevant edges; and 2) the reduction in complexity of the HVS model itself. Hence, what is needed is an edge detector that only extracts edges most closely related to the occurrence of ringing, and a HVS model that is simpler (and thus more applicable for real time implementation) than the approaches existing in literature.

II. Perceptual Edge Extraction

Edge Preserving Smoothing and Canny Edge Detection: When interpreting the surrounding world, humans tend to respond to differences between homogeneous regions rather than to structure within these homogeneous regions. Hence, finding perceptually strong edges mainly implies that texture existing in homogenous regions can be neglected as if viewed from a long distance. This can be implemented by smoothing the image progressively until textual details are significantly reduced, and then applying an edge detector. Subsequently, a canny edge detector is applied to the bilaterally filtered image to obtain the perceptually more meaningful edges. Since the input image is already filtered, the subsequent canny algorithm is implemented without its inherent smoothing step, while keeping the other processing steps unchanged.

The Canny edge detector uses two thresholds to detect strong and weak edges, and includes the weak edges in the output only if they are connected to strong edges. Their value is automatically set, depending on the image content.

Perceptual Edge Map Formation: Since the HVS does not perceive luminance variations at pixel level, the detected edge pixels are necessarily combined into perceptually salient elements, facilitating further analysis and processing. These perceptual elements, which we refer to as line segments (LS), are constructed over the canny edge map and will be used as the basis for ringing region detection.

III. Experiment

RINGING ARTIFACTS

The main attraction of our algorithm is that it can highly preserve the image information while smoothing out the ringing artifacts. This is because only the regions related to the ringing artifacts are modified while other components remain the same. For the strong texture and edge regions we perform the above quad-tree partition and edge detector so as to avoid loss of edge information. Moreover, another previously developed method significantly reduced the visual quality of ringing artifacts. However, PSNR improves insignificantly and in fact can even decline after the ringing artifacts are removed using their proposed strategy. For removing ringing artifacts from images, the proposed voting strategy can select the best morphological filter that can significantly improve the quality of the reconstructed images. Also, the fidelity preservation of the proposed filter against ringing artifact method makes it a promising approach for stretching the wavelet compression of images to lower bit-rate.

FILTERING AND EDGE DETECTION

An important characteristic of the image processing system is the significant level of testing and experimentation that normally is required before arriving at an acceptable solution. There is no clear cut boundaries for the implementation of the application based on the digital image processing, it may be varies in continuum from image processing at one end to the computer vision at the other. However, one useful paradigm is to consider three types of computerized processes in this continuum: low level, mid level and high level processes. A low level process involves primitive operations such as image processing to reduce noise, contrast enhancement and image sharpening. Mid level processes on image involves tasks such as segmentation, recognition. Finally, higher level processing involves “making sense” of an ensemble of recognized objects, as in image analysis and performing the cognitive functions normally associated with human vision. Here this experimentation process involves low level and mid level process of image processing, these processes can be further implemented in the number of other object decisions from basic analysis to data processing, image processing, image transmission, image construction, image reconstruction and for the security concern. This algorithm is specially developed in view to operate with data acquisition system, image capturing and processing, enhancement of the old but important images, enhancement of faint images by removing noises and number of others scientific analysis. To filter the noisy image, we remove the noise, but also cause edge to be blurred. A medium filter can be used to remove impulsive noise without blurring edges of the images. Here low pass filter is implemented for removing of noises from the selected image. To form a low pass filter we need to implement a filter mask, the projected mask used for filtering is given below.

Mask=

$$\begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

Enhancement/Histogram

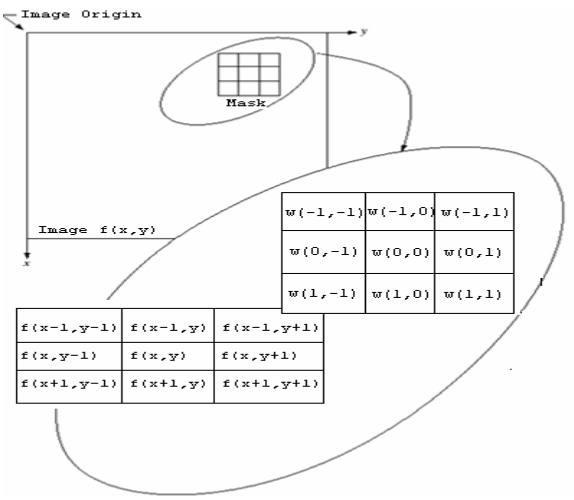
We can also enhance the contrast of an image using “Histogram Equalization”. To enhance the contrast of image requires the command b=histeq(I). it may be possible to plot the histogram of the images by executing the command b=imhist(I), histogram may be plotted for the further analysis of the images step by step analysis by analysis.

Edge Detection

Finally we implement image edge detection so that we can identify the boundary of object in an image. For this, we apply a spatial mask

$$\text{Mask} = \begin{bmatrix} -1 & -2 & -1 \\ -2 & 12 & -2 \\ -1 & -2 & -1 \end{bmatrix}$$

The mechanics of spatial filtering are illustrated in the figure below. The process consists simply of moving the center of the filter mask ω from point to point in an image, f. at each point (x, y), the response of the filter at that point is the sum of the products of the filter coefficients and the corresponding neighbourhood pixels in the area spanned by the filter mask.



Edge Detection Methods

Three most frequently used edge detection methods are used for comparison. These are (1) Roberts Edge Detection, (2) Sobel Edge Detection and (3) Prewitt edge detection.

The details of methods as follows, 1) The Roberts Detection: The Roberts Cross operator performs a simple, quick to compute, 2-D spatial gradient measurement on an image. It thus highlights regions of high spatial frequency which often correspond to edges. In its most common usage, the input to the operator is a gray scale image, as is the output. Pixel values at each point in the output represent the estimated absolute magnitude of the spatial gradient of the input image at that point.

+1	0
0	-1

Gx

0	+1
-1	0

Gy

The Prewitt Detection: The prewitt edge detector is an appropriate way to estimate the magnitude and orientation of an edge. Although differential gradient edge detection needs a rather time consuming calculation to estimate the orientation from the magnitudes in the x and y-directions, the compass edge detection obtains the orientation directly from the kernel with the maximum response. The prewitt operator is limited to 8 possible orientations, however experience shows that most direct orientation estimates are not much more accurate. This gradient based edge detector is estimated in the 3x3 neighbourhood for eight directions. All the eight convolution masks are calculated. One convolution mask is then selected, namely that with the largest module

-1	+1	+1
-1	-2	+1
-1	+1	+1

0°

+1	+1	+1
-1	-2	+1
-1	-1	+1

45°

3) The Sobel Detection: The Sobel operator performs a 2-D spatial gradient measurement on an image and so emphasizes regions of high spatial frequency that correspond to edges. Typically it is used to find the approximate absolute gradient magnitude at each point in an input gray scale image. In theory at least, the operator consists of a pair of 3x3 convolution kernels as shown. One kernel is simply the other rotated by 90o.This is very similar to the Roberts Cross operator. The convolution masks of the Sobel detector are given below.

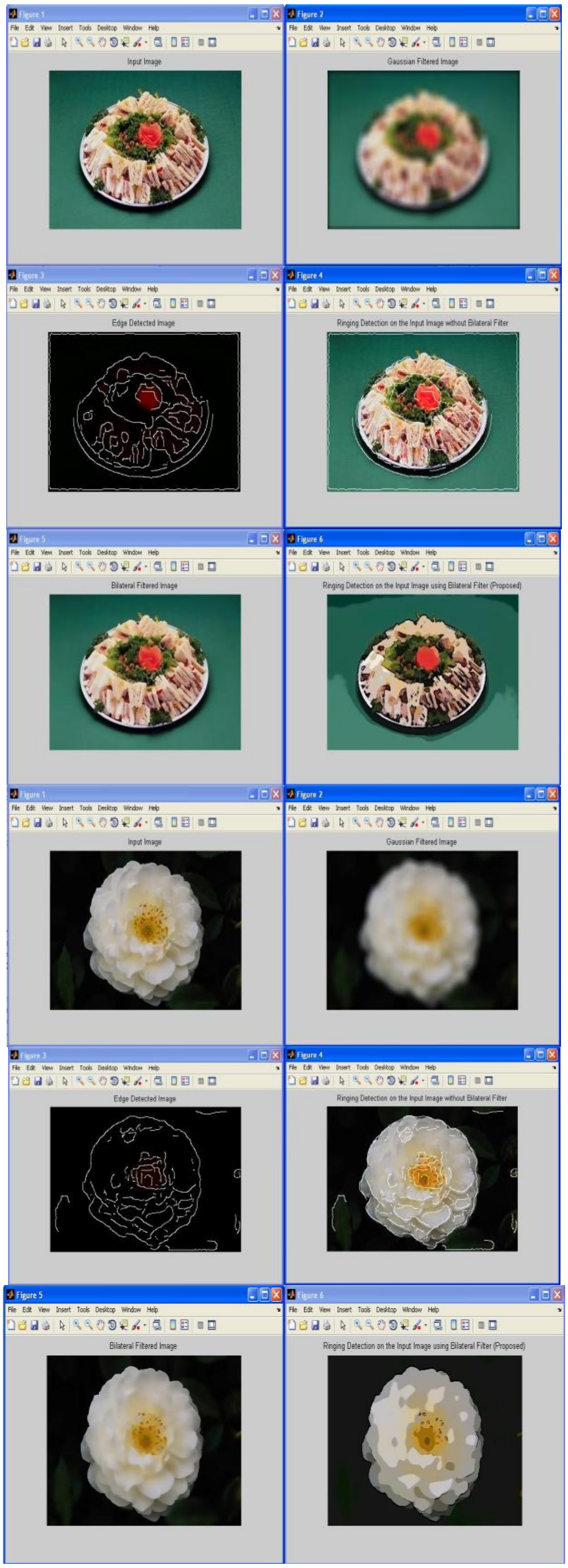
BILATERAL FILTER

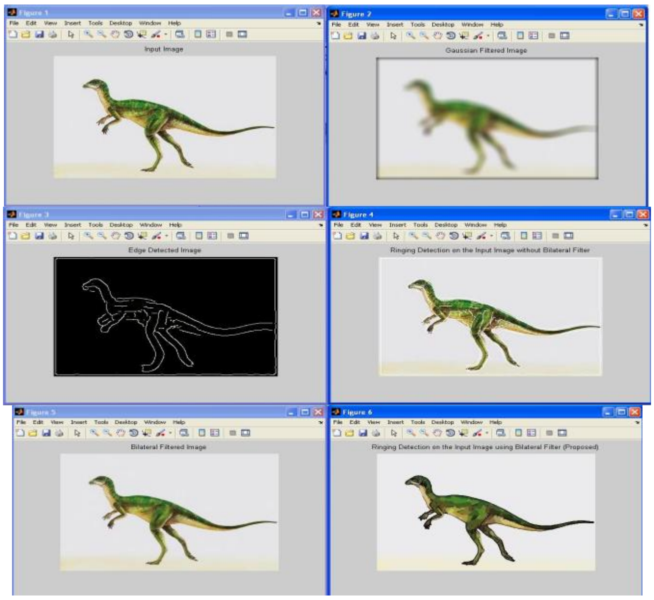
The bilateral filter is the framework for our proposed algorithm. Here, we would like to point out that the bilateral filter is essentially a smoothing filter; it does not restore the sharpness of a degraded image. Aleksic *et al.* modified the bilateral filter to perform both noise removal and sharpening by adding a high-pass filter to the conventional bilateral filter. This filter essentially performs USM sharpening for pixels that are above a preselected high pass threshold. Therefore, it produces halo artifacts as does an USM filter.

In contrast to the extensive effort to improve de-noising algorithms, much less has been done for sharpening algorithms. The USM remains the prevalent sharpening tool despite the drawbacks that it has. First, the USM sharpens an image by adding overshoot and undershoot to the edges which produce halo artifacts.

Second, when applied to a noisy image, the USM will amplify the noise in smooth regions which significantly impairs the image quality.

IV. Results





The ABF retains the general form of a bilateral filter, but contains two important modifications. First, an offset ζ is introduced to the range filter in the ABF. Second, both ζ and the width of the range filter σ_r in the ABF are locally adaptive. If $\zeta = 0$ and σ_r is fixed, the ABF will degenerate into a conventional bilateral filter. For the domain filter, a fixed low-pass Gaussian filter with $\sigma_d = 1.0$ is adopted in the ABF. The combination of a locally adaptive ζ and σ_r transforms the bilateral filter into a much more powerful filter that is capable of both smoothing and sharpening. Moreover, it sharpens an image by increasing the slope of the edges.

V. Conclusion

The human vision model is implemented, based on the local image characteristics around detected edges, to expose only the perceptually prominent ringing regions in an image. The proposed detection method is validated with respect to ringing regions resulting from a psycho visual experiment, and shows to be highly consistent with subjective data. The performance of our approach is compared to existing alternatives in literature, and has been proved to be promising in terms of both reliability and computational efficiency. The proposed ringing region detection method is meanwhile extended with a ringing annoyance metric that can quantify perceived ringing annoyance of compressed images

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