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Artifact Reduction For Visually Challenged

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Abstract

*Compression of image or video now happens to be an essential feature to fit a large amount of binary data into an available narrow bandwidth digital communication channel. Inveterate compression algorithms formulated by means of Discrete Cosine Transform and Wavelet Transform suffers a lot with the presence of undesirable frequency components which in turn pull down the visual quality of the image or video. Those frequency components create prominent visible changes, identified as artifacts. The visual quality of such images needs improvement by the elimination of these artifacts not only for consumer electronics but also for the analysis and decision making algorithms in real time systems. Artifacts can be modeled with the characteristics of neighboring pixels. The most noticeable are blocking, ringing and mosquito artifacts. The proposed adaptive filter applicable for JPEG compression algorithms detects the blocking artifacts with the new metric voted as Total Blocking Error. Subsequently the adaptive control superimposed for the corrective parameter of the localized filter and for the correlation factor to create the new adaptive quantization matrix for correcting the rounded off Discrete Cosine Transform coefficients at the transmitter side reduces the blocking artifacts. The boundary pixels of each n*n block yields the measure of blocking annoyances with this new metric. Experimentation with SAR, Medical and Conventional images proved that the value of the metric gets increased with the increase in the compression ratio and gets reduces with the proposed adaptive algorithm. Results bestow the assessment slot in for the adaptiveness suggested is strong worthy in improving the visual quality both quantitatively and qualititatively.*

Keywords: Artifact reduction; adaptive control; weighted q matrix; Total Blocking Error etc.

1. Introduction

Image and video compression should facilitate the storage and transmission, while maintaining the image with acceptable visual quality. JPEG, a block based compression scheme at high compression ratio annihilate the visual quality of the image at the borders of each n * n block where n may be a multiple of eight. The coarse quantization of DCT coefficients possessing low energy compaction leads to the appearance of nuisance in the block borders. Subsequently the quantization with rounding off process leads to another increase in loss of information resulting in distortions as ringing and mosquito effects.

Literature survey reveals the existence of methodologies for detection and reduction of artifact in the pixel domain or in the transform domain. Researchers proposed various algorithms with filtering in wavelet-based domain [8], in DCT-domain methods [10], or with Markov Random Field and models [9,14,15]. Nevertheless Kong H, S,[6] in spatial domain analyzed the blur during artifact removal , and suggested for edge enhancement. JPEG 2000 formulated through wavelet transform suffers with ringing annoyances [5]. Still researcher has to go for miles for the progressive and effective retrieval of images after compression. Joint Photographic Experts Group (JPEG) standard originated with DCT commonly degrades the visual value of the images at low bit-rates mainly because of the elimination of the high frequency components. JPEG may be operated as sequential, progressive, and hierarchical for loss encoding, and another as lossless encoding [2]. Iterative algorithm with a spatial filter of size m*n together the weighted quantization matrix had been proposed in 1992 [11].

A localized DCT-based filter with condition on the similarity between surrounding blocks is implemented by D˜ung T. V˜o and Truong Q. Nguyen for enhancing chroma component. [1]. The DC coefficients are calibrated using gradient continuity constraints. Then, an improved Huber-Markov-random-field-based smoothing is applied. The constrained optimization is implemented by the iterative conditional mode for the removal of JPEG artifacts. [4]. Hantao Liu et.al . Coded the algorithm to detect the ringing regions and an edge preservation to enable the visual quality of the image [3]. Truong Quang Vinh and Young-Chul Kim categorize each pixel into one of classes namely smooth region and edge region, which are described by the edge-protection maps. Based on these maps, a two-step adaptive filter which includes offset filtering and edge-preserving filtering is used to remove block artifacts. [13].

JPEG 2000 standard with Golomb Rice Technique for various wavelet transforms like D2, D4, D8, D10, D12, Haar and DMEY for compression and decompression [12]of image signals are analyzed for image enhancement. Predictors, constructed based on a broken line regression model with the narrow quantization constraint set, depends on the frequency components by using a simple classifier, This adaptation enables an appropriate blurring depending on the smooth or detail region[7], and shows improved performance in terms of the average distortion and the perceptual view.

2. Background

The image to be experimented by JPEG compression is first segmented into non overlapping blocks of 8×8 pixel. Spatial information of each and every block is converted into frequency information through Discrete Cosine transform (DCT) and the resulting set of 64 frequency coefficients are quantized by dividing each coefficient by its corresponding entry in a quantization table, then rounding the result to the nearest integer.

After the quantization, each block DCT coefficients are linearly ordered using a zigzag traversal of the array, run length encoded, subsequently followed by entropy coding. Observation reveals that many different transformed coefficient values become quantized to the same integer value. Also learnt as equivalent DCT values lay in an interval whose length is the size of the corresponding quantization value. Thus the higher this quantization value, the wider the corresponding interval which in turn make more information loss in the process.

Blocking the quite common compression artifact exists both in JPEG and MPEG., and viewed as undesirable artificial horizontal and vertical straight lines created between the blocks,. Its existence mainly characterizes the inability of the DCT blocks to include correlations between blocks. While there is truth to this, the phenomenon can be explained by considering the compression of a single block or two or more adjacent blocks. In few moment applications single block is examined, changing the texture as well as compression noise in general. These artifacts can be modeled as 2-D step functions, a perceptual measure of the block structure.

3. Blocking Level Estimation- New Quality Measure

The definition of “image quality” can be as high-level as measuring realism of an image. Let Y (m, n) denotes the samples of original image, and X (m, n) denote the samples of compressed image. M and N are number of pixels in row and column directions respectively. Blocking level estimation in vertical direction exploits analysis particularly only through last columns and the first columns of each block and the one in horizontal direction with the first and last rows of each and every block.

Diversity between the last column of the specific block $X_{i,j}$, and the first column of $X_{i,j-1}$ yield a measure of the blocking effects in the column direction of the decompressed image X.

Difference in between first and second block formulated as

$$V_c^1(1,2) = [X_{1,1}(:,8) - X_{1,2}(:,1)]. \quad (1)$$

Column and row edge difference vectors formulated since

$$V_c^1=\{[X_{1,1}(:,8)-X_{1,2}(:,1)],[X_{1,2}(:,8)- X_{1,3}(:,1)],\ldots[X_{1,n-1}(:,8) - X_{1,n}(:,1)]\}, \quad (2)$$

The norm of cumulative sum of all such difference referred as Column edge difference is a proportionate measure of the existence of the vertical blocking effect. Hence a proportionality factor is introduced in the computation of the new metric. Equally a proportionate amount of the norm of the row difference vector gives up a measure of the horizontal blocking level. Column and row information put together creates the new quality measure as the Total Blocking error (TBE) as

$$\alpha_1 \| V_c \| + \alpha_2 \| V_r \|,$$

where

$$V_c = \{ V_c^1 + V_c^2 + V_c^3 + \ldots\ldots\ldots V_c^n\}. \quad (4)$$

and

$$V_r = \{ V_r^1 + V_r^2 + V_r^3 + \ldots\ldots\ldots V_r^n\}.. \quad (5)$$

α_1 and α_2 are the proportionality constants. Hitherto, algorithms are developed with quality metrics like SNR and MSE , the ratio between the maximum possible power of a signal and the power of corrupted noise that affects the fidelity of its representation, is of more valuable and worthy by having a quality metric, which in turn take into consideration of the amount of compression artifacts. New parameter TBE described with its mathematic background found to be well suited for artifact detection and reduction with adaptive parameters.

4. Adaptive Enhancement with TBE

The Gradient, also called the Hamilton operator is a vector operator for any n-dimensional scalar function representing a particular direction in the n-D space along which the function increases most rapidly, and also the rate of the increment. For an image the edges can be distinguished easily with gradients since the increment in the x or y direction is moderate in the meticulous spatial domain. Boundary plots with the gradient operator in the X and Y direction, crafted capitulate the edge protection information. The new image blocking artifact measure metric TBE adjust the adaptive threshold.

Contrast measure in different bands has a multistage structure, and consists of approximately equal radial frequencies. Elimination of high frequencies is compensated with the modified de-quantization table, obtained by weighting the quantization table transmitted amid the compressed image. Schematic diagram of the proposed algorithm at the receiver side is presented in Figure (1).

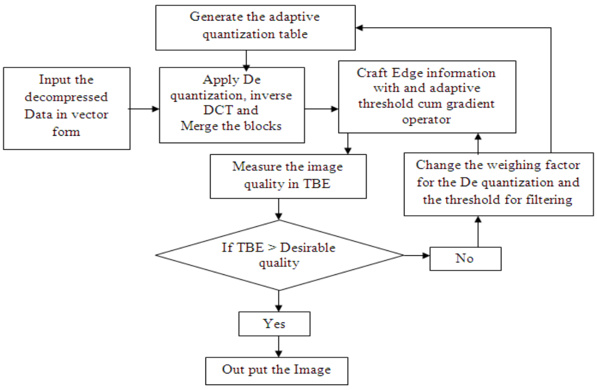

Fig. 1. Schematic Diagram of the Proposed Algorithm.

Fig. 2(a). Input Image

Fig 2**(b).** Output Image

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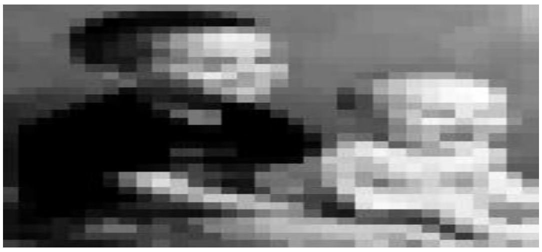

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