Compressed Domain Image Enhancement

Dr. L.M.Waghmare**
Mr. N.N.Ghuge* , Mr.Bhushan D.Patil*
**Professor
*PG-students
Department of instrumentation
SGGS Institute of Engineering and Technology Nanded

Abstract :- In this paper an image enhancement algorithm for images compressed using the JPEG standard is presented. The algorithm is based on a contrast measure defined within the discrete cosine transform (DCT) domain. The advantages of this algorithm are 1) the algorithm does not affect the compressibility of the original image because it enhances the images in the decompression stage and 2) the approach is characterized by low computational complexity. The proposed algorithm is applicable to any DCT-based image compression standard, such as JPEG.

INTRODUCTION

The goal of image enhancement is to improve the image quality so that the processed image is better than the original image for a specific application or set of objectives . Many image enhancement algorithms have been proposed. One of the most widely used algorithms is global histogram equalization , which adjusts the intensity histogram to approximate a uniform distribution. The main disadvantage of global histogram equalization is that the global image properties may not be appropriately applied in a local context In fact, global histogram modification treats all regions of the image equally and, thus, often yields poor local performance in terms of detail preservation. Therefore, several local image enhancement algorithms have been introduced to improve enhancement . Each of these algorithms can be classified into two types of image enhancement methods indirect image enhancement methods and direct image enhancement methods. The indirect image contrast algorithm enhancement they enhance the image without measuring the contrast. The direct methods establish a criterion of contrast measure and enhance the images by improving the contrast measurement directly. A key step in the direct image enhancement approach is the establishment of a suitable image contrast measure. For simple patterns, two

Both measures are therefore unsuitable for measuring the contrast in complex images. Because human contrast sensitivity is a function of spatial frequency, an image's spatial frequency content should be considered in the definition of contrast. The contrast measure explicitly satisfies this requirement. That definition of local bandlimited contrastassigns a contrast value to every point in the image for each spatial frequency band. For each frequency band, contrast is defined as the ratio of the bandpass-filtered image at that frequency to the image lowpass-filtered to an octave below the same frequency. This multiscale contrast structure has found wide applications especially in image processing problems related to the human vision systemThis letter provides a newcontrast measure that can be used to measure the contrast of images in the DCT domain. The contrast measure is defined as the ratio of high-frequency content and low-frequency content in the bands of the DCT matrix. Our contrast measure also has a multiscale structure that corresponds with the human vision system. Based on this contrast measure, an image enhancement algorithm for direct application to the compressed domain is developed. The basic idea of our algorithm is to filter the image by manipulating the DCT coefficients according to the contrast measure defined. The proposed algorithm has the following advantages: 1) the algorithm does not affect the compressibility of the original image; 2) given a majority of zero-valued DCT coefficients (after quantization), the algorithm expense is relatively low; and 3) the proposed image enhancement algorithm is applicable to any DCT-based image compression standard, such as JPEG.

A. IMAGE CONTRAST ENHANCEMENT IN JPEG DOMAIN

A JPEG system is composed of an encoder and a decoder. In the encoder, the image is first divided into no overlapping 8x 8 blocks. Then, the two-dimensional DCT is computed for each 8x 8 block. Once the DCT coefficients are obtained, they are quantized using a specified quantization table. Quantization of the DCT coefficients is a lossy process, and in this step, many small coefficients (usually high frequency) are quantized to zeros. The zig-zag scan of the DCT matrix followed by entropy coding makes use of this property to lower the bit rate required to encode the coefficients. In the decoder, the compressed image is decoded and then dequantized by pointwise multiplication with the quantization table and inverse-DCT-transformed.

Let $\{x_{i,j}\}$ be an 8x 8 block in the original image, and the DCT transform of it is $\{d_{k,l}\}$. The 2-DCT transformation is expressed As

$$d_{k,l} = \frac{c(k)c(l)}{4}\sum_{i=0}^{7}\sum_{j=0}^{7} x_{i,j} \cos\left(\frac{(2i+1)k\pi}{16}\right)\cos\left(\frac{(2j+1)l\pi}{16}\right) \quad \text{.................1}$$

where $k,l=0,1.........7$ and

$$c(k) = \begin{cases} 1/\sqrt{2} \text{ if } k=0 \\ 2 \text{ otherwise} \end{cases} \quad \text{.................2}$$

The DCT inverse transformation can be expressed as

$$x_{i,j} = \frac{c(k)c(l)}{4}\sum_{k=0}^{7}\sum_{l=0}^{7} d_{k,l} \cos\left(\frac{(2i+1)k\pi}{16}\right)\cos\left(\frac{(2j+1)l\pi}{16}\right) \quad \text{.................3}$$

where $i,j=0,1.........7$

We see that each represents the contribution corresponding to the *kl* th waveform and the coefficients in the output DCT block are arranged left to right, and top to bottom in order of increasing spatial frequencies in the horizontal and vertical spatial dimensions, respectively. The spatial frequency properties of the DCT coefficients provide a natural way to define a contrast measure in the DCT domain. It is known that the human visual detection depends on the ratio between high-frequency and low-frequency content. Thus, the contrast measure can be defined as the ratio of highand low-frequency content in the bands of the DCT matrix. We first classify the oefficients into 15 different frequency bands. The th band is composed of the coefficients with $n=k+l$. A band defined by $n=k+l$ gives a diamond-shaped approximation to a circle and, thus, selects approximately equal radial frequencies. Therefore, the image block generated retaining only one band can be thought of as the band pass version of the original image block. As the band number increases, the frequency content of the band pass image block corresponds with higher frequencies and, thus, creates a primitive multiscale structure.
Our local contrast measure is defined on each band with band number more than 0. The contrast at the nth band ($n>=1$) is defined as ,

$$c_n = \frac{E_n}{\sum_{t=0}^{n-1} E_t} \quad \text{.........................4}$$

where

$$E_t = \frac{\sum_{k+l=t} |d_{k,l}|}{N} \quad \text{.........................5}$$

E1 block

$$D = \begin{bmatrix} d_{00} & d_{01} & d_{02} & d_{03} & d_{04} & d_{05} & d_{06} & d_{07} \\ d_{10} & d_{11} & d_{12} & d_{13} & d_{14} & d_{15} & d_{16} & d_{17} \\ d_{20} & d_{21} & d_{22} & d_{23} & d_{24} & d_{25} & d_{26} & d_{27} \\ d_{30} & d_{31} & d_{32} & d_{33} & d_{34} & d_{35} & d_{36} & d_{37} \\ d_{40} & d_{41} & d_{42} & d_{43} & d_{44} & d_{45} & d_{46} & d_{47} \\ d_{50} & d_{51} & d_{52} & d_{53} & d_{54} & d_{55} & d_{56} & d_{57} \\ d_{60} & d_{61} & d_{62} & d_{63} & d_{64} & d_{65} & d_{66} & d_{67} \\ d_{70} & d_{71} & d_{72} & d_{73} & d_{74} & d_{75} & d_{76} & d_{77} \end{bmatrix} \quad \text{.............6}$$

is the average amplitude over a spectral band. Fig. 1 llustrates the first and fourth bands and

$$N = \begin{cases} t+1,..t<8 \\ 14-t+1,..t>=8 \end{cases} \quad \text{..............................7}$$

Here, for the sake of simplicity, we assume that visual acuity is isotropic. The definition provides a local contrast measure for each band ($n>=1$) in the DCT domain. The contrast measure in the *n* th band is the ratio of the frequency content of the band pass image block obtained by the th band and the frequency content of the lowpass image block that can be generated by retaining all of the bands in which the band numbers are less than . Thus, the definition of our contrast measure has a multiscale structure similar to and in a primitive sense.

B.Image Enhancement in JPEG Domain

There are three ways to enhance the JPEG compressed images. The first is to enhance the image before compression. However, there are two disadvantages of this approach. One is that enhancement will reduce the compressibility of the original image; the other is that it will affect all the receivers. The second way is to enhance the image after decompression. Because the postcompression approach does not affect the compressibility of the original image, it is often adopted. In this letter, we consider direct enhancement in the compressed domain. The basic idea of this method is to enhance the image by manipulating the DCT coefficients.
Compared with the image enhancement in the spatial domain, this method can reduce storage requirements and computational expense as the majority of the coefficients in the DCT domain are zeros after quantization.The proposed image enhancement algorithm is based on the contrast

measure proposed. Let the contrast of he original block be C=$(c_1 \ldots\ldots c_{14})$, where c_n is the contrast at a specific frequency bandcorresponding to and let the contrast of the enhanced block be denoted

By $'\overline{C} = (\overline{c_1} \ldots\ldots \overline{c_{14}})$ If, for example, one wishes to enhance the contrast uniformly for all frequencies, then

$$\overline{c}_n = \lambda c_n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 8$$

leading to

$$\frac{\overline{E}_n}{\sum_{t=0}^{n-1} \overline{E}_t} = \overline{c}_n = \lambda c_n = \frac{\lambda E_n}{\sum_{t=0}^{n-1} E_t} \ldots\ldots\ldots\ldots\ldots\ldots 9$$

it can be stated as

$$\overline{E}_n = \lambda H_n E_n \ldots\ldots\ldots\ldots\ldots 10 \qquad \ldots\ldots\ldots n >= 1$$

where

$$H_n = \frac{\sum_{t=0}^{n-1} \overline{E}_t}{\sum_{t=0}^{n-1} E_t} \ldots\ldots\ldots\ldots 11 \qquad \ldots\ldots n >= 1$$

From we can obtain the enhanced DCT coff $\overline{d}_{k,l}$

$$\overline{d}_{k,l} = \lambda H_{k+l} d_{k,l} \ldots\ldots\ldots\ldots\ldots 11 \qquad k + l >= 1$$

$H_n(n = 1, 2 \ldots\ldots\ldots, 14)$ can be obtain by recursion.

Result :

The algorithm is implememted on the ATLAB6p5 environment .fig given below are the non enhance image and result after enhancement

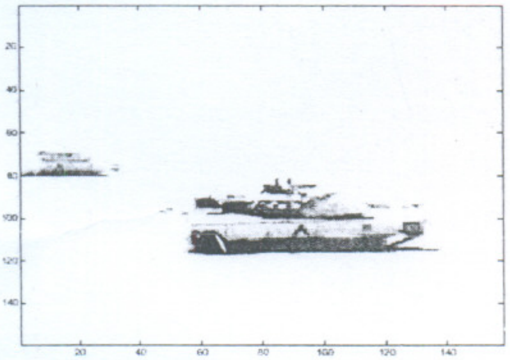

Fig.1. Compressed image without enhancement

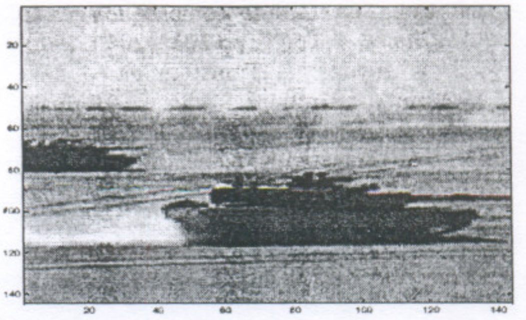

fig.2. Compressed domain enhance image using proposed algorithm

CONCLUSION

In this paper, we have described an image contrast enhancement algorithm that is based on a contrast measure defined in the DCT domain. The comparative analysis between the proposed algorithm and two existing algorithms has shown the merit of the contrast measure-based approach.

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