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Image Compression with Preservation of Edges using Wavelets and Contourlets

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***Abstract:* - In this paper image compression offers a good representation of images while using the least quantity of bits. Several lossy image coders are designed without considering the image nature. The image important information (e.g., edges) can be discarded at the coding quantization stage, that information is needed for image understanding and recognition. The possibility of saving storage space and preserving image important information in a joint way becomes imperative in areas such as medicine, mobile devices, and pattern recognition systems, this article addresses the design of an edge-preserving lossy image coder by means of wavelets and contourlets. The results expected will have superior performance from the proposed coder against the traditional edge-preserving coders. The proposed coder ensures that the edges of an image are always preserved even at very low bit rates and obtained decompressed images can be successfully used for future pattern recognition tasks.**

Key Words: - Transform domain, preserving edge, multiresolution, multidirection, wavelets, and contourlets.

I.INTRODUCTION:

In digital images there are important informations are represented by shapes, contours, edges, etc., that give important information about the image. The lossy feature preserving image compression becomes imperative in different areas such as medical and textile industries. A digital image uses a big storage space and big bandwidth for transmission, in mobile devices this is a problem because the space and bandwidth can be spent or saturated rapidly. A possible solution to solve this problem is to find a representation that use less information to represent digital images, by this necessity image compression emerges in the field of video and digital images.

Image compression addresses the problem of reducing the data amount required to represent a digital image and is made by a removal process of the image redundant information. An ideal scheme is to made lossy image compression in order to save a lot of storage space but sacrificing the quality of an image. Many compression techniques have been developed based on statistical coding, predictive coding, vector quantization etc. A goal followed by image compression coders is to reduce the artifacts in order to preserve some image features and obtain good quality reconstructed image. In this paper is proposed a technique is transform coding. Image coding plays an important role in technology due to the fact that a great part of the information used and generated by human beings (video and images) is digital. The main goal of image coding is to reduce the quantity of bits needed to represent digital images, whose final perception can be adapted to the requirements of final users from the distortion point of view. The information of edges and textures can be used for future tasks such as image classification, compression, and recognition. There are several applications that exploit the domain transform as a base for image compression. For example, the wavelet transform can detect the information of the singularities (horizontal, vertical, or diagonal) of an image represented by the wavelet detailed coefficients. So we go for the new scheme structure is represented by the contourlet transform. This transform can find singularities not only in three directions, but in 32 different directions. For both transforms, the important information determined by image features is sometimes lost in the coder quantization stage. In order to solve the problem of important lost information, we propose a combination of lossy image coding and feature preserving.

The major drawback for wavelets in two dimensions is their limited ability in capturing directional information. To overcome this deficiency, researchers have recently considered multiscale and directional representations that can capture the intrinsic geometrical structures such as smooth contours in natural images.

The module of proposed compression systems are: a) Selection of images, b) Edge Detection, c) Transformation of domain d) Pixel Mapping, e) Compression of images and h) Decompression of images. The model appears in Fig. (1)

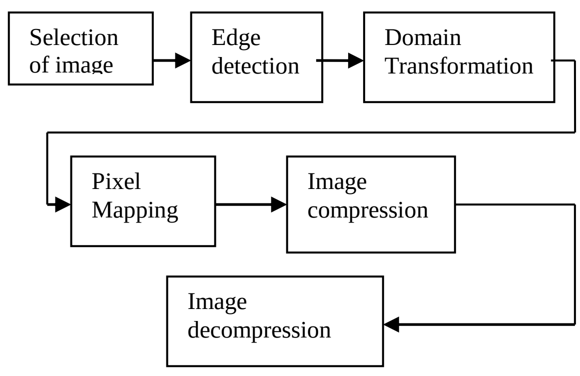

Fig.1.Block Diagram of compression Systems

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II. THE CONTOURLET TRANSFORM:

The contourlet transform is a true 2D transform defined in the discrete form to capture the edge information in all directions. The contourlet transform first decomposes the image by Laplacian pyramid to detect the edges in all scales, and then it applies directional filter bank to link point discontinuities into linear structure. Contourlets not only possess the main features of wavelets (namely, multiscale and time-frequency localization), but also offer a high degree of directionality and anisotropy.

The main difference between contourlets and other multiscale directional systems is that the contourlet transform allows for different and flexible number of directions at each scale.

Typically, a separable 2-D wavelet transform provides:

Multiresolution:

Multiresolution is the ability to visualize the transform with varying resolution from coarse to fine

Localization:

Localization is the ability of the basis elements to be localized in both the spacial and frequency domains

Critical sampling:

Critical sampling is the ability for the basis elements to have little redundancy.However, it is not capable of providing:

Directionality:

Directionality is having basis elements defined in a variety of directions.

Anisotropy:

Anisotropy is having basis elements defined in various aspects ratios and shapes.

II a. CONTOURLET CONSTRUCTION:

Fig (2) flow graph of the contourlet transform. It consists of two major stages: .Subband decomposition. The directional transform. At the first stage, used as a Laplacian pyramid (LP), and for the second one used as a directional filter banks (DFB).

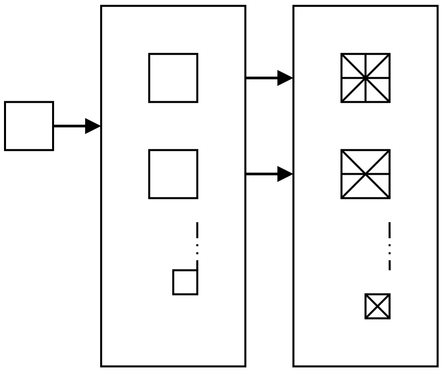

Fig.2. A Flow graph of the contourlet transform. The image is first decomposed into subbands by the Laplacian pyramid and then each detail image is analyzed by the directional filter banks.

Selection of image:

In the first stage, selection of image. To select the image depends on the frequency namely Low frequency, Medium frequency & High frequency. barbara show themselves in fig (3).

Fig.3.Selection of image Barbara.

Edge Detection:

The characteristics of the images must be selected to preserve, in this case the edges, algorithms of edge detection: Canny, Sobel, Roberts and Prewitt. Fig(4)

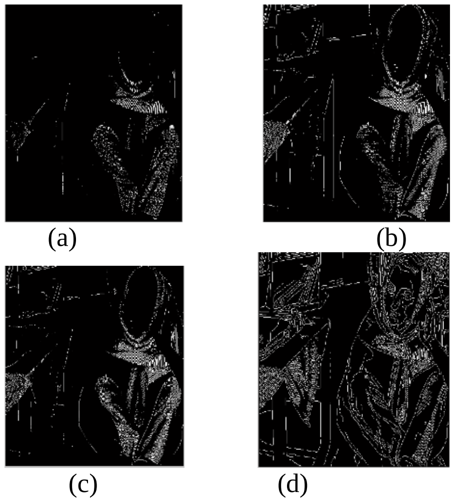

Fig.4.Maps of edges, a) Barbara with Robert, b) Barbara with prewitt, c) Barbara with Sobel, and d), Barbara with Canny.

Domain Transformation:

In this stage domain transformation is applied on the original image. A domain transformation offers an alternative representation of an image that can reveal features difficult to detect in the original domain. The transformation is made seeking two goals: a) concentrate a great quantity of the signal energy in a few numbers of coefficients and b) obtain as a result the decorrelated coefficients. Here use two transforms: the discrete wavelet transform (DWT) and the discrete redundant contourlet transform (DRCT).

The DWT allows a hierarchical decomposition of an input signal into referential signal series of low resolution and its associated detail signals. The DWT offers a good representation of the high frequency components (edges).

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Fig.5.DRCT with five decomposition level a).Barbara b).Goldhill

The DRCT allows a multiscale and directional decomposition of an image using a combination of a modified Laplacian pyramid and a directional filter bank (DFB). The DRCT allows for a different number of directions at each scale.The DFB is designed to capture high-frequency components, the Laplacian pyramid offers subband decomposition to avoid leaking of low frequencies into several directional subbands, and thus directional information can be captured efficiently.

Compute the DRCT for the original and the edge image with two pyramidal decompositions using the Haar filter and four and eight directional subbands using the PKVA ladder filters.

As in wavelets, any other filter can be used. After the decompositions, compute the size of the approximation matrix of the original image and then the corresponding matrix is copied to the edge image decomposition in order to obtain the final DRCT (fig.5.). This process is made to highlight the edge points.

Pixel Mapping:

In this stage the positions of the original domain edge points are mapped to the transformed domain positions. The DRCT parent-child relation is more complicated to compute because depending on the decomposition level, the children of a coefficient can be isolated in two different subbands.

Pixel Mapping steps are:

a) Use of the edge map obtained

b) Doubling the area position of a pixel defined by a coordinate position obtained at feature vector extraction stage

c) Applying image down sampling,

d) Repeating *b* and *c* an 'n' number of levels

e) Marking the descendent coefficients as a part of edge until the original image size is reached.

Image Compression:

In this stage, consider the approximation problem of contourlets by keeping the M largest coefficients. For the compression problem, To account for the cost to encode quantized coefficients, as well as the cost to index the retained coefficients (fig 3).The M retained contourlet coefficients are well organized in tree structures. Specifically, from coarse to fine scales, significant contourlet coefficients are successively localized in both location (contourlets intersect with the discontinuity curve) and direction (intersected contourlets with direction close to the local direction of the discontinuity curve).

Image Decompression:

Image Decompression is the inverse process of compression. Obtain information about the domain transform used, the number of decomposition and pyramidal levels, and the coefficients computed at the transformation process. To decompress an image and use the inverse DRCT that allows transforming the coefficients from the contourlet domain to the spatial domain. The inverse transforms allow observing the quality of the decompressed images.

Experimental Results:

Table 1: Wavelets error results

Original image	MSE	SNR(dB)	PSNR(dB)
Barbara	166.67	12.28	51.82
Goldhill	45.43	18.05	63.12

Table2:Contourlets error results

Original image	MSE	SNR(dB)	PSNR(dB)
Barbara	166.34	12.29	51.84
Goldhill	51.62	17.50	62.00

Conclusion and future work:

In this paper, contourlet-based image compression with preservation edges methods are proposed. I have introduced the DRCT and the DWT as tools to model the edges of the images by applying multiscale and multidirectional analysis. Use the transformations as base to design an edge-preserving lossy image compression. The importance of the proposed model is to improve the measure of the original and reconstructed image error, and in the fine reconstruction of the edges.

In the future, the method can be improved by finding a way to compute the best subband decomposition and by improving the stage of the detection and mapping the relevant information.

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