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Image Compression Using Double Wavelet Transform and Sift Transform

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ABSTRACT: In this paper, Images require substantial storage and transmission resources, thus image compression is advantageous to reduce these requirements. A good strategy of pictures compression should assure a good compromise between a high compression rate and a low distortion of the picture. In this paper, we present a direct solution method based on discrete wavelet transform (DWT) for scale invariant features transform (SIFT) [11] image compression. This method is a combination of DWT decomposition and SIFT image compression. Wavelet transform is applied to entire images, so it produces no blocking artefacts; this is a major advantage of wavelet compression over other transform compression methods. The results show that the DWT for input image succeeded to improve high performances in terms of compression ratio and reconstruction quality.

KEYWORDS: Image compression, image coding, SIFT,perceptual quality, local feature descriptor, feature extraction

I. INTRODUCTION

The fast development of computer applications came with an enormous increase of the use of digital images, mainly in the domain of multimedia, games, satellite transmissions and medical imagery. This implies more the research on effective compression algorithms. The basic idea of image compression is to reduce the middle number of bits by pixel (bpp) necessary for image representation. The image compression approaches can be divided into two methods: lossless and lossy. A number of advanced image compression schemes have been introduced since the well-known JPEG standard, driven by the explosion of digital images over the Internet. State-of-the-art mainstream image coding schemes such as JPEG 2000, MPEG-4 AVC/H.264 intra coding, and the emerging HEVC intra coding (HEVC in short) [1] are examples that greatly outperform previous generations in terms of coding efficiency. Digging into the detailed.techniques, one can easily observe that these mainstream coding schemes make use of the statistical correlation among pixels within an image for compression. From JPEG to the latest HEVC, an increasing number of prediction directions, partitions and transforms have been introduced in the pursuit of high coding efficiency; small improvements are accomplished with the high cost of increased complexity in both encoder and decoder. One cannot help worrying about the future of mainstream compression schemes if they rely only on the techniques based on classical information theory to explore the inside statistical redundancy for high pixel-level fidelity.

Based on human visual system (HVS) [2], visual redundancy has been considered in addition to statistical redundancy in the development of compression techniques toward perceptual quality. These schemes compress an image by identifying and utilizing features within the image to achieve high coding efficiency [3]. For example, edge based and segmentation-based coding schemes [4][5] are presented based on the human eye's ability to identify edges and group similar regions. Nevertheless, the development of these schemes, though promising, is influenced greatly by the availability and effectiveness of HVS as well as certain algorithms, such as edge detection and segmentation tools. Moreover, they still only consider the redundancy, either statistical or visual, within one image.

Image compression using external image datasets has also been investigated. Generally speaking, vector quantization (VQ) [6] can be regarded as an example in which the codebooks are trained from an external image dataset. Later, visual patterns learned at patch level are introduced in vector quantization for the compression of edge regions [7][8]. However, these VQ-based schemes measure the correlations by pixel values in the training and matching process, which are incapable of utilizing the visual correlation effectively.

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With the exploration of digital images over the Internet, there is a trend to investigate new technologies to make use of the massive number of images. Recent efforts have shed a light that local feature descriptors not only help enhance image search but also provide hints to visually interpret image content. Local feature descriptors describe image regions by gradient histograms around the selected key points, which are invariant to image scales and rotations. Based on local feature descriptors, such as SIFT [7], the visual correlations among images are explored in order to help solve the problems of image in painting and completion. Later on, Weinzaepfeletal.demonstrate that meaningful reconstruction is achievable merely based on SIFT descriptors [1].

II. IMAGE PRETREATMENT WITH DWT TRANSFORM

A. The Discret Wavelet Transform

The DWT provides sufficient information for the analysis and synthesis of a signal, but is advantageously, much more efficient. Discrete Wavelet analysis is computed using the concept of filter banks.

B. Haar Wavelet Transform

To understand how wavelets work, let us start with a simple example. Assume we have a 1D image with a resolution of four pixels, having values [9 7 3 5]. Haar wavelet basis can be used to represent this image by computing a wavelet transform. To do this, first the average the pixels together, pairwise, is calculated to get the new lower resolution image with pixel values [8 4]. Clearly, some information is lost in this averaging process. We need to store some *detail coefficients* to recover the original four pixel values from the two averaged values. In our example, 1 is chosen for the first detail coefficient, since the average computed is 1 less than 9 and 1 more than 7. This single number is used to recover the first two pixels of our original four-pixel image. Similarly, the second detail coefficient is -1, since 4 + (-1) = 3 and 4 - (-1) = 5. Thus, the original image is decomposed into a lower resolution (two-pixel) version and a pair of detail coefficients.

C.Compression of 2D image with Haar Wavelet Technique

It has been shown in previous section how one dimensional image can be treated as sequences of coefficients. Alternatively, we can think of images as piecewise constant functions on the half-open interval [0, 1). To do so, the concept of a *vector space* is used. The transformation of the 2D image is a 2D generalization of the 1D wavelet transformed already discussed. It applies the 1D wavelet transform to each row of pixel values. This operation provides us an average value along with detail coefficients for each row. Next, these transformed rows are treated as if they were themselves an image and apply the 1D transform to each column. The resulting values are all detail coefficients except a single overall average co-efficient. In order to complete the transformation, this process is repeated recursively only on the quadrant containing averages. Now let us see how the 2D Haar wavelet transformation is performed. The image is comprised of pixels represented by numbers [12]. Consider the 8□ 8 image taken from aspecific portion of a typical image shown in Fig. 6. The matrix (a 2D array) representing this image Now we perform the operation of averaging and differencing to arrive at a new matrix representing the same image in a more concise manner. Let us look how the operation is done.

Compression techniques

There are many different forms of data compression [6]. This investigation will concentrate on transform coding and then more specifically on Wavelet Transforms. Image data can be represented by coefficients of discrete image transforms. Coefficients that make only small contributions to the information contents can be omitted. However wavelets transform is applied to entire images,rather thansubimages, so it produces no blocking artefacts. This is a major advantage of wavelet compression over other transform compression methods.

An important point to note about Wavelet compression is explained by Aboufadel[3]: "The use of wavelets and thresholding serves to process the original signal, but, to this point, no actual compression of data has occurred". This explains that the wavelet analysis does not actually compress a signal, it simply provides information about the signal which allows the data to be compressed by SIFT which use standard entropy coding techniques, such as Huffman coding. Huffman coding is good to use with a signal processed by wavelet analysis, because it relies on the fact that the data values are small and in particular zero, to compress data. It works by giving large numbers more bits and small

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numbers fewer bits. Long strings of zeros can be encoded very efficiently using this scheme. Therefore an actual percentage compression value can only be stated in conjunction with an entropy coding technique.

WAVELET AND COMPRESSION

Wavelets are useful for compressing signals but they also have far more extensive uses. They can be used to process and improve signals, in fields such as gray scale image. They can be used to remove noise in an image.

SIFT-BASED IMAGE COMPRESSION

Our SIFT-based image compression scheme is introduced in this section. First, the framework of our coding scheme is presented. Then, the modules employed in the encoder and decoder will be discussed in detail.

Overview

The basic idea of our SIFT-based image coding scheme is illustrated in Fig. 1. On the encoder side, the visual description containing key SIFT descriptors is first extracted and encoded. The set of differential SIFT descriptors are then generated containing the rest of the important SIFT descriptors and coded as augment information. These two together form the final coded bit stream. The corresponding decoder decodes the bit stream and gets the two groups of SIFT descriptors. The SIFT descriptors extracted from the two groups are then used in the SIFT-based matching to achieve candidate patches retrieved from a large image database. At last, the candidate patches are integrated into the visual description to generate the final reconstructed image.

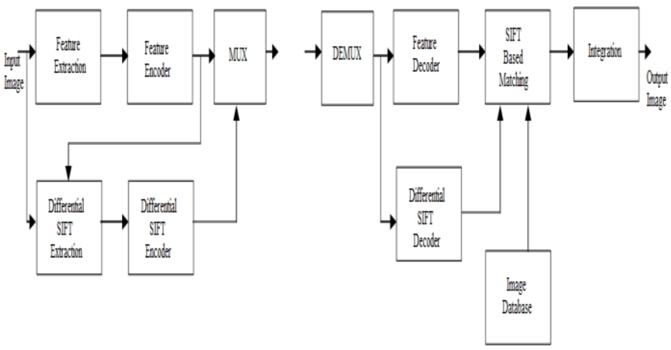

Fig.1 SIFT Transform compression

III. SYSTEM DESCRIPTOR

ENCODER

Our encoder compresses an image based on the SIFT descriptors. Instead of coding the SIFT descriptors directly, we propose reforming the SIFT descriptors into two representative groups and coding them accordingly. In this subsection, the encoding modules shown in Fig. 1 are presented in detail.

Visual description extraction

The SIFT descriptors, as we know, characterize the features around key-points extracted from a series of smoothed and resampled images. Compliant with the human visual system, basic salient features become dominant and the fine features become weak with the increase of the scale level. The salient features explicit in the smoothed and resampled images are valuable in our image representation, which outline the semantic meaning of the visual content. We are also aware of the fact that SIFT descriptor lacks the grey values and color information of the featured region so that it is difficult to recover the grey and color information from only SIFT descriptors; a SIFT descriptor contains a 128-dimensional vector which is very expensive in terms of bit consumption. Therefore, we propose separating the SIFT descriptors into two groups for efficient coding. The visual description is one of the groups that contains not only the SIFT descriptors of the salient features but also basic grey and color information of the original image.

DECODER

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The decoding process of our SIFT-based image compression is illustrated in the right portion

3.3.1. *Decoding of visual description and differential SIFT*
Corresponding to the encoding process, we employ the intra decoding scheme in HEVC for the decoding of the visual description and use a simple fixed-length decoding scheme to interpret the differential descriptors. Then we get two sets of information – reconstructed visual description and the differential descriptors .

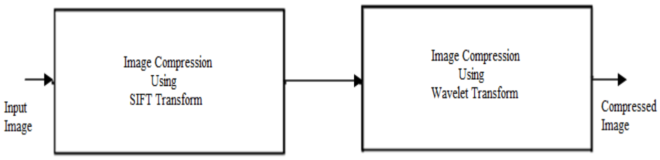


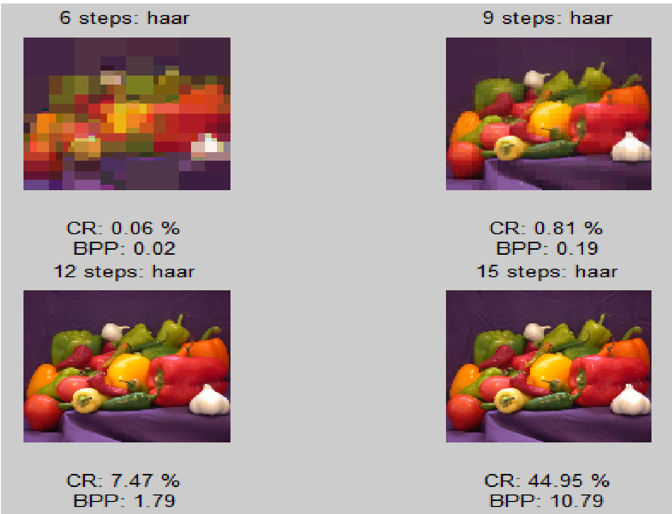
Fig.2 The combined approach of 2DWT and SIFT transforms

IV. METHODOLOGY

MATLAB is a numerical computing environment and fourth-generation programming language developed by Math Works. MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment whereproblems and solutions are expressed in familiar mathematical notation. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interface, and interfacing with program written in other languages, including C, C++. In the MATLAB tool using the HAAR transform and SIFT transformation finding the image Compression Ratio,Bits Per Pixel(BPP) value.

A. HAAR TRANSFORM

The below figure.3 refer value of compression ratio (CR)and bit per pixel(BPP), using for HARR transform.



Shown in Fig .3 Haar transform image compression

B.BIOR TRANSFORM

In both wavelet and double wavelet transform technique, the bior4.4 (biorthogonal) wavelet type is better than haar wavelet type because both compression ratio and bits per pixel is less in biorthogonal wavelet type,Also compression ratio and bits per pixel is less in the proposed double transform technique.

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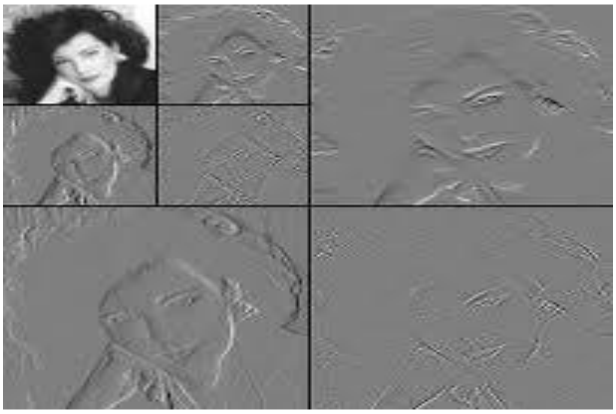
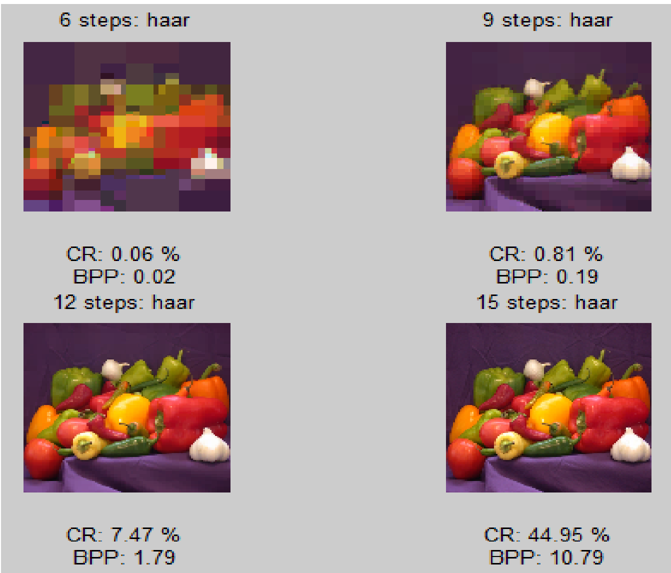


Fig.4. decomposed 2 level of the image

V. EXPERIMENTAL RESULTS

shown in Fig. 5. The input image before compression



Shown in Fig .6.the compression image by HAAR transform

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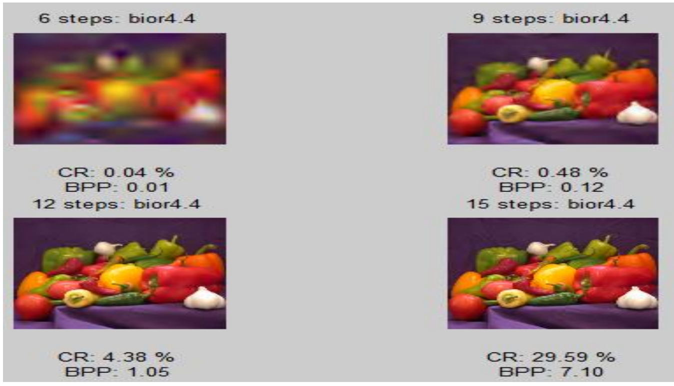
A low complex 2D image compression method using Haar wavelets as the basis functions along with the quality measurement of the compressed images have been presented here. Shown in figure .8 by using compression image by Haar transform.



Shown in Fig .7.BIOR transform

A picture can say more than a thousand words. However, storing an image can cost more than a million words. This is not always a problem because now computers are capable enough to handle large amounts of data. However, it is often desirable to use the limited resources more efficiently. For instance, digital cameras often have a totally unsatisfactory amount of memory and the internet can be very slow. In these cases, the importance of the compression of image is greatly felt. The rapid increase in the range and use of electronic imaging justifies attention for systematic design of an image compression system and for providing the image quality needed in different applications. Wavelet can be effectively used for this purpose.

Wavelet type	Decompression level	Compression ratio Haar	Bior	Bitper pixel (BPP) Haar	Bior
Image compress Using Wavelet transform	6	0.06%	0.05%	0.02	0.01
	9	0.81%	0.56%	0.19	0.13
	12	7.47%	4.92%	1.79	1.18
	15	44.95%	32.42%	10.79	7.79
SIFT and 2DWT wavelet transform	6	0.06%	0.04%	0.01	0.01
	9	0.75%	0.48%	0.18	0.12
	12	7.05%	4.38%	1.69	1.05
	15	42.89%	29.59%	10.29	7.10

Shown in table.1.outputcomparison Haar and Bior transforms by decompression level.

This paper proposes a novel image compression scheme based on local feature descriptors. Our compression scheme interprets images by SIFT descriptors instead of pixel values. The SIFT descriptors are manipulated into two groups in our encoder for efficient compression. A significantly down sampled image is first generated as the visual description of the input image that contains the key SIFT descriptors. Then the rest of the important SIFT descriptors are simplified, forming the differential SIFT descriptor set. These two groups are then compressed separately. The corresponding decoder makes use of the visual correlation among images through SIFT-based matching for image

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reconstruction. Our preliminary results demonstrate the feasibility of compression using local feature descriptors. The perceptual quality of our reconstructed images is comparable with that of HEVC and JPEG.

VI.CONCLUSION

We verify the compromise that exists between the compression ratio and the quality of the rebuilt image. Indeed, we apply the DWT transform, when we use SIFT to the compression technique. We note that the 2D DWT with SIFT transform compression method provide us better results than the DWT compression method. When we apply 2D DWT to SIFT compression technique the compression ratio is increasing and the mean square error decreases. We note also that by 8*8 decomposition block size, 2D DWT with SIFT compression method provide us increasing compression ratio and decreasing mean square error by applying DWT transform to the original image and by 4*4 decomposition block size increasing compression ratio and mean square error

In this image based visual servoing the experiments were done in Our cloud-based image coding scheme is not a replacement of the conventional image coding. Our solution aims at new scenarios, e.g. compression and reconstruction for internet or cloud applications where a large-scale image set is always available. Although the results are preliminary, we believe it is a promising step towards much larger, "Internet-based" image compression.

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