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# Review paper on Image Compression Using DCT, KLT and DWT

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***Abstract----- In multimedia time image compression is needed to reduce the size of data without effect its quality, by the compression we store maximum data, fast transformation and save time efficiently. The reconstructed image to be same as original image or some loss may be neglected. This compression is done by two techniques: lossless technique or lossy technique methods.***

***In this paper we compare the performance of several transform coding methods, Discrete Fourier Transform, Discrete Cosine Transform, Wavelets Packet and Karhunen-Loeve Transform, commonly used in image compression systems through experiments. These methods are compared for the effectiveness as measured by rate-distortion ratio and the complexity of computation. Two different approaches can be used in the selection of the transformed amplitudes.***

***One is linear approximation, which projects the image over N vectors chosen a prior. However, better approximations can be achieved by choosing the N basis vectors based on the image, DCT and KLT approximation. In future, Complexity of images can be reduced with more efficient evaluation and with more accurate and high rate of recognition can be achieved along with comparisons with existing results by using video compression techniques.***

***Keywords---- Discrete Cosine Transformation (DCT), Peak Signal to Noise Ratio (PSNR), Joint Photographic Group Expert (JPEG), Wavelet Transform (WT), Discrete Fourier Transform (DFT)***

## I. REVIEW METHODOLOGY

The digital multimedia is popular nowadays because of their highly perceptual effects and the advanced development its corresponding technology. However, it often requires a large amount of data to store these multimedia contents due to the complex information they may encounter. Besides, the requirement of resolution is much higher than before, such that the data size of the image is surprisingly large.

In other words, a still image is a sensory signal that contains significant amount of redundant information which exists in their canonical forms. Image data compression is the technique of reducing the redundancies in image data required to maintain a given quantity of information. Therefore, how to improve image compression becomes an important question. Great progress has been made in applying digital signal processing or wavelet transform techniques in this area.

## II. INTRODUCTION

Three basic data redundancies can be categorized in the image compression standard. Image compression is an application of data compression that encodes the original image with few bits. The objective of image compression is to reduce the redundancy of the image and to store or transmit data in an efficient form The main goal of such system is to reduce the storage quantity as much as possible, and the decoded image displayed in the monitor can be similar to the original image.

1. Spatial redundancy: it is due to the correlation between neighbouring pixels.
2. Spectral redundancy: it is due to correlation between the colour components.
3. Psycho-visual redundancy: it is due to properties of the human visual system.

The spatial and spectral redundancies are present because certain spatial and spectral patterns between the pixels and the colour components are common to each other, whereas the psycho-visual redundancy originates from the fact that the human eye is insensitive to certain spatial frequencies. The principle of image compression algorithms are (i) reducing the redundancy in the image data and (or) (ii) producing a reconstructed image from the original image with the introduction of error that is insignificant to the intended applications. The aim here is to obtain an acceptable representation of digital image while preserving the essential information contained in that particular data set.[2].

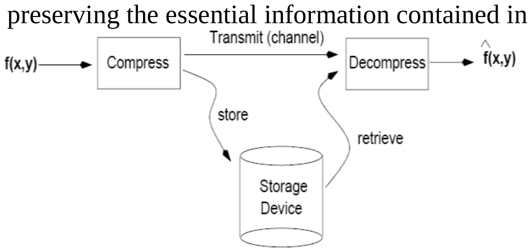


Fig 1. Image compression

 

The essence of each block will be introduced in the following sections. In recent years, the development and demand of multimedia product grows increasingly fast, contributing to insufficient bandwidth of network and storage of memory device.

Therefore, the theory of data compression becomes more and more significant for reducing the data redundancy to save more hardware space and transmission bandwidth. In computer science and information theory, data compression or source coding is the process of encoding information using fewer bits or other information-bearing units than an unencoded representation Image compression is an application of data compaction that can reduce the quantity of data. The block diagram of image coding system is shown in Fig.2

The camera captures the reflected light from the surface of the object, and the received light will be converted into three primary colour components R, G and B. These three primary colour components are processed by coding algorithms afterward. Image compression addresses the problem of reducing the amount of data required to represent a digital image. It is a process intended to yield a compact representation of an image, thereby reducing the image storage/transmission requirements.

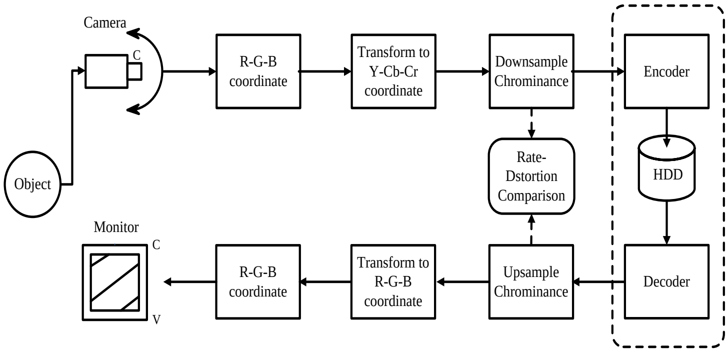


Fig. 2 The block diagram of the general image storage system.

Compression is achieved by the removal of one or more of the following three basic data redundancies:

1. Coding Redundancy
2. Inter-pixel Redundancy
3. Perceptual Redundancy

Coding redundancy occurs when the codes assigned to a set of events such as the pixel values of an image have not been selected to take full advantage of the probabilities of the events [2]. Inter-pixel redundancy usually results from correlations between the pixels. Due to the high correlation between the pixels, any given pixel can be predicted from its neighbouring pixels. Perceptual redundancy is due to data that is ignored by the human visual system. In other words, all the neighbouring pixels in the smooth region of a natural image have a high degree of similarity and this insignificant variation in the values of the neighbouring pixels is not noticeable to the human eye.

***Image Compression using Discrete Wavelet Transform***

The wavelet transform (WT) has gained widespread acceptance in signal processing and image compression. Because of their inherent multi-resolution nature, wavelet-coding schemes are especially suitable for applications where scalability and tolerable degradation are important.

***Why Wavelet-based Compression***

Despite all the advantages of JPEG compression schemes based on DCT namely simplicity, satisfactory performance, and availability of special purpose hardware for implementation, these are not without their shortcomings. Since the input image needs to be "blocked," correlation across the block boundaries is not eliminated. This results in noticeable and annoying "blocking artifacts" particularly at low bit rates.

***Why the DCT is used***

The Discrete Cosine Transform was not the only transform that could have been used when the JPEG committee set the standard in 1982. Others include:

1. Discrete Fourier Transform (DFT)
2. Discrete Sine Transform (DST)
3. Discrete Hadamard Transform (DHT)
4. Karhunen-Loeve Transform (KLT)

Although better compression can be obtained from larger block sizes, this is by far the most efficient, computationally. The KLT provides the maximum energy compaction in the sense that it packs the most image energy into the fewest transform elements. It minimises the total entropy of the image, and completely decorrelates the coefficient values. However, the KLT has the disadvantages that it is image dependent, and it does not have any known fast method of computation. The DCT achieves the second best energy compaction, and is almost as good as the KLT, if the image pixels are highly correlated (hence the poor performance on cartoon images, where the pixels are highly decorrelated).

The DCT has the following advantages:

1. It has several fast implementation methods
2. It can be separated into two 1-d DCTs

3. The DCT is independent of image content
4. The perceptual qualities of human vision can be incorporated

It is for these reasons that the JPEG committee used the DCT for their compression routines.

***Comparison of Image Compression Technique***

In short, this work compare that DCT is close to KLT for:

1. DCT is a good replacement for KLT
2. Close to optimal for highly correlated data
3. Not depend on specific data
4. Fast algorithm available.

## III. BRIFE HISTRY

***Discrete Fourier Transform***

The Fourier transform decomposes a signal into frequency components for its analysis. The Discrete Fourier Transform (DFT) estimates the Fourier transform of a signal from a finite number of its sampled points. Since sinusoidal waves last infinite, DFT has very poor local property.

***Discrete Cosine Transform***

The Discrete Cosine Transforms (DCTs) can not be treated simply as a discretized approximation of its continuous Fourier cosine transform. DCT has shown its superiority in bandwidth compression of a wide range of signals such as speech, TV signals, and images.

***Discrete Wavelet Transform***

Wavelet transform has emerged as a powerful tool for many applications including data compression and feature detection in sounds, biomedical data and images. The motivation behind its development was the search for fast algorithms to compactly represent of functions and data sets. Compression occurs because pixel values are correlated by the smoothness of the image [5]. The most dissimilarity between DFT and DWT is that individual wavelet functions are compactly supported in space and in frequency. This localization feature makes the representation of image in the transformed domain sparse. This sparseness, in turn, results in a number of useful applications such as data compression, detecting features in images, and removing noise from signals.

***Wavelet Packets and the best basis***

A further degree of freedom can be obtained by choosing the bases adaptively, depending on the signal properties. From families of wavelet packet bases, a fast dynamical programming algorithm is used to select the “best” bases which reflect the signal structures. The advantage of this method over traditional wavelet transform methods is that the bases are chosen automatically to best represent the particular image. In this sense the transform is highly nonlinear [6].

***Karhunen-Loeve Transform***

The Karhunen-Loeve Transform (KLT) is a preferred method for approximating a set of vectors by a low dimensional subspace [1]. This subspace is spanned by the eigenvectors of corresponding auto-covariance matrix. This transform is optimal in that it completely decorrelates the signal in the transform domain. Practical implementation of KLT involves the estimation of the auto-covariance matrix of the data sequence, its diagonalization, and the construction of the basis vectors. So the basis vectors are depended on the signal, which cannot be predetermined, and must be completely repeated whenever any new data is added. Although the high computational complexity has made KLT an ideal but impractical tool, it does provide a benchmark against which other discrete transform may be judged [1].

DCT has advantage:

It has been implemented in single integrated circuit

It has the ability to pack most information in fewest coefficients

It minimizes the block like appearance called blocking artifact that results when boundaries between sub-images become visible [11].

## IV. CONCLUSION

While the DCT-based image coders perform very well at moderate bit rates, at higher compression ratios, image quality degrades because of the artifacts resulting from the block-based DCT scheme. Wavelet-based coding on the other hand provides substantial improvement in picture quality at low bit rates because of overlapping basis functions and better energy compaction property of wavelet transforms. wavelet-based coders facilitate progressive transmission of images.

Hence it is believed there is lots of application in which compression techniques can utilized with more robust and feasibility.

## V. FUTURE WORK

Future work would be to make it has higher compression ratios avoid blocking facts:

1. Allows good localization both in time and spatial frequency domain.
2. Transformation of the whole image - introduces inherent scaling.
3. Better identification of which data is relevant to human perception – higher compression ratio

Complexity of images can be reduced with more efficient evaluation and with more accurate and high rate of recognition can be achieved along with comparisons with existing results by using video compression techniques.

 

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