International Journal of Advance Research, IJOAR .org
Volume 1, Issue 7, July 2013, Online: ISSN 2320-9194

2-D SIGNAL PROCESSING FOR IMAGE COMPRESSION

S. Venkatesan, Vibhuti Narain Rai

Abstract:

An image is basically a 2-D signal processed by the human optical system. The signals representing pictures are sometimes in analog kind. However, for process, storage , and transmission by laptop applications, they are regenerated from analog to digital kind. A digital image is largely a pair of Dimensional array of pixels. Pictures develop the numerous part of knowledge, significantly in remote sensing, medical specialty and video conferencing applications. The application and depending on info and computers still grow, thus too will our requirement for economical ways of storing and broadcasting giant amounts of knowledge.

Keywords: 2-D signal, Image, Compression, Pixels, Pictures

Introduction

Image compression addresses the matter of reducing the quantity of data needed to represent a digital image. It is a method supposed to yield a compact illustration of a picture, thereby reducing the image storage/transmission needs. Compression is achieved by the removal of 1 or additional of the 3 basic data redundancies:

1. Coding Redundancy

2. Interpixel Redundancy

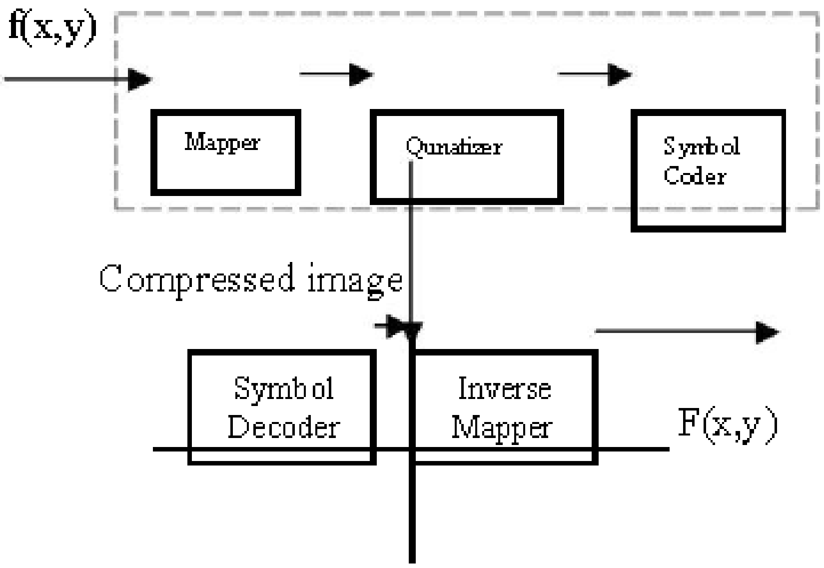
3. Psychovisual Redundancy

Coding redundancy exists when not more optimum code words are used. Interpixel redundancy results from correlations between the pixels of a picture. Psychovisual redundancy is as a result of data that is unnoticed by the human optical system (i.e. Visually non essential information). Compression techniques cut back the quantity of bits needed to represent a picture by taking advantage of those redundancies. AN inverse method referred to as decompression (decoding) is applied to the compressed data to induce the reconstructed image. The target of compression is to cut back the quantity of bits achievable, whereas keeping the resolution and also the visual quality of the reconstructed image as near the initial image as achievable. Compression systems are composed of 2 distinct structural blocks: AN encoder and a decoder.

Image f (x, y) is fed into the encoder, that produces a set of symbols form input data and utilizes them to represent the image. If we allow let n1 and n2 denote the quantity of knowledge carrying units (sometimes bits) within the original and encoded pictures severally, the compression that's achieved are often quantified numerically via the compression magnitude relation,

$CR = n1 / n2$

As shown within the figure, the encoder is accountable for reducing the coding , interpixel and psychovisual redundancies of input image. On 1st stage, the mapper transforms the input image into a format designed to decrease interpixel redundancies. The second stage, quantize block reduces the accuracy of mapper’s output in accordance with a predefined criterion. In third and finish, a symbol decoder produces a code for quantized output and maps the output in accordance with the code. These blocks carry out, in reverse order, the inverse operations of the encoder's symbol and mapper block. As quantization is permanent, an inverse quantization is incorporated.



Advantages Of Compression

• It provides a possible price savings related to causing less data over switched phone wherever price of the call is mostly based upon its long duration.

• It not solely reduces storage needs however additionally overall execution time.

• It additionally reduces the chance of transmission errors since fewer bits are transferred.

• It additionally provides a level of security against illicit checking.

COMPRESSION TECHNIQUES

The compression techniques are loosely classified into 2 classes relying whether or not a certain reproduction of the initial image may well be reconstructed using of the compressed image. These are:

1. Lossless technique
2. Lossy technique

Lossless compression technique

In lossless compression techniques, the initial image can be entirely recovered from the compressed (encoded) image. These are referred to as noiseless since they do not add noise to the signal (image). It is additionally referred to as entropy coding as it utilizes the statistics/decomposition techniques to get rid off /reduce redundancy. Lossless compression is employed for a small number of applications with rigorous needs like medical imaging. Following techniques are incorporated in lossless compression:

1. Run length encoding.

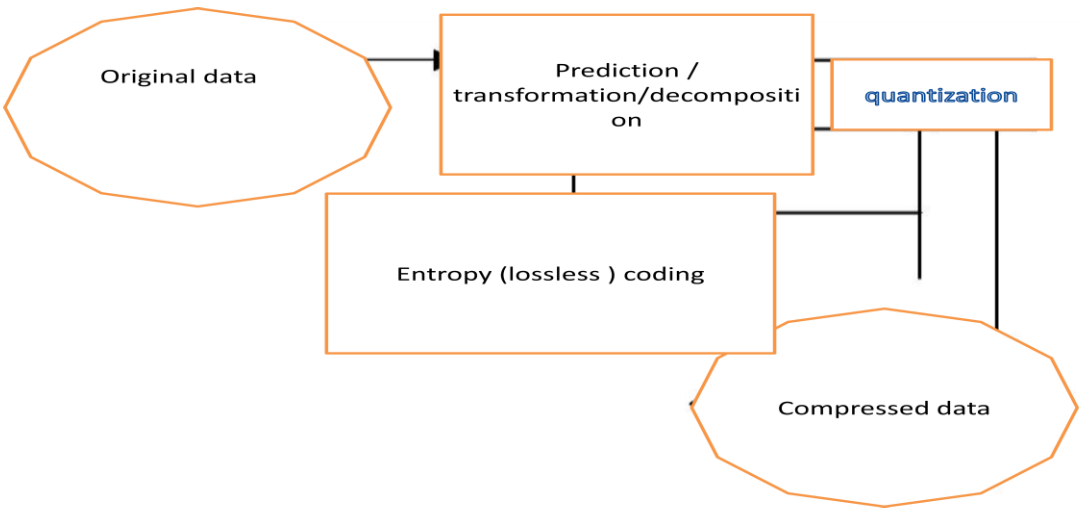
2. Huffman encoding

3. LZW coding.

4. The area is coding.

Lossy compression technique

Lossy schemes offer abundant higher compression ratios than lossless schemes. Lossy schemes are widely used for the standard of the reconstructed pictures is adequate for many applications .Buy this theme, the decompressed image is not the image of the initial image, however moderately near it.



As explained in the definition of lossy compression techniques. During this prediction – transformation – decomposition method is totally reversible .The quantization method leads to loss of data . The entropy coding after the quantization step, however, is lossless. The coding could be a reverse method. Firstly, entropy coding is applied to compress data to obtain quantized data. Secondly, dequantization is applied to it and finally the inverse transformation to induce the reconstructed image. Major performance issues of a lossy compression theme include:

1. Compression ratio.

2. Signal - to – noise ratio.

3. Speed of encoding and decoding.

Lossy compression techniques include following schemes:

1. Transform coding.

2. Vector quantization.

3. Fractor coding.

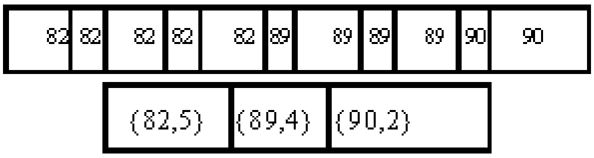
4. Block Truncation coding.

5. Subband coding.

Lossless Compression Techniques

Run Length Encoding

This is an extremely easy compression methodology used for serial data. It is especially helpful just in case of repetitive data. This system replaces sequences of identical symbols (pixels), referred to as runs by shorter symbols. The run length code for a gray scale image is pictured by a sequence of { VI , R I} where VI is the intensity of pixel and ray refers to the quantity of consecutive pixels to the intensity view as shown within the figure. If each VI and R I are pictured by one byte, this span of twelve pixels is coded utilizing eight bytes yielding a compression ratio of 1: 5



Run –Length
Figure: Encoding

Huffman Encoding

This is a general technique for coding symbols replying on their statistically prevalent frequencies (probabilities). The pixels within the image are treated as symbols. The symbols that occur additional often times are allocated a smaller range of bits, whereas the symbols that occur less often times are allocated a comparatively larger range of bits. Huffman code could be a prefix code. This implies that the (binary) code of any image isn't the prefix of the code of the other image. Most image coding standards utilize lossy techniques within the earlier stages of compression and make use of Huffman coding as the final step.

LZW Coding

LZW (Lempel- Ziv – Welch) is a dictionary originated coding . It is static or dynamic. In the first type dictionary is fixed in the coding process whereas in dynamic, dictionary updates on the fly. LZW is largely used in industry and is employed as a compress command on UNIX.

Area Coding

Area coding is a superior style of run length coding, reflective of the 2 dimensional characters of pictures. This can be a big advance over the opposite lossless strategies.

Medical Image Compression

Compression of medical pictures to decrease back their storage and transmission bandwidth if of high interest in the processing of medical images. However, the compression can cut back the image fidelity, particularly once the pictures are compressed at lower bit rates. The created image suffers from interference artifacts. The standard of the image is severely degraded beneath the circumstances of high compression ratio, that is shown by the JPEG normal. Within the recent years, abundant of the analysis activities in image coding are concentrated on the discrete wavelet transform because the overlapping nature of the transformation alleviates interference artifacts. The multi-resolution character of the discrete wavelet transform results in superior energy compaction and continuous quality of the decompressed image. Moreover, the multi-resolution transformation domain means wavelet compression strategies degrade far more graciously than block-DCT strategies as the compression magnitude ratio will increase. Currently, discrete wavelength transform is employed for the decomposition and reconstruction of pictures .

Wavelet based compression offers multi-resolution stratified characteristics hence pictures are often compressed at completely different levels of resolution and might be consecutively processed from low resolution to high resolution. Wavelets are localized in time (space) and frequency (scale) domains. Hence, it is trouble free to capture local characteristics in a signal.

Haar Transform and Fast Haar Transform

The Haar transform (HT) is one of the best basic transformations from a space domain or a local frequency domain. This methodology reduces the calculation work. HT decomposes every signal into 2 elements, one is termed average (approximation) and different is understood as distinction (detail). Haar transformation is genuine and orthogonal. The essential vectors of Haar matrix are sequence ordered. It bears varied properties like orthogonality, linear section, compact support, good reconstruction.

Modified Fast Haar wavelet Transform

For modified fast Haar wavelet transform (MFHWT) it can be carried out by just acquiring (w+x+y+z) /4 instead of acquiring (x+y) /2 for approximation and (w+x-y-z) /4 instead of (x-y) /2 for distinguishing process. 4 nodes have been taken into consideration at once. Notice that the calculation for (w+x-y-z) /4 will give the detail coefficients in the level of n-2. For the idea of getting detail coefficients, differencing process (x-y) /2 still needs to be carried out. The decomposition step can be carried out by utilizing matrix formulation and to decrease the memory necessities of the transform and the quantity of inefficient movement of Haar coefficients. The drawback in number of addition and subtraction operation can be balanced by the reducing in number of division operation [4]. Overall, the algorithm of decomposition for the MFHWT for 2N data as follows:

For coefficients at level $N-\theta$, where 1, int () 2
$N\theta$= 4
$x4i + x4i + 1 + x4i + 2 + x4i + 3$, Where i 0, (2N) 4=1
(Approxinate coefficients), 4
$x4i + x4i + 1 - x4i + 2 - x4i + 3$, Where i 0, (2N) 4=1
(Detail coefficients at level n-2), 2
$x2i - x2i + 1$, Where i 0 (2N) 2 = 1
(Detail coefficients at level n-1).

If the 2N is divisible by four, the decomposition steps are often reduced by applying the rule. All the required coefficients are often obtained. If the 2N is divisible by 2only, we want to conduct the last decomposition step by using the similar manner as for FHT. The comparison between typical quick Haar Transforms, FHT and projected changes quick Haar Transform, for N=4.

Set Partitioning in Hiersrchichal Trees (SPIHT)

SPIHT is wavelet based image compression methodology. It provides the very best Image Quality, Progressive image transmission, totally embedded coded file, easy quantization algorithm, quick coding/decoding, fully adaptive, lossless compression, actual bit rate coding and Error protection. SPIHT makes use of 3 lists – the List of great Pixels (LSP), List of Insignificant Pixels (LIP) and List of Insignificant Sets (LIS). These are coefficient location lists that contain their coordinates. After initialization, for each level of threshold, the algorithm takes two stages. One is that the sorting pass containing organized lists. The other one is that the refinement pass that which will carry out progressive coding transmission. It is capable of regaining the image precisely by coding all bits of the transform. However, the wavelet transform gives a good reconstruction given that its numbers are kept as infinite impreciseness numbers. The diagram showing compression utilizing DWT and ISPIHT is given in figure one.

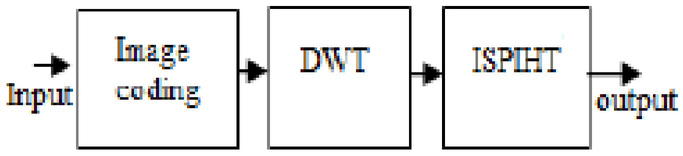


Fig.1 Compression using DWT and ISPIHT

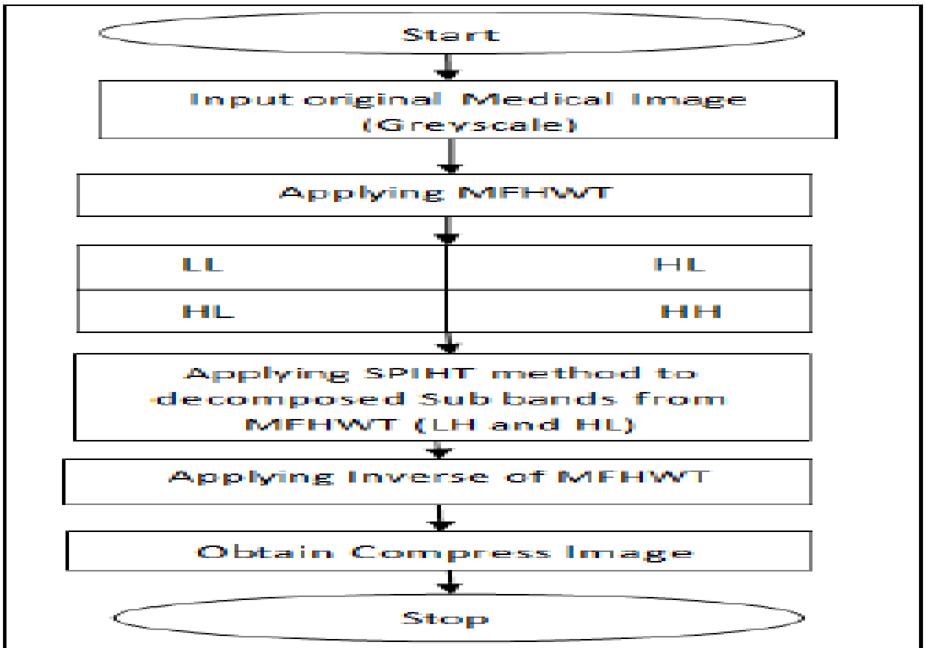
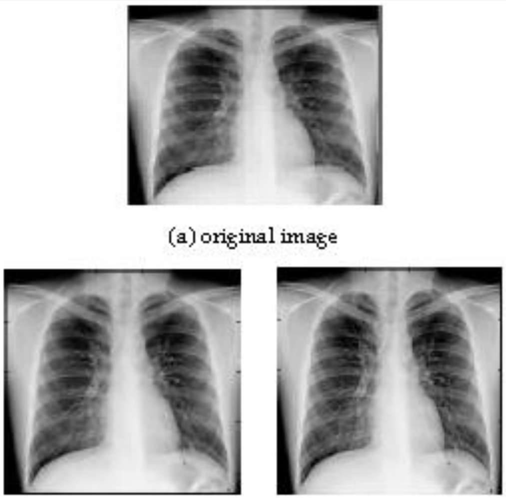


Fig.2 Flow chart of proposed method (ISPIHT)

The original image and compressed images of chest using SPIHT and ISPIHT are shown in figure 3.



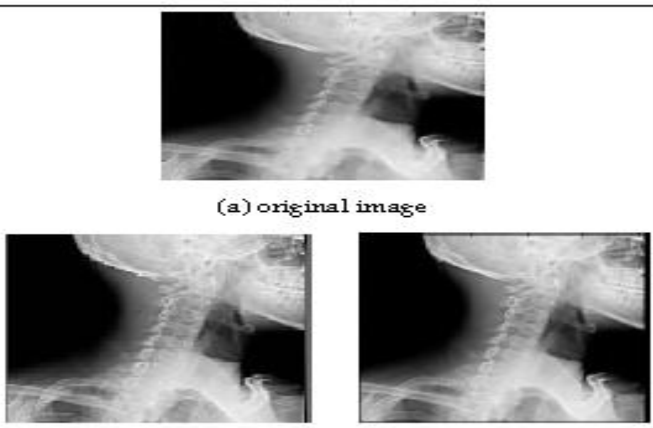
(a) original image

(b) Spiht compression (c) ispiht compression

Fig.3 Images of chest

The original image and compressed images of the chest using

SPIHT and ISPIHT are shown in figure 4



(a) original image

(b) Spiht compression (c) ispiht compression

Fig.4 Images of spinal cord

The respective values of PSNR for chest and spinal cord fo:

TABLE 1
COMPRESSION WITH SPIHT AND ISPIHT

Compression method	Images	PSNR
Spiht	Chest	60.25
Ispiht	Chest	65.15
Spiht	Spinal Cord	55.10
Ispiht	Spinal Cord	60.66

compression with spiht and ispiht are given in below table 1.

Conclusion

Image compressions are often lossy or lossless. Lossless compression is typically most popular for artificial pictures like technical drawings, icons or comics. This can be as a result of lossy compression strategies, particularly once used at low bit rates, introduce compression artifacts. Lossless compression strategies can also be more popular for prime price content, like medical imaging or image scans created for documentation purposes.

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