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Design and Implementation of SPIHT Algorithm for Image Compression

Vijayakumar Sajjan[1], Mohd Parvez Ali[2]
Assistant Professor[1], B.Tech Student[2]
Department of Electronics and Communication Engineering
LIET, Hyderabad, India

Abstract:
As a state-of-the-art image compression algorithm, SPIHT has wider applications in the compression of images. A typical example is an improvement to SPIHT was used to compress images. Although this improvement decreases the requirement for space and time, and makes SPIHT a more appropriate algorithm for hardware implementation, it still contains a great deal of redundant search, greatly reducing encoding speed. And the volume of raw image data captured by the high resolution camera is extremely huge. Thus the efficient image compression method should be used to decrease the bit rate. The image compression method based on wavelet is used more widely nowadays. SPIHT displays exceptional Characteristics over several properties like good image quality, fast coding and decoding, a fully progressive bit stream, application in lossless compression, error protection and ability to code for exact bit rate. The improved algorithm keeps the high SNR unchanged, increases the speed greatly and reduces the size of the needed storage space. It can implement lossless or lossy compression, and the compression ratio can be controlled. It could be widely used in the field of the high-speed and high-resolution image compression and applied them to the improved SPIHT algorithm for multi-spectral image compression, greatly reducing redundant search and improving coding speed, and are implementing a SPIHT algorithm which reduces memory usage and computation time with an acceptable PSNR loss and compression ratio also MSE.

Key words: Image compression, SPIHT, SNR, Multi-spectral, Etc

I. INTRODUCTION

Data compression is the technique to reduce the redundancies in data representation in order to decrease data storage requirements and hence communication costs. Reducing the storage requirement is equivalent to increasing the capacity of the storage medium and hence communication bandwidth. Thus the development of efficient compression techniques will continue to be a design challenge for future communication systems and advanced multimedia applications. Data is represented as a combination of information and redundancy. Information is the portion of data that must be preserved permanently in its original form in order to correctly interpret the meaning or purpose of the data. Redundancy is that portion of data that can be removed when it is not needed or can be reinserted to interpret the data when needed. Most often, the redundancy is reinserted in order to generate the original data in its original form. A technique to reduce the redundancy of data is defined as Data compression. The redundancy in data representation is reduced such a way that it can be subsequently reinserted to recover the original data, which is called decompression of the data.

II. EXISTING SYSTEMS

In the recent years, there is a large amount of information present in the form of Digital image data. At present, there is a huge demand for the image size and resolution. It is the outcome of the expansion of best and less exclusive image acquits icon devices. As arithmetic coding method can obtain optimal performance for its ability to generate codes with fractional bits, it is widely used by various image compression algorithms, such as the QM in JPEG, the MQ in JPEG2000 and the context-based adaptive binary arithmetic coder in H.264. The traditional lossless compression coding methods include Huffman coding, arithmetic coding, etc. In the new modern coding method, the wavelet transform, as mathematics research tools, accomplishes widely use and development in image processing and compression. Image Compression done on image may be lossless or lossy. In the lossless type, Images can be recreated exactly without any change in the power values. This limits the amount of compression that can be reached in images encoded using this technique. There are a number of purposes such as satellite image processing, medical and document imaging, which do not bear any losses in their data and are often compressed using this type. On the other hand, lossy encoding is based on adding off the reach comp or bit rate with the twist other reconstructed image. By the use of transform encoding methods, lossy encoding can be obtained with LZW, JPEG etc and EZW,WDR,ASWDR, etc are the examples of loss less image comp technique. Most of the image compression techniques carried out up till now all is having some sort of redundancy.

III. PROPOSED WORK

The proposed SPIHT algorithm is beneficial in order to achieve the better compression ratio. Using image processing techniques, we can sharpen the images and make high contrast to make a more useful for display and also reduce amount of memory requirement for storing image information etc. Due to such techniques, image processing is applied in "recognition of images" as in factory floor quality assurance systems, "image enhancement", as in satellite reconnaissance systems, "image synthesis" as in law enforcement suspect identification systems, and "image construction" as in plastic surgery design systems. Application of compression is in broadcast TV, remote sensing via satellite, military communication via aircraft, radar, Teleconferencing, facsimile transmission etc. Especially, the set portioning in hierarchical trees (SPIHT) uses an AC (Arithmetic coding) method to improve its peak signal-to-noise ratio (PSNR). Although the theory and program code of AC are mature, the complicated internal operations of AC limit its application for real time fields, such as satellite image and high speed camera image compressions. In order to achieve performance gains, high speed architecture of AC must be designed to meet the throughput requirement. A typical successful example is that an improvement to SPIHT `was used to compress multispectral images. Although this improvement decreases the requirement for space and time, and makes SPIHT a more appropriate algorithm for hardware implementation, SPIHT is currently one of the three highest levels of wavelet image coding algorithm. The algorithm uses quad tree structure effectively after the image was decomposed by wavelet and the pixel set was decomposed continually according to the importance of direct subsequent node pixels and indirect subsequent node pixels. The image data is coded eventually into the binary symbols sequence according to its symbols and importance. By using this algorithm, we can get the highest PSNR values for a different types of gray-scale images for a given compression ratio. It provides good differentiation standards for all ensuring algorithms.

It stands for set partitioned into hierarchical trees. It was developed for best developed transmission, as well as for compression. During the decoding of an image, the quality of a displayed image is the superior that can be reaching for the number of bits input by the decoder up to that time. In the progressive transmission method, decoder starts by setting the reconstructed image to zero. Then transformed co-efficient is inputted and decodes them and uses them to generate an improved rebuilt images to transmit most important information. First is the main aim of this type of transmission, SPIHT uses The Mean squared error (MSE) twist measure. EZW algorithm is the base version for SPIHT coder and it is a powerful image compression algorithm that generates an embedded bit stream from which the best recreated images in the MSE sense can be extracted at different bit rates, Some of the best results highest PSNR values and compression ratios for a different types of gray scale images have been gained but this algorithm, we can't compress the images dynamically rather we have to change the image manually every time. One of the major challenges in enabling mobile multimedia data services will be the need to process and wirelessly transmit a very large volume of data. While significant improvements in achievable bandwidth are expected with future wireless access technologies, improvements in battery technology will lag the rapidly growing energy requirements of future wireless data services. One approach, to mitigate this problem is to reduce the volume of multimedia data transmitted over the wireless channel via data compression techniques.

A. Classification of Compression Algorithms

Data compression can be understood as a method that takes an input data D and generates a shorter representation of the data c(D) with less number of bits compared to that of D. The reverse process is called decompression, which takes the compressed data c(D) and generates or reconstructs the data D‟ as shown in Figure 1. Sometimes the compression (coding) and decompression (decoding) systems together are called a "CODEC".

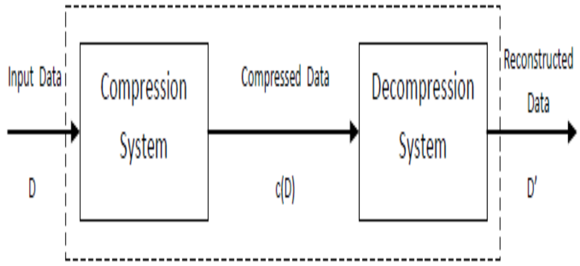


Figure.1. Codec

The reconstructed data D‟ could be identical to the original data D or it could be an approximation of the original data D, depending on the reconstruction requirements. If the reconstructed data D‟ is an exact replica of the original data D, the algorithm applied to compress D and decompress c(D) is lossless. On the other hand, the algorithms are lossy when D‟ is not an exact replica of D. Hence as far as the reversibility of the original data is concerned, the data compression algorithms can be broadly classified in two categories – lossless and lossy. Usually lossless data compression techniques are applied on text data or scientific data.

B. Advantages of Compression

- It reduces the data storage requirements
- The audience can experience rich-quality signals for audio-visual data representation
- Data security can also be greatly enhanced by encrypting the decoding parameters and transmitting them separately from the compressed database files to restrict access of proprietary information
- The rate of input-output operations in a computing device can be greatly increased due to shorter representation of data
- Data Compression obviously reduces the cost of backup and recovery of data in computer systems by storing the backup of large database files in compressed form.

C. Data Compression Model

A model of a typical data compression system can be described using the block diagram shown in Figure 2. A data compression system mainly consists of three major steps – removal or reduction in data redundancy, reduction in entropy and entropy encoding.

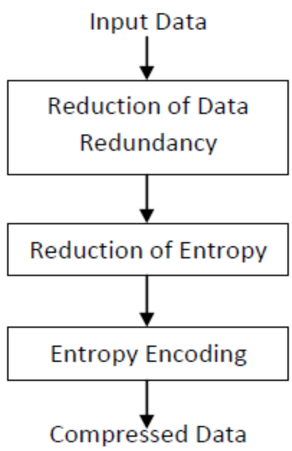


Figure.2.Image Compression

Image compression is the application of Data compression on digital images. The objective of image compression is to reduce redundancy of the image data in order to be able to store or transmit data in an efficient form. Image compression can be lossy or lossless. Lossless compression is sometimes preferred for artificial images such as technical drawings, icons or comics. This is because lossy compression methods, especially when used at low bit rates, introduce compression artifacts. Lossless compression methods may also be preferred for high value content, such as medical imagery or image scans made for archival purposes. Lossy methods are especially suitable for natural images such as photos in applications where minor loss of fidelity is acceptable to achieve a substantial reduction in bit rate. The lossy compression that produces imperceptible differences can be called visually lossless. Run-length encoding and entropy encoding are the methods for lossless image compression. Transform coding, where a Fourier-related transform such as DCT or the wavelet transform are applied, followed by quantization and entropy coding can be cited as a method for lossy image compression.

D. Compression Artifact

A compression artifact (or artefact) is the result of an aggressive data compression scheme applied to an image, that discards some data that may be too complex to store in the available data-rate, or may have been incorrectly determined by an algorithm to be of little subjective importance, but is in fact objectionable to the viewer. Artifacts are often a result of the latent errors inherent in lossy data compression.

Some of the common artefacts are:

Blocking Artifacts: A distortion that appears in compressed image as abnormally large pixel blocks. Also called "macro blocking," it occurs when the encoder cannot keep up with the allocated bandwidth. Image uses lossy compression, and the higher the compression rate, the more content is removed. At decompression, the output of certain decoded blocks makes surrounding pixels appear averaged together and look like larger blocks.

Colour Distortion: As human eyes are not as sensitive to colour as to brightness, much of the detailed colour (chrominance) information is disposed, while luminance is retained. This process is called "Chroma subsampling", and it means that a colour image is split into a brightness image and two colour images. The brightness (luma) image is stored at the original resolution, whereas the two colour (Chroma) images are stored at a lower resolution. The compressed images look slightly washed-out, with less brilliant colour.

Ringing Artifacts: In digital image processing, ringing artifacts are artifacts that appear as spurious signals ("rings") near sharp transitions in a signal. Visually, they appear as "rings" near edges. As with other artifacts, their minimization is a criterion in filter design. The main cause of ringing artifacts is due to a signal being band limited (specifically, not having high frequencies) or passed through a low-pass filter; this is the frequency domain description. In terms of the time domain, the cause of this type of ringing is the ripples in the sinc function, which is the impulse response (time domain representation) of a perfect low-pass filter. Mathematically, this is called the Gibbs phenomenon.

Blurring Artifacts: Blurring means that the image is smoother than originally.

Wavelet Transform: Wavelets are mathematical functions defined over a finite interval and having an average value of zero that transform data into different frequency components, representing each component with a resolution matched to its scale. The basic idea of the wavelet transform is to represent any arbitrary function as a superposition of a set of such wavelets or basis functions. These basis functions or baby wavelets are obtained from a single prototype wavelet called the mother wavelet, by dilations or contractions (scaling) and translations (shifts). They have advantages over traditional Fourier methods in analyzing physical situations where the signal contains discontinuities and sharp spikes. Many new wavelet applications such as image compression, turbulence, human vision, radar, and earthquake prediction are developed in recent years. In wavelet transform the basic functions are wavelets. Wavelets tend to be irregular and symmetric. All wavelet functions, $w(2kt - m)$, are derived from a single mother wavelet, $w(t)$. This wavelet is a small wave or pulse like the one shown in Fig.

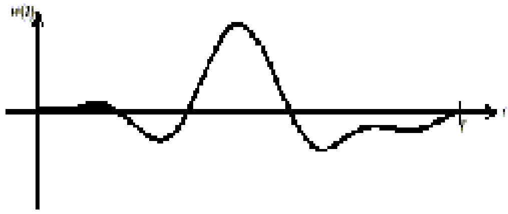
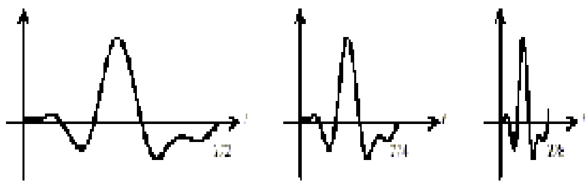


Figure.3. Mother wavelet w(t)

Normally it starts at time $t = 0$ and ends at $t = T$. The shifted wavelet $w(t - m)$ starts at $t = m$ and ends at $t = m + T$. The scaled wavelets $w(2kt)$ start at $t = 0$ and end at $t = T/2k$. Their graphs are $w(t)$ compressed by the factor of $2k$ as shown in Fig. For example, when $k = 1$, the wavelet is shown in Fig (a). If $k = 2$ and 3, they are shown in (b) and (c), respectively.



(a)w(2t) (b)w(4t) (c)w(8t)

Figure.4. Scaled wavelets

The wavelets are called orthogonal when their inner products are zero. The smaller the scaling factor is, the wider the wavelet is. Wide wavelets are comparable to low-frequency sinusoids and narrow wavelets are comparable to high-frequency sinusoids.

IV.PROPOSED SPIHT

Parents and children

SPIHT was introduced in [1]. It is a refinement of the algorithm presented by Shapiro in [2]. SPIHT assumes that the decomposition structure is the octave-band structure and then uses the fact that sub-bands at different levels but of the same orientation display similar characteristics. As is seen in Figure the band LL HL has similarities with the band HL (both have high-pass filtered rows). To utilize the above observation SPIHT defines spatial parent-children relationships in the decomposition structure. The squares in Figure represent the same spatial location of the original image and the same orientation, but at different scales. The different scales of the subbands imply that a region in the sub-band LL HL is spatially co-located (represent the same region in the original image) with a region 4 times larger (in the two dimensional case) in the band HL. SPIHT describes this collocation with one to four parent-children relationships, where the parent is in a sub-band of the same orientation as the children but at a smaller scale .If. this prediction is successful then SPIHT can represent the parent and all its descendants with a single symbol called a zero-tree, introduced in [2]. To predict energy of coefficients in lower level sub-bands (children) using coefficients in higher level sub-bands (parents) makes sense since there should be more energy per coefficient in these small bands, than in the bigger ones. To see how SPIHT uses zerotrees the workings of SPIHT are briefly explained below. For more information the reader is referred to [9]. SPIHT consists of two passes, the ordering pass and the refinement pass. In the ordering pass SPIHT attempts to order the coefficients according to their magnitude. In the refinement pass the quantization of coefficients is refined. The ordering and refining is made relative to a threshold. The threshold is appropriately initialized and then continuously made smaller with each round of the algorithm. SPIHT maintains three lists of coordinates of coefficients in the decomposition. These are the List of Insignificant Pixels (LIP), the List of Significant Pixels (LSP) and the List of Insignificant Sets (LIS). To decide if a coefficient is significant or not SPIHT uses the following definition. A coefficient is deemed significant at a certain threshold if its magnitude is larger than or equal to the threshold. Using the notion of significance the LIP, LIS and LSP can be explained. The LIP contains coordinates of coefficients that are insignificant at the current threshold, The LSP contains the coordinates of coefficients that are significant at the same threshold. The LIS contains coordinates of the roots of the spatial parent-children trees.

1]In the ordering pass of SPIHT (marked by the dotted line in the schematic above) the LIP is first searched for coefficients that are significant at the current threshold, if one is found 1 is output then the sign of the coefficient is marked by outputting either 1 or 0 (positive or negative). Now the significant coefficient is moved to the LSP. If a coefficient in LIP is insignificant a 0 is outputted.

2] Next in the ordering pass the sets in LIS are processed. For every set in the LIS it is decided whether the set is significant or insignificant. A set is deemed significant if at least one coefficient in the set is significant. If the set is significant the immediate children of the root are sorted into LIP and LSP depending on their significance and 0s and 1s are output as when processing LIP.

After sorting the children a new set (spatial coefficient tree) for each child is formed in the LIS. If the set is deemed insignificant, that is this set was a zero-tree, a 0 is outputted and no more processing is needed. The above is a simplification of the LIS processing but the important thing to remember is that entire sets of insignificant coefficients, zero-trees, are represented with a single 0. The idea behind defining spatial parent-children relationships as in is to increase the possibility of finding these zero-trees.

3] The SPIHT algorithm continues with the refinement pass. In the refinement pass the "next bit" in the binary representation of the coefficients in LSP is outputted. The "next bit" is related to the current threshold. The processing of LSP ends one round of the SPIHT algorithm, before the next round starts the current threshold is halved.

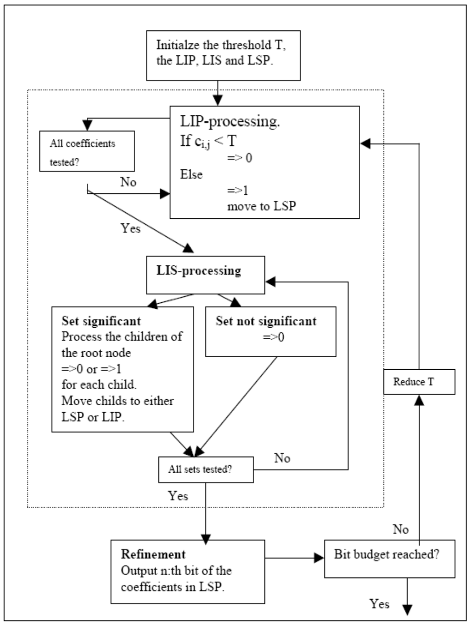
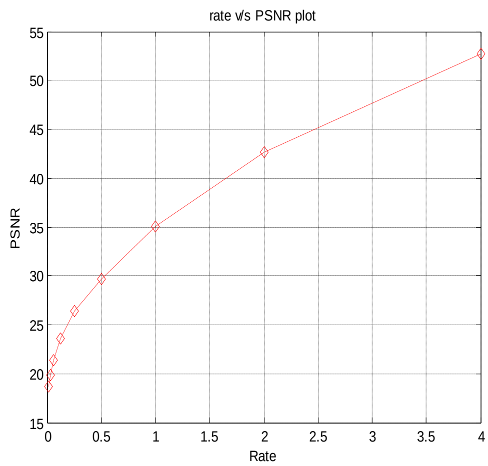


Figure.5. Below is a schematic of how SPIHT works.

SPIHT deserves special attention because it provides the following.

1] Good image quality, high PSNR;
2] It is optimized for progressive image transmission;
3] Produces a fully embedded coded file;
4] Simple quantization algorithm;
5]Fast coding/decoding (nearly symmetric);
6] Has wide applications, completely adaptive;
7] Can be used for lossless compression;
8] Can code to exact bit rate or distortion;
9] Efficient combination with error protection.

V.SIMULATION RESULT



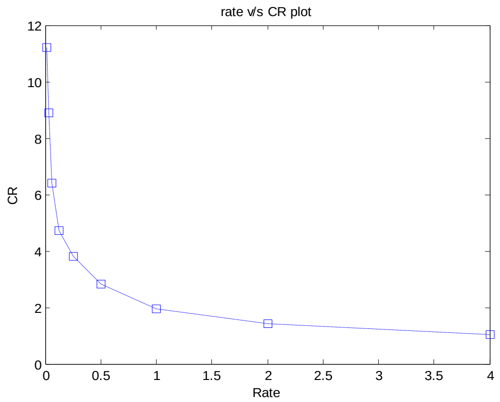


Figure.6. Image compression Using SPIHT algorithm.

The psnr performance is 48.09 dB

Figure.7. Image compression Using SPIHT algorithm

The SPIHT (Set Partitioning in Hierarchical Trees) algorithm is a fast and efficient technique for image compression and encryption. SPIHT generally operates on an entire image at once. The whole image is loaded and transformed and then the algorithm requires repeated access to all coefficient values. After the wavelet transform, we use this algorithm to encode the wavelet coefficients. The SPIHT algorithm has received widespread recognition for its notable success in image coding. Here we apply the SPIHT algorithm for wavelet transformation of images. The principle of the SPIHT algorithm is partial ordering of the transform coefficients by magnitude, with asset partitioning sorting algorithm ordered by bit plane transmission and exploitation of self-similarity across different layer. The SPIHT method is not a simple extension of traditional methods for image compression and itrepresents an important advance in the field. The method deserves special attention because it provides the advantages like highest image quality, progressive image transmission, fully embedded code file, simple quantization algorithm, fast coding/decoding, completely adaptive, lossless compression, exact bit rate coding and error protection. Here in this project, we are implementing a SPIHT algorithm which reduces memory usage and computation

VI.CONCLUSION

The SPIHT (Set Partitioning in Hierarchical Trees) algorithm is a fast and efficient technique for image compression and encryption. SPIHT generally operates on an entire image at once. The whole image is loaded and transformed and then the algorithm requires repeated access to all coefficient values. After the wavelet transform, we use this algorithm to encode the wavelet coefficients. The SPIHT algorithm has received widespread recognition for its notable success in image coding. Here we apply the SPIHT algorithm for wavelet transformation of images. The decompressed image has a high PSNR value for textured images which depicts the superiority of SPIHT algorithm in scientific image processing and implementing a SPIHT algorithm which reduces memory usage and computation time with an acceptable compression ratio also MSE.

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