Simulation of Wavelet Transformation base Still Image Compression using SPECK Algorithm

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Abstract— Image Encryption and Compression has been implemented in practical scenarios. Here pair of encryption then compression algorithm has been implemented and it will be performed efficiently. Here encryption-then-compression (ETC) system has been proposed. Finally the decrypted image obtained from the decryption process which should be represented the original information then analysis the performance based on the PSNR estimation. The SPECK algorithm uses recursive set-partitioning method to sort subsets of wavelet coefficients by hierarchical structure and energy clustering in frequency as well as in space which are the fundamental characteristics of an image compression get exploited. And we are comparing both compression results PSNR results.

Key words: Image Compression, SPECK Algorithm

I. INTRODUCTION

Image Encryption and Compression has been implemented in practical scenarios. Here pair of encryption then compression algorithm has been implemented and it will be performed efficiently. Here encryption-then-compression (ETC) system has been proposed with both lossless and lossy compression are performed. This approach provided a reasonably high level of security. Encryption turns your data into high-entropy data, usually indistinguishable from a random stream. Compression relies on patterns in order to gain any size reduction. At the compression part, modified flood fill algorithm and run length encoding proposed. For decompression and decryption process performed by reversing the compression and encryption process. Finally the decrypted image obtained from the decryption process which should be represented the original information then analysis the performance based on the PSNR estimation. And the SPECK algorithm uses recursive set-partitioning method to sort subsets of wavelet coefficients by maximum magnitude with respect to thresholds that are integer powers of two. The well defined hierarchical structure and energy clustering in frequency.

II. 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.

A. Introduction to 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,
- Wavelet transform decomposes a signal into a set of basis functions.
- These basis functions are called wavelets
- Wavelets are obtained from a single prototype wavelet ψ(t) called mother wavelet by dilations and shifting:

$$\Psi a, b(t) = \frac{1}{\sqrt{|a|}}\Psi\left(\frac{t-b}{a}\right) \text{…eq no (1)}$$

Where *a* is the scaling parameter and *b* is the shifting parameter

B. Introduction of SPECK Algorithm

1) Speck (Set Partitioned Embedded block coder)

Image coding utilizing scalar quantization on hierarchical structures of transformed images has been a very effective and computationally simple technique. Shapiro was the first to introduce such a technique with his Embedded Zero tree Wavelet (EZW) algorithm. Said & Pearlman successively improved the EZW algorithm based on a set-partitioning sorting algorithm called the Set-Partitioning In Hierarchical Trees (SPIHT) which provided an even better performance than the improved version of EZW. The algorithm used in this paper has its roots primarily in the ideas developed in the SPIHT, EBCOT, and image coding algorithms. It is different from some of the above mentioned schemes in that it does not use trees which span, and exploit the similarity, across different subbands; rather, it makes use of sets in the form of blocks. The main idea is to exploit the clustering of energy in frequency and space in hierarchical structures of transformed images. Thus, the image coding scheme is called Set Partitioned Embedded block coder (SPECK). In SPECK, the blocks are recursively and adaptively partitioned such that high energy areas are grouped together into small sets whereas low energy areas are grouped together in large sets. This algorithm makes use of the adaptive quad tree splitting to zoom into high energy areas within a region to code them with minimum significance maps.

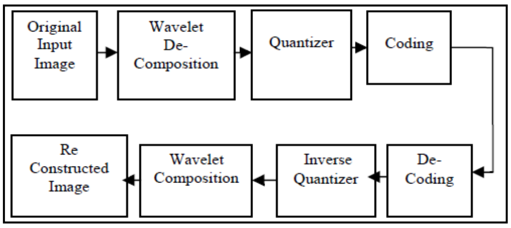

Fig. 1: Block diagram of SPECK image CODEC.

Fig. 1 shows typical image CODEC system. It comprises of three main stages: Transformation (Discrete Wavelet Decomposition), Quantization and Coding by rounding to the nearest integer.

a) Transformation

The principle of discrete wavelet image coding is based on the decomposition of an image into a number of frequency bands referred to as sub-bands.

b) Quantization

Each sub bands are quantized using uniform scalar quantizer, which is used to control the total bit rate.

c) Coding

The quantizer stage will be followed, by the scanning process of significant sets formation of binary bit stream. To reconstruct the image, the decoder basically performs the three main inverse operations in reverse order.

C. Introduction of Encryption-Then-Compression System (ETC)

Image Encryption and Compression has been implemented in practical scenarios. Here pair of encryption then compression algorithm has been implemented and it will be performed efficiently. Here encryption-then-compression (ETC) system has been proposed with both lossless and loss compression are performed. This approach provided a reasonably high level of security. Encryption turns your data into high-entropy data, usually indistinguishable from a random stream. Compression relies on patterns in order to gain any size reduction. Here encryption has been implemented by several methods such as GAP, Mapping process, Clustering process and Permutation. In Proposed Method Encryption-then-Compression (ETC) has been designed to receive an efficient image. First Segment the image into blocks. Each block GAP-Gradient-Adjusted Prediction is implemented. GAP scheme to achieve better speed and better prediction accuracy as and hence provide potential for further improvements in Lossless Image Compression. Next Clustering algorithm has been proposed here zig zag raster diagonal algorithm has been implemented. This ZZRD is a 2-D square matrix is split into exactly two halves diagonally, and the upper left part is scanned in Zigzag fashion. Finally permutation process is performed with key generation and encryption algorithm. At the compression part, modified flood fill algorithm and run length encoding proposed. For decompression and decryption process performed by reversing the compression and encryption process. Finally the decrypted image obtained from the decryption process which should be represented the original information then analysis the performance based on the PSNR estimation.

III. ETC (ENCRYPTION-THEN-COMPRESSION) ALGORITHM MODULES

- Segmentation
- GAP-Gradient-Adjusted Prediction
- zig zag raster diagonal
- Image encryption
- Modified Flood Fill Algorithm
- Run Length Encoding
- Decompression
- Decryption

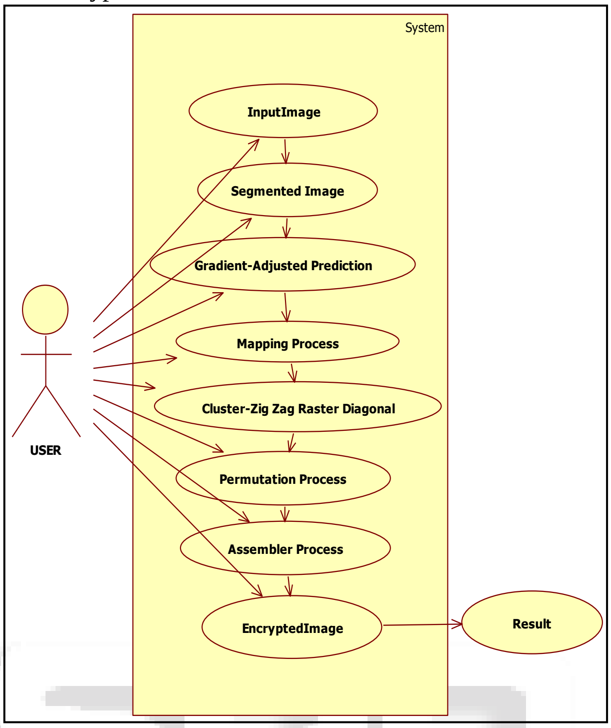

Fig. 2: ETC Algorithm Modules

A. Segmentation

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as superpixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic.

B. GAP- Gradient-Adjusted Prediction

Gradient adjusted prediction (GAP) is an efficient prediction method for lossless compression of video. By calculating its gradient in latitudinal and longitudinal orientation with the known context, the pixel value can be well estimated and used for predictive coding. However, when realizing this method in a real-time compression system, it needs a large amount of memory space. The number of operations for each pixel is also large.

C. Zig Zag Raster Diagonal

Zig Zag Raster Diagonal (ZZRD) to analyze correlations in the image and strengthen the correlation in the resulting linear pixel sequence, which is easily exploitable for purposes of compression. Zigzag (ZZ) scanning pattern is such a method and is widely used in many compression techniques.

D. Image Encryption

The technique involves three different phases in the encryption process. The first phase is the image encryption where the image is split into blocks and these blocks are permutated. Further permutation is applied based on a random number to strengthen the encryption. The second phase is the key generation phase, where the values used in the encryption process are used to build a key. The third phase is the identification process which involves the numbering of the shares that are generated from the secret image. These shares and the key are then transferred to the receiver. The receiver takes the help of the key to construct the secret image in the decryption process. The technique proposed is a unique one from the others in a way that the key is generated with valid information about the values used in the encryption process.

E. Decompression

Take the Pixel stream for particular pixel values. Check whether that particular pixel values. If it is located in Center Pixel.

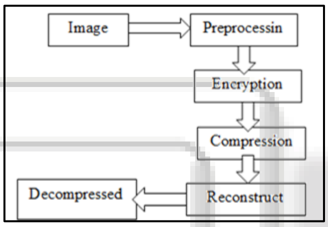

Fig. 3: Block Diagram of Decompressed Decrypted Image

IV. RESULTS AND COMPRESSION

Images [512×512]	PSNR(db) of SPECK	PSNR(db) of ETC
Fig 1.png	12.5937	15.9845
Fig 2.png	24.1067	27.2141
Fig 3.png	36.5260	39.4057
Fig 4.png	38.2634	42.1256

Table 1: PSNR values

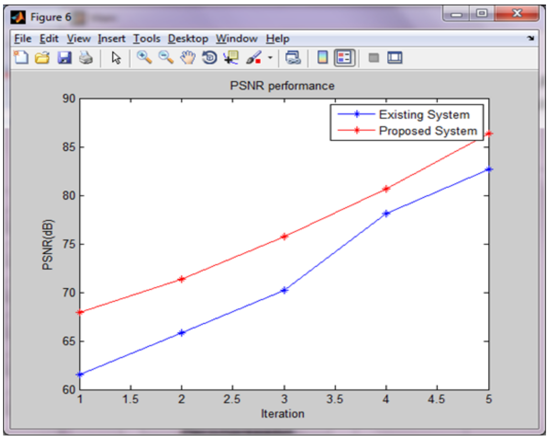

Fig. 4: Graphical representation of PSNR

We have considered the problem of lossy compression of encrypted 4 images data. Compression of encrypted image is not possible by using any of the classical compression techniques. We proposed a system and showed that lossy compression of encrypted image data is indeed possible by using compressive sensing techniques. The basis pursuit ETC algorithm was appropriately modified to enable joint encryption and compression. In Proposed Method Encryption-then-Compression (ETC) has been designed to receive an efficient image. First Segment the image into blocks. Each block GAP-Gradient-Adjusted Prediction is implemented. GAP scheme to achieve better speed and better prediction accuracy as and hence provide potential for further improvements in Lossless Image Compression. Next Clustering algorithm has been proposed here zig zag raster diagonal algorithm has been implemented. This ZZRD is a 2D square matrix is split into exactly two halves diagonally, and the upper left part is scanned in Zigzag fashion. Finally permutation process is performed with key generation and encryption algorithm. At the compression part, modified flood fill algorithm and run length encoding proposed. For decompression and decryption process performed by reversing the compression and encryption process. Finally the decrypted image obtained from the decryption process which should be represented the original information then analysis the performance based on the PSNR estimation.

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