

An Analysis and Implementation with Lossless Compression of JPEG Coded Photo Collections

Nishara AJ¹ Rajasekaran B²

PG Student¹, Associate Professor²

Department of ECE

VMKV Engineering College, Salem, Tamil Nadu, India

Abstract: The explosion of digital photos has posed a significant challenge to photo storage and transmission for both personal devices and cloud platforms. To propose a novel lossless compression method to further reduce the size of a set of JPEG coded correlated images without any loss of information. The proposed method jointly removes inter/intra image redundancy in the feature, spatial, and frequency domains. For each collection, we first organize the images into a pseudo video by minimizing the global prediction cost in the feature domain. We then present a hybrid disparity compensation method to better exploit both the global and local correlations among the images in the spatial domain. Furthermore, the redundancy between each compensated signal and the corresponding target image is adaptively reduced in the frequency domain. Experimental results demonstrate the effectiveness of the proposed lossless compression method.

Keywords: Intra and inter image redundancy, JPEG, Image Compression, Lossless

1. INTRODUCTION

Nowadays Image applications are widely used, driven by recent advances in the technology and breakthroughs in the price and performance of the hardware and the firmware. This leads to an enormous increase in the storage space and the transmitting time required for images. This emphasizes the need to provide efficient and effective image compression techniques. We provide a method which is capable of compressing images without degrading its quality. This is achieved through minimizing the number of bits required to represent each pixel. This, in return, reduces the amount of memory required to store images and facilitates transmitting image in less

time. Image compression techniques fall into two categories: lossless or lossy image compression. Choosing which of these two categories depends on the application and on the compression degree required. Lossless image compression is used to compress images in critical applications as it allows the exact original image to be reconstructed from the compressed one without any loss of the image data. Lossy image compression, on the other hand, suffers from the loss of some data. Thus, repeatedly compressing and decompressing an image results in poor quality of image. An advantage of this technique is that it allows for higher compression ratio than the lossless. Compression is achieved by removing one or more of the three basic data redundancies:

- 1) Coding redundancy, which is presented when less than optimal code words are used;
- 2) Inter pixel redundancy, which results from correlations between the pixels of an image;
- 3) Psycho visual redundancy, which is due to data that are ignored by the human visual system.

So, image compression becomes a solution to many imaging applications that require a vast amount of data to represent the images, such as document imaging management systems, facsimile transmission, image archiving, remote sensing, medical imaging, entertainment, HDTV, broadcasting, education and video teleconferencing. One major difficulty that faces lossless image compression is how to protect the quality of the image in a way that the decompressed image appears identical to the original one. In this paper we are concerned with lossless image compression based on LZW and BCH algorithms, which

compresses different types of image formats. The proposed method repeats the compression three times in order to increase the compression ratio. This method is an implementation of the loss-less image compression. The steps of our approach are as follows: first, we perform a pre-processing step to convert the image in hand into binary. Next, we apply the LZW algorithm on the image to compress. In this step, the codes from 0 to 255 represent 1-character sequences consisting of the corresponding 8-bit character, and the codes from 256 through 4095 are created in a dictionary for sequences encountered in the data as it is encoded. The code for the sequence (without that character) is emitted, and a new code (for the sequence with that character) is added to the dictionary. Finally, we use the BCH algorithm to increase image compression ratio. An error correction method is used in this step where we store the normal data and first parity data in a memory cell array, the normal data and first parity data form BCH encoded data. We also generate the second parity data from the stored normal data. To check for errors, we compare the first parity data with the second parity data. Performance of the fractal based on GA comprises of 3 components total amount of search space points second number of cycles T and initial population size S. Iterations will varies from image to image for sake of near-optimal solution. Image self-transformability characteristic is take into account and also reduced. Compression implements the GAs which greatly decreases the search space. It discusses practical implementation of the proposed method and classification technique. In lossless compression technique is proposed in order to obtain compression at high ratio. As characteristics of image maximized local and global redundancy so it reduces redundancy at both local and global level. First divided image into blocks of different length and then depending on the characteristics of pixels in each block encode these pixels. Coding schemes discussed in this study are implemented in different fields for various applications owing to their unique characteristics. For wide commercial usage there

various available schemes but for improved performance there is need of newer and better techniques to be developed. Still this field demands more progress and research possibilities. We discuss different image compression techniques and their merits demerits their applications. This paper is organized as follows: Section 2 describes existing work. Section 3 presents the proposed work. Section 4 discusses experimental results. Section 5 gives conclusions and future scope of the work

II. EXISTING SYSTEM

HEVC will focus on the block-based MC/DCT hybrid coding of the residual schemes and give a review of the current design of HEVC and discuss the features that differentiate it from its predecessor. Although HEVC has not yet been finalized, the key elements of this new standard have been identified and it is still being slightly fine-tuned, and will include other features by the time it reaches its final form. It is important to note that this paper serves as a snapshot of the current condition of HEVC as it gets close to its completion status. In that respect, the final version will differ somewhat from what is described. In addition to the novel algorithms mentioned above, the HEVC proposals also includes the following features; Simple quad-tree structure supporting large macroblock sizes of 32x32 and 64x64, Low complexity B pictures that only use integer motion vectors for SKIP and DIRECT modes, and Spatially Varying Transform (SVT) that allows the position of the transform change arbitrarily within the macroblock. The main aspects of the proposed coding tools could be described in detail in the subsequent sections.

2.1 QUADTREE BASED BLOCK PARTIONING

An important difference of HEVC compared to H.264/AVC is the frame coding structure. In HEVC each frame is divided into the basic processing unit scheme called Largest Coding Units (LCUs). LCUs can be recursively split into smaller Coding tree Units (CTUs) using a generic quadtree segmentation structure (a nested quadtree structure) that indicates

the subdivision of the CU for the purpose of prediction and residual coding. CUs can be further split into Prediction Units (PUs) used for intra- and inter-prediction and Transform Units (TUs) defined for transform and quantization (see figure 2). However, in H.264/AVC, each picture is partitioned into 16x16 macroblocks, and each macroblock can be further split into smaller blocks (as small as 4x4) for prediction. As the picture resolution of videos increases from standard definition to HD and beyond, the chances are that the picture will contain larger smooth regions, which can be encoded more effectively when large block sizes are used. This is the reason that HEVC supports larger encoding blocks than H.264/AVC, while it also has a more flexible partitioning structure to allow smaller blocks to be used for more textured and in general uneven regions. Hence, it has been designed to target ultra-high resolution with higher frame rates compared to H.264/AVC. Taking this into consideration, HEVC has introduced a new partitioning image scheme concept based on a quadtree structure with larger block size – a 64x64 Coding Unit (CU) and can be recursively further split into 4 CUs (Quadtree), which are used as the basic unit for intra- and inter-coding. The size of CUs can be as large as that of LCUs or and become as small as 8 x 8, depending on the picture content. Because of recursive quarter-size splitting, a content-adaptive coding tree structure comprised of CUs is created in HEVC.

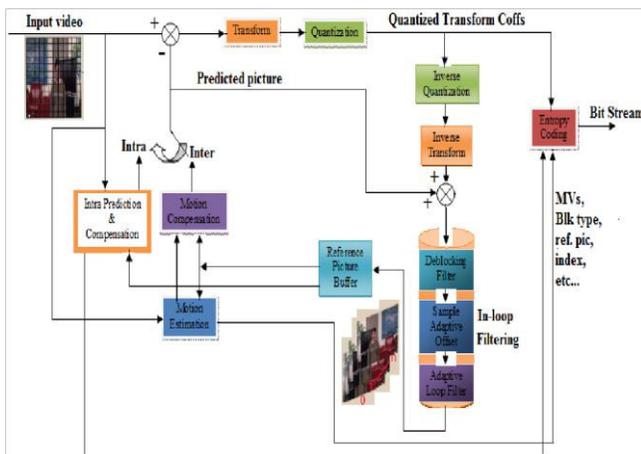


Fig 2.1: Existing Block Diagram

Finally, since HEVC applies a DCT-like transformation to the residuals to decorrelated data, TU is the basic unit for transform and quantization, which may exceed the size of PU, but not that of the CU. Only two TU modes are considered signaled by transform unit size flag: i) If the Transform unit size flag = 0 \rightarrow $2N \times 2N$

(i.e., the same as the CU size), ii) Else if the

Transform unit size flag = 1 \rightarrow Square units of smaller size are considered: $N \times N$ if PU splitting is symmetric or $N/2 \times N/2$ if PU splitting is asymmetric. HEVC introduced tiles as a means to support parallel processing, with more flexibility than normal slices in H.264/AVC but considerably lower complexity than flexible macroblock ordering (FMO). Tiles are specified by vertical and horizontal boundaries with intersections that partition a picture into rectangular regions. To support parallel processing, each slice in HEVC can be subdivided into smaller slices called entropy slices. Inter-prediction explores temporal redundancy between frames to save coding bits. By using motion compensated prediction, the best matching position of current block is found within the reference picture so that only prediction difference needs to be coded. Each PU coded using interprediction, has a set of motion parameters, which consists of a motion vector, a reference picture index, and a reference list flag. Inter-coded CUs can use symmetric and asymmetric motion partitions (AMPs). AMPs allow for asymmetrical splitting of a CU into smaller PUs. AMP can be used on CUs of size 64x64 down to 16x16 and improves the coding efficiency since it allows PUs to more accurately conform to the shape of objects in the picture without requiring further splitting.

2.2 INTER AND INTRA-PREDICTION CODING

The existing sub-pel interpolation method has been improved by replacing the fixed filters by the adaptive ones or by redesigning the filter

coefficients. Several proposals adaptively update interpolation filters by the least squares method in order to minimize the prediction errors of each video frame. In multiple sets of filters are transmitted for an adaptive selection at slice or partition level. The extra overheads are reduced by making use of the symmetry properties of these filters. In addition to adjusting filters on the fly, some redesigned filters are proposed. The schemes increase the precision for filtering operations.

2.3 TRANSFORM CODING

In H.264/AVC and MPEG-4 standards, the DCT basis is not optimal for various directional patterns in residual signals. The transform basis should be made adaptable to the statistical variation of realizations. Therefore, anticipation of a need for better transform coding tools leads to redesigning the existing DCT-based coding for further optimizing the energy compaction of residual signals. HEVC applies a DCT-like integer transform on the prediction residual. HEVC includes transforms that can be applied to blocks of sizes ranging from 4x4 to 32x32 pixels and also supports transforms on rectangular (non-square) blocks particularly in case of Asymmetric Motion Partitioning (AMP), Non-Square Transform (NSQT).

2.4 QUANTIZATION

In the MC/DCT hybrid video coding schemes, uniform scalar quantization schemes are usually utilized to quantize the transform coefficients, and the quantization step size, which determines the quantization strength, is transmitted to the receiver. To achieve better quantization, optimized quantization decision at the macroblock level and at different coefficient positions are proposed. More recently, for HEVC gives an improved, more efficient Rate Distortion Optimized Quantization (RDOQ) implementation. In, Adaptive Quantization Matrix Selection (AQMS), a method deciding the best quantization matrix index, where different coefficient positions can have different

quantization steps, is proposed to optimize the quantization matrix at a macroblock level. The quantization weighting matrix, which is controllable can be either uniquely defined and sent to the decoder as coding parameters, or substituted by a default one.

2.5 IN-LOOP PROCESSING/FILTERING

In HEVC internal scheme, two types of filtering processes have been obtained. The first one is Interpolation Filtering (IF), which is used to obtain the samples at fractional pixels for motion vectors pixel accuracy and the second one is In- Loop Filtering (LF), in order to restore the degraded frame caused by compression.

2.6 DRAWBACKS OF EXISTING WORK:

On the other hand, all these methods were proposed to compress the pixels in raw images in a lossy way. When extended for lossless compression of JPEG coded images, these methods may not perform well and may even be worse than using the original JPEG files since they take no consideration of the JPEG coding effects as well as the characteristics.

III. PROPOSED SYSTEM

We propose a new coding method for lossless compression of JPEG coded image collections. Specifically, We compress a JPEG coded image collection by making use of both the inter correlation among images and the intra correlation within each image in the feature, spatial, and frequency domains jointly. For each input JPEG coded image collection, we decode all JPEG files before further compression, resulting in the corresponding YUV image set. Then the prediction structure of the image set is determined based on the similarity between each pair of images in the feature domain. The prediction structure is formed in a tree structure generated from a directed graph via the minimum spanning tree (MST) algorithm in which parent nodes (i.e. images) can be used as references to predict their children. Based on the prediction structure, we then exploit both the inter

and intra redundancies in the spatial domain. For inter coded images, the disparity between each pair of target and reference images is reduced by joint global and local compensations in the pixel space. Specifically, larger geometric deformations and illumination differences are compensated by the global holography and photometric transforms, respectively, while smaller disparities are further compensated by the HEVC-like block based intra/inter prediction. For the root image in each MST, the global compensation is bypassed and only intra prediction is performed. All the parameters of MST, transformations, and modes are entropy coded and stored for use in decoding. Details on the spatial. Baseline JPEG Compression

The JPEG group has specified a family of image coding standards. The most popular one is the baseline JPEG.

3.1 FEATURE-DOMAIN DETERMINATION OF PREDICTION STRUCTURE

Unlike natural video sequences which have strong temporal correlations, images in a collection usually have loose correlations and may vary in rotation, scale, and illumination. The inter-image disparities in image collections can be more complicated than those in videos. Traditional pixel-level disparity measurements, e.g. MSE, are not capable of effectively measuring the correlation between images. To introduce the feature-domain similarity to measure the inter-image correlation by the distance of their SIFT descriptors to deal with large geometric transformations and luminance changes. A SIFT descriptor describes the distinctive invariant feature of a local image region, which consists of the location, scale, orientation, and feature vector. The key-point location and scale are determined by finding the maxima and minima of the difference of Gaussian filtered signals. The feature vector is a 128-dimensional vector which characterizes the local region by the histogram of the gradient directions, and the orientation denotes the dominant direction of the gradient histogram. SIFT descriptors have been demonstrated to have a high level of distinctiveness and thus are widely used in image search and object recognition.

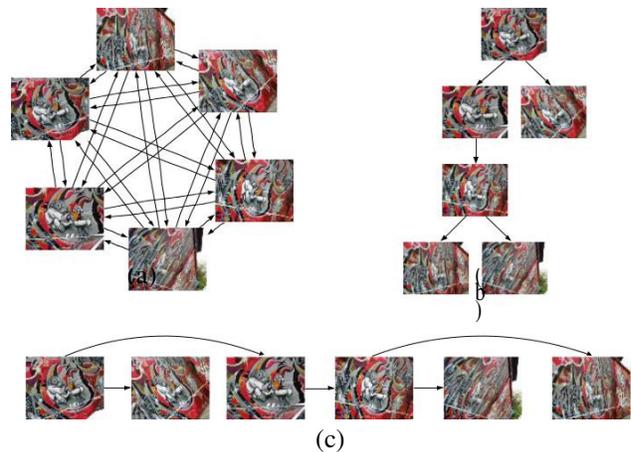


Fig 3.3: Feature-based determination of prediction structure

(a) Directed graph in which each node denotes one image and arrows denote the prediction paths between images. (b) The MST deduced from the directed graph (a) by minimizing the total predictive cost. (c) Prediction structure determined by depth-first traversing the MST.

3.2 SPATIAL DOMAIN DISPARITY COMPENSATION

Given the prediction structure of an image set Π , we then perform the spatial-domain disparity compensation to better exploit the correlations between images as well as image regions. As illustrated in Fig. , the root image in each MST is intra coded and compensated in the local compensation module. The other images are coded in reference to their parent images. Both the global and local compensations are performed on the reference image to approximate the corresponding target image.

3.3 FREQUENCY-DOMAIN REDUNDANCY REDUCTION

After the disparity compensation, the redundancy between the target and compensated blocks will be reduced by calculating the residual signal. In all previous image set compression schemes, the residual signal is generated in the spatial domain. On the other hand, JPEG coded images are quantized during lossy compression. It enables us

to introduce the quantization in the frequency-domain redundancy reduction. In our scheme, we generate the residual signal between quantized DCT coefficients of the target and compensated blocks. Quantized DCT coefficients of the target JPEG coded image can be acquired by the JPEG entropy decoding. We then perform the same 8_8 DCT

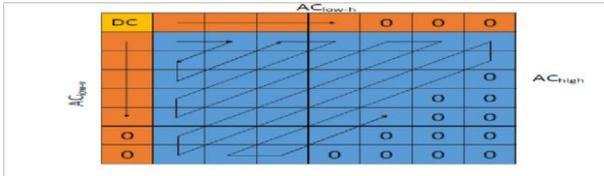


Fig 3.4 Four Partition of 8X8 DCT transform as well as the quantization of the JPEG coded image on the corresponding compensated block. The residual signal is generated by calculating the difference between the two sets of quantized DCT coefficients.

3.4 ENTROPY CODING

In information theory an entropy encoding is a lossless data compression scheme that is independent of the specific characteristics of the medium. One of the main types of entropy coding creates and assigns a unique prefix-free code to each unique symbol that occurs in the input. Besides using entropy encoding as a way to compress digital data, an entropy encoder can also be used to measure the amount of similarity between streams of data and already existing classes of data. This is done by generating an entropy coder/compressor for each class of data; unknown data is then classified by feeding the uncompressed data to each compressor and seeing which compressor yields the highest compression. The coder with the best compression is probably the coder trained on the data that was most similar to the unknown data.

IV. SIMULATION AND RESULTS

For the above proposed work discussion work is to implement with the help of Mat Lab tool, The original JPEG image Compressed and analysis it compression ratio,PSNR and Mean sation, and frequency-domain redundancy reduction, will be introduced in greater detail.



Fig 4.1 Input image



Fig 4.2 Compressed image

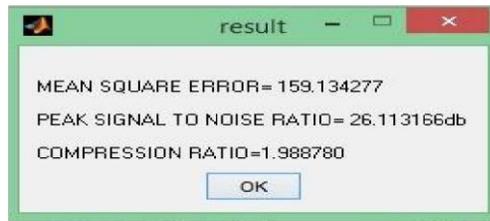


Fig 4.3 Compression Ratio and Mean of Compressed Image

V. CONCLUSION

In this paper, we propose a new hybrid compression method to further reduce the file size of JPEG coded image collections without any fidelity loss. In our proposed method, we determine the prediction structure of each image collection by a

feature domain distance measure. The disparity between images is then reduced by joint global and local compensations in the spatial domain. In the frequency domain, the redundancy between the compensated and target images is reduced and the remaining weak intra correlations are further exploited in our entropy coding. By exploiting the correlations in the feature, spatial, and frequency domains, our scheme achieves up to 48.4% bit-savings and outperforms all state-of-the-art JPEG recompression schemes. We believe it can greatly reduce the storage cost for backup and archive of JPEG coded image collections for both personal and cloud applications. In this paper, we focus on the efficient compression method for a set of clustered JPEG images. We notice that the clustering can be time consuming if one collection is too large. Possible solutions may involve advanced fast clustering methods and introducing assistant information. For example, we can make use of the time stamps or GPS information in the meta data of images to separate a large collection to smaller ones. We would like to pay attention to reduce the complexity of the clustering module for large scale image sets in our future work. Besides, the performance of our proposed scheme could be further improved in several ways. First, we could speed up the encoding and decoding process by introducing parallel techniques. Second, we can further reduce the complexity of the local compensation in our scheme by not only leveraging some fast algorithms proposed for HEVC but also reducing complexity by direct operating on the JPEG coded DCT coefficients. Finally, we notice that the feature-based distance approximation may not be always efficient. In the future, we would like to investigate advanced distance metrics in which the number as well as the overlapped area of matched features are taken into account. We may also introduce a light weight version of the distance metrics so that the pixel-domain distance between two images can be measured much more accurately at low computational cost.

VI. REFERENCES

- [1] R. C. Gonzalez, R. E. Woods and S. L. Eddins, "Digital Image Processing Using MATLAB," Pearson Prentice Hall, Upper Saddle River, 2003.
- [2] K. D. Sonal, "Study of Various Image Compression Techniques," Proceedings of COIT, RIMT Institute of Engineering & Technology, Pacific, 2000, pp. 799-803.
- [3] M. Rabbani and W. P. Jones, "Digital Image Compression Techniques," SPIE, Washington. doi:10.1117/3.34917
- [4] D. Shapira and A. Daptardar, "Adapting the Knuth-Morris-Pratt Algorithm for Pattern Matching in Huffman Encoded Texts," Information Processing and Management, Vol. 42, No. 2, 2006, pp. 429-439. doi:10.1016/j.ipm.2005.02.003
- [5] H. Zha, "Progressive Lossless Image Compression Using Image Decomposition and Context Quantization," Master Thesis, University of Waterloo, Waterloo.
- [6] W. Walczak, "Fractal Compression of Medical Images," Master Thesis, School of Engineering Blekinge Institute of Technology, Sweden
- [7] R. Rajeswari and R. Rajesh, "WBMP Compression," International Journal of Wisdom Based Computing, Vol. 1, No. 2, 2011. doi:10.1109/ICIIP.2011.6108930
- [8] M. Poolakkaparambil, J. Mathew, A. M. Jabir, D. K. Pradhan and S. P. Mohanty, "BCH Code Based Multiple Bit Error Correction in Finite Field Multiplier Circuits,"
- [9] B. Ranjan, "Information Theory, Coding and Cryptography," 2nd Edition, McGraw-Hill Book Company, India, 2008.