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Scanned Multifarious Image Compression Using RD Segmentation Techniques

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ABSTRACT

The proposed system to overcome this drawback, the technique described here utilizes the R-D Optimization segmentation technique to segment the compound document into smooth and non-smooth image. The modified MMP techniques which include quad tree based segmentation for image and binary tree based segmentation for non-smooth image is used, which greatly reduce the complexity of segmentation in the given image. The proposed Compression algorithms are efficiently, improved the quality of scanned images, reducing the cost functions and to improve the compression ratio. Effectively reduce the encoding time while retaining the quality of the retrieved.

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INTRODUCTION

A. Scanned Compound images:

Compound images are the images containing both smooth and the non-smooth parts**.** An important part of this process is the scanning of paper documents. However, the generation of a large number of scanned document images arises the problem of efficiently coding them. A straightforward approach to it is to encode such images using traditional state-of-the-art image encoders like SPIHT, JPEG, JPEG2000, or H.264/AVC Intra. However, they are not capable of achieving a satisfactory performance for non-smooth image regions, like the ones corresponding to text or graphics, frequently present in scanned documents. Or smooth images, most of the transform coefficients representing the highest frequencies are of little importance, allowing their coarse quantization. This leads to a high compression ratio without compromising the perceptual quality of the reconstructed images. However, when the input image does not present a low-pass nature, the coarse quantization of these high frequency coefficients results in highly disturbing visual artifacts, like ringing and blocking. An alternative is the use of encoding methods specifically developed for text-like image coding, like JBIG. Unfortunately, such algorithms tend to have serious limitations when used to encode smooth regions of compound images. Several algorithms, like Digipaper, DjVu, and JPEG2000 have been proposed for compound document compression. They adopt the MRC (Mixed Raster Content) model in order to decompose the original image in several distinct layers. Despite the popularity of the MRC model for compound image compression, it has some limitations like the segmentation process for separating an image and text is not accurate. It loses effectiveness when the document's complexity increases. A pixel classification error occurs. Unlike synthetic or computer generated documents, these images cannot be easily segmented into foreground and background objects; as a consequence, state-of-the-art compound document encoders tend to have poor results. When DjVu is used for compressing scanned compound image, the scanning process degrades the character's crisp edges, causing their erroneous inclusion in the background layer. As this layer is coded using a wavelet based algorithm, the coarse quantization of its high frequency coefficients results in illegible characters in the text. This is an important drawback, as it can compromise the legibility of the document. To overcome such drawbacks, a novel compound document encoder based upon the multidimensional multiscale parser algorithm (MMP) was introduced. This algorithm uses an adaptive dictionary of vectors, formed by recursively parsing previously encoded blocks of data, in order to recurrently approximate variable-length blocks of the input image. This process can be regarded strategies used in Lempel-Ziv encoders and standard Vector

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Quantization (VQ), with the introduction of an important principle: multiscale approximate pattern matching. A block classification scheme is used to separate pictorial macro blocks of text and graphic ones. Each of these two types of macro blocks is then encoded using a version of the MMP algorithm specifically designed to encode it. The limitation of this MMP algorithm is that the block classification error cannot be identified and the cost in coding efficiency is also greatly high. Hence, to overcome such drawbacks, in our proposed model morphological transformations and R-D segmentation is implemented. The modified MMP techniques are introduced for the segmented image blocks and text blocks. This eliminates the pixel classification error, thereby reducing the redundant information. The storage capacity will be increased and the compression ratio also increases. Finally the quality of the image will be improved greatly.

B. MMP (Multi dimensional Multi scale Parser):

a. MMP-FP (Multi dimensional Multi scale parser-Flexible Partitioning):

The previous versions of the MMP algorithm use a fixed dyadic block partitioning scheme. An NxN square block could be either split in two NxN/2 blocks or, alternatively, two NxN/2 blocks. In the fixed partition scheme, it was always chosen one of the two options. A case is referred where square blocks are divided in the vertical direction as vertical segmentation. For example, considering 8x8 input blocks and the use of vertical segmentation, there would be seven different scales: 8x8, 4x8, 4x4, 2x4, 2x2, 1x2 and 1x1. However, experimental results demonstrate differences of up to 0.4 dB in the signal-to-noise ratio (PSNR), depending upon MMP using a vertical segmentation or a horizontal segmentation direction. This observation indicates a limitation in the MMP's capability to adapt freely to the image structure, with costs in the coding efficiency. Gains could be achieved if the algorithm could divide each block either in horizontal or vertical directions, in order to minimize the Lagrangian representation cost. Such flexible segmentation schemes have already been known to improve the performance of other block based image encoders. In MMP-FP (Flexible Partition), the index that minimizes the Lagrangian cost of the representation of a given block X^l is determined using the same procedure as in the conventional MMP algorithm. Nevertheless, there is an important difference in the block segmentation procedure: every sub block is segmented in both the horizontal and vertical direction the one which contributes towards the smaller overall Lagrangian cost is chosen. From the bottom of the segmentation tree up, the Lagrangian cost function for each segmentation option is evaluated, and the option with lower cost is chosen. In other words, the child nodes generated by the segmentation direction with higher cost are pruned. If the lowest Lagrangian cost corresponds to a non segmentation decision (i.e., the block corresponds to a tree leaf), then all child nodes are pruned. In order to achieve this, the segmentation flags must be three-valued, indicating if the block should be split in the vertical direction, in the horizontal direction, or not split at all. It is important to note that, due to the pruning step, the optimized segmentation tree keeps the binary structure, since each block is either split into two sub blocks or kept in its original size. It is important to note that this improved partitioning scheme originates new scales in the dictionary. For example, in the case of a 16X16 block size, the original MMP block segmentation procedure only uses square and rectangular blocks with 2:1 proportions, generating a total of 9 different scales (16x16, 16x8,8x8,\ldots, 1x1). On the other hand, the new block segmentation scheme may generate blocks of 25 possible scales (16x16,16x8, 8x16 (new), 16x4 (new), 4x16 (new), , 1x1), with no restriction on the aspect ratio, meaning that all blocks with dimensions 2^m x 2^n are available are available, for m,n=0,….4.

The disadvantage of using the MMP-FP technique is that, the blocks are segmented either horizontally or vertically and hence there is an improved chance of obtaining high redundancy of data's. Due to thus the encoding time will be increased. Since segmentation is performed vertically or horizontally there may be a heavy loss in pixels.

b. MMP-Text (Multi dimensional Multi scale Parser-Text):

The MMP - Text algorithm is implemented, in order to optimize it for efficiently coding non-smooth regions. We refer to the resulting MMP-based codec as MMP-text. By investigating the effectiveness of predictive coding in non-smooth image coding, the experiments carried out showed that the prediction is of little utility for text images. High frequency transitions compromise the accuracy of the prediction stages, resulting in residue blocks with an energy level close to that of the original block. As a consequence, the number of bits spent to encode the Prediction plus the predicted residues is often higher than the number of bits spent to encode the block with a non-predictive approach. This difference tends to increase when flexible segmentation is used. This is so because in flexible segmentation the number of prediction blocks tends to be higher, and so is the overhead spent for encoding the prediction modes. This led us not to use the prediction stage in the MMP - text.

Similar to the procedure of MMP-FP slight modifications are performed in MMP-Texts.

The disadvantage of using the MMP-Text technique is that, the blocks are segmented either horizontally or vertically and hence there is an improved chance of obtaining high redundancy of data. Due to thus the encoding time will be increased.

Since segmentation is performed vertically or horizontally there may be a heavy loss in pixels.

II Proposed Technique:

In the proposed system, with the help of morphological operators the noise present in the foreground and the background layers of the input image is eliminated with the help of top hat and bottom hat filters. The input image is then subjected to R-D segmentation where the image regions and the text regions are completely segmented. With the R-D segmentation the further distortions present in the image are removed. Modified MMP-Text encoding technique is applied to the text blocks and modified MMP-FP encoding techniques are applied to the image blocks. Here Binary Tree based segmentations apply to the text blocks. That is the blocks are segmented horizontally or vertically till the maximum level. This greatly reduces the redundancy of data's. The high cost blocks in the tree based segmentation are pruned away. They are then applied to the Integer wavelet transformations where the pixels from the spatial domain are converted to the frequency domain and the signals are passed. The integer values are rounded off by the quantization process and finally the compressed, encoded text blocks are obtained. The encoded blocks are then assigned with the code vectors for dictionary matching purposes. Adaptive Dictionary for non-smooth side is created for storing away the existing encoded text blocks. The encoded blocks in the dictionary are maintained in the tree format. The same technique is applied for the smooth part where modified MMP-FP techniques are used. The image blocks are subjected to quad tree based segmentation where the smooth parts are split into four quadrants recursively. This process will continue and at the end of this quad tree segmentation process all the blocks will be of the same pixel value. From that only the least cost blocks are selected pruning away the high cost blocks. The similar procedure as in the modified MMP-Text is applied till the compressed encoded blocks are obtained. And the adaptive tree based dictionary for the smooth part is created for traditional pattern matching methods. The concatenation of both compressed smooth and non-smooth encoded blocks give the compressed output image which is then subjected to decompression technique. This decompression is just the inverse process of the compression technique.

a. R-D Segmentation:

As explained earlier the input compound image after subjected to the morphological operations for the noise removal undergoes the R-D Segmentation process. -D Segmentation stands for Rate Distortion segmentation where segmentation takes place diving the compound document into smooth and non-smooth part. The smooth part is the region containing only the image blocks and non-smooth part is the region containing only the text/graphics. They are classified based on the threshold values of the images and texts. The block segmentation technique used previously segments the image into text blocks, image blocks and complex blocks. The complex blocks are the blocks intermediate to text blocks and the image blocks which again should be segmented into smooth and non-smooth blocks. To avoid this complexity R-D Segmentation technique is implemented to completely segment the smooth regions from the non-smooth regions easily and quickly.

b. Decompression:

The decompression technique is the inverse process of the compression technique. The compressed output is subjected to decompression technique in order to retrieve the original image. The compressed output is matched with the least nodes both with the text encoded block and image encoded block present in the adaptive dictionary. If the least cost blocks are satisfied with the compressed output, then the entire tree is considered with the use of code vector and scale dimensions. The inverse transformation is applied for both the text encoded blocks and the image encoded blocks where the frequency domain in converted back into the spatial domain. Binary tree based labeling is applied to the non-smooth regions and the quad tree based labeling is applied to the smooth regions. The concatenation of the smooth and non-smooth blocks make the original image to be retrieved. Using the morphological operators, the noise present in the image is eliminated and a noise free enhanced original image is obtained.

III. Comparision of Results and Discussions:

Table I: Table for Psnr Value &Compression Ratio.

Types of Algorithm	Range Blocks	Compression Ratio	Encoding Time in msc	PSNR in db
JPEG2000	4×4 8×8	6.73:1	2370	26.22
DjVu	4×4 8×8	13:1	347	24.43
H.264	4×4 8×8	1.89:1	6500	34.39
MMP	4×4 8×8	6.73:1	5390	28.86
MODIFIED MMP	4×4 8×8	6.66:1	4200	30.20

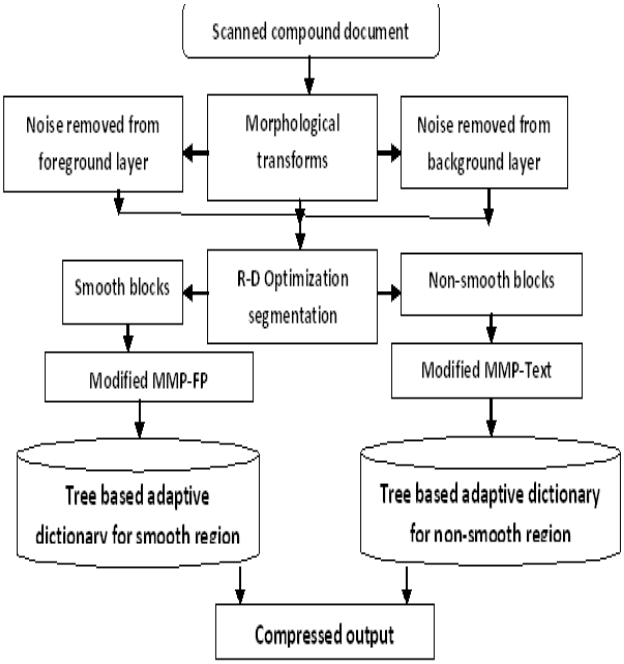

Fig. 1: Proposed System Architecture.

IV. Experimental Analysis:

System performance is an important part of the project as it evaluates the efficiency of the system developed.

In this project, the Peak Signal to Noise Ratio (PSNR) is used to measure the performance of the system. The MMP encoder has been used to compress a number of scanned compound images and the quality of the compressed images is measured using the PSNR values and compression ratio. The quality of the original image is shown in Fig 2 and reconstructed image are same.

Fig. 2: Input Scanned Compound Document.

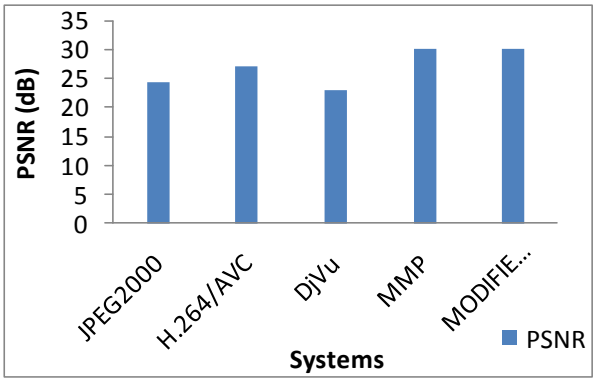

Fig. 3: Comparison Graph for PSNR.

The comparative performance of proposed system with the other encoders is shown in Table I. The bar chart in Fig 2I has been plotted for these values. From this graph, it can be seen that the performance of the proposed system is comparable with JPEG2000, H.264/AVC, DjVu and significantly better than MMP.The PSNR value is found to be 30.20db and the compression ratio is found to be out performance of existing one. Encoding time and compression ratio are also used to measure the performance of the compressed image.

V. Conclusion:

The input scanned compound image when subjected to the R-D Optimization segmentation technique, the compound image is segmented into smooth and non-smooth blocks effectively. The modified MMP techniques which include quad tree based segmentation for image and binary tree based segmentation for non-smooth image is used, which greatly reduce the complexity of segmentation in the given image. The proposed Compression algorithms efficiently improve the quality of scanned images, reduce the cost functions and improve the compression ratio. It also effectively reduces the encoding time while retaining the quality of the retrieved image.

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