Enhanced Hybrid Compression Methods for Compound Images

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Abstract **-This work presents an efficient compound image compression method based on object, block and layer–based segmentation techniques, which introduces a new hybrid scheme for segmenting compound images. Effective compound image compression algorithms require compound images to be first segmented into regions such as text, pictures and background to minimize the loss of visual quality of text during compression. This work discusses the relative advantages of each scheme and studies the use of fast classification techniques for segmentation that can be used together with chosen compression architecture. The algorithms have been developed and implemented to compress and decompress the given image using suitable techniques for each method in a MATLAB platform. The performance metrics like Compression ratio, PSNR, Compression and Decompression time are tested for six models.**

Keywords- Compound Image, Object Based, Saliency Map, Segmentation.

I. INTRODUCTION

Images are the most common and convenient means of conveying or transmitting information. A picture is worth a thousand words. An image is a data representing a two-dimensional scene. A digital image is composed of pixels arranged in a rectangular array with a certain height and width [1]. Each Pixel may consist of one or more bits of information representing the brightness of the image at that point and possibly including color information encoded as RGB triples.

Compound images are combinations of text, graphics and natural images. Compound Images are used widely for sharing of desktop images, storing and distribution of images. Compound images are basically represented in two forms,

- Vector
- Raster

The rasterized images which are the compound images are the bitmaps containing mix of text, graphics and natural image. The vector images are made up of basic geometric shapes such as points, lines and curves. Compound images are used in PowerPoint Presentation, wallpapers and web pages. Compound images are also very helpful in the area of cloud computing where the images can be displayed to remote clients [2]. The main goal of compound image analysis is to recognize the various regions of an image and incorporate compression that is appropriate for each region.

II. SEGMENTATION APPROACHES

Compound Image is a combination of text, graphics and pictures. Compound Images can be classified and compressed based on block based and layer based and object based classification methods.

A. Block Based

Block based approach divides an image into blocks of regions. Each region follows approximate object boundaries and is made of rectangular blocks [3]. Block-based segmentation algorithms are developed mostly for grayscale or color compound images.

B. Layer Based

In layer based classification method, image is divided into rectangular layers, which can have one or more objects and mask planes. Most layered coding algorithms use the standard three layers Mixed Raster

Content (MRC) representation. Foreground plane is poured into background plane through the mask or selector plane [4].

C. Object Based

In this segmentation method, an image is divided into regions in which object boundaries are found exactly. The object may be a Text, Picture or a graphical object. Most of the researchers found that this type of segmentation is more complex than other methods [4].

III. EXISITING SYSTEM

A. Block Based Compound Image Compression

This model uses the AC coefficients introduced during DCT to segment the image into three blocks such as: background, text/graphic and image blocks. This algorithm works by using AC energy thresholding for background block segmentation and for remaining blocks classification, K-means clustering of feature components were generated for each block [5]. The k-means clustering method is applied to the smooth block and non-smooth blocks clearly segments the text block and image block. The Text block is compressed using Deflate algorithm and the Image block is compressed using JPEG.

B. Layer Based Compound Image Compression

In this method, the first stage of segmentation splits the compound image into region of bright and dark background. The second stage is a refinement step which designs binary segmentation mask accurately based on top hat transform in order to partition the compound image into two layerssuch as the background layer and the foreground layer.The foreground layer contains colors of text, and the background layer contains continuous tone, halftone pictures and background colors. The mask layer contains contours of text and other fine image structures [8]. The foreground and the background layers are compressed using JPEG 2000 and the mask layer is compressed using JBIG.

C. Compound Image Compression Using Hybrid Method1

In this model, the compound image is divided into 16x16 blocks. Using the gradient values and a combination of decision rules, the block is classified into five different regions which are background block, text block, picture block, graphics block and overlapping blocks. The layer based segmentation is applied tothe overlapping block. The overlapping block uses the layer based approach to segment the block into three layers text, picture and mask [6]. The text layer is compressed using token based coder. The Mask layer is compressed using JBIG (Joint Bi-level Image Experts Group) algorithm. The picture layer is compressed using the JPEG coder.

IV. PROPOSED SYSTEM

A. Object Based Compound Image Compression

In this method, the compound image is segmented using the saliency map and the segmented regions are compressed using the suitable compression algorithms.

The saliency map takes the following steps: feature map creation using feature information, conspicuity map creation, and saliency map creation through the various thresholding and combining method of conspicuity map.

$$\bar{I} = \bigoplus_{c=2}^{4} \bigoplus_{s=c+3}^{c=4} N(I(c,s)) \tag{1}$$

$$\bar{C} = \bigoplus_{c=2}^{4} \bigoplus_{s=c+3}^{c+4} \left[N\left(RG(C,S)\right) + N(BY(c,s))\right] \tag{2}$$

$$\bar{O} = \sum_{\theta \epsilon \{0°,45°,90°,135°\}} N\left(\bigoplus_{c=2}^{4} \bigoplus_{s=c+3}^{c+4} N(O(c,s,\theta) \right) \tag{3}$$

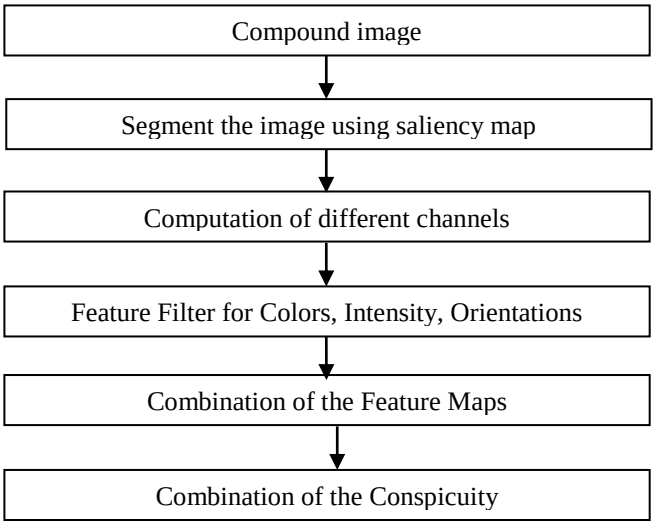

Figure 1. Block Diagram for Object based Compound Image Compression

The feature maps for intensity (I), color (C) and orientation (O) are normalized and added to calculate the conspicuity maps. The feature maps are combined into three conspicuity maps. The conspicuity maps are obtained through across-scale addition by reducing each map to the lowest resolution and point-by-point addition.To compute saliency map

$$s = \frac{1}{3} N(\overline{I}) + N(\overline{C}) + N(\overline{0}) \quad (4)$$

The equation (1) is used to calculate the conspicuity map for Intensity (I) and the equation (2) is used to calculate the conspicuity map for Color(C) and the equation (3) is used to calculate the conspicuity map for Orientation (O).

The three conspicuity maps are normalized and summed as final input *S* to the saliency map using the equation (4).

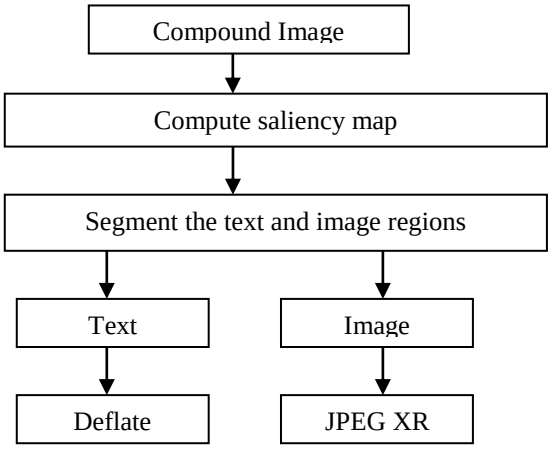

Figure 2. Block Diagram to Compute the Saliency Map.

The text region is compressed using lossless Deflate algorithm which is a combination of both LZ77 and Huffman algorithm. The image region is compressed using new compression standard JPEG XR as shown in Figure 2.

A new image compression standard, JPEG eXtended Range (JPEG XR) has been developed which addresses the limitations of currently used image compression standards.JPEG XR use Lapped Biorthogonal Transform (LBT) to convert image samples into frequency domain coefficients as shown in Figure3. LBT is integer transform and it is less computationally expensive than DWT used in JPEG2000. It reduces blocking

artifacts at low bit rates as compared to JPEG. JPEG XR mainly targets to increase the capabilities of existing coding techniques and provides high performance at low computational cost.

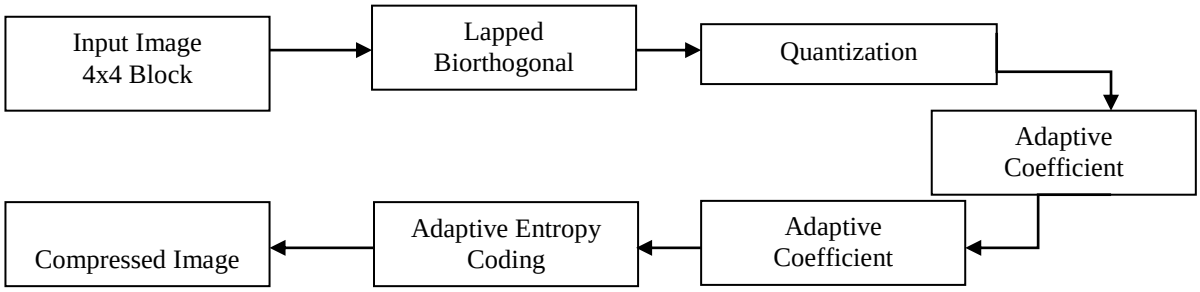

Figure 3. Block Diagram for JPEG XR.

D. Compound Image Compression Using Hybrid Method2

In this model, the compound image is divided into 16x16 blocks. Using the gradient values and a combination of decision rules, the block is classified into five different regions which are background block, text block, picture block, graphics block and overlapping blocks. The overlapping block is dealt with separately and uses the object based approach to segment the block into text and image region.

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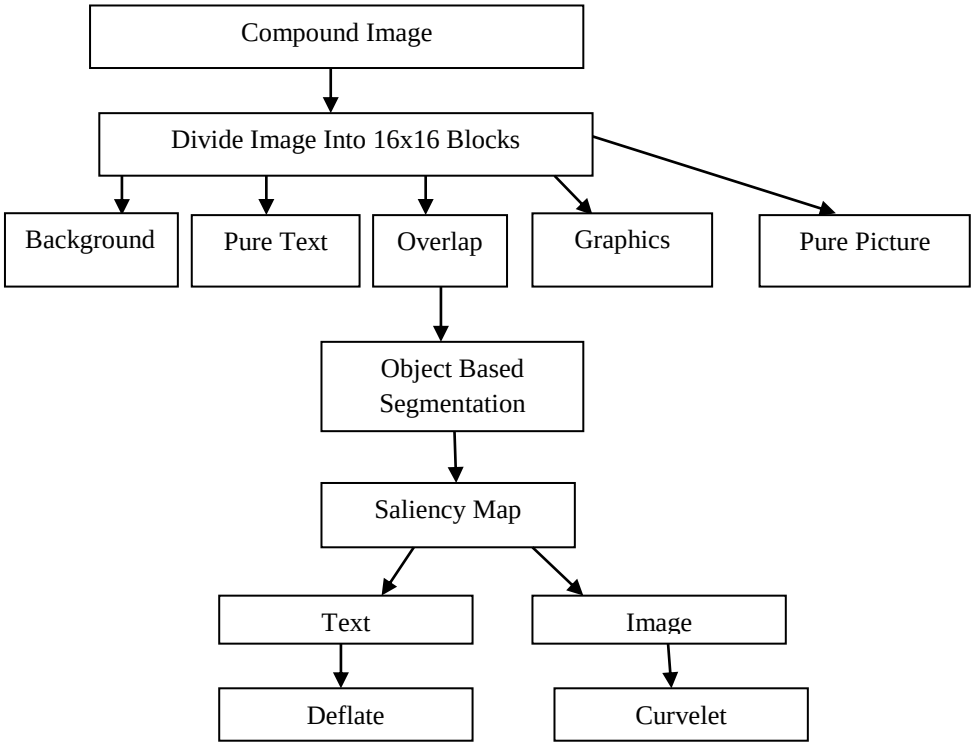


Figure 4. Block Diagram for Compound Image Compression using Hybrid Method2

The figure 4 shows that the text region is compressed using Deflate algorithm. Image region is compressed using Curvelet Transform.The curvelet is the extension of wavelet but there also exist correspondence between wavelet subband and curvelet subband [9]. In wavelet transform, there is limitation of representing discontinuity in edge using wavelet transform. Curvelet transform is solution of such problem.

E. Compound Image Compression Using Hybrid Method3

In this model, the image is decomposed based on Region Classification (RC) decomposition in MRC model in which the regions containing graphics and text are represented in a separate Foreground layer and it includes letters, blank spaces of text. The mask layer contains colors of text. The Background layer contains the picture. The mask layer clearly differentiates the text, graphic regions and the background contains the background image and complex graphics.

The saliency map is created for foreground and background layers. Based on the Histogram and Gradient features, text and Image regions are segmented. The Text region is compressed using Deflate algorithm. Curvelet Transform technique is applied for image compression as shown in figure 5.The deflate standard is often used in images, where human perception of potential data loss is leveraged to improve the compression efficiency [7].

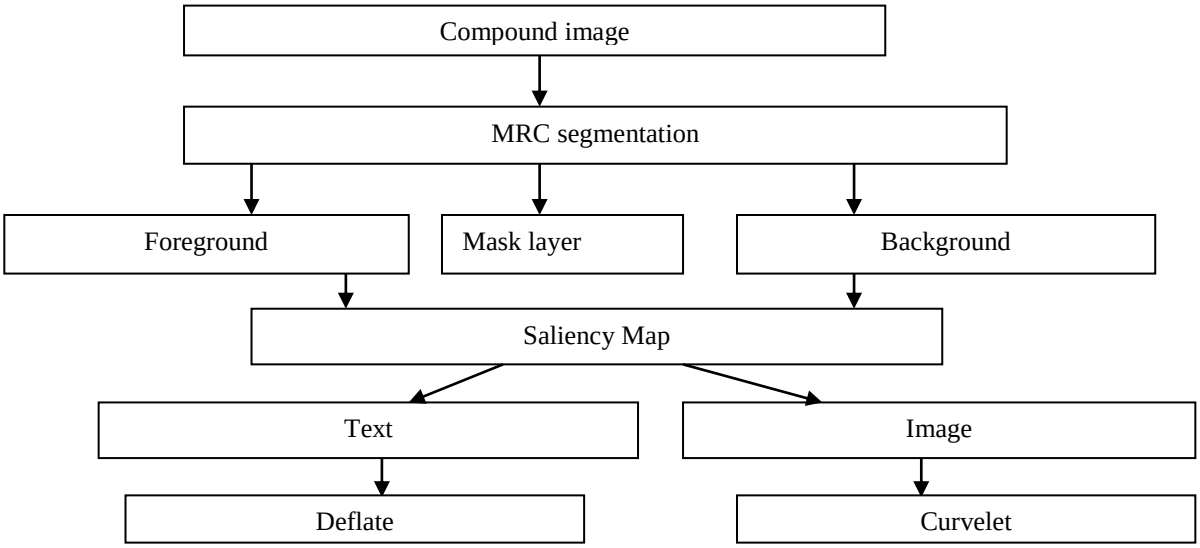
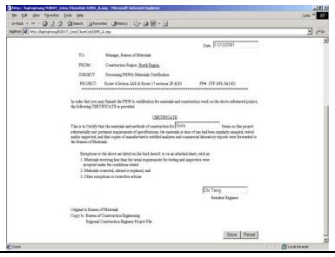


Figure 5. Block Diagram for Compound Image Compression using Hybrid Method

V. RESULTS AND PERFORMANCE ANALYSIS

In order to verify the performance of proposed algorithms, experimental evaluation is performed using a variety of images. For experimentation, six images like PPT Image, Pure Text Image, Pure Picture Image, Compound Image1, Compound Image2 and Desktop Image have been used for testing as shown in Table 1.

Table 1.Test images used.

Compound Image 	**Compound Image2** 	**Desktop Image** 
Ppt Image 	**Pure Text** 	**Pure Picture** 

In order to verify the performance of proposed algorithms, experimental evaluation is performed using a variety of images. For experimentation, six images like PPT Image, Pure Text Image, Pure Picture Image, Compound Image1, Compound Image2 and Desktop Image have been used for testing as shown in Table 1. The images were selected in a way that they were a combination of all classes of compound images. All the images were of the size 256x256 pixels.

Table 2. PSNR for Images based on Six Compound Image Compression Techniques.

Images	Block Based (in db)	Layer Based (in db)	Object Based (in db)	Hybrid Method1 (in db)	Hybrid Method2 (in db)	Hybrid Method3 (in db)
Compound Image1	18.74	21.66	23.95	25.96	28.58	31.36
Compound Image2	18.26	21.78	22.71	25.77	28.20	32.47
Desktop Image	19.14	19.46	22.08	26.09	29.04	31.44
PPT Image	18.09	21.17	22.22	24.56	28.09	31.05
Pure Text	19.18	21.90	22.09	25.15	27.96	32.08
Pure Picture	18.96	19.70	22.85	24.42	28.17	31.32

Table 3. Compression Time for Images based on Six Compound Image Compression Techniques.

Images	Block Based (in secs)	Layer Based (in secs)	Object Based (in secs)	Hybrid Method1 (in secs)	Hybrid Method2 (in secs)	Hybrid Method3 (in secs)
Compound Image1	1.95	0.33	1.21	3.53	1.28	0.38
Compound Image2	1.53	0.32	0.82	1.71	0.14	0.35
Desktop Image	0.89	0.31	0.74	2.40	0.07	0.28
PPT Image	1.43	0.39	0.70	1.84	0.10	0.31
Pure Text	0.90	0.32	0.70	1.57	0.08	0.26
Pure Picture	1.19	0.31	0.72	1.67	0.10	0.33

Table 4. Decompression Time for images based on Six Compound Image Compression Techniques.

Images	Block Based (in secs)	Layer Based (in secs)	Object Based (in secs)	Hybrid Method1 (in secs)	Hybrid Method2 (in secs)	Hybrid Method3 (in secs)
Compound Image1	1.62	0.23	0.52	0.15	0.13	0.10
Compound Image2	2.47	0.24	0.35	0.17	0.12	0.12
Desktop Image	0.74	0.22	0.30	0.19	0.126	0.123
PPT Image	1.29	0.92	0.29	0.30	0.17	0.13
Pure Text	0.72	0.26	0.36	0.16	0.127	0.125
Pure Picture	1.04	0.23	0.32	0.16	0.125	0.123

The main objective of the tests was to find which of the proposed algorithms is best suited for Compound Image Compression. The quality measures like PSNR, Compression Time and Decompression Time for the test images are shown in the tables below.The Peak Signal to Noise Ratio is used as a quality measurement between the original and the decompressed image.Higher PSNR valuerepresents the better quality of compressed or reconstructed image. The PSNR values for the all the test images are shown in the Table 2.

The compression time and decompression time is defined as the amount of time required to compress and decompress an image respectively. This quality parameter shows the speed and complexity of the compressed image. The Compression Time for all the six test images is shown in the Table 3. The Decompression Time for all the six test images is shown in the Table 4.

VI. CONCLUSION

The Compound Image Compression Techniques like Block Based, Layer Based, Object Based, Hybrid Method1 (Block+Layer) are the existing techniques in Compound Image Compression. Since there are limitations in the existing techniques, the two enhanced hybrid methods are proposed. Most of the researchers have used only the block and layer based compound image compression due to its simplicity. But in the proposed work, the effort is taken in the object based compound image compression also. To avoid the

limitations in the existing techniques, the proposed hybrid methods were segmented and compressed in an efficient way.

The object based method uses the saliency map for segmentation and uses the JPEG XR for image compression. The Proposed Hybrid Methods uses the Curvelet Transform for compound image compression while the existing techniques used the wavelet and wavelet packet for compression. The quality parameters like PSNR, Compression Time and Decompression Time are calculated for six images. Based on the experimental results, the proposed Hybrid Method3 (Layer+Object) results with the high PSNR value for all the images.

REFERENCES

[1] Rafael C. Gonzalez, Richard E. Woods, and Steven L. Eddins, "Digital Image Processing: using MATLAB", Pearson Prentice Hall, First Edition, 2004.

[2] Said, A. Compression of compound images and video for enabling rich media in embedded systems, PIE/IS&T Visual Communications and Image Processing Conference, SPIE Proc. Vol. 5308, PP. 69-82, 2004.

[3] M. Sundaresan and S. Annadurai. "Block Based Compound Image Compression Using Wavelets And Wavelet Packets", IETECH Journal of Advanced Computations, Vol. 3, No. 3, PP. 74 – 79, 2009.

[4] Mtimet,J. and Amiri.H, "A layer-based segmentation method for compound images",10th International Multi-Conference on Systems, Signals & Devices (SSD), 2013.

[5] P. Mahesh, P. Rajesh, I. Suneetha, "Improved Block Based Segmentation for Jpeg Compressed Document Images", IJRET: International Journal of Research in Engineering and Technology, ISSN: 2319-1163 pISSN: 2321-7308", Vol. 02, No. 11, 2013.

[6] Maheswari,D. and Radha V. Enhanced Layer Based Compound Image Compression, Proceedings of the First Amrita ACM-Celebration of Women in Computing ISBN: 978-1-4503 0194-7, PP. 209-216, 2010.

[7] M.Sundaresan and E.Devika, "Efficient Integrated Coding for Compound Image Compression", International Journal of computational Intelligence and informatics, Vol. 2: No.2, September 2012.

[8] S. Ebenezer Juliet , V. Sadasivam ,D. JemiFlorinabel, "Effective layer-based segmentation of compound images using morphology", J Real-Time Image Proc (2014) 9:299–314, DOI 10.1007/s11554-011-0223-8Springer, 2011.

[9] Swati D. Pethapara, Devendra Patel, BhumikaMakwana, "Comparison of Image Compression Techniques Using Wavelet and Curvelet Transform", International Journal of Engineering Sciences & Research Technology, January 2014.