ISSN: 2278 – 7798
International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 2, Issue 3, March 2013

CONTENT BASED IMAGE COMPRESSION TECHNIQUES: A SURVEY

Salija.p, Manimekalai M.A.P, Dr.N.A Vasanti

Abstract— **There are many image compression methods which compress the image as a whole and not considering the devices storage and resources. The application of multimedia devices has developed during the recent years which results in insufficient bandwidth and the storage space in each device. The term compression becomes more and more significant for the storage space conserving and other requirement. Compression reduces the redundancy and encodes the data with fewer bits thus reduce the consumption of the devices resources, storage space, network bandwidth etc. content based compression become more significant in the field of medical and multimedia compression in order to preserve the important region in an image. Content based image compression with less computational complexity is important in the field of resource limited multimedia devices. This paper reviewed different types of compression methods. These methods are compared with each other using PSNR and computational complexity associated for each method.**

***Index Terms*— compression, computational complexity, mobile multimedia, spatial scalable, resource limited, Seam, SPIHT etc .**

I. INTRODUCTION

Image compression process reduces the total number of bits required for representing original image in storage or transmission purpose. Due to the rapid increase in multimedia, sensor, medical application, it requires to reduce the amount information for the purpose of efficient storage and transmission. These methods require content based image compression without losing the important information with less computational complexity for resource limited mobile multimedia devices. Compression [1] is to reduce the redundancy for storing the bits as compact as possible and to display the original image at the decoder side with quality. The first thing is to reduce the correlation between the adjacent pixels. Similarity between the adjacent pixels is very high. So it is necessary to reduce the correlation, there are many methods such as subband coding, predictive coding, orthogonal coding etc. the main aim of quantization is to reduce the precision and to achieve high compression ratio. So that the bits required to storing is reduced. Entropy encoding is to achieve less average length of the image. The basic block diagram for image compression is shown in figure1. Decoding is the reverse process of encoding steps. The main blocks are quantization and entropy coding. Original image may be color or gray. For color images we need to convert it into RGB to YCbCr format for compression. but the image compression for resource limited devices becomes more challenging due to the requirements of that devices.

We know that, there are many multimedia [12] devices with different resolutions in the market. They share the same content as in the internet or from other devices. As the size of display device is continue to changing the quality of shared content is also get reduced. Users want see good quality images in their devices, these devices are restricted by their display devices size and resources. Content based image compression with less computational complexity is important in these types of devices and also to retarget images in the receiver side with quality is an important challenge. PSNR value is used for evaluating the performance of compressed image, it estimates the difference between the original image and the decode image.

$$\text{PSNR} = 20log_{10}\frac{255}{MSE} \quad (1)$$

$$\text{MSE}=\sqrt{\sum_{x=0}^{W-1}\sum_{y=0}^{H-1}[p(x,y)-p'(x,y)]^2} \quad (2)$$

Where, p(x, y) is the pixel value of original image, p'(x, y) is the pixel value of decoded image. The compression efficiency is the capability to display the compressed data with high quality while representing it with less number of bits. The compression scheme shows trade off in various factors such as quality of compressed data, distortion introduced (for lossy compression), computational complexity, compression efficiency etc. it is very difficult to achieve content based compression while considering all these parameters also to retarget the same at the decoder side. There are two types of image compression lossless and lossy. In the case lossless image compression which uses the coding technique without

Manuscript received Feb, 2013.

Salija.p, *Department of Electronics and Communication, Karunya University, Karunya Nagar, Coimbatore, Tamil Nadu India..*

Mrs.Manimekalai M.A.P, *Department of Electronics and Communication, Karunya University, Karunya Nagar, Coimbatore, Tamil Nadu, India.*

Dr. N.A. Vasanthi , *Dean &head of Computer Science Engineering, Nehru Institute of Engineering & Technology, Coimbatore, Tami Nadu, India.*

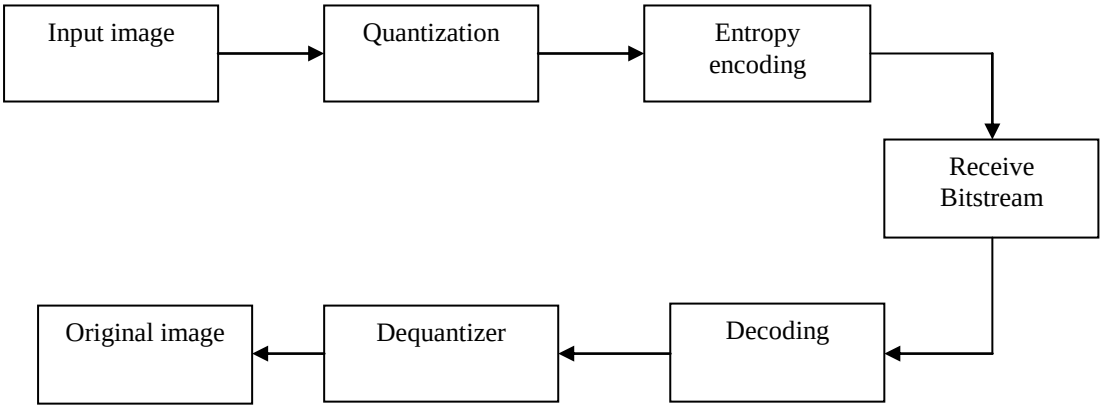


Fig 1. General block diagram for image encoder

loss of any data. But in the case of lossy compression uses the coding technique with loss of information. Image compression is needed mostly in the sensor networks, decoder. medical application, resource limited multimedia devices etc.

II. Compression Techniques

A. Edge based inpainting

It provides a method for image compression by skipping the some regions at the encoder. At the encoder some information is automatically skipped. The technique encoder erases and the decoder restores is used here. Assistant information for restoring the image at the decoder is extracted from the skipped region. In this method image is analyzed at the encoder, from the analyzed image some portions are automatically skipped. Assistant information is collected from this skipped region in order to reconstruct the image at the decoder side. Transform based conventional coding is used for image at the encoder. Inpainting technique is used to combine the assistant information and the image at the decoder side for reconstructing the original image. Topology based algorithm is used for extracting the important information. Inpainting algorithm [2] uses pixel wise scheme and patch wise scheme to reproduce the image. Pixel wise is used to fill the small gap while introducing blurring effects. Patch wise uses seams to introduce between others. This method is able to remove enough regions to achieve compression and also due to the delivered assistant information image is retarget at the decoder. It achieves high resolution detection but spatial scalability is not supported also inpainting method is computationally very complex. So this method is not suitable for resource limited devices to achieve desired qualities. The average bit rate requires varies from 0.6 bpp to 1.5 bpp.

B. Seam-Spiht

It uses an image resizing method. It compresses the image in content aware manner namely seam carving [3]. Seam is the connected path of pixels from top to bottom or from left to right. It changes the size of image by carving out or inserting the pixels in to the image. It uses an energy function to define the importance of the pixels. The first step in seam carving is to find the gradient of the image. It can be calculate either from luminance channel or from intensity. After the gradient calculation next is to find the energy of each pixel. It is the sum of minimum value of three neighboring pixels. Then find the optimal seam from each row for optimal seam path. Then remove the seam path to reduce the size. Two types are there vertical or horizontal. We can use either ways, energy indicate the important pixel in the image. High values indicate the high preference and removes the low energy pixels while preserving the important region in the image. This method encodes in content aware manner and transmits in progressive manner with low bitrate. ROI is extracted and SPIHT is used for coding the image at the encoder based on wavelet transform. At the decoder seams are added to display the original image. This method is quiet simple and content aware compression can achieve. This method uses different coding technique for both ROI and NON-ROI. Computational complexity associated with the seam carving is very high. Also the coding efficiency is far below than the wavelet based method. The side information [4] transmitted contains more bits per second. It depends on the image. So the actual image transmission requires large band width. Bitrate varies from 0.9 to 2 bpp for side information. The average PSNR for different bitrate is shown in table1:

TABLE 1

Bpp	PSNR(db)
0.25	28.1
0.50	30
0.75	31.5
1.00	32
1.50	34.5
2.00	37

C. JPEG compression

It is an image dct based international standard for still image compression method. Most widely and popularly used image compression method. The basic idea is the DCT transform and Huffman coding. JPEG [5] can use for different applications and JPEG has two compression formats, that is lossy and lossless. Dct based using for lossy compression techniques and the predictive method for lossless

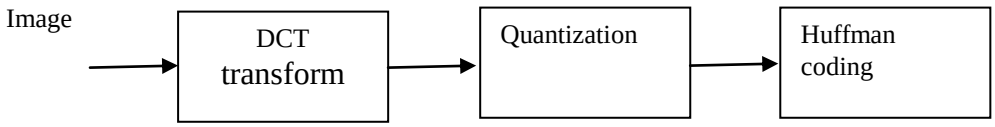


Fig 2.General block diagram for JPEG

Compression. Figure 2 shows the block diagram for basic JPEG. DCT divides the images into number of blocks and to decode the image the transformation matrix will transmit. Quantization method is used for removing the high frequency component from the image since eye is more much more sensitive to low frequencies. Then DC coefficients and AC coefficients are ordered difference and zigzag manner respectively. It is followed by Huffman coding.

This method can achieve high quality at the decoder side and excellent coding efficiency can achieve. Rate of distortion is very low. But this method compress the image as whole only dyadic resize is achieved. It does not support the content based image compression so the loss of important information of original image happens. The average PSNR for different bitrate is shown in table2.

TABLE 2

Bit rate	PSNR (db)
0.125	23
0.50	30
2.00	35.5

D.Bi-directional similarity

This method provides a method to summarize the data of an image by similarity measure [6]. So it will contain less amount of information about the image and visible artifacts present are removed. It measures similarity between two different data and this data should optimize for retargeting purpose. This technique can be apply for variety of applications. Also the overall complexity of this method is very high. Also this method is not suitable for resource limited mobile multimedia devices.

E. Concentration-Dilution based compression

It provides a method for image resizing. Concentration shrinks the mage size without losing the important information. Dilution is the reverse process of the concentration [7]. This method utilizes the principle of seam carving for image resizing. This method is useful for restricted display devices for better resolution. Seam carving [3] which removes path of pixels from image. Seam with lowest energy will remove for reducing the size. This method transmits the data related to the seam connection for dilution process. Information related to the removed seams is processed for insertion at the decoder side. If the seam removal is increased then the quality is affected, so this paper provides automatic detection of number of seams to be removed. This sets a threshold value for that purpose. Simple linear interpolation is performed is at the receiver for dilution process. Since the removed seams are at pixel width. Bit rate saving is more for this method as compared to the other method such as JPEG [5]. It can achieve high resolution detection and also suitable for display size restricted devices. But due to simple interpolation method visible artifacts may present at the end image. The average bitrate varies from .4 to 1.3and the bit rate required for transmission of side information in low as compared to seam-spiht (0.1 to 0.3). 2 to 40% bitrate can save by using this method. This method can use for pre and post processing method for image compression.

F. *Hybrid transform for image compression*

This method provides hybrid transforms [8] for image compression. It has gained popularity in the recent years in researches. The main application is for medical images. This method uses discrete wavelet based and discrete cosine based transform. This method gives high compression ratio and quality and also computationally complex. It applies DWT, the decomposition at any level includes high and low frequencies. DCT is applied to LL and HH coefficient. Then applying quantization and entropy encoding. The images can recover by applying the reverse process at the receiver. The average PSNR values obtained for various quantization factors is shown below in table 3.

TABLE 3

Q.factor	PSNR
0.2	35
0.5	31
1.0	29

This method compresses the image as a whole. The content based compression cannot be achieved be using this method. Also it cannot resize the image according to the display devices resolution. So this method cannot be used for resource limited mobile multimedia devices.

G.SPIHT

It is an efficient wavelet based image compression technique [9]. It has advantages like progressive transmission, error protection, fast coding/decoding, lossless compression, image quality etc. it consists of the List of Significant Pixels [10] (LSP), List of Insignificant Pixels (LIP) and List of Insignificant Sets (LIS). These are the location of coefficients in coordinates. Image iis decompose into multilevel. As level increases the compression efficiency is also increases. Then arranges these into a tree structure called spatial orientation tree (SOT). This has either no child or four children in each level. SOT's are scanned in zig zag order and will transmit in progressive manner. It achieves high quality and compression ratio. The distortion ratio is also getting reduced. It is useful for medical images to achieve high compression ratio. It can vary from 95 to 99. The average PSNR values for different decomposition levels and bit rate are shown in table3 & 4. The computational time required at encoder approximately is 400s. And at the decoder side it vary (20 to 40s) depends on the image size

TABLE 3

Bit rate	PSNR(db)
0.50	23
1.00	28
1.50	33.5
2.00	36

TABLE 4

Level	PSNR(db)
2	20.0
3	31.9
4	32.9
5	36.0

This method compresses the image as a whole. So the spatial scalability cannot be achieved. Content based image compression is necessary in resource limited mobile multimedia devices.

H. Scale and stretch image Resizing

It provides a method for image resizing without losing important regions. It calculates a warping function [11] for image resizing. It aims to reduce the noticeable distortion in resized images. It uses a salient map, which is based on automatic calculation of gradient-salient measures. It uses a optimal scaling facto for each local region. The amount of deformation is determined by the saliency map. It allows the important region to unaffected and the other homogeneous regions changes or enlarges according to the application. Warping method places a grid mesh on the image and computes a new geometry inside the mage itself. Region s with important information is unaffected and other homogeneous region scale to new value. Since humans are less sensitive to distortions in the homogeneous part such as sea, cloud etc. this method is mostly used in video applications. It preserves the important regions according to the application. But this method cannot the preserve the aspect ratio so this method is not suitable for resource limited multimedia devices.

I. Pruning based compression

This method uses pruning method [12] to reduce the size and edge based interpolation is used to retarget the back to their original size. The main aim of this method is to reduce the bit rate for transmission. This technique is mainly using in video coding.

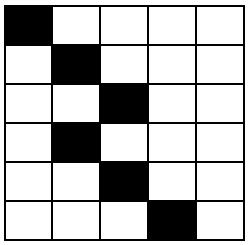
TABLE 5

Bit rate	PSNR(db)
1.00	34
1.50	38
2.00	40

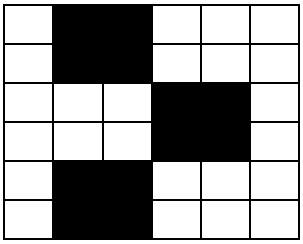
It prunes the data by dropping the rows and columns prior to encoding. Interpolation method n this method considering spatio-temporally neighboring pixels. Most of the methods considering only the neighboring pixels. The average PSNR value obtained for different bitrate is shown in the table 5 above. This method can achieve high resolution detection and quality. But the computational complexity is high. The computational time reduces as the size of the data to prune decreases. Interpolation process is also computationally high. So by using this method spatial scalability cannot achieve for resource limited mobile multimedia devices.

J. Content based image compression (block seam-SPIHT)

This method provides efficient image compression for mobile multimedia devices [14]. It retargets the image with less computational complexity. This method uses block based seam carving [13] to remove seams from the image. So the computational complexity is reduced to a great extent. It also uses a seam energy map to indicate the importance of pixel in the image. This paper addresses indicating the importance of image retargeting at the decoder with less computational complexity in resource limited mobile multimedia devices.



Seam carving



Block based seam carving

In this the wavelet coefficients after decomposition are encoded according to the resultant energy map. The block based seam carving that removes a block of pixel at a time. That is seam element is block of pixel. So the computational complexity associated with the seamcarving can be reducing and can achieve content based compression. In this method original image is decompose into multilevel at the same time it will analyze the image and find ROI and non-ROI. The aim of extracting the ROI is to give high energy value to important region. So during block based seam carving remove only low energy pixels. That is less important regions. The decomposed images are arranges according to the resultant energy map. In this method ROI and non-ROI using the same encoding method. SPIHT is used to encode the information. Side information such as seam position, image sizes etc are transmitted along with code stream. At the decoder side user has the opportunity to retarget the image in content aware manner with appropriate resolution. The bit rate for transmitting side information is less (0.07 to 0.09). The average PSNR value obtained is shown below table6.

TABLE 6

Bit rate	PSNR
0.5	30
1.0	32
1.5	37
2.0	38

This method provides a better method for content based image compression with less computational complexity in resource limited mobile multimedia devices. It achieves better arbitrary resolution at the user end while maintaining the

important information with high quality. Also keeps the decoder complexity low.

III. Analysis

Image compression for resource limited mobile multimedia devices requires content based image compression with less computational complexity. Also to retarget the image with less computational complexity. From the above methods we can show that there occurs tradeoff between the quality, bit rates, computational complexity, resolution detection, content based compression etc. it is very difficult to achieve compression with these requirements.

TABLE 7

Method	PSNR (db)
JPEG	33
Hybrid Transform	32
SPIHT	34
Pruning Based	36
Seam-Spiht	34
Content based	35

As we consider the quality, quality increases with bit rate. As we increase the bit rate then the efficient compression cannot be achieved. The main aim is to reduce the number bits to represent the original image.

Also to retarget the image side information is also need to transmit. If increase the side information then the original information in given bit rate reduces. From the above discussion we showed that quality increases with bit rate. The bitrate for concentration dilution based method requires 0.1bpp t0 .18bpp. And for seam carving based method requires .6bpp t0 2bpp for side information transmission. The content based method requires only 0.07bpp to 0.09bpp. While considering the computational complexity, seam carving method is computationally very complex and interpolation and inpainting methods are also computationally very complex and time consuming. The block based seam carving maintain the content based image compression and computationally not complex. But compared to SPIHT, hybrid, JPEG etc block based is computationally complex. But while considering quality, spatial scalability, content based compression etc, block based seam carving with SPIHT is the better for resource limited mobile multimedia devices.

IV. Conclusion

In this paper, we discussed different image compression techniques. Content based image compression for mobile multimedia devices should be low computational complex and also achieve spatial scalability. From these method content based image compression based block based seam carving and SPIHT meets the desired criteria. This method is computationally less complex and achieve content based image compression also allows the user to retarget the images with appropriate resolution. Computational complexity at the receiver also less. Other methods have tradeoff between quality of image, bitrate, computational complexity, spatial scalability etc. block based seam carving and SPIHT method meets all these criteria that is acceptable to the resource limited devices.

References

[1] "An Introduction to Image Compression" Wei-Yi Wei
[2] D. Liu, X. Y. Sun, F.Wu, S. P. Li, and Y. Q. Zhang, "Image compression with edge-based inpainting," *IEEE Trans. Image Process.*, vol. 17, no. 10, pp. 1273–1287, Oct. 2007.
[3] S. Avidan and A. Shamir, "A seam carving for content-aware image resizing," *ACM Trans.*
[4] N. T. N. Anh, W. X. Yang, and J. F. Cai, "Seam carving extension: A Compression perspective," in *Proc. ACM Conf. Multimedia*, Oct. 2009,pp. 825–828.
[5] D. S. Cruz, R. Grosbois, and T. Ebrahimi, "JPEG 2000 performance evaluation and assessment," *Signal Process.*
[6] D. Simakov, Y. Caspi, E. Shechtman, and M. Irani, "Summarizing visual data using bidirectional similarity," in *Proc. IEEE Int. Conf.*
[7] Y. Tanaka, M. Hasegawa, and S. Kato, "Image coding using concentration and dilution based on seam carving with hierarchical search," in *Proc. IEEE Int. Conf.*
[8] "Efficient Hybrid Transform Scheme for Medical Image Compression" Aree Ali Mohammed, Jamal Ali Hussein, *International Journal of Computer Applications*
[9] "Image compression based on improved spiht and Region of interest" Sandeep Kumar, Dr. Sanjay Sharma.
[10] "Implementing the SPIHT Algorithm in MATLAB," Aldo Morales and Sedig Agili Department of Electrical Engineering.
[11] Y. S. Wang, C. L. Tai, O. Sorkine, and T. Y. Lee, "Optimized scaleand-stretch for image resizing," *ACM Trans.*
[12] D. T. Vo, J. Sole, P. Yin, C. Gomila, and T. Q. Nguyen, "Selective data pruning-based compression using high-order edge-directed interpolation,"*IEEE Trans. Image Process*
[13] "Block-based Seam Carving", Kazu Mishiba and Masaaki Ikehara, 2011 1st International Symposium on Access Spaces (ISAS),
[14] C. W. Deng, W. S. Lin, and J. F. Cai, "Content-based image compressionfor arbitrary-resolution display devices," in *Proc. IEEE Int. Conf.Commun.*,

Salija P is a research scholar pursuing M-tech in Communication system from Karunya University, India. She secured B-Tech in Electronics and communications from CUSAT, India in 2011.

Mrs.Manimekalai M.A.P presently working as Assistant Professor in Electronics and Communication Engineering at Karunya University. She has secured B.E in Electronics and Communications and M.E in Applied Electronics.