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# Performance Comparison of K-means and Rectangle Segmentation Algorithms in Compression of Color Images

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**Abstract-With Development of Science, Advancement of Technology, lot of Images are transported in compressed data formats.The use of color in image processing is motivated by two Principal factors; First color is a powerful descriptor that often Simplifies object identification and extraction from a scene. Second, human can discerned thousands of color shades and Intensities, compared to about only two dozen shades of gray.The main objective of this paper is to compare performance based on quality measures towards the compression of color images using K-means and Rectangle segmentation algorithms. In this paper, color image compression using Rectangle Segmentation is proposed, in which adjacent pixel points satisfying consistency condition are viewed as the same image block. Also, without the restriction of square which abides to 2n, the image block can be rectangle which reduces the amount of block, and improves the compression ratio. The algorithm is tested On several color images and results are compared with other image compression technique like K-means in terms of performance metrics like PSNR , CR,Execution Time etc.The experimental resuls show the K-mean algorithm is better than Rectangle segmentation in terms of PSNR leads to good quality Image , effect of changing cluster size on image quality is noticed.**

**Keywords-Color Image compression, Rectangle segmentation, Sparse Matrix, K-means.**

## 1. INTRODUCTION

An image is essentially a 2-D signal processed by the human visual system. The signals representing images are usually in analog form. However, for processing, storage and transmission by computer applications, they are converted from analog to digital form.Image compression is a method through which we can reduce the storage space of images, videos which will helpful to increase storage and transmission process's performance. Image compression may be lossy or lossless. Lossless compression involves with compressing data which, when decompressed, will be an exact replica of the original data .In Lossy compression some of the finer details in the image can be sacrificed for the sake of saving a little more bandwidth or storage space.

Humans have always seen the world in color but only recently have been able to generate vast quantities of color images with such ease. In the last three decades, we have seen a rapid and enormous transition from gray scale images to color ones.

Today, color and multi spectral properties of images are becoming increasingly crucial to the field of image processing often extending or replacing previously Known gray scale techniques. In a digital true-color image, each color component is quantized with 8 bits and so a color is specified with 24 bits. As a result, there are 224 possible colors for the image. Furthermore, a color image usually contains a lot of data redundancy and requires a lot of storage space. In order to lower the transmission and storage cost image compression is desired[2].

## 2. IMAGE COMPRESSION

Image compression is getting more and more attention day by day as high speed compression and good quality of image are in high demand. One advantage of an Image compression is to reduce the time taken for transmission of an image. Different image compression methods are presented in literature.

Transform based image compression algorithm are very popular. Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT)are used broadly in this field. DCT based JPEG standard, divides the input image into blocks, DCT is performed on each block then the resulting coefficients are quantized and coded. The DCT-based image compression quality is studied by experiments in the subjective and the objective two evaluation methods in the paper. At first, the DCT coefficients option is important to affect the static image compression quality, the option method of DCT coefficients is illustrated [3].. After the introduction of wavelet transform, it has gained broad popularity according to its unique de-correlation property. The most important advantage of DWT based image compression techniques is lack of blocking artifact [4]. Among Compression algorithms, most of popular are HuffmanCoding,Vector Quantization, Run Length Encoding,LZW Coding are the most popular methods[5]. Fractal image coding method is a novel compression method, in which the local self-similarity of the image is used to eliminate cross-scale redundancy existing in image data [6].A new new contourlet based lossy image compression method for medical ultrasound images in which we apply a new thresholding process on the coefficients before quantization. We select the threshold due to coefficients occurrence in the contourlet domain.Due to this time saving ability, the algorithm can be used in online mage transmission systems[7]. Image Compression based on Optical Wavelet Transform is realized by using 4f optical information processing system[9].The Quarter-tree

decomposition of image compression Method characters with relative simplicity and fast calculation, however compression ratio is not very high. In order to overcome this flaw, one new segmentation method named the Rectangle Segmentation is proposed, in which adjacent pixel points satisfying consistency condition are viewed as the same image block. Also, without the restriction of square which abides to 2n, the image block can be rectangle which reduces the amount of block, and improves the compression ratio. Image compression ratio can be further augmented by combining the storage method of sparse matrix. Therefore, a new image compression algorithm proposed named the Rectangle Segmentation and Sparse Matrix Storage (RSSMS) compression algorithm [10].

Organization of this paper as follow: section 2 introduces image compression methods, then Section 3 describes our proposed work and in section 4 we present our results and the last section is conclusion.

## 3. PROPOSED METHODOLOGY

In this paper we have performed color image Compression by using Rectangle segmentation algorithm and comparative analysis with K-means algorithm in terms of Performance metrics i.e PSNR,CR,Execution time etc.

### 3.1 Rectangle Segmentation Algorithm

To overcome drawback of Quarter-tree Decomposition method a new method called Rectangle segmentation and Sparse Matrix Storage is proposed by Shengli Chan[9].In Quarter-tree Decomposition method,An image is segmented into four square blocks A layer-by-layer by the size of 2n in the Quarter-tree decomposition method. Any image block meeting consistency condition but not size of 2n will still be segmented into different smaller blocks.

### 3.1.2 FLOWCHART OF ALGO.

Working of Rectangle Segmentation algorithm is explained in terms of flowchart**:**

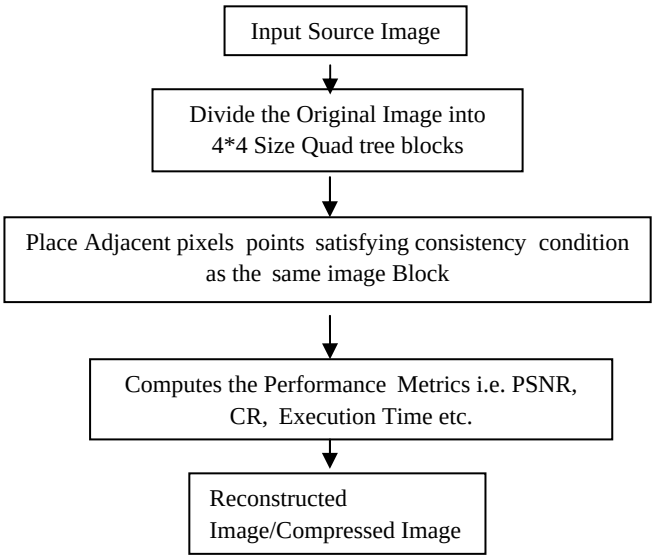



**Fig.1 Rectangle Segmentation Algorithm**

### 3.2 K-means Algorithm

K -means is a simple algorithm that has been adapted to many problem domains. K-means clustering is a method of vector quantization originally from signal processing, that is popular for cluster analysis in data mining. K-means clustering aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster. Clustering technique is used to put similar data items in a same group. K-Means algorithm is an unsupervised clustering algorithm that classifies the input data points into multiple classes based on their inherent distance from each other.K-means is a widely used partitional clustering method. While there are considerable research efforts to characterize the key features of K-means clustering, further investigation is needed to reveal whether the optimal number of clusters can be found on the run based on the cluster quality measure.

### 3.2.1 FLOWCHART OF ALGO.

Working of Rectangle Segmentation algorithm is explained in terms of flowchart**:**

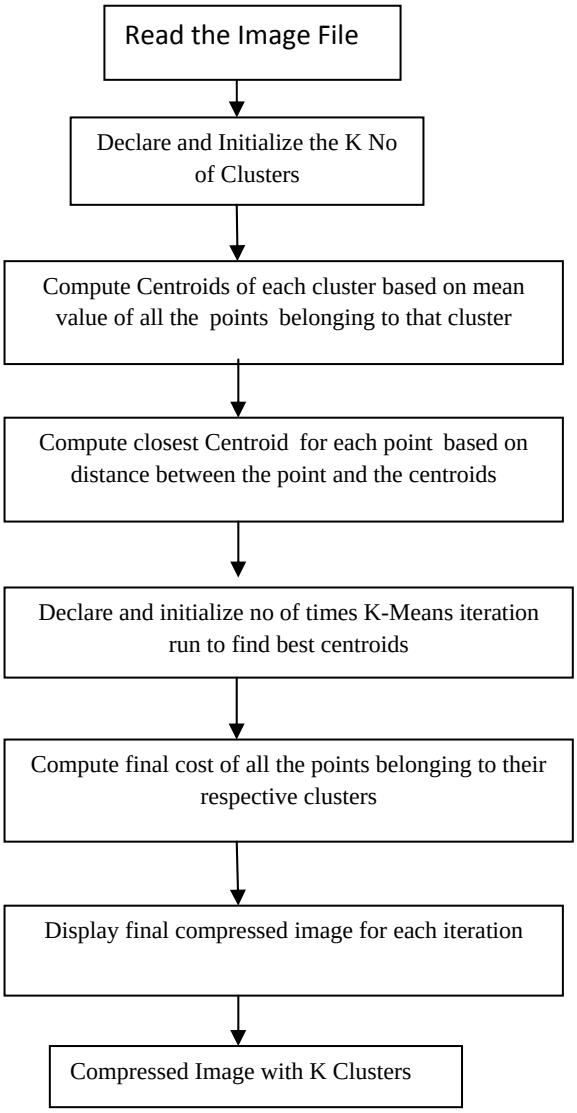



**Fig.2 K-means Algorithm**

### 3.3 Block Diagram of Proposed Research Work

Working of Proposed Research Work is explained in terms of Block Diagram:

- Fig 3 Enumerates the block diagram of compression of color Images using K-Mean Clustering and Rectangle segmentation algorithms.
- The same set of Input Images/Test Images is applied to both of algorithms and their results are evaluated. .
- Evaluation of results is done by using Compression Metrics i.e. PSNR,CR,Execution Time.
- The motive of this research is to compress the color images and measure their Quality parameters for comparative analysis.

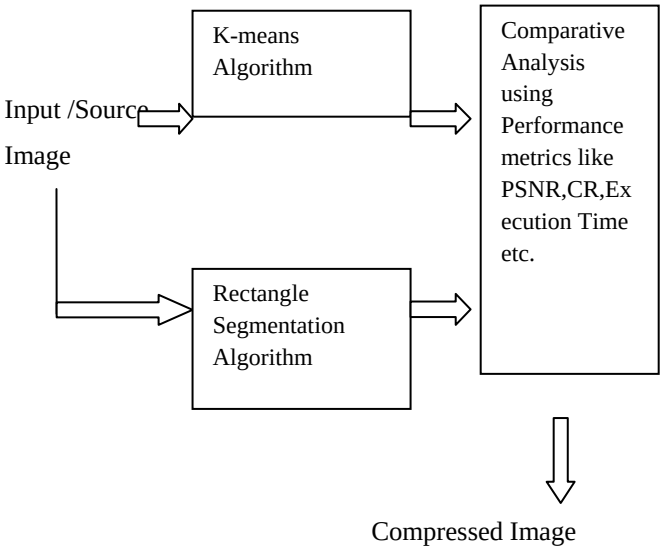



**Fig3.Proposed Research Methodology**

## 4. Experimental Results And Analysis

In this section, We descried the experimental verification of both algorithms on different set of color images as test images to perform comparative analysis using Compression metrics like PSNR,CR,Execution Time etc.The experimental results show that K-means Algorithm outperforms Rectangle Segmentation Algorithm in terms of Quality of color images.The Quality of Reconstructed Image is measured in terms of Compression metrics like PSNR,CR,Execution Time etc.The simulation results are performed using MATLAB SOFTWARE.Different Quality metrics are:

**a)PSNR**

Peak Signal to Noise Ratio (PSNR) is one of the quantitative measures for image quality evaluation. PSNR is based on Mean Square Error (MSE).

$$PSNR = 10 \log10 (255 \wedge 2 / MSE) \quad (1)$$

where MSE is the Mean Square Error and is used to obtain the total amount of difference between two images. MSE iscalculated as below:

$$MSE = (\sum I(m,n) - DI(m,n))^2 / (M * N) \quad (2)$$

Where M*N are the size of original image, I(m,n) andDI(m,n) are original image and decompressed image,respectively.

**b)Compression Ratio:**

Compression Ratio (CR) is defined as follow:

CR= Original file size/ Compressed file size (3)

**c)Execution Time:**

The time taken by algorithm to compress the image is called execution time of that algorithm.it is generally measured in seconds or minute.

### 4.2 Simulation Results of K-means algorithm

To evaluate the Performance of K-means Algorithm,experiments are conducted on several color images as test images using MATLAB Version 7.10.

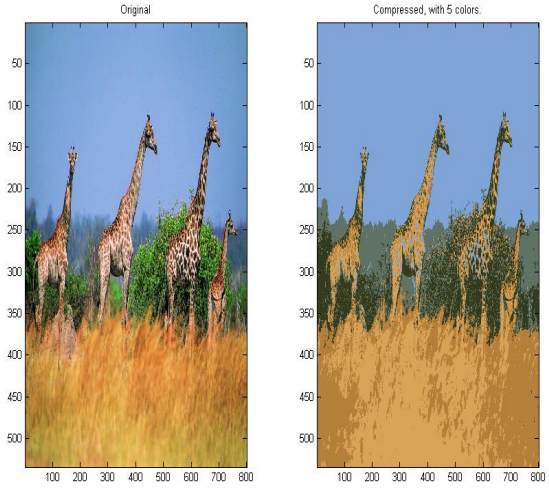



Fig1.Giraff.jpg(PSNR=108.7843db)

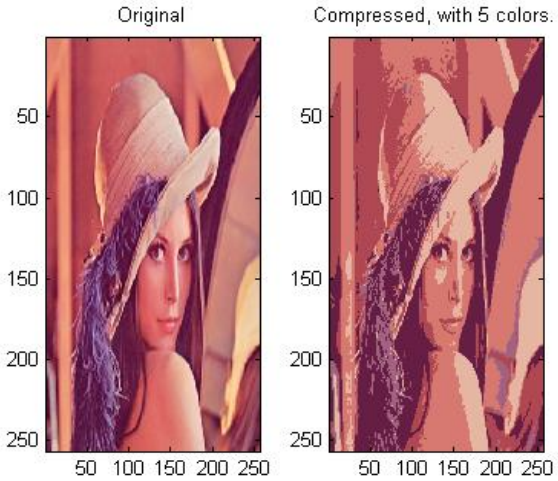



Fig2.lena.png( PSNR= 119.1838db)

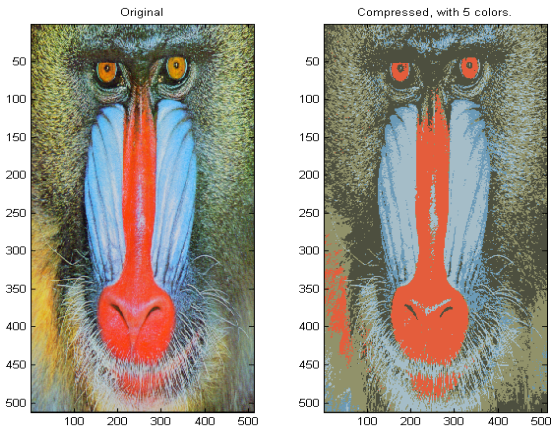



Fig3.Babbon.tiff(PSNR=116.41db)

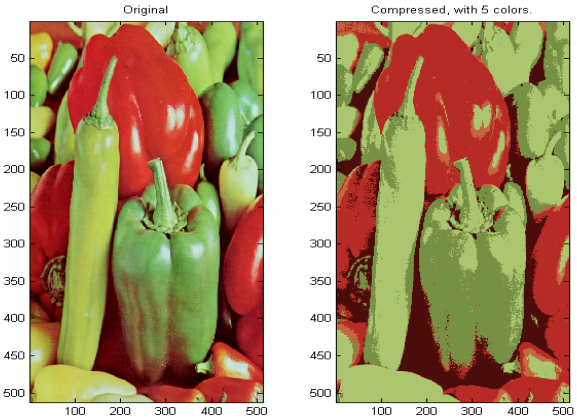



Fig4.Peppers.tif(PSNR=124.1785db)

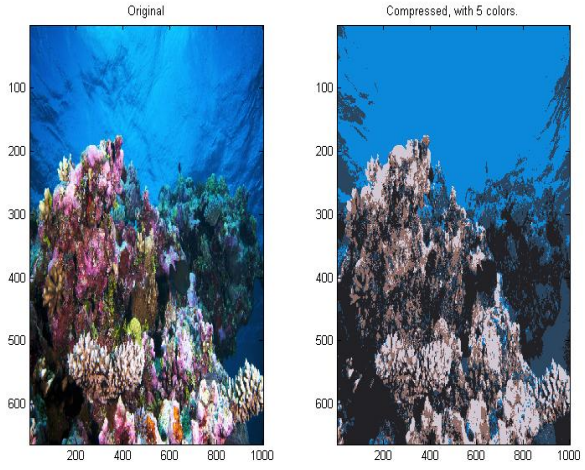
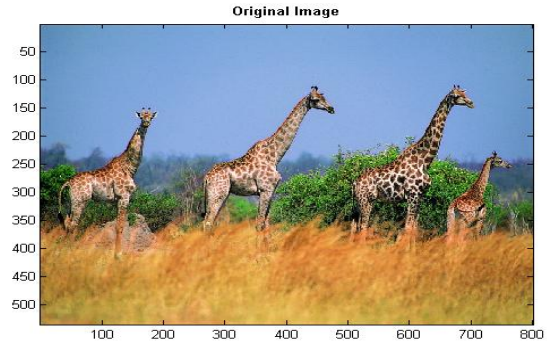



Fig5GreatBarrierReef.jpg(PSNR=133.0857)

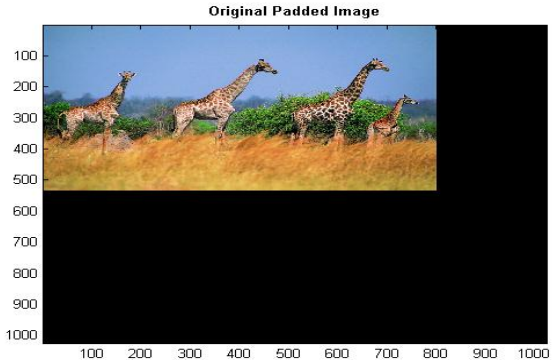
### 4.3 Simulation Results of Rectangle Segmentation algorithm

To evaluate the Performance of Rectangle Segmentation Algorithm,experiments are conducted on several color images as test images using MATLAB Version 7.10.

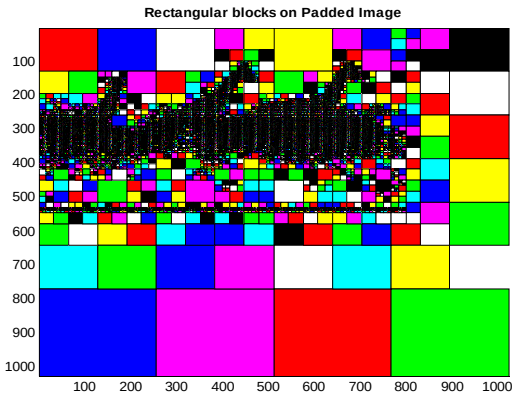
**Test Image 1:Giraff.jpg**



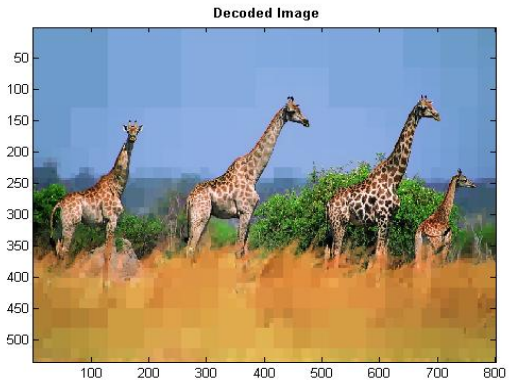

(a)




(b)



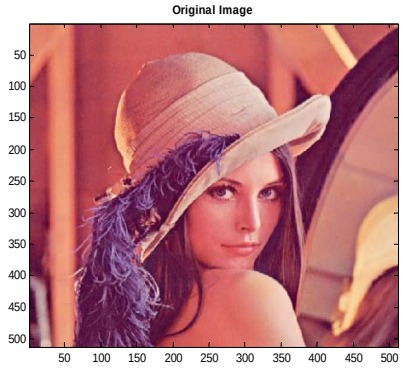

(c)




(d)

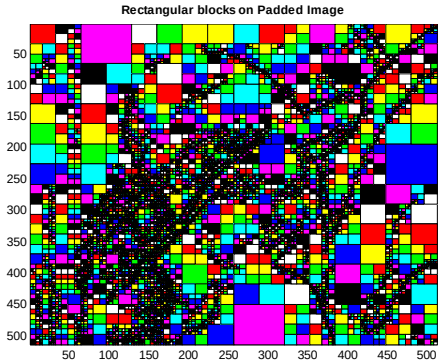
Fig6.Giraff.jpg(PSNR=77.2108db) a)Original Image b)Padded Image c)Rectangular blocks on Padded Image d)Reconstructed Image

**Test Image 2:Lena.png**




(a)


(b)

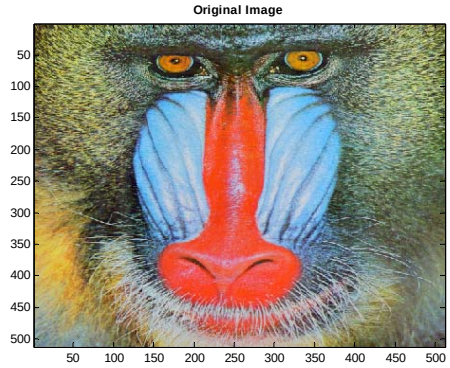



(c)

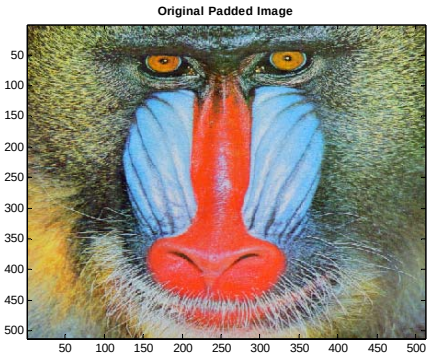

(d)

Fig7.Lena.png (PSNR=86.75db) a)Original Image b)Padded Image c)Rectangular blocks on Padded Image d)Reconstructed Image

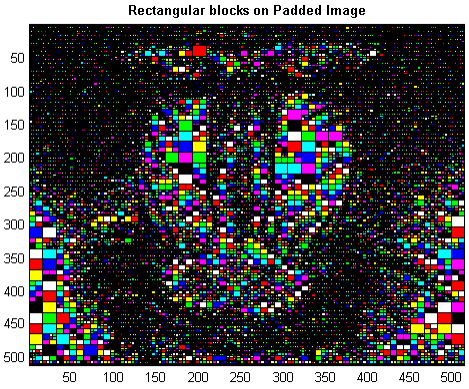
**Test Image 3:Baboon.tiff**



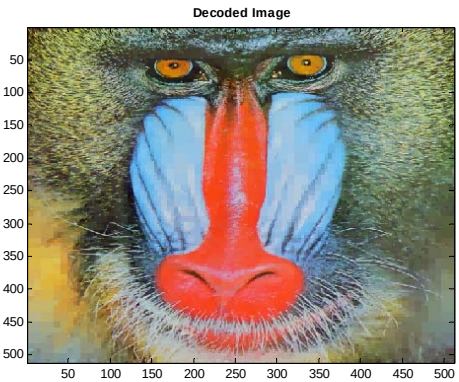

(a)




(b)



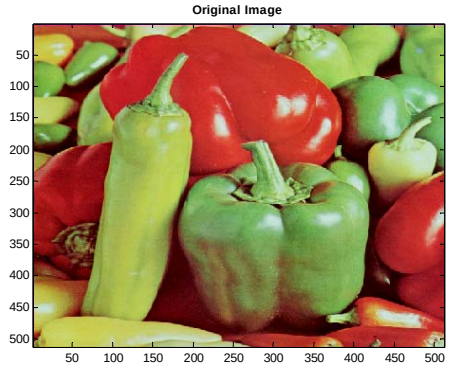

(c)



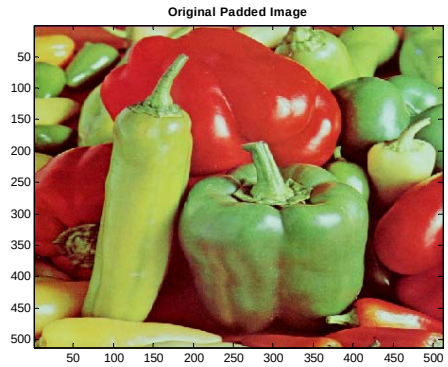

(d)

Fig8.Baboon.tiff (PSNR=84.25db) a)Original Image b)Padded Image c)Rectangular blocks on Padded Image d)Reconstructed Image

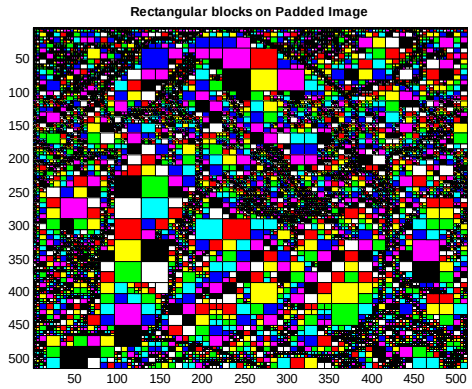
**TestImage4:Peppers.tiff**



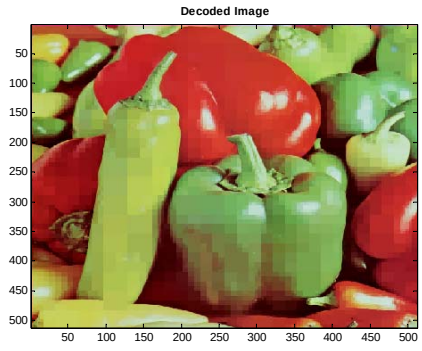

(a)




(b)



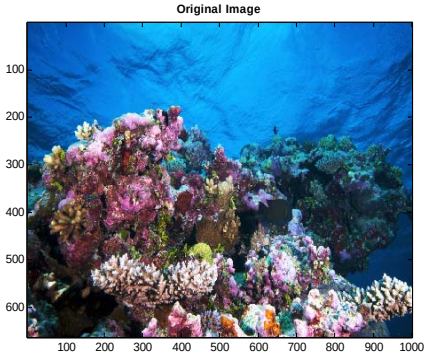

(c)



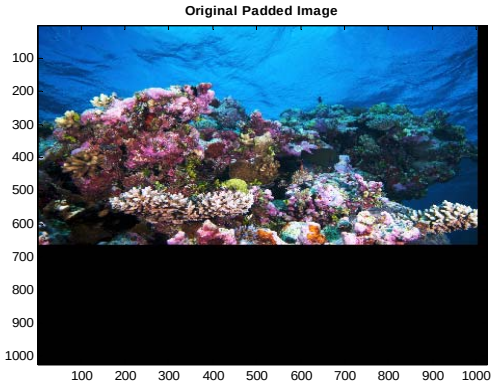

(d)

Fig9.PeppersRGB.tiff (PSNR=86.75db) a)Original Image b)Padded Image c)Rectangular blocks on Padded Image d)Reconstructed Image

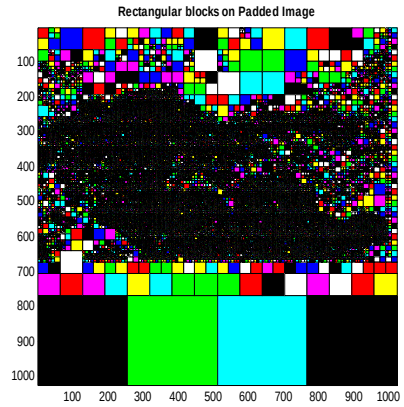
**TestImage5:GreatBarrierReef.jpg**



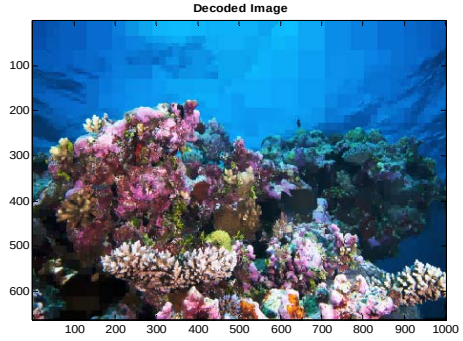

(a)




(b)




(c)




(d)

Fig10.GreatBarrierReef.tiff (PSNR=79.39db) a)Original Image b)Padded Image c)Rectangular blocks on Padded Image d)Reconstructed Image

**Table1.Comparative Analysis of K-mean and Rectangle Segmentation Algorithm**

| Test Image | Performance Metrics | | | | | |
|---|---|---|---|---|---|---|
| | Algorithm Used | | | | | |
| | *K-means* | | | *Rectangle Segmentation* | | |
| | ***PSNR*** | ***CR*** | ***Execution Time(sec)*** | ***PSNR*** | ***CR*** | ***Execution Time(sec)*** |
| 1.Giraff.jpg | 108.78 | 0.0018 | 112.35 | 77.21 | 0.27 | 115.89 |
| 2.Lena.png | 119.18 | 0.00065 | 77.17 | 86.75 | 0.035 | 26.53 |
| 3.Baboon.tiff | 116.41 | 0.00039 | 78.40 | 84.25 | 0.112 | 177.87 |
| 4.Peppers.tiff | 124.17 | 0.00037 | 41.65 | 86.75 | 0.031 | 40.41 |
| 5.Great Barrier.jpg | 133.08 | 0.00025 | 196.93 | 79.39 | 0.10 | 389.86 |

### 4.3 Comparative Analysis

Comparative analysis of both the algorithms are done using performance metrics like PSNR,CR,Execution Time etc.The comparative results are shown in form of table: 1

### 4.4 K-mean Based Image Compression Quality Using Different no of Cluster sizes

To evaluate the effect on quality of Image in terms of PSNR,when same set of image is applied under different cluster sizes(K=5,K=10,K=20,K=30).

**Test Image Lena.Tiff**

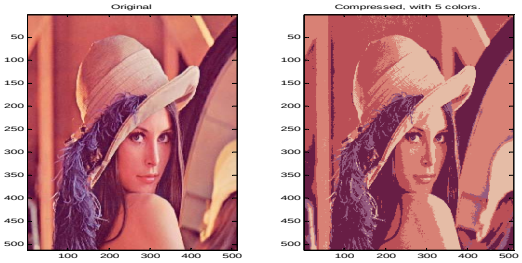



Fig11(a)K=5(PSNR=116.41db)


Fig11(b)K=10(PSNR=120.0005db)

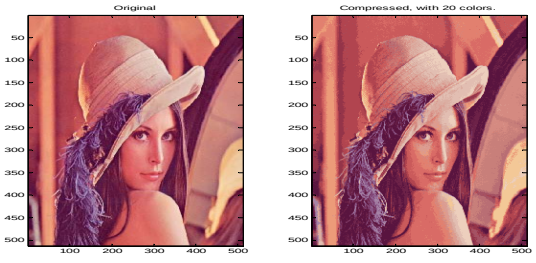



Fig11 (c) K=20(PSNR=127.93db)

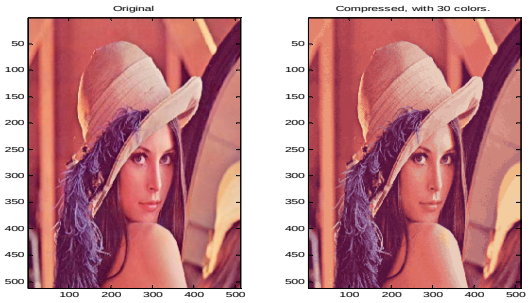
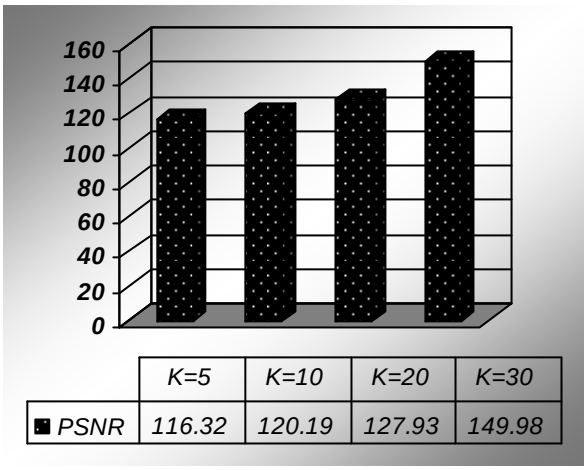



Fig11 (d) K=30(PSNR=149.98db)

**TableII.Effect of Changing Cluster Size on Image Quality of Lena**

| Cluster Size | Performance metrics | | |
|---|---|---|---|
| | ***PSNR*** | ***CR*** | ***Execution Time(sec)*** |
| **K=5** | 116.32 | 0.00039 | 78.68/1.31min |
| **K=10** | 120.19 | 0.00056 | 314.96/5.24min |
| **K=20** | 127.93 | 0.00088 | 1268.02/21.13min |
| **K=30** | 149.98 | 0.00118 | 2998.97/49.98min |

**Fig12.Effect of Changing Cluster Size on PSNR of Lena Image**




Increase in Cluster Sizes increases PSNR of Reconstructed Images

## 5. CONCLUSION AND FURTHER RESEARCH

In this Paper, We have discussed Comparison between Rectangle Segmentation and K-means Algorithms using color images as test images in terms of Performance metrics like PSNR,CR,Execution time etc.

From the Table 1,PSNR value of K-means algorithm is far better than Rectangle Segmentation which leads to better Image Quality,But Compression Ratio of K-means algorithm is low. The execution time of K-mean algorithm is low as compared to Rectangle Segmentation algorithm in most of cases as per Experimental Analysis.

From Table 2, Effect of Changing cluster size is measured in terms of PSNR. High PSNR leads to High Quality of Reconstructed Image. As the Value of K increases, Higher is PSNR from Experimental study. From the result Images in section 4.4 it is clear that when value of K is gradually increasing, the image quality also gradually better, and we noticed. For, K=30 the reconstructed image is almost similar to original image.

Further Directions to Research Work includes Improving Execution Time /Speed of K-mean Algorithm as Value of K increases. Further Compression Ratio of K-mean Algorithm is improved ,may be combined with sparse matrix storage concept to improve CR. To Improve the Speed of K-mean Algorithm, Concept of Coresets can be used which is till now applied to 3D datasets in area of data mining[15]. Both of algorithms in future also experimented with Medical Images like MRI,X-ray etc.

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