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Research paper

Optimization Before Biomedical Image Compression Using CLAHE and DCS

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Abstract

In current years, improving the Compression Ratio (CR) in medical imaging is essential and becomes big challenge in the field of biomedical. In that direction we have done optimization before biomedical image compression. For the same we have used the image enhancement techniques. For the enhancement of an image we have used Contrast Limited Adaptive Histogram Equalization (CLAHE) and Decorrelation Stretch (DCS) algorithms. By optimizing an image before compression we have achieved better Compression Ratio (CR) and Peak Signal to Noise Ratio (PSNR) than existing methods of an image compression. Mainly results are compared with Oscillation Concept method of an image compression with and without optimization.

Keywords: *Optimization, image enhancement, oscillation concept, CLAHE, DCS.*

1. Introduction

In the field of medical, all the parts of body are very sensitive and necessary to analyze carefully. Hence, biomedical image compression is highly important topic for the research. As biomedical images are increasing there is a need of more space for keeping data in hospitals. This data is very important for diagnosis and treatment. Many compression algorithms are available but to achieve better Compression Ratio is a big challenge. While compressing the data there should be importance of removing errors without losing original information. For improving image quality and minimizing the errors, there is use of optimization before compression.

Here we have used Optimization before biomedical image compression using image enhancement algorithms i.e. CLAHE and DCS methods. By using these methods we have achieved better results than oscillation concept method without optimization. [2, 4, 7]

2. Methodology

1. Optimization Before Compression

Input As shown in figure below, we have used optimization before image compression for obtaining required format of an image. We are using image enhancement methods for improving the significance of an input image. Figure shows that we have used Oscillation Concept for image compression. [2,4].

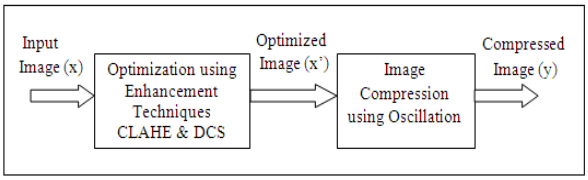


Fig. 1: Optimization before Image compression

Oscillation Concept: Oscillation concept is the new approach to biomedical image compression. It introduces the theory of oscillations in images. It states that, in every image there are variations in pixels with respect to x and y axis of an image. These variations are nothing but oscillations at image. Appropriate oscillations can be utilized for an image compression. Here, we are applying this oscillation theory to biomedical images. This method gives an effective compression ratio. [4,11]

Optimization of an Image: Optimization means gaining the required format of an image which would be suitable for an image compression. By using Optimization technique we can convert an original image into the required or proper format .Optimization of an image is used to minimize the size for the visually acceptable images. This method will also reduce the load time. It removes non-visible information. In this paper image enhancement is considered as an optimization problem.

Types of an optimization are Generic Algorithm (GA), Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO). [5]

Image Enhancement: Image Enhancement is used many times for improving the perception or significance of information in images. It is also used as pre-processing mechanism which provides "better" input to many image processing techniques. It is mainly used for Gray-level images. Image enhancement is classified into many methods as below. [6,9]

Methods of image enhancement

1. Histogram Equalization (HE)
2. Adaptive Histogram Equalization (AHE)
3. Decorrelation Stretch (DCS)
4. Image Adjust (IA)
5. Image Noise (IN)

i) Histogram Equalization (HE): For enhancement of the contrast of an image, Histogram equalization technique is used. It is also usedto enhance a color image.Intensity distribution of an image is graphically represented by this technique. It quantifies the number of pixels for each intensity value considered.[9]

ii) Adaptive Histogram Equalization (AHE): This is the modified part of HE. It is a computer image processing technique used to improve contrast in images. It would over amplify noise in homogeneous regions of an image. By using AHE, enhancement process applied over a specific region of an image and adjust contrast according to their neighboring pixels.[1]

Contrast Limited Adaptive Histogram Equalization (CLAHE): The CLAHE is the modified or advanced version of AHE. Basically CLAHE is used for biomedical imaging and proven for successful enhancement. This algorithm was developed to prevent the over amplification of noise. CLAHE algorithm is making parts of images called tiles or into contextual regions and applies the histogram equalization to each one. This technique is able to increase contrast more than other techniques. It introduces large change in the pixel gray level. By using CLAHE technique, hidden features of images are more visible. Contrast enhancement amount is directly proportional to the slope of the Cumulative Distribution Function (CDF) at that intensity level. Hence contrast enhancement can be limited by limiting the slope of the CDF. [1, 3, 5]

iii) Decorrelation Stretch (DCS): The DCS is an image enhancement technique. It is the process that is used to enhance (stretch) the color differences found in a color image. It enhance the separation of color i.e. R/G/B in images with high inter-channel correlation. This method is used for removing inter-channel correlation found in input pixels hence it is known as Decorrelation stretch (DCS). Sampled pixels are taken and nine sums that are needed to calculate the covariance matrix for the three channels are accumulated.

Following formula is used for calculating Sum.[8,10]
For l=1,3; m=1,l, and sampling n pixels ,

$$SUMX_{l,m} = \sum_{k=1}^{n} Pk,l * Pk,m \quad (1)$$

$$SUM_{l} = \sum_{k=1}^{n} Pk,l \quad (2)$$

Where Pk, l is the value of the kth pixel for Channel l
Covariance &Correlation Matrices are computed, using the following formulas. The elements of covariance matrix are computed as follows.

$$Covl.m = \frac{1}{n-1}\left[\text{SUMXl,m} - \frac{1}{\text{n}} * \text{SUMl} * \text{SUMm}\right] \quad (3)$$

For the correlation matrix elements

$$Corrl.m = \frac{Covl,m}{Covl,l*Covm,m)^{1/2}} \quad (4)$$

The Eigenvectors and Eigen values of the system described by the correlation matrix (or, optionally, of the covariance matrix) are computed. The matrix of eigenvectors is referred to as the rotation matrix, R, in subsequent steps.[15]
The "stretching vector" (or Normalization vector), s, is formed by taking the reciprocal of the square root of each element in the Eigen value vector, and multiplying it by the desired standard deviation for the output image channels.[8]
Out of all above methods we have used CLAHE and DCS which are image enhancement methods for optimization. We have implemented optimization method before compression by using Matlab simulation. [12]

2. Algorithm Steps

i) Contrast Limited Adaptive Histogram Equalization (Clahe)

Following steps are used for the enhancement of an image and it will be used as image optimization using CLAHE.[14]

1. Calculate total size of an Image
2. Resize the image 255 x255
3. Specify Grid Size-32 pixel
4. Calculate the histogram from left to right corner for each Grid point.
5. Calculate CDF of each grid.
6. Enhance histogram which is directly proportional to slope of CDF.
7. Repeat steps 3 to 6 for each grid in an image.
8. Obtained enhanced Image.

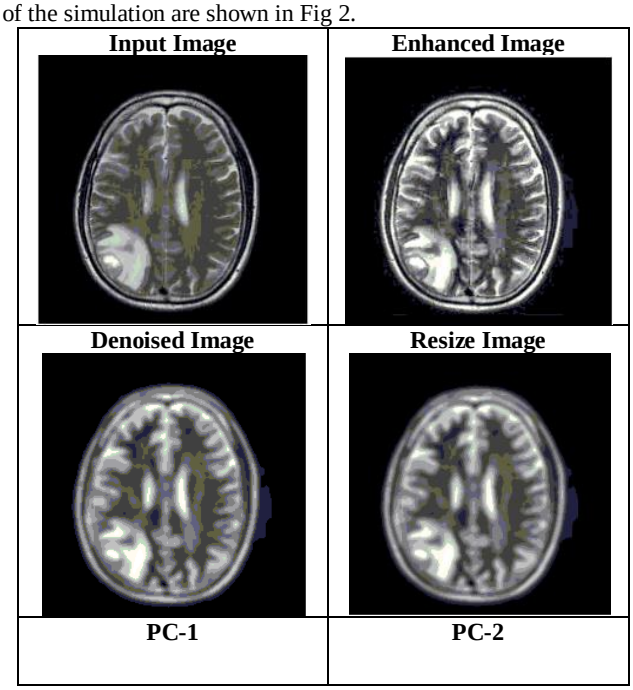
ii) Decorrelation Stretch (Dcs)

Following steps are used for the enhancement of an image and it will be used as image optimization using DCS.

1. Read Input Image.
2. Find Covariance of matrix.
3. Separate RGB band.
4. Find Eigen vector of R/G/B image
5. Stretch Eigen vector of each R/G/B
6. To equalize band variance
7. Apply Inverse K-L transform
8. Obtained enhanced Image.

3. Results and Discussions

For analysis of an image, 8 bit brain image has been taken as test images as shown in Fig.3. Results show that a high compression ratio and better PSNR is achieved using Matlab simulation. When optimization is used before image compression using Oscillation concept. It preserving the quality of image. The executed results of the simulation are shown in Fig 2.



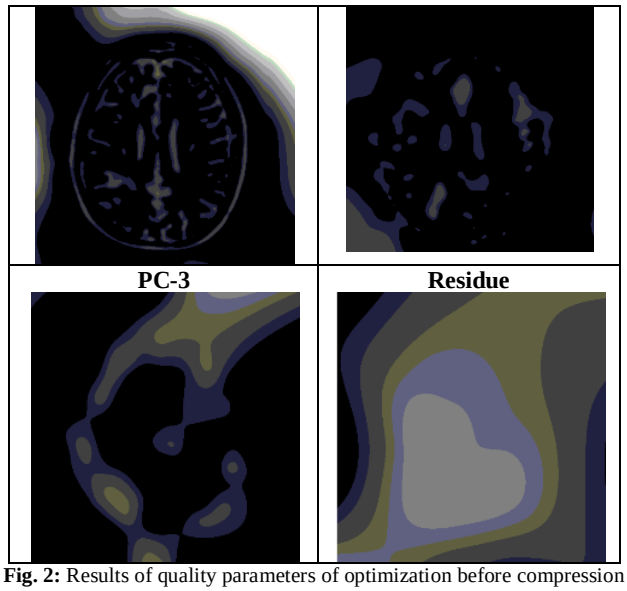


Fig. 2: Results of quality parameters of optimization before compression

A. Comparative of Different Parameters for Oscillation Concept Method with and Without Optimization

Sr. No	Technique used for Image Compression	Parametes			
		CR	MSE	PSNR	MSSIM
1	Oscillation Concept Method with Optimization	5.11	34.34	32.77	0.54
2	Oscillation Concept method without optimization	4.32	36.06	32.56	0.53

B. Comparative Analysis Using Graphical Representation

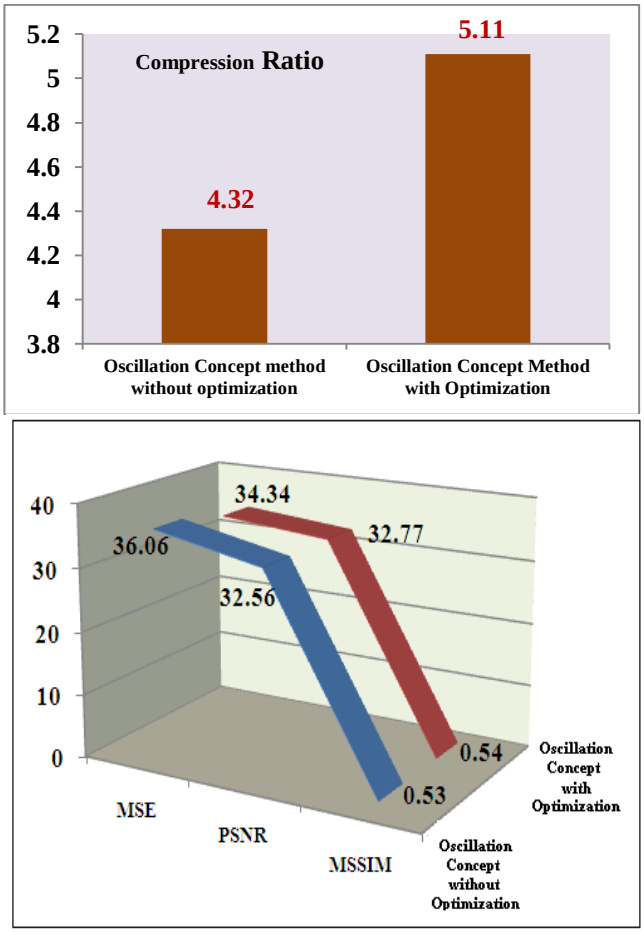


Fig. 3: Comparative Analysis with and without optimization

4. Conclusion

This paper has discussed image enhancement techniques, Contrast Limited Adaptive Histogram Equalization (CLAHE) and Decorrelation Stretch **(**DCS). These image enhancement techniques used for optimization of an image before compression. This paper has discussed oscillation concept for an image compression. In this paper most important parameter is Compression Ratio and due to optimization before image compression we have achieved better Compression ratio i.e.5.11.It is also noted that we have achieved better results for other parameters like PSNR, MSE and MSSIM. Hence, we can conclude that the optimization before image compression is very useful technique which gives better results.

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