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ROI Based Image Compression of Medical Images

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ABSTRACT

Medical imaging is one of the best techniques for monitoring the person's health condition which is used widely nowadays. One of the problems that physicians encounter with it to store the medical images. This storage occupy more area for storing images long time as there is need to keep the record of numerous patients. So there is need to compress the image to be resolved in a variety of medical images, including radiography, magnetic resonance (MR), mammography, and ultrasound images, X-Rays, Brain MRI, CT images and so on. The rapid and reliable digital transmission and storage of medical and biomedical images would be tremendous boon to the practice of medicine. So this long term rapid transmission is prohibitive without image compression, to reduce the size of files. To make the Medical Images more useful and process able, there is need to reduce the transmission time and storage space for the images. The image may become more visual too, by compressed as it will also help to reduce transmission errors as less data will be transmit, also reduce the cost. Majority of the traditional methods lacks in terms of low compression ratio with lossless technique, some methods having problem of lost data when lossy compression technique is used. In vector quantization technique there is low PSNR values. Further, some methods provide high mean square errors. MAXSHIFT, SPIHT, and General scaling methods having low complexity but provide better results. DCT algorithm works efficiently to compress the image; it applied on the image blocks. If the blocks are too large then local features are no longer exploited, but if the blocks are too small then the images are not effectively correlated. So the size of the blocks is important as they determine the effectiveness of the transform over the image. But still there is not a single algorithm giving optimized values on above factors. Here our proposed work dealt with the investigation and implementation of traditional compression algorithm of Images of Medical domain, as a preliminary step and then proposed a compressed algorithm, known as a region growing algorithm to overcome the above adaptive problems being faced by traditional and also generated a quantitative analysis result of compression with various parameters PSNR and MSE. This proposed technique give best performance in terms of computation and speed of computation is high. Furthermore, resulting parameters (such as PSNR, MSE, and entropy) are calculated and compared with existing algorithm and observed that the proposed algorithm has better performance.

Keywords:- *MRI , ROI, DCT, MAXSHIFT, SPIHT Brain MRI*

I. INTRODUCTION

Medical Imaging

Nowadays, many fields of human life are turning into computerized system. This demands to store amount of information in digital form. This all become possible for progressing in registration of diverse kind of data. This overall progress is being observed in wide field of digital images which also covers medical images. Radiology began as a medical sub-specialty in first decade of the 1900's after the discovery of x-rays by Professor Roentgen. The development of radiology grew at a good pace until World War II. Extensive use of x-ray imaging during the second world war, and the advent of the digital computer and new imaging modalities like ultrasound and magnetic resonance imaging have combined to create an explosion of diagnostic imaging techniques in the past 25 years.
Digital image processing technology for medical applications was inducted into the Space Foundation Space Technology Hall of Fame in 1994. Medical imaging has great impact on the diagnosis of diseases and surgical planning [5]. Medical imaging is the technique, process and art of creating visual representations of the interior of a body for clinical analysis and medical intervention. Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities. Although imaging of removed organs and tissues can be performed for medical reasons, such procedures are usually considered part of pathology instead of medical imaging.
As the health care is computerized, new techniques and applications are developed, among them the MRI, CT, endoscopy, elastography, tactile imaging, thermography, medical photography techniques. MR and CT produce sequences of images (image stacks) each a cross-section of an object. In hospitals, physicians keep record for large number of medical examination results, through which doctors make a diagnosis based on various examination results. Such systems are useful for patients to gain access

to their medical data. A quite good example is IZIP-Czech system, which give internet access to patient's health record. Day by day, hospital databases are increasing rapidly, every day there is need to record thousands of images for some period as data can be used later. During substituting image data, one wants to keep high quality level data, less transmission time and storage space. The increase of throughput in used communication connections unfortunately is insufficient, so some additional solutions must be carried on to satisfying requirements. More capacity also increases the cost. So to overcome these problems, image compression techniques are researched and developed. There are many different approaches for image compression and every approach produces many diverse methods. For medical images, it must be required special treatment of compression because correctness of diagnosis is depending on it and distortion in the image, low quality of the image can be harmful for patient's health. The initial emphasis was on information preserving methods. In means of scan pixel difference was researched by Takaya et al in [6]. Assche et al exploit the inter-frame redundancy in [7]. Linear predictive coding schemes were investigated in [8].

Up until 2010, 5 billion medical imaging studies had been conducted worldwide. [9] Radiation exposure from medical imaging in 2006 made up about 50% of total ionizing radiation exposure in the United States.[10]

Steps for Medical Images

By increasing the demand of direct digital imaging systems for medical diagnostics, digital image processing becomes more crucial. Hence to make this process easy, National Electrical Manufacturers Association (NEMA) created the Digital Imaging and Communications in Medicine (DICOM) standard [11], which assists the allocation and analysis of medical images such as MRI'S, CT scans and ultrasound. Digital image processing basically covers four major areas for medical image processing, as shown in diagram (Fig. 1) [12].

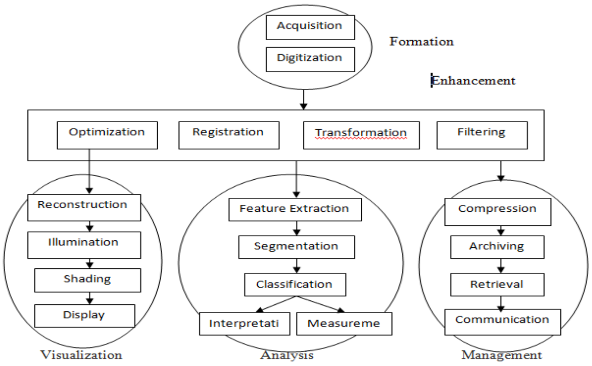

Figure 1: Steps of Medical Image

Image Formation: It includes all the steps from capturing the image to outlining the digital image matrix. Acquisition and digitization comes under formation.

Image Enhancement: It includes all the steps of transforming, registration and filtering the images.

Image Visualization: It demotes all classes of manipulation for optimized output of the image of that matrix. It involves illumination, shading and display steps.

Image Analysis: It includes all the steps for processing the image like feature extraction, segmentation and classification. These steps require prior knowledge on the content and nature of the system.

Image Management: It summarizes all the techniques that offer the efficient storage space, transmission, archiving, and retrieval of image data.

II. IMAGE COMPRESSION TECHNIQUES

There are mainly two categories of image compression such as lossless and lossy compression, depending whether or not an exact model is totally reconstructed.

Lossless compression

In lossless compression, the reconstructed image remains identical to the size of the original image, after compression. It can only achieve reserved amount of compression. This is also called noiseless as it does not add noise to the image or signal. This type of compression used only with few applications where information should not be loss for instance medical imaging. Lossless coding also referred as entropy coding [14]. Examples of lossless [15] image compression are PNG and GIF.

Lossy Compression

In lossy compression, the reconstructed image is not identical to the original image but reasonably close to the size of the image [20]. It also degrades the image as it completely discards the redundancy from the signal or image. It also results loss of information by using quantization process, which sorts the data into different bins and each bin represented by a value, but provides much higher compression ratio.

III. REGION OF INTEREST (ROI)

ROI is designed to owing to the boundaries of lossy and lossless compression techniques. Most of the lossless compression techniques, the compression ratio are near to 80% of original size, while for lossy coding method, the compression ratio is much higher (up to 5-30 %) [6],[8] but there may be major loss in data. Thus, ROI is mainly introduced for medical images, as medical images do not afford any loss of information in highly diagnostic important parts. Medical image is divided into two parts: ROI and non-ROI part. ROI part is considered as most diagnostic important part, also called foreground part, other remaining part is known as non-ROI part, also called background part. Hence there is need to apply lossless compression technique for preserving the quality of the diagnostic part (ROI), as well as provide [6],[22] high compression ratio. During the transmission of the image for telemedicine purposes, the ROI part is required to be transmitted first or at a higher priority, so the coefficients associated with ROI are transferred first before those associated with non-ROI part.

Region Growing

Region growing is a simplest region-based method. It is also known as pixel-based method. Region growing method examines the entire neighbouring pixels of primary seed points and check whether these neighbouring pixels are adding to the region or not. This procedure is same as data clustering method. Firstly, region growing choose a set of seeds. Selection of seed point is depend on the user criteria such as it may be depend on pixel intensity, gray level texture or color level. Primary region starts at the exact location of the seed point and seed point (selected pixel) select all the adjacent pixels to add in the region. The image information is also important in the region growing.

IV. METHODOLOGGY

Proposed Algorithm

Earlier studies have proved that medical images face different types of problems due to the various factors as discussed in previous chapter. The proposed algorithm works using haar wavelet technique and provides best PSNR results as compared to previous technique.

The following steps are required to fulfil the above objectives:

1. Start the process to browse the image.
2. Apply region growing algorithm on the browsed image.
3. Select the region of interest (ROI) part by using the mouse click.
4. Apply the first-level DWT (using haar wavelet) on the selected ROI part of the image.
5. Calculate the PSNR and MSE values of the first-level decomposed image.
6. Again apply the second-level DWT (using haar wavelet) on the first-level decomposed image.
7. Decode the image using IDWT (inverse discrete wavelet transforms).
8. Calculate the PSNR and MSE values of the second-level decomposed image, and get the reconstructed image.
9. Then final output image displayed.
10. Calculate the entropy of the original and final image.
11. Repeat the same process to applying on more images.

V. RESULT & DİSCUSSİON

In this work all the experiments are performed in MATLAB and the compression experiments are performed on the number of images. The comparison of proposed algorithm is also done with existing algorithm using a number of quality evaluation parameters discussed in previous chapter. The result of various experiments using quality factors are analyzed below.

Test Images

In the image compression experiments, different medical images are taken in order to apply the proposed method of compression. The proposed algorithm has been applied on various data sets of gray scale images, out of which the results of four images are presented in this work. Figure 2 is the original image that is used to select the region of interest (ROI) part by applying region growing algorithm.

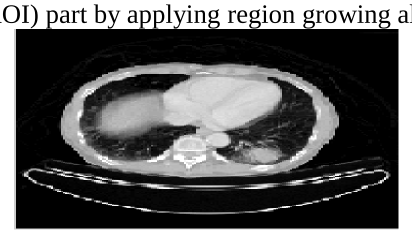

Figure 2: Brain Image

Results

Furthermore, results are given by applying proposed algorithm on these different images. For every image, firstly there is original image of ROI part which is selected by region growing. Then using haar wavelet first-level decomposition is applied on all the original images to compress the images. After that, again second-level decomposition is applied on first-level decomposition compressed images to recompress the images. Finally, using inverse DWT, reconstructed and error image displayed as output image.

Compression of test image 1

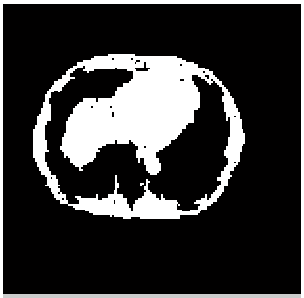

Figure 3(a): Region growing original image

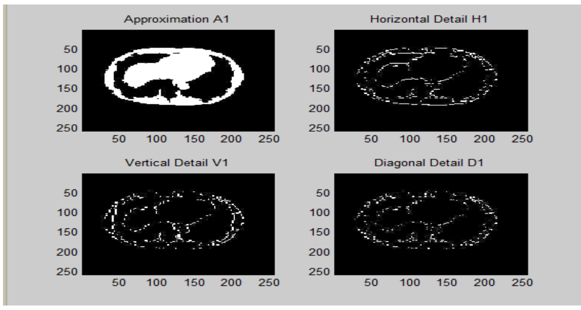

Figure 3(b): 1-Level Decomposition

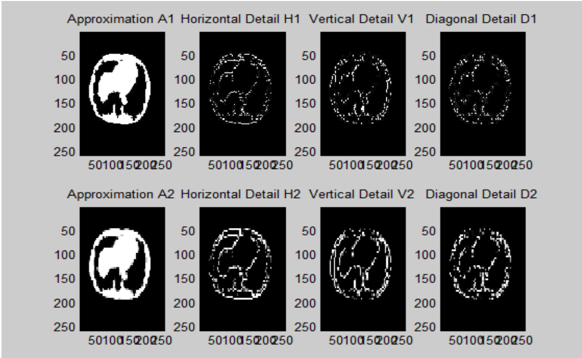

Figure 3(c): 2-Level decomposition

Figure 3(d) Final reconstructed image & Error Image

Comparison of quality Parameters with previous algorithm

In this, above table is showing results for proposed method. Now, in the following table, this work is comparing the proposed technique with previous technique. As shown:

Table 1: Comparison of Evaluation Parameters

Sno	Image Type	MSE		PSNR	
		DWT	DCT	DWT	DCT
1.	Brain Image	3.66	0.86	312.48	48.76
2.	Vm Image	2.21	1.08	314.67	47.79
3.	Brain2	1.18	0.31	307.39	53.13

VI. CONCLUSION & FUTURE WORK

Today, some of diseases can be detected using medical imaging methods. One of the problems that physicians encounter with it to store the medical images. This storage occupy more area for storing images long time as there is need to keep the record of numerous patients and these images also contain redundancy. So there is need to identify redundancy and compress images. The various types of compression techniques are studied in this work such as lossy and lossless. This work discusses ROI-based medical image compression. This region of interest based compression techniques helps to reduce the size of the image without degrading the quality of the important data. Wavelet method is recommended for ROI-based medical image applications because of the perfect reconstruction with low complexity of the image. Further, the haar wavelet transform (lossless compression) is applied on the ROI part to compress the image. Then decode the image using IDWT method. This proposed technique give best performance in terms of computation and speed of computation is high. It was observed that the proposed algorithm has better performance as compared to other algorithms. Moreover, the proposed algorithm is also compared with some standards and already developed algorithms. Furthermore, resulting parameters (such as PSNR, MSE, and entropy) are calculated and compared with existing algorithm.

Future Work

This image compression work is further extended for three-level decomposition of DWT technique and can get better results with the help of different types of threshold techniques. Further, this work can be performed on color scale and real time images.

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