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Medical Image Compression Based on Adaptive Techniques

A Thesis

Submitted to the Computer Science Department\ College of Science \University of Diyala
In a Partial Fulfillment of the Requirements for The Degree of Master of Science in Computer.

By

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بسم الله الرحمن الرحيم

قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ

الْحَكِيمُ

صدق الله العظيم

البقرة (32)

Dedication to

This work is dedicated to my family, whose assistance, forbearance, and continues encouragement during the whole period of time, made it possible to finish this work. Also dedicated to giving the effort to my parents, I wish to express my love and gratitude to my beloved family members

With My love
Mena

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First of all, praise is to GOD, the lord of the whole creation, on all the blessing was the help in achieving this research to its end.

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I would like to express my gratitude to my father, my mother, my sisters and my brothers.

Mena mohammed

Examination Committee Certification

We certify that we have read this research entitled ***"Medical Image Compression Based on Adaptive Techniques "***, and as an examining committee, examined the student " **Mena Mohammed Abood"** in its contents and that in our opinion, it is adequate as fulfill the requirements for the Degree of Master in Computer Science at the Computer Science Department, University of Diyala.

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We certify that this research entitled "*Medical Image Compression Based on Adaptive Techniques*" was prepared by **Mena Mohammed Abood** under our supervisions at the University of Diyala Faculty of Science Department of Computer Science, as a partial fulfillment of the requirements needed to award the degree of **Master of Science in Computer Science**.

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Abstract

The image compression concept aims to significantly decrease the size of different image kinds with preventing harmful distortion and malformation during reconstruction. The medical image compression term is a crucial topic in image processing system to compress and decompress the different kinds of medical image, this term can be performed thorough both main lossless and loosy techniques. Although these techniques are used to design the compression system, they have some challenges in original size reduction, computational complexity level, and minimum square error.

In this thesis, these challenges have been addressed to improve the compression performance for sensitive medical image. Firstly, segmentation the medical image (Skin Canser, MRI) into ROI and NROI. Secondly, a new hybrid Set Partition in Hierarchical Tree–Particle Swarm Optimization (SPIHT- PSO) algorithm is derived for the Region of Interest (ROI) based on lossless compression technique. thirdly, a Two Dimensional-Discrete Cosine Transform (2D-DCT) algorithm has been developed for the Non-Region of Interest (NROI) according to loosy compression technique, this algorithm can increase the compression ratio and enhance the compression performance. finally, in coding used two technique the Run-Length Encoding (RLE) and the Huffman coding algorithms to enlarge the compression ratio. In addition, This cascaded algorithm does not require high level of computational complexity and then it is faster for transmission purposes.

The results indicate that the SPIHT-PSO algorithm has increase the compression ratio better than SPIHT. Furthermore, the result of ROI region

better than the result of NROI region. While the result of coding when used (RLE- Huffman) algorithm better than the result when used (RLE) alone or Huffman algorithm. The different parameters of compression process indicate that the proposed system is better than that of traditional systems that described in literature. The compression ratio is increased with average of (37.8301 - 46.04672) % and the peak signal to noise ratio is raised with average of (44.8464 - 68.8438) %.

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List of Abbreviation

Abbreviation	***Meaning***
SPIHT	Set Partitioning in Hierarchical Trees
LIP	List of Insignificant Pixels
LIS	List of Insignificant Sets
LSP	List of Significant Pixels
PSO	Particle Swarm Optimization
DCT	Discrete Cosine Transform
1D	One Dimension
2D	Two Dimensions
RLE	Run Length Encoding
CR	Compression Ratio
MSE	Mean Square Error
PSNR	Peak Signal to Noise Ratio
MAE	Mean Absolute Error
PMSE	Peak Mean Square Error
NK	Normalized Cross-Correlation
SC	Structural Content

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Chapter One

Introduction

Chapter One

Introduction

1.1 Medical Image Compression

Image Compression (ICOMP) has played an essential role in the image transmission and storage application. These application as medical, remote sensing, satellite communications, and military involve high quality image. The previous applications have one common goal to alter the representation of information contained in an image so that it can be represented sufficiently well with less information [1, 2].

The ICOMP techniques can be classified into two types, lossless and lossy coding. The first type, lossless coding, has a reconstructing procedure and then it keeps the information quality throughout the encoding and decoding procedure. In contrast, the second type, lossy coding, performs a big Compression Ratio (CR) with preserving quality as much as possible [2, 3].

Normally, the procedure of ICOMP contains two basic stages; encoder and decoder. The encoder stage transforms the original image into code sequence in the transmitter. In the receiver, the decoder regenerates the necessary data to reconstruct the original image, where the reconstructed image should be looked like the original one [4].

A typical block diagram of the compression procedure can be described briefly as shown in Figure 1.1. In the compression stage, the preprocessing prepares the image for an encoding procedure using some of operations. In backward manner, the compressed image is decoded using a decoder in the decompression stage. After that, the post processing block can be used to remove some malfunctions that are produced by the compression stage [4].

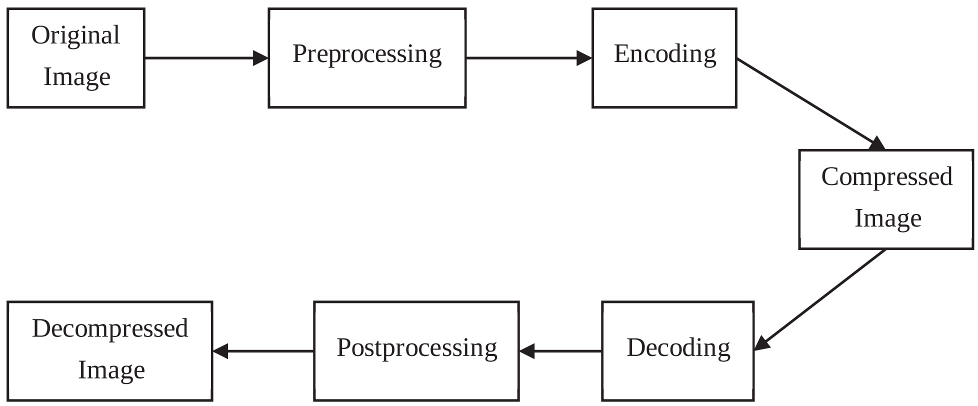

Figure 1.1: Typical Block Diagram of Compression Process [4].

As aforementioned above, the lossless compression technique (or error-free) keeps the image specification during compression and decompression processes. Thus, the decompressed image is identical to the original image. In other words, this technique permits the image to be compressed and decompressed without losing its data [5, 6]. The lossless techniques have several types such as Huffman coding, arithmetic coding, and Lempel-Ziv techniques. Although the lossless compression process has a low CR that is equal to a ratio of the original image size to the compressed image size, the medical image processing involves this technique due to it is considered as a critical application [7, 8].

The medical imaging processing is a process that generates images for the human body. These images are either for the clinical cases such as testing a disease or medical cases such as studying the anatomy. The medical imaging consists of many kinds such as nuclear medicine, thermography, investigating of radiological sciences, medical photography, and investigating of human pathological. Figure 1.2 shows different kinds of medical image [9].

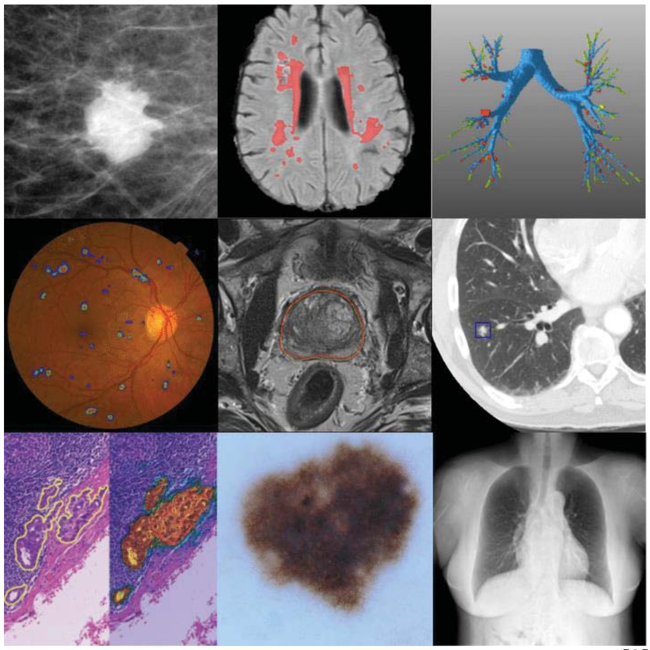

Figure 1.2: Different Kinds of Medical Image [9]

The medical imaging applications have been stored digitally with the modern devices that are used for such applications. Thus, the storing devices such as computer are used to save the compressed images to reduce the storing size without affecting the image quality. The imaging technique that have used are magnetic resonance imaging, computed tomography scan, radiography, X-ray, ultrasonography, and others [10].

1.2 Literature Review

Related recent studies, which have proposed several algorithms on medical ICOMP, are discussed in this section.

In 2014, N. K. Sahu *et. al.* [11] proposed a hybrid algorithm using the Huffman coding (as a lossless compression technique) with Linear Predictive Coding (LPC) (as a lossy compression technique) to enhance the compression performance. It compressed both ROI (Region of Interest) and NROI (Non-Region of Interest) individually. The experimental results shows that better Signal to Noise Ratio (SNR) with acceptable Compression Ratio (CR) has been achieved using hybrid scheme based on Huffman and LPC , the algorithm also has better robustness.

In 2015, S. Singh and E. S. Singh [12] discussed about the ROI based Medical image compression technique. DCT (Discrete Cosine Transform) method is used with the ROI part of the image to reduce the blocking effect in the image for the better understanding. ROI based compression techniques helps to reduce size of image without degrading the quality of the important data. The area of improvement can be a system which itself identifies the area of interest within the medical image and then applies various compression techniques on region of interest as well to reduce size of the image.

In 2016, all the next works was done. In the study by A. Dhivakar *et. al.*, the embedded zero tree wavelet coder (EZW) was investigated to compress different medical image types [13]. It evaluated many parameters such as Mean Square Error (MSE), Bit per Pixel (BPP), Peak SNR (PSNR) and CR. It also found the reconstructed image quality depends on the decompression process, the image specifications and its storing aspects.

B. V. Reddy *et. al.* [14] proposed Daubechies Wavelet Transform (DbWT) as lossless compression for ROI and EZW as a lossy compression for NROI. This technique is proposed to obtain better compression performance. The results cleared that the DbWT is better than the Haar Wavelet Transform (HWT) in terms of PSNR and CR.

K. Ravi *et. al.* [15], segmented the medical image in ROI and Non-ROI region using the edge based segmentation technique. The general

PCA(Principal Component Analysis) algorithm is applied on the Non-ROI and Block-based PCA applied on ROI .From this work, it's found that region-based PCA performs much better than the PCA algorithm with regards to image quality, yielding similar compression ratio as the PCA algorithm.

B. Perumal and M. P. Rajasekaran [16] discussed the Discrete Wavelet Transform (DWT), Back Propagation Neural Networks (BPNN) and hybrid DWT-BP (Discrete Wavelet Transform-Back Propagation) compression techniques. The result depicted that the hybrid DWT-BP achieve better CR and PSNR yet it has high computational complexity level.

V. J. Preeti and C. D. Rawat [17] presented a hybrid compression scheme by encoding the ROI of brain magnetic resonance imaging using arithmetic coding and NROI using the Set Partition in Hierarchical Trees (SPIHT) algorithm. This scheme is obtained in terms of PSNR, Structural Similarity Index (SSIM) and Virtual Information Fidgety (VIF). However, it influenced by the computational complexity.

K. Chandrashekhar and S. Monisha [18] extracted ROI part with the help of thresholding method of segmentation and compressed with the help of SPIHT algorithm thus producing a good quality image and NROI part is compressed with the help of Haar wavelet transform (HWT). The proposed algorithm provided better PSNR values for medical images.

M. S. Ibraheem *et. al.* [19] proposed Logarithmic Number System–DWT (LNS-DWT) algorithm near-lossless compression. It achieved higher quality of image than the classical DWT but with a longer time. The tradeoff between the speed and image quality that is an essential factor for the radiologists, delivered better results. The obtained PSNR is better than the classical DWT but it required a longer time.