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Department of Computer Techniques Engineering

Medical Image Compression Using RLE and DWT Techniques

A Graduation Project Submitted to the Department of Computer Techniques Engineering / Al-Hikma University College as a Partial Fulfillment of the Requirement of the BSc. Degree in Computer Techniques Engineering – Networks

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Supervisor's Certification

I certify that the preparation of the graduation research project" **Medical Image Compression Using RLE and DWT Techniques"** was made under my supervision at the Network / Department of Computer Techniques Engineering – Al-Hikma University College in partial fulfillment of the requirements for the degree of BSc. inComputer Techniques Engineering.

Signature:

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Date: / 06 / 2021

Examining Committee Report

We certify that we have read this graduation research project "**Medical Image Compression Using RLE and DWT Techniques**" and as an examining committee, examined students in it's content and in what is related to it, and that in our opinion it meets the standard of a graduation research project for the degree of BSc. in Computer Techniques Engineering.

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Date: / 06 / 2021

بسمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ ﴿1﴾ خَلَقَ الْإِنسَانَ مِنْ عَلَقٍ ﴿2﴾

اقْرَأْ وَرَبُّكَ الْأَكْرَمُ ﴿3﴾ الَّذِي عَلَّمَ بِالْقَلَمِ ﴿4﴾

عَلَّمَ الْإِنسَانَ مَا لَمْ يَعْلَمْ ﴿5﴾

صدق اللَّهُ العظيم

سورة العلق الآية (من 1 الى 5)

Dedication

To the prophet Mohammed and his family .

To all the martyrs of Iraq .

To My family with all respect and appreciation.

Abstract

Image Processing is the processing of images, series of images or videos by using mathematical operations by using any form of signal processing techniques. Image Compression and Image Enhancement are the most widely used techniques in Image Processing. Now a day there is an increasing need of these techniques in the medical field. This project is focused on the performance quality comparison of medical images using Image Compression and Enhancement Techniques. This analysis is used to suggest the better techniques for compression and enhancement of medical images.

In this study, the main objective is to attain an efficient output of a medical image. This undergoes a series of steps starting with compression and then followed by the enhancement of the medical image to get an enhanced output. We provide a detailed analysis of all the techniques involved in this process. The images quality is then assessed on various performance parameters.

A detailed literature research has been done to study the various techniques in both image compression and enhancement. The performance metrics are considered by understanding the literature research from various papers. The Discrete Wavelet Transform (DWT) and Run Length Encoding (RLE) are applied in this study, the enhancement of the compressed outputs is performed using Image Intensity Adjustment. The results are obtained and the performance metrics are compared. MATLAB is used for the coding purpose.

The results are calculated using the performance metrics PSNR, MSE and SSIM where the values for each technique are tabulated. Then plots for each image and for each performance metric are plotted. Through these outputs we compare different performance parameters by adjusting the coefficients and also the block sizes.

With a detailed analysis and logical comparison of the performance metrics we conclude the better performance metric than the other and also which combinations of compression and enhancement techniques are better with each other.

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Chapter One

Introduction

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Introduction

1.1 Introduction

As in today's world of emerging technology where most of the data is recorded in digital format, virtually all image interpretation and analysis involves some elements of digital processing. This digital image processing involves the processing of images, series of images or videos by using mathematical operations by using any form of signal processing techniques. Image compression and image enhancement are the most widely used techniques in image processing. Different types of images like binary images, indexed or pseudo colored images, grayscale images, true color images also known as RGB images are generally used in image processing. Image Processing is of generally digital image processing but there are also analog and optical image processing possible image compression is an efficient technique to reduce the size of graphical file and also reduce the storage requirement area [1].

Medical images like Magnetic Resonance Imaging (MRI) scans, X-ray images are the most used images these days in the medical field. As there is an emerging growth of population these days so are the health issues of the people. The differ- ent cases of number of patients and their records are maintained in the hospitals. So, for storing all the case history of a patient there are a number of medical

images that has to be stored in the system database. In this regard the medical images are compressed using several techniques and thus images are stored and transmitted from one system to another for the ease of communication. So,

In this project the medical images undergo both compression and enhancement techniques consecutively. And later on the performance quality of the images are tested on different performance parameters which are mostly used in to check the performance of compression and enhancement techniques.

1.2Motivation

Image compression and image enhancement techniques are the most widely used techniques these days in the field of medical images. So, in this master project we compare the performance quality of the different compression and enhancement techniques based on different performance metrics. The basic idea is to consider different medical images and perform compression techniques on the images. Then the images are again restored back by enhancing them. Then, we calculate the performance measures techniques of the compression and enhancement tech by using different performance parameters like peak signal to noise ratio (PSNR), mean square error(MSE) and structural similarity index modulation(SSIM).

Our main motive of this project is to compare different techniques on the same medical images and see how the performance varies on different combinations accordingly. Thus the quality of the output image is compared with the inputimage and the performance of

the combinations are analyzed.

1.3 Aims and Objectives

The main aim of this paper is the performance quality comparison of medical images using both image compression and enhancement techniques. The objectives mainly include:

1.3.1 Selection of necessary medical image database from the open source libraries available.

1.3.2 Compression of the medical images using both WDT and RLE compressiontechniques.

1.3.3 Enhancing the compressed images using different enhancement techniques.

1.3.4 Comparison and evaluation of the quality of the obtained output images ineach case with respect to the original image.

1.4 Research Questions

The research questions discussed in this project are :

1.4.1 What are the methods or techniques used for image compression?

1.4.2 What are the methods or techniques used for image enhancement?

1.4.3 What are the performance metrics that need to be considred to comparethe performance results of different combinations of image compression andenhancement methods?

1.5 Documentation Framework

The document is organized as mentioned below.

Chapter 1 gives a brief introduction about the project in which way image processing is being used widely these days in the field of medical images. This section also deals with the main motive of the project and the aims and objectives of this project. This is further followed by research questions and documentation framework.

Chapter 2 discusses the related work image compression and image enhancement of medical images.

Chapter 3 mainly focuses on the various methods or techniques used for the performance quality comparison of medical images. Here we first discuss about the literature review that has been done for this project and then followed by compression and enhancement techniques in this project in detail. Then the performance metrics are analyzed one after the other and how each metric is implemented.

Chapter 4 includes the results and the analysis part of each technique. The values that are obtained from each performance metric are tabulated and the respective graphs plotted for each metric are included in this section. The results are analyzed and validated.

Chapter 5 gives a clear conclusion of the project based on the above analyzed and validated results. The future scope of this project is also mentioned here in this section.

Chapter Two

Related Work

Chapter Two

Related Work

This project mainly focuses on the concepts of image compression and image enhancement techniques. In this project work a literature review has been made in order to assess the progress made in the field of image compression and image enhancement techniques on medical images [2-7]. ,The comparison between the RLE and Huffman algorithms for lossless data compression of medical images is effectiveness of the algorithm in the process of reducing the size of the files[8-9].

Image enhancement technique for image contrast enhancement using a histogram modified framework and its applications is effectiveness of the algorithm in comparison to other enhancement algorithms[10].

When used morphological filtering for image enhancement for cleaning the image from various types of noise using the morphological operations like erosion, dilation for the enhancement of the images[11].

Chapter Three

Methodology

Chapter Three
Methodology

3.1Theoretical Background

The performance metrics that are to be used for comparison of the compressed and enhanced images were selected by reading several related research papers and journals. The methodology to reach the aim of this project involves an experimentation part from which the required data and graphical representations canbe obtained to make an appropriate analysis. The experimentation includes collecting the values of the selected performance metrics and plotting the graphs for the values obtained. The experiments were performed using MATLAB software.

For this purpose we need medical images to test and compare the techniques. So a medical database of nearly one hundred images is collected from an open source in the Internet. This database is a collection of 100 medical gray scale images taken from different open sources for testing in the code. The dimensions of the images taken are nearly .The images that are collected are free from the copyrights issues and are open for the public to use them.

The block diagram in fig 3.1 depicts the research methodology followed in thisproject to achieve the desired goal of this project.

3.2Image Compression Techniques

Image Compression addresses the problem of reducing the irrelevance and redundancy of the image data in order to be able to store or transmit data in efficient form. As there is a wide growth in medicine field in day to day life there is also a great need for image compression techniques for storing abundant data and information. Image Compression is nothing but the size of the image is actually reduced in size without degrading the quality of the image[12]. The reduced file size thus helps in storing more number of images in a file and for easy sending and communication to others[13].

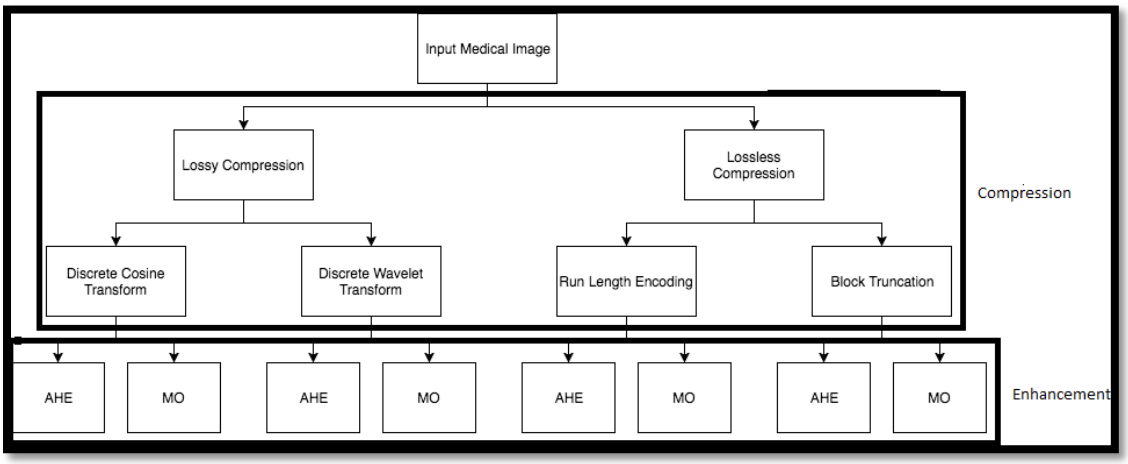


Figure 3.1.: Block Diagram of the Compression and Enhancement Process.

There are several ways in which images can be compressed.

There are many techniques in image compression but in this project we used techniquesrespectively.

1. Discrete Wavelet Transform (DWT)
2. Run Length Encoding (RLE)

3.2.1Discrete Wavelet Transform (DWT)

One of the most widely used transform techniques for image compression of medical images using wavelets is Discrete Wavelet Transform (DWT). This DWT is very useful for compressing signal and also shows better results for medical gray scale images. While using DWT the important parameters that are taken into consideration are testing the image, wavelet function, number of iterations and calculation complexity. These wavelets transforms are used to process and improve signals in fields like medical imaging where image degradation is not tolerated.

The same input image which is taken earlier for DCT is now compressed using the DWT compression technique. The image is converted from mat to gray and then it is divided into 4 bits in the form of (low, low), (low, high), (high, low), (high, high). The image is undergone through DWT compression and then the image is again resized to original size. In this way the image is compressed using DWT. The performance metrics are then calculated using PSNR, MSE, and SSIM and are tabulated for the further comparison with the other techniques.

3.2.2 Run Length Encoding (RLE)

In the other compression techniques, one of the most widely used encoding techniques is Run length encoding (RLE). RLE technique actually compresses the medical images without losing the important information or data. This technique compresses the images with a continuous long sequence into a single data sequence. Run Length Encoding is mostly in use din compressing black and white images as this gives better results in compression of images.

In this project, the medical image is selected from the medical images database from an open source and is tested using matlab. The image is first converted from mat to gray and is given as an input for compression. Image intensity adjustment algorithm is also used here to enhance the contrast of the image. This algorithm does not provide any significant change in the original file. The loaded image is further converted into the desired form and the for loop is implemented. The iteration is repeated as long as the coefficients of the images used are iterated and the image is compressed into a single sequence. Then the image is iterated and then the loop is removed. Then the RLE out compressed image is obtained and the lossless compression using RLE is obtained.

3.3 Enhancement Techniques

Image enhancement is the popular and the most widely known technique of image processing. Many images like medical images,

satellite images, aerial images and even real life photography suffer from noise and poor contrast. Image enhancement algorithms offer a wide variety of approaches for modifying images to achieve visually acceptable images. The choice of such techniques is a function of the specific task, image content, observer characteristics, and viewing conditions. The point processing methods are most primitive, yet essential image processing operations and are used primarily for contrast enhancement [16]. Enhancement techniques improve the quality of the image view, blurring, noise and increasing contrast and improve the borders and sharpness of the image.

The enhancement methods can broadly be divided in to the following two categories,

1. Spatial domain
2. Frequency domain

Spatial domain and frequency domain include techniques like point processing,image smoothening, edge detection and image sharpening. The techniques used in this project are spatial domain which deal with the image pixels and enhance the contrast and the compressed medical images are well enhanced by image adjust- ment. The techniques used in project to enhance the compressed medical images are:

1. Adaptive Histogram Equalization (AHE)
2. Morphological Operations (MO)

3.4 Adaptive Histogram Equalization (AHE)

Adaptive Histogram Equalization is the method used for the contrast enhance- ment of images. This is mostly used in gray scale images like medical images where they are in low contrast and they are hence enhanced. The compressed medical images are enhanced again by using this contrast enhancement methodas it is simple and effective. It generates mapping for each pixels from the sur- rounding windows [10].The method is simple and computationally effective that makes it easy to implement and use in real time systems [17].

In this project the medical images from the database that are selected and compressed are given as an input for enhancement. By using the matlab commands and functions the image is enhanced using AHE. Image intensity adjustment is also used in combination with AHE so as to enhance the pixels more clearly. The performance metrics are measured, tabulated and plotted as graphs for a clear understanding of the comparisons made.

2. Morphological Operations (MO)

This technique Morphological Operations (MO) is used in image enhancement of binary images and is also extended to medical images. This is the combination of both erosion and dilation. The images that are compressed are undergone through morphological operations where the background of the image is enhanced efficiently using erosion and dilation. Image background approximation to the background by means of block analysis in conjunction with transformations that enhance images with poor lighting. The multibackground notion is introduced by means of the opening by reconstruction shows a comparison among several techniques to improve contrast in images Thus the desired enhanced outputs are obtained [18].

Chapter Four

Results

And

Discussion

Chapter Four
Results and Discussion

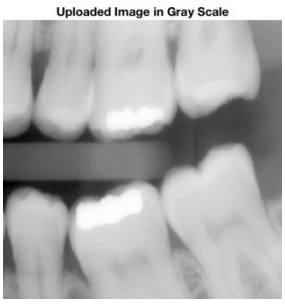
4.1 Introduction

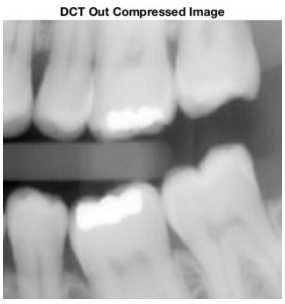
To analyze the results three images are selected and then the specific outputs of the respective image are displayed here as results of both compression and enhancement techniques. The images that are considered are named 111.tif, 222.tif and 333.tif respectively. The values obtained from those medical images are also tabulated in a tabular form and displayed accordingly.

Output Image for 111.tif

The Compressed and the Enhanced outputs of this image are displayed one after the other below.

- DWT technique

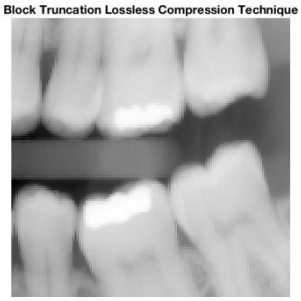


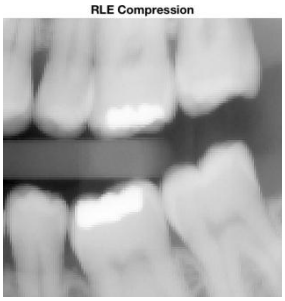


(a) Original Image (b) DWT out compressed image

Figure 4.1.: Image compression of medical image using DWT

RLE Techniques





(a) BTC Compressed Image (b) RLE Compressed Image

Figure 4.1.5: Lossless Compression using BTC and RLE

Output Image for 222.tif

- WDT Techniques

(a) Original Image (b) DWT out compressed image

Figure 4.2.1: Image compression of medical image using DWT

RLE Techniques

(a) BTC Compressed Image (b) RLE Compressed Image

Figure 4.2: Image Compression using BTC and RLE

Output Image for 333.tif

- WDT Techniques

(a) Original Image (b) DWT out compressed image

Figure 4.3-1.: Image compression of medical image using DWT

- RLE Techniques

(a) BTC Compressed Image (b) RLE Compressed Image

Figure 4.3.-2: Lossless Compression using BTC and RLE

- WDT Techniques

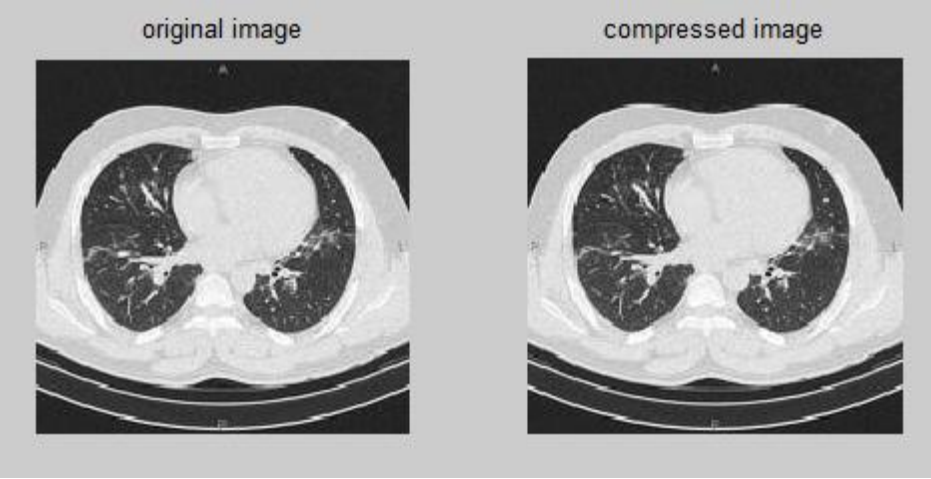


Figure 4.4.-1: Image compression of medical image using DWT

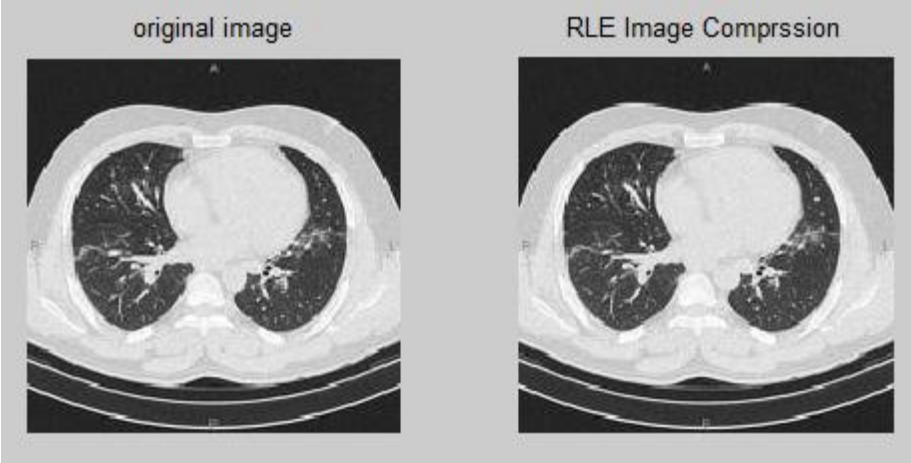
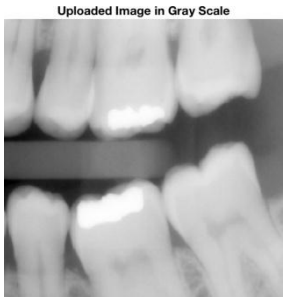


Figure 4.4.2: Image Compression using RLE

Table(4.1) Compression ratio of medical Images in WDT and RLE

Original image	**Compression Ratio by WDT**	**Compression Ratio by RLE**
	**0.0209**	**0.0143**
	**0.0954**	**0.0236**

	**0.0321**	**0.154**
	**1.0000e-04**	**0.0574**

Chapter Five

Conclusions

Chapter Five

Conclusions

The main purpose if this project is to analyze the performance parameters and the performance of the different compression and enhancement techniques. A detailed literature review has been done to understand the different characteristics and the working of these techniques. From this literature research, a clear knowledge has been obtained on the compression and enhancement techniques and how they work on medical gray scale images.

Firstly, the compression is performed using both DWT, RLE are used for compression. DWT compression gives better results than RLE. data.

Each compression technique is further enhanced using AHE and MO tech- niques.Here, we observe the combinations of the compression and enhancement techniques that worked well together. RLE has good values and better quality of images after enhancement rather than BTC by comparing the PSNR and SSIM values.The combination of AHE and RLE gives better enhancement results com- pared to any other techniques.

In the case of DWT compression AHE enhanced the compressed image sig- nificantly comparing the PSNR and SSIM values for AHE with DWT before and after AHE. Morphological operations are used to enhance the background rather than the sharpening or increasing the image contrast. this technique in specific is used to enhance the particular region of interest as seen in the results.

There is always a need to explore new methods to find an effective solution. In future, people may also use genetic algorithms and edge detection techniques and can compare these techniques by using different parameters.

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