CHAPTER 7

DISCUSSION AND CONCLUSION

7.1 INTRODUCTION

Telemedicine is the integration of telecommunication and information technology aimed at enhancing quality health care services to a wide and remote population. The main focus of telemedicine is to provide quick access to the health care provider, thereby saving on the time and cost required for patient transfer to the site of the doctor.

A major requirement of telemedicine is the transfer of medical images across the telemedicine network. These images could be in the form of X ray, CT, MRI, PET images. The amount of information present in these images is very huge. In order to transmit these medical images effectively with the available bandwidth, these medical images need to be compressed. To investigate the benefits of image compression, a near lossless compression algorithm was proposed and implemented in chapter 3. The technique was based on Haar wavelet compression. An improvement over the existing Huffman compression namely the 3-pattern Huffman encoder was proposed for the entropy encoding stage.

An improved feature extraction technique, a variation of the Fast Fourier Transform FFT namely the Image Retrieval Specific IRS-FFT was used to extract the coefficients of the compressed images, more specifically to be the energy features presented in chapter 4.
The main focus of this thesis was to gain insight into some of the key issues identified in telemedicine and to implement novel techniques and algorithms in order to address those issues.

The original work in this thesis is primarily targeted at these particular areas.

1. Improving the existing Huffman algorithm and developing a new 3-pattern Huffman compression algorithm for compressing the medical images without compromise on image quality.

2. An investigation into the effect of dimensionality, and proposing a new feature extraction technique IRS-FFT. A brief discussion on the classifiers available in literature and the effect of classifier for image retrieval.

3. An investigation into the need of effective segmentation techniques for effective compression. A hybrid compression technique was designed and implemented for higher compression.


7.2 ROLE OF IMAGE COMPRESSION ON MEDICAL IMAGES

Chapter 3 provides a thorough overview of the need of image compression and a number of commonly used compression algorithms available in the literature.

The proposed method made certain improvements on the existing Huffman technique to determine the best component and the most frequent
occurring pattern in the image to be processed. The patterns selected by the proposed technique will be the input to the encoder and the output of the encoder would be the compressed image with the footer information. In the current study, two compression techniques were investigated. In the first technique, Haar wavelet with Huffman coding is used for compressing the medical images. The second compression technique is based on the proposed 3 pattern Huffman compression.

It could be observed from Figure 7.1 that the compression ratio ranges from 32.325% to 35.175% with an average compression ratio of 33.085 which is achieved by the proposed method. On the contrary, the average compression ratio achieved for Haar wavelet with Huffman coding is 35.84%. Results showed that the proposed compression technique achieves better compression ratio by an increase of 2.755%.

![Figure 7.1 Compression Ratio on the 176 image dataset](image)

A PSNR value of 40 and above is acceptable, since it provides reconstructed images whose errors are not discernable by the naked eye. The proposed three pattern Huffman encoding techniques has an average PSNR of
40.3476 for medical images and improves the PSNR by 1.34 % compared to Huffman encoding.

7.3 EFFECT OF SEGMENTATION FOR EFFECTIVE COMPRESSION OF MEDICAL IMAGES

The literature review highlights the significance of image segmentation prior to compression. A segmentation approach has been presented in this thesis. The proposed hybrid compression technique compresses the Region of Interest ROI with a near lossless compression algorithm and the non-Region of Interest non ROI with a lossy compression algorithm. The ROI was compressed by Haar wavelet with a decomposition value of 1 and the non ROI was compressed using Haar wavelet with a decomposition value of 5, presented in detail in Chapter 5.

Figure 7.2 clearly shows that the compression factor obtained for Huffman encoding, 3 pattern Huffman encoding and the proposed hybrid compression method.

![Figure 7.2 Compression factor of MRI medical images for different techniques](image-url)
The proposed technique improves the average compression factor by 1.27 compared to 3-pattern Huffman and by 1.55 as compared to Huffman encoding, validated on the 176 image dataset.

7.4 MEDICAL IMAGE RETRIEVAL USING IRS-FFT AND PROPOSED MLP NEURAL NETWORK CLASSIFIER

Chapter 4 presents an overview of the dimensionality problem and proposed a novel feature extraction technique IRS-FFT.

![Classification accuracy by different classifiers on original and compressed image](image)

**Figure 7.3** Classification accuracy by different classifiers on original and compressed image

Figure 7.3 clearly shows that the proposed IRS-FFT method for feature extraction is able to provide better features for the classification algorithms like Naive Bayesian classifier, Radial Basis Function classifier and the MLP Neural Network classifier, when compared to the Fast Fourier transform.
The latter part of Chapter 5 presents an overview of the proposed neural network classifier for effective image retrieval.

Figure 7.4  Classification accuracy obtained using proposed Neural Network classifier

The classification accuracy achieved by the proposed MLP-Neural Network classifier is shown in Figure 7.4. The proposed neural network classifier specifically designed for the image retrieval problem is able to achieve a classification accuracy of 90.34%. This rate is higher than the Multi-Layer Perception Neural Network by an average improved increase of 2.5%, across all experiments, shown in Figure 7.4.

7.5 A GENETIC OPTIMIZED NEURAL NETWORK FOR EFFECTIVE IMAGE RETRIEVAL IN TELEMEDICINE

The experimental results of a Genetic Optimised Neural Network for the 176 image data set are presented in Chapter 6.
From Figure 7.5, it could be observed that the proposed GOP Neural Network shows improved classification accuracy compared to that of the MLP neural network.

7.6 FUTURE PROSPECTS

Continuing on from the research presented in this thesis, a number of possible avenues for future research can be identified, including:

1. This thesis has presented an approach of segmentation in which the Region of Interest ROI is extracted. Further work can be done to extract ROI’s using soft computing techniques.

2. This work focused on gray scale images. However, newer imaging modalities produce color images. The proposed technique can be used to study the performance in other imaging modalities.
7.7 CONCLUSION

In this thesis, the technological issues identified in telemedicine technology have been identified and addressed. Various types of compression algorithms namely lossless, near lossless and lossy compression algorithms were studied and implemented in Chapter 3.

Techniques for effective feature extraction for image retrieval were presented in Chapter 4. Features were extracted from the MRI medical images. The attributes or features considered here were the wavelet energy features. Various classifiers starting from the theoretically optimal Bayes classifier (RBF, MLP Neural Network) for efficient classification was discussed for effective classification. It turns out that even when the optimal classifier could be constructed, still some misclassifications can occur as expressed by the Bayes error. It was conjectured that the only way to improve the classification performance was to improve the feature extraction stage.

A novel neural network classifier and a genetic optimized neural network classifier were presented in Chapters 5 and 6. Various retrieval parameters namely precision, recall and f-measure were implemented and analyzed.