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Performance Evaluation of Wavelet-Based Compression Techniques in Medical Imaging

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The field of medical imaging is becoming popular and prone to research day-by-day and there is an exponential rise of medical images. In telemedicine applications, we need to store and transmit the diagonastic images much frequently, Hence, there is a need to compress the images. DICOM uses image compression standards like JPEG-LS, EZW, *etc.*, to compress the medical images. There is always a tradeoff between quality and amount of storage(or bandwidth) needed. We want bitrate as low as possible and quality as high as possible. As there is a tradeoff, we may have to sacrifice one for the other. But in medical images, quality cannot be compromised too much as it may lead to wrong diagnosis. Presently we have very good compression techniques based on wavelets. In this paper we have analysed some wavelet based compression techniques like Embedded Zerotree Wavelet (EZW), Set Partitioning in Hierarchical Trees (SPIHT) and JPEG2000. These techniques are analysed on some medical test images. The performance evaluation is based on objective parameters like PSNR, BER *etc.*. Some other parameters despite being objective in nature, take care of visual and structural quality, these parameters are WSNR, VIF and SSIM.

Keywords : DICOM, EBCOT, EZW, JPEG2000, SPIHT.

1. INTRODUCTION

Medical images are a critical component of the healthcare system with great impact on the societys welfare. Traditionally medical images were stored on film but the advances in modern imaging modalities made it possible to store them electronically [1]. Medical imaging has become a major tool in clinical trials since it enables rapid diagnosis with visualization and quantitative assessment. Medical imaging techniques produce very large amounts of data, especially from CT, MRI and PET modalities. Until 2010, 5 billion medical imaging studies had been conducted worldwide.

DICOM (Digital Imaging and Communication in Medicine) is a standard for handling, storing, printing and transmitting medical images, which has been developed by ACR/NEMA [2]. (The ACR is the American College of Radiology and NEMA is the National Electrical Manufacturers Association). It proposes a novel framework for classifying various strategies for storing, retrieving and processing digital medical images. DICOM standard makes different equipments compatible to communicate. For example, all CT images will be stored in the same format irrespective of manufacturer and the header information pertaining to the CT images will also be in the same format irrespective of which device generated the image. Because of the strong adaptability of DICOM, it was necessary to adopt DICOM standard in several professional fields.

Data compression relies on widely used compression standards like JPEG [3], JPEG Lossless, JPEG 2000, or MPEG-2 for multi-image (video) sequences. Different medical applications require different level of image quality. Mostly, in medical applications lossless compression techniques are used, so as to secure very minute details that are very important in these applications [4].

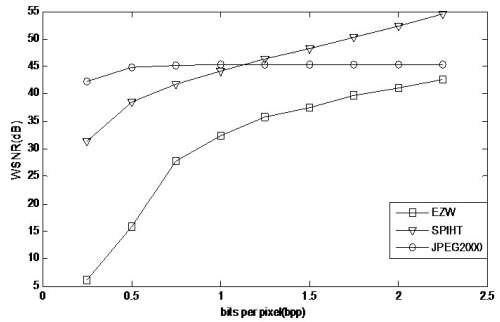

Figure 8. Weighted Signal-to-Noise Ratio

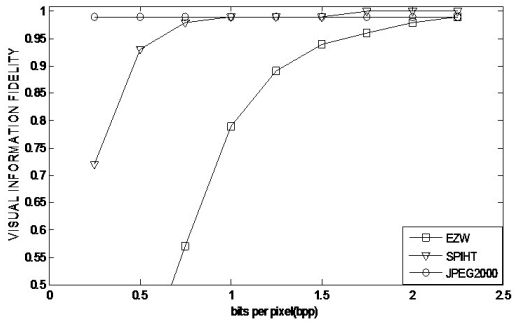

Figure 9. Visual Information Fidelity

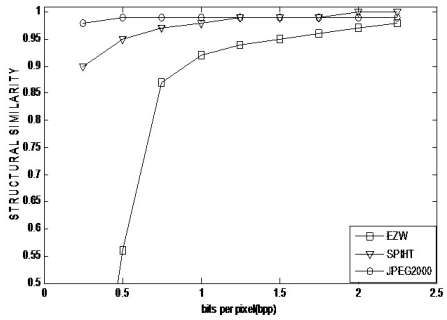

Figure 10. Structural Similarity

quality region is earlier reached by SPIHT or we can say SPIHT can compress in high quality region at lower bitrates as compared to JPEG2000, which is desired in medical imaging.

There are many things to improve in medical imaging, some of these are:

1. Region of Interest coding, which can emphasis more on the desired regions and rest of the image can be highly compressed.
2. The compression should not remain confined to images only but should be extended to medical video applications as well. To explore new compression techniques, we need to check on images initially, but should be extended to video applications as well.

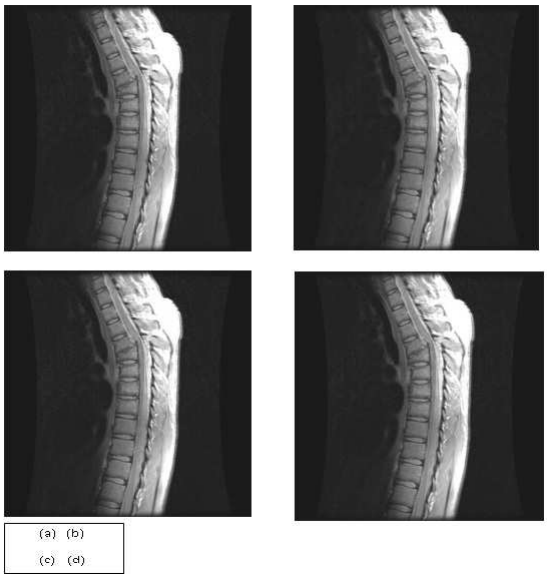

Figure 11. Images of Spine MRI at Bpp = 2; (a) Original Uncompressed Image,(b) Compressed with EZW, (c) Compressed with JPEG2000 and (d) Compressed with SPIHT

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