Medical Image Compression Using SPIHT and Wavelet-Based Techniques

Overview of the Project

This project, titled "Medical Image Compression Using SPIHT and Wavelet-Based Techniques," explores the application of advanced image compression methods to reduce the size of medical images while maintaining their diagnostic quality. The project specifically implements SPIHT (Set Partitioning in Hierarchical Trees) compression in combination with wavelet-based transforms—Lifting 5/3 and Lifting 9/7 wavelets—to compress different regions of interest (ROI) and non-region of interest (non-ROI) in medical images. The goal is to enhance storage and transmission efficiency while minimizing image distortion.

The study focuses on the comparative performance of the 5/3 and 9/7 wavelet filters, widely known for their use in compression standards like JPEG 2000. Various metrics, including Peak Signal-to-Noise Ratio (PSNR), Compression Ratio (CR), Mean Square Error (MSE), encoding time, decoding time, and transforming time, were used to evaluate compression performance. Based on the findings, the 5/3 wavelet transform outperformed the 9/7 wavelet transform in terms of compression efficiency and image quality.

Advantages of the Project

- **Efficient Storage and Transmission**: Medical images are often large, and efficient compression allows for reduced storage space and faster transmission, particularly important for telemedicine and electronic health records.
- **Preservation of Diagnostic Quality**: By applying lossless compression to the regions of interest (ROI) and lossy compression to non-ROI, the diagnostic integrity of critical image areas is preserved while less important areas are compressed to reduce file size.
- **Adaptable Compression Techniques**: The use of Lifting 5/3 and 9/7 wavelets offers flexibility in applying either lossless or lossy compression, ensuring that users can select the most appropriate technique for their specific needs.
- **Performance Metrics**: The GUI provides real-time calculations of compression metrics such as MSE, PSNR, and compression ratio, allowing users to evaluate the quality and efficiency of the compressed image.
- **Faster Image Processing**: The project evaluates and optimizes compression and decompression times, ensuring that the techniques are suitable for practical use in medical image processing systems.

Graphical User Interface (GUI) Overview

The project includes a user-friendly GUI that allows for easy interaction with the compression system. Below are the key functionalities of the GUI:

1. **Image Selection**: The GUI enables users to browse and select the medical image for compression. Once the image is selected, the system displays its histogram and automatically identifies the background regions of uniform intensity.
2. **Segmentation Options**: Users can select a segmentation method (region growing) from a combo box to divide the image into ROI and non-ROI. The segmented image is then displayed, showing the percentage of each area.
3. **Preview of Segmentation**: After applying the segmentation, users can preview the segmented image to verify the accuracy of the identified regions.
4. **Wavelet Compression Selection**: From another combo box, users can select the desired wavelet compression technique—Lifting 5/3 or Lifting 9/7. The selected wavelet technique is applied to the ROI for lossless compression, while SPIHT compression is applied to the non-ROI for lossy compression. The GUI displays a preview of the image after compression, along with individual compression ratios for each region.
5. **Image Reconstruction and Performance Metrics**: After compression, the GUI reconstructs the entire image and displays it to the user. It also calculates and displays important performance metrics, such as MSE, PSNR, segmentation time, compression time, and the overall compression ratio.

Conclusion

This project successfully implements an efficient and user-friendly system for medical image compression using wavelet-based techniques and SPIHT. The GUI enables users to interact with the system seamlessly, allowing for image segmentation, compression, and real-time performance evaluation. The use of adaptive compression techniques ensures that important diagnostic regions of medical images are preserved, while non-essential regions are compressed to optimize storage and transmission. This approach provides a practical solution for healthcare environments that rely on high-quality, compressed medical imaging data.