Lossless Compression Based Image Compression Technique for Medical Imaging

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Abstract: Large amount of medical image sequences are available in various hospitals and medical organizations, which occupies considerable storage space. Hence to reduce the storage space there is a need for compressing medical images. There are several lossy and lossless compression techniques. Using lossy compression the original images are not recovered exactly but using lossless compression techniques the original images can be recovered exactly. This paper discusses about the various lossless compression based for various medical images. With the increasing utilization of medical imaging in clinical practice and the growing dimensions of data volumes generated by various medical imaging modalities, the distribution, storage, and management of digital medical image data sets requires data compression. Over the past few decades, several image compression standards have been proposed by international standardization organizations. This paper discusses the current status of these image compression standards in medical imaging applications together with some of the legal and regulatory issues surrounding the use of compression in medical settings.

I. INTRODUCTION

Introduction Medical imaging has become an indispensable tool in clinical practice. Studies have shown links between the use of medical imaging exams and declines in mortality, reduced need for exploratory surgery, fewer hospital admissions, shorter hospital stays, and longer life expectancy [1]. As a result, the utilization of medical imaging has risen sharply during the early part of the last decade. In 2003, the percentage of medical visits in the US by patients aged ≥ 65 years that resulted in medical imaging was estimated to be 12.8% [2]. While earlier medical imaging exams were recorded on Radiological film, most exams are now acquired digitally. In addition to increased utilization, there have also been major advances in medical imaging technology that have resulted in significant increases in the quantity last few decades. For example, in early 1990s, a typical Computed Tomography (CT) exam of the Thorax would have consisted of 25 slices with 10 mm thickness, yielding a data size of roughly 12 megabytes (MBs). Today, a similar exam on a modern CT scanner can yield sub-millimetre slice thickness with increased in-plane resolution resulting in 600 MB to a gigabyte of digital medical imaging data during the (GB) of data. In a modern hospital, Picture Archiving and Communication Systems (PACS) handle the short- and long-term storage, retrieval, management, distribution, processing, and presentation of these large datasets. Data compression plays an important role in these systems. Since the earliest days of PACS, compression of medical images has been anticipated and novel compression techniques have been proposed before standardized compression.

II. IMAGE SEGMENTATION

Image segmentation is performed to locate the tumour region of the MRI image. Segmentation partitions the image into set of semantically meaningful, homogenous, and non overlapping regions of similar attributes such as intensity, depth, colour or texture [9]. The ROI part is extracted from the brain MRI image using a threshold based segmentation procedure. Image thresholding is one of the simplest and effective, segmentation procedures. It separates the image into desired classes based on an intensity value called as threshold [20].

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A pre-processing of an image is done before applying

The threshold algorithm. Pre-processing involves enhancement of a given MRI image to improve the interpretability of the information present in images for human viewers. A filtering approach is used to enhance the given MRI image [21]. It involves a combination of median filter for the reduction on salt and pepper noise and high pass filtering performs image sharpening. The enhanced image is then segmented using maximum entropy based thresholding method which selects a threshold value that corresponds to maximum entropy between the lower and higher frequency bands. The frequency bands correspond to intensity levels of the object and background Respectively [22]. Let \( t \) be the threshold, and the probabilities corresponding to object and background are:

\[
\begin{align*}
O & : P_0/P_t, P_1/P_t, \ldots \ldots , P_t/P_t \\
B & : P_{t+1}/(1-P_t), P_{t+2}/(1-P_t), \ldots \ldots , P_L/(1-P_t)
\end{align*}
\]

Where \( L \) corresponds to number of intensity levels in an Image. The entropies for the object and foreground are then defined as:

\[
\begin{align*}
H(O) & = \ln P_t + H_t/P_t \\
H(B) & = \ln (1-P_t) + H_L - H_t/(1-P_t)
\end{align*}
\]

The information between the object and background is given as:

\[
\Psi(t) = H(O) + H(B)
\]

The optimal threshold is then calculated as:

\[
t^* = \text{Arg Max } \Psi(t)
\]

For symmetrical distribution value of \( t \) is considered to be half of the number of gray levels. Morphological operators such as erosion and dilation are then used to create a binary mask from the segmented image. These operations remove the excess information present in the image after thresholding which does not contribute to the tumour region. The intensity value of the pixels in binary mask containing tumor region is one, while that of other pixels is reduced to zero [3]

### III. PROPOSED APPROACH

The detection and extraction of the brain tumor from MR images. The approach consists of three phase such that during first phase input image is being pre-processing followed by second phase threshold segmentation with further application of morphological operations, finally tumor detected and extracted and image is given as output.
IV. SIMULATION RESULTS

In this section, the results obtained from experimentation to test the performance of hybrid coding scheme of SPIHT with arithmetic coding are presented. The simulation has been done using MATLAB. The performance is evaluated on gray Scale brain MRI images as shown in Figure

A - Image Pre-Processing and Enhancement

Pre-processing stage removes the noise and also high frequency artifact seen in the image. It removes the patient name, age and other marks within in the image. You’ll find so many methods available for pre-processing technique. After these stages the medical image is converted into standard image without noise, film artifacts and labels. This process is done by using median filter, high pass filter, label filter etc. In our experimentation we’ve used for pre-processing and histogram equalization for image enhancement. Figure 2(a) will be original image without pre-processing. The Figure 2(b) and Figure 2(c) shows MRI image after pre-processing stage when label and high pass filters are applied.

C- Experimental Results

The Experiment of detection of tumor in MRI brain image is carried out using thresholding segmentation and based on morphological operations and the snapshot of various stages of image processing is shown in the Figure 4 from a to h Each step indicates how detection of tumor is processed.
Figure 2 (a) will be original image tumor region

Figure 2 (b) enhanced image
Figure 2(c) high pass filters are applied.

Shows MRI image after pre-processing stage when label and high pass filters are applied

Figure 2(d) high pass filters are applied.

C- Threshold Segmentation
Segmentation is a division of the digital image into multiple parts and objective process is to simplify the representation of the image to what is more pronounced for the Figure 3. Tumor detection process. (a) Original MRI brain image, (b) Detected tumor in original image, (c) Morphological operations image. analysis of the image. (d) binary image , (e) initial LSF image The threshold of an image is calculated using the Equation (2). Thresholding creates binary images from grey-level ones by turning all pixels below some threshold to zero and all pixels above that threshold to 1. If $g(x, y)$ is a threshold version of $f(x, y)$ at some global threshold $T$, then

$$g(x, y) = 1 \text{ if } f(x, y) > T$$
0 if \( f(x, y) < T \) \( (2) \)

The output of thresholding segmentation is shown in . \( f(x, y) \) is the pixels in the input image and \( g(x, y) \) is the pixels in the output image.

![Figure 3 (a) Original MRI brain image](image)

![Figure 3 (b) Detected tumor in original image](image)

![Figure 3 (c) Morphological operations image](image)

Detected tumour in original image. The output of the threshold image is a binary image.
When using tumor region augmentation and partition, domain knowledge and spatial information can be integrated into feature extraction methods to make feature representation more discriminative.

Instead of directly using segmented tumor region as ROI, we use the augmented tumor region as ROI. As pointed out in it is beneficial to capture a certain amount of context. Using augmented tumour region as ROI will not only take advantage of the information in the tumour but also utilize the information provided by tumour-surrounding tissues. Considering that brain tumours of the same category are often found in similar places, tumor-surrounding tissues offer important clues for the identification of tumour categories. For example, meningiomas are usually adjacent to skull, gray matter. In light of the above
discussion, we enlarge the tumor region via image dilation with a disk-shaped structuring element of radius R. An appropriate R can be found by trying several different values.

![Figure 3 (f) final LSF image](image1.png)

**Figure 3 (f) final LSF image**

![Figure 3 (e) tumor region and no-tumor region](image2.png)

**Figure 3 (e) tumor region and no-tumor region**

V. CONCLUSION

Region of interest based hybrid compression techniques reduces the size of image while preserving the fidelity of diagnostically important regions. These techniques enable better image examination and also address the issues regarding image handling and transmission in telemedicine systems. Automatic segmentation procedure efficiently extracts the arbitrary tumor regions with less background present in ROI portion. Entropy based lossless compression encodes the ROI portion. The hybrid scheme achieves upto 50% less compression as compared to that of irreversible compression technique, but the quality of the medical image is preserved both objectively and subjectively. In this paper, we presented a method for image acquisition, image pre-processing using high pass and label filtering, image enhancement using
histogram equalization, segmentation using threshold and morphological operations therefore the
detection of the tumor. Some of the features of the tumor are detected which will be helpful in medical
applications. The future works involve the segmentation and detection of more images with more features
which help in classifying several types of the tumors.

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