SPIHT Algorithm based Medical Image Compression of ROI

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Abstract: CT or MRI Medical imaging produces digital form of human body pictures. There exists a need for compression of these images for storage and communication purposes. Current compression schemes provide a very high compression rate with a considerable loss of quality. In medicine, it is necessary to have high image quality in region of interest, i.e. diagnostically important regions. In this paper firstly image is filtered with the help of median filter to remove noise then Region of interest part is extracted with the help of thresholding method of segmentation and compressed with the help of SPIHT Algorithm thus producing a good quality image. Our algorithm provides better PSNR values for medical images than previous methods.

Keywords: SPIHT(Set Partitioning In Hierarchical Tree), Binary Thresholding, median filter, PSNR(Peak signal to noise ratio)

1. Introduction

Image compression based on region of interest has been one of the hot issues in the field of image compression and coding. However, there is not a fixed model for region of interest automatic detected. In order to reduce storage spaces and transmission times of infrared target image data, a coding way is proposed for ROI automatic detected of image based on the region growing segmentation algorithm. In order to improve efficiency for transferring image data in real time, a coding-crossed algorithm for ROI automatic detected of infrared target image is studied as same time as it is realized on the frame of SPIHT Algorithm. An experimental study is also conducted that is proved the method of detecting automatically and compression algorithm based on region of interest automatic detected is reliable and effective, significant in applications.

Currently, many applications want a representation of the image with minimal storage. Most images contain duplicate data. There are two duplicated parts of data in the image. The first is the existence of a pixel that has the same intensity as its neighboring pixels. These duplicated pixels waste more storage space. The second is that the image contains many repeated sections (regions). These identical sections do not need to be encoded many times to avoid redundancies and, therefore, we need an image compression to minimize the memory requirement in representing a digital image. The general principle used in the process of image compression is to reduce duplication of data within the image so that the memory needed to represent the image is smaller than the original image.

The block diagram of the proposed methodology is shown below:-



Figure 1: Block diagram of methodology

Hence the methodology consist of following parts :- 1. Filtering

- 2. Segmentation of ROI
- 3. Image compression using SPIHT Algorithm

2. Methodology

2.1 Filtering

In image processing, it is often desirable to be able to perform some kind of noise reduction on an image so that image could be clearly visible. In this methodology median filter is used.

The median filter is a non linear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise

The main idea of the median filter is to run through the signal entry by entry, replacing each entry with

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the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal .For 2D (or higher-dimensional) signals such as images , more complex window patterns are possible (such as "box" or "cross" patterns)

In this methodology a *brain tumor* image is considered as shown below:-



Figure 2: Brain Image with Tumor

Noise in the form of salt & pepper noise is added. It is filtered with the help of median filter and output is shown below:-



(a) (b) **Figure 3**: (a) Brain image with salt & pepper noise (b) Filtered image (PSNR-37.8858 dB)

2.2 Segmentation of Region of Interest (ROI)

In the proposed methodology Binary thresholding method is used for segmenting the image into ROI and NROI part.

Image thresholding is a simple, yet effective, way of partitioning an image into a foreground and background. This image analysis technique is a type of image segmentation that isolates objects by converting grayscale images into binary images. Image thresholding [6] is most effective in images with high levels of contrast. The simplest thresholding methods replace each pixel in an image with a black pixel if the image intensity is less than some fixed constant T (that is), or a white pixel if the image intensity is greater than that constant.

In this method the ROI part is the tumor part in the brain having the intensity greater than the background part so

tumor part is separated from the original brain image and further compressed for transmission.

The segmentation of ROI and NROI part is shown below:



Figure 4: (a) Outlined tumor part in the Brain image (b) Binary image obtained after thresholding, threshold value(T=190) (c) Tumor part (ROI) (d) Background part after removal of the tumor(NROI)

2.3 SPIHT Algorithm

SPIHT (Set Partition in Hierarchical Trees) [5] is one of the most advanced schemes, even outperforming the state-of-the art JPEG 2000 in some situations. The basic principle is the same; a progressive coding is applied, processing the image respectively to a lowering threshold. The difference is in the concept of zero trees (spatial orientation trees in SPIHT). There is a coefficient at the highest level of the transform in a particular sub band which considered insignificant against a particular threshold; it is very probable that its descendants in lower levels will be insignificant too. Therefore we can code quite a large group of coefficients with one symbol. A spatial orientation tree is defined in a pyramid constructed with recursive four sub bands splitting.

Normally most of an images energy is concentrated in the low frequency components Consequently the variance decreases as we move from the highest to the lowest levels of the sub band pyramid Furthermore it has been observed that there is a spatial self similarity between sub bands and the coefficients are expected to be better magnitude ordered if we move downward in the pyramid following the same spatial orientation [1]

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Figure 5: Flowchart of SPIHT

2.3.1 Spatial Orientation tree

A tree structure called spatial orientation tree naturally defines the spatial relationship on the hierarchical pyramid Figure-6 shows how our spatial orientation tree is defined in a pyramid constructed with recursive four sub band splitting Each node of the tree corresponds to a pixel and is identified by the pixel coordinate Its direct descendants offspring correspond to the pixels of the same spatial orientation in the next finer level of the pyramid The tree is defined in such a way that each node has either no off spring (the leaves)or four off spring which always form a group of adjacent pixels In Fig-6 the arrows are oriented from the parent node to its four off spring The pixels in the highest level of the pyramid are the tree roots and are also grouped in 2 x 2 adjacent pixels However their off spring branching rule is different and in each group one of them indicated by the star in Figure-5 has no descendants

The following sets of coordinates are used to present the new coding method:-

- O(i, j)-set of coordinates of all off spring of node (i, j)
- 2. D(i, j)-set of coordinates of all descendants of the node (i, j)
- 3. *H* set of coordinates of all spatial orientation tree roots (nodes in the highest pyramid level)

4.
$$L(i, j) = D(i, j) - O(i, j)$$

For instance except at the highest and lowest pyramid levels we have

 $O(i, j) = \{(2i, 2j), (2i, 2j + 1), (2i + 1, 2j), (2i + 1, 2j + 1)\}$ We use parts of the spatial orientation trees as the partitioning subsets in the sorting algorithm The set partitioning rules are simply-

- *1*. The initial partition is formed with the sets (i, j) and D(i, j) for all $(i, j) \in H$
- 2. if D(i,j) is significant then it is partitioned to L(i,j) plus 4 single element set s with $(k,l) \in O(i,j)$
- 3. If L(i,j) is significant then it is partitioned into 4 sets D(k,l) with $(k,l) \in O(i,j)$



Figure 6: Example of parent offspring dependency in Spatial Orientation tree

2.3.2 Coding Algorithm

Since the order in which the subsets are tested for significance is important in a practical implementation the significance information is stored in three ordered lists called list of insignificant sets (LIS), list of insignificant pixels (LIP) and list of significant pixels (LSP). In all lists each entry is identified by a coordinate (i, j) which in the LIP and LSP represents individual pixels and in the LIS represents either the set L(i, j) or D(i, j). To differentiate between them we say that a LIS entry is of type A if it represents D(i, j) and of type B if it represents L(i, j)

During the sorting pass the pixels in the LIP-which were insignificant in the previous pass are tested and those that become significant are moved to the LSP Similarly sets are sequentially evaluated following the LIS order and when a set is found to be significant it is removed from the list and partitioned The new subsets with more than one element are added back the LIS while to the single coordinate sets are added to the end of the LIP or the LSP depending whether they are insignificant or significant respectively The LSP contains the coordinates of the pixels that are visited in the refinement pass.

In the proposed methodology the Brain tumor image is then separated into ROI and NROI part. The ROI part is compressed with help of SPIHT Algorithm and then reconstructed at receiver end. The PSNR of reconstructed image is calculated and shown below:-



Figure 7:(a) ROI uncompressed part before applying SPIHT Algorithm (b) Reconstructed image of the tumor of the brain with PSNR=69.7988 dB for bpp=1.00

3. Experimental Result

We applied the algorithm in the test image "ROI part of the Brain image with tumor" as shown in Figure-7a. Table-1 illustrates compressed image quality with different bit rate values (number of bits per pixel).We have varied the bits per pixel from 0.25-2.00 Bpp and PSNR is calculated. We have

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found from Table-1 that for higher bit rate higher PSNR is obtained. Hence we have obtained a satisfactory result and in future we would compress NROI part using different algorithm and combine both to obtain a more better result.

S.No	BPP(Bits Per Pixel)	PSNR(dB)
1	0.25	44.7834
2	0.50	55.6991
3	0.75	64.1189
4	1.00	69.7988
5	1.25	73.4051
6	1.50	74.8632
7	1.75	75.3880
8	2.00	75.4566

Table 1: PSNR Calculation			
	BPP(Bits Per	D G L H	

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