Computer-Aided Detection system for Hemorrhage contained region

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ABSTRACT

This paper aims to introduce the automated method to detect and classify an abnormality (hemorrhage) of stroke in brain CT image. Initially, the image is pre-processed to remove film artifacts and skull region. Before the abnormality region is segmented, the image is pre-segmented. In this stage, the image is subdivided into four regions to find the region that has the possibility for inclusion of abnormal areas. Thus, the unnecessary regions are no need to search and segment. This paper proposes pre-segmentation steps for the detection of abnormal region in brain image. Then, abnormalities can be segmented by grouping homogeneous regions according to the predefined criteria. The accuracy of the segmentation results can be assessed by the specialist.

KEYWORDS

CT, Medical imaging, Hemorrhage, Infarct

1. INTRODUCTION

Medical imaging refers to the techniques and processes used to create images of the human body for various clinical purposes. In the medical field, the analysis for medical image take parts a great significance role. The problems for medical image are complicated and need to be correct diagnosis and treatment for disease. The success of medical image diagnosis depends on the quality of segmentation process. X-ray, MRI, and CT scan produce different medical image. CT images are used for stroke detection due to its advantages. The perfect image segmentation algorithms can greatly support for the success of medical image analysis. This paper organized as follows. Section 2 presents some related works. Section 3 discusses about the stroke. Section 4 presents some segmentation methods. Section 5 provides the pre-processing stage. The proposed pre-segmentation method is presented in section 6. Section 7 concludes the paper and presents further extension.

2. RELATED WORKS

T Kesavamurthy, Subha Raniand N Malmurugan proposed a Gabor filter technique for Computed Tomography image which is used for early diagnosis of human brain infarct [2]. Since Gabor filters are band-pass in nature, and infarcts lie in a particular frequency range, so choose only a subset of Gabor filter bank. The proposed image processing technique helps the radiologists to diagnose the early stage of brain infarct in CT image efficiently. It can only be used to detect brain infarct and the results were evaluated only on 53 patients. The condition for hemorrhage will not be passed by this filter and output image has no segmented portion. Most research no stroke detection mainly focuses on hemorrhage detection [6]. Mayank Chawla, Saurabh Sharma, Jayanthi Sivaswamy, Kishore L.T presented a method for the detection and classification for acute infarct, chronic infarct and hemorrhage [3]. This system proposes an algorithm based on contra-lateral symmetry to detect stroke affected slices in a given CT volume. The contra-lateral symmetry condition will fail when the same type of stroke occurs symmetrically in both hemispheres. Such cases cannot be handled by this algorithm. Segmentation is carried out by depending on the assumption that abnormality regions are located to a single hemisphere with a healthy hemisphere on the other side. Only the dissimilarity between two hemispheres is examined. ZHANG XiaoFeng, ZHANG CaiMing, TANG WenJing and WEI ZhenWen proposed improved FCM algorithm by basing on the histogram, called HisFCM [4]. To classify the image into classes with the help of histogram, peaks can be denoted. The proposed method may fail in region of interest (ROI) retrieval in images because a segmentation method only using color information and statistical information provided by the given image. N. Mohd Saad, S.A.R. Abu-Bakar, Sobri Muda, M. Mokji, A. R. Abdullah presented region growing segmentation of brain MRI [1]. Split and Merge algorithm with quad tree structure is proposed. If four neighboring squares are found to be uniform, they are replaced (merged) by a single square composed of the four adjacent squares. The regions that are homogeneous to the predefined criteria are merged to get the region of interest. The resulted square may be greater or smaller than the real ROI. The segmented region may be same or not with the ROI.

3. STROKE

Stroke is a disease that can cause severe disabilities by affecting the brain's blood vessel [3]. A stroke will occur when a blood vessel bursts or block. And brain cannot perform the basic functions and can lead to long term disability and death. Strokes are mainly classified in two categories: (1) Ischemic stroke or infarct and (2) Hemorrhagic**.** Hemorrhage means blockage of a blood vessel supplying the brain due to lack of blood supply. Infarct means bleeding into or around the brain due to rupture of blood vessel. The bright (white) regions can be said that a hemorrhage appears in the brain CT image.

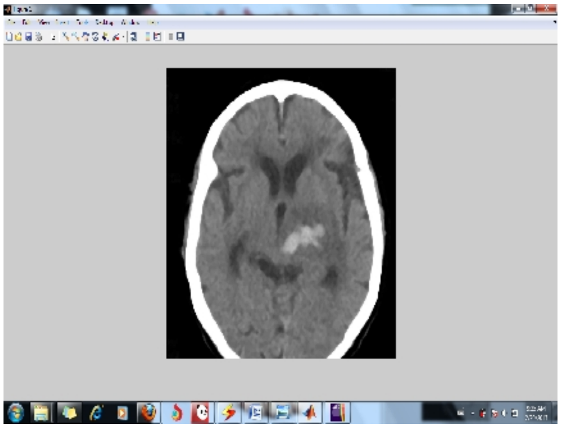

Figure1. CT image with Hemorrhage region

4. SEGMENTATION METHODS

- Thresholding

Image is segmented by comparing all pixel values with the pre-defined threshold values. Wrong threshold selection can cause the erroneous segmented results. These kinds of techniques are thus not reliable.

- Region growing techniques

It tries to extract the regions that are connected based on some similarity criteria. The Technique is not fully automatic.

- Supervised and Un-supervised Segmentation Methods

In supervised segmentation, some criteria are specified in training stage. The image is segmented according to predefined criteria in training stage such as k-NN, ANN. Un-supervised classification algorithm is efficient and less error sensitive, such as k-means, hierarchical clustering, self organizing map (SOM), normalized cut algorithm, fuzzy c-means and so on.

5. PRE-PROCESSING

The images from CT scan (.jpg) are needed to be pre-processed.

5.1. Background removal

Pre-processing stage is performed for skull removal and intensity enhancement. Skull portion shares similar gray level values with certain brain structures. Tracking algorithm is performed to removes skull pixels. The CT image consists of film artifact or labels such as patient name, age and marks. Film artifacts are removed by starting from the first row and the first column by using median filter.

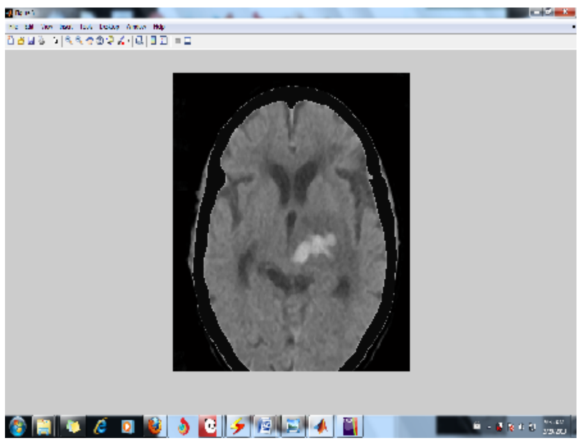

Figure 2.CT image with Hemorrhage region after removing skull portion

Tracking Algorithm for Removal of skull portions in CT

Step 1: Obtain the CT image and store it in a two dimensional matrix.
Step 2: Start from pixel at first row, first column (left side) of the matrix
Step 3: Select the threshold value from left side of the matrix.
Step 4: If the intensity value is greater than the threshold value then, value zero is assigned to that pixel, thus skull portion for left part is removed.
Step 5: Repeat the above steps (2-4) to remove the right, top and bottom skull portions of the CT.

6. PRE-SEGMENTATION

The entire image is broken into four regions. Due to pre-segmentation, the unnecessary regions are no need to search and cluster. So it can conclude that the region' mean value is higher than the other regions, it may contain hemorrhage area. The region that contains infarct area may have low mean value. And standard deviation value of the abnormality contained region is smaller than the other regions. Statistical features, mean and standard deviation, are used to distinguish the normal and abnormal regions. Mean and standard deviation are the statistical features that are frequently used. The mean is the average value of all pixel in an image. For a grey scale image this is equal to the average brightness or intensity. Standard deviation is the variation from its mean. They can be defined by Eq. (1) and Eq. (2) respectively.

$$\mu = \frac{1}{N}\sum_{i=1}^{N-1} P(i) \tag{1}$$

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=0}^{N-1}(P(i)-\mu)^2} \tag{2}$$

i = random variable representing the N intensity levels of the image, *P* (*i*) = histogram of *i*.
The proposed steps for pre-segmentation are:
Step 1: The image is divided into 4 regions.
Step 2: Compute pixel values for each regions.
Step 3: Compare each with the predefined criteria (pixel value).
Step 4: The region with abnormal region is given into segmentation process.

6.1 Experimental results

Figure 3 shows the four regions of the brain CT image. Table 1 presents the four regions' mean value and standard deviation. At the pre-segmentation stage, the region that may contain abnormal area is selected among the regions according to mean value and standard deviation.

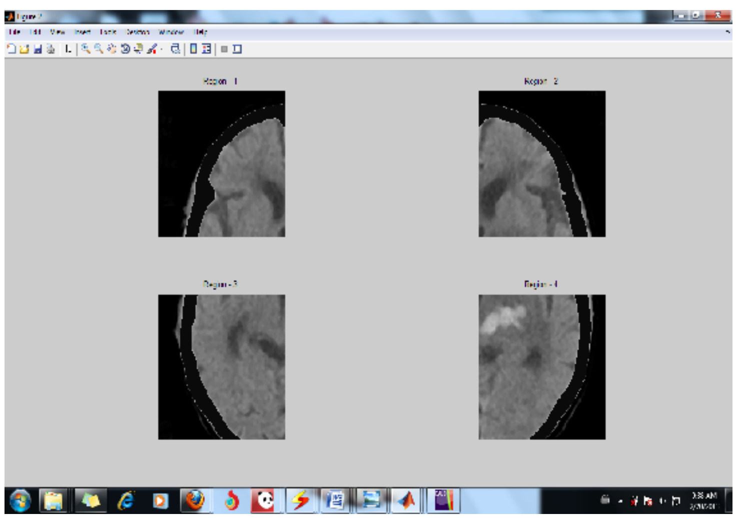

Figure 3.Four regions after pre-segmentation

	Region 1	Region 2	Region 3	Region 4
Mean	79.4853	82.9202	98.8963	105.4585
Std	82.9937	81.2784	71.3924	67.5052

Table1. Four regions with their mean values and standard deviations

As shown in figures, only region (4) has the possibility for inclusion of abnormal area. Because only region (4) has the maximum mean value and minimum value of standard deviation. In reality, hemorrhage region is located in region (4). So region (4) is fed into the further detail segmentation step.

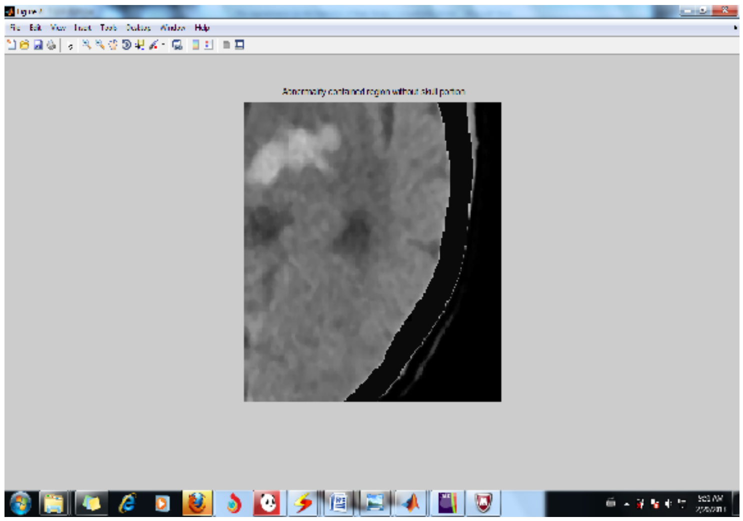

Figure 4.Region - 4, Abnormality contained region

7. CONCLUSION AND FURTHER EXTENSION

The proposed system is to produce precise segmentation of brain images using intensity information along with neighbourhood relationships. The proposed pre-segmentation steps are carried out in this paper. This pre-segmentation process makes the segmentation process faster than the ordinary process. The final segmentation results tested upon the regions resulted from pre-segmentation and the accuracy rates of the proposed system will be described in the further works. The brain CT images are segmented into their separate tissue types and will result in abnormal tissue being easier to identify. This system will help the radiological specialists to detect the hemorrhage region in brain and to get a faster and accurate decision. And it can be used as a second opinion to make a decision. The accuracy for segmented results can be determined by the knowledge of the radiologists. The system can be extended to detect other brain abnormalities - tumor, abscess and lesion etc. The adaptive algorithms can be applied in other medical images such as lung, liver, and bone to detect their related diseases such as cancer, tuberculosis.

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