HEMORRHAGE DETECTION SYSTEM USING WATERSHED SEGMENTATION

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ABSTRACT

Medical imaging is the process of developing the visual representations of the inner constituents of body along with certain functions of the organs or tissues constituting its physiology. The images are obtained by various techniques such as Magnetic Resonant Imaging (MRI), Computed Tomography (CT) and are processed for medical assistance and treatment. The objective of the system mentioned in this paper is to detect the presence of hemorrhage using watershed segmentation. The proposed system employs CT images to find the hemorrhage. The images undergo pre-processing to make them suitable for further processing. Pre-processing is done before finding hemorrhage which includes Grayscale conversion, image resizing, edge detection and sharpening. Once preprocessing is done the images undergo morphological operations that will help in identifying the shape related features in correspondence to the hemorrhage. Closing reconstruction, Sobel and markers are used in the processed CT image to highlight the interested region. And then the image undergoes watershed segmentation process. The result thus obtained detects the presence of hemorrhage. The system has an accuracy of 97%. Finally the result of segmentation is fed to a classifier to find the type of hemorrhage detected. The final outcome can be viewed and interpreted by a medical assistance. The outcome of the research increases the chances of predicting hemorrhage in the image.

KEYWORDS

CT, MRI, Hemorrhage, Watershed algorithm, Segmentation

1. INTRODUCTION

A brain hemorrhage is a type of stroke that is caused due to bleeding which occurs due to the result of ruptured artery. This affects the nearby tissues. The pooled blood may cause hematoma. It is identified that trauma and high blood pressure are the main sources for hemorrhage. The severity depends on the bleeding and needs immediate medical treatment. Medical imaging is used to create the visual representations of the organs and tissues of the body. Medical imaging such as MRI and CT are performed to visualize the presence of such hemorrhage. In order to predict exactly the presence of hemorrhage or increase the chances of predicting the presence of hemorrhage, medical images require further processing. For this reason, watershed algorithm is proposed in this paper. The proposed system employs CT scanner to scan the tissues inside the organs at various levels of intensity. The scanned image is then pre-processed to remove the unwanted noises. Pre-processing involves a series of operations eliminating the unwanted distortions and to enhance certain properties of the image. After pre- processing, a set of non-linear operations called morphological operation which is carried out to shape the structuring element in the image. The basic objective of these operations is to remove any imperfections present in the image. Erosion and dilation are the most common such operations. Once morphological operation is over, the image is segmented using watershed algorithm for further processing. Segmentation is a technique for dividing the image into multiple segments such that it is easier to analyze or process.

2. LITERATURE SURVEY

C. Amutha Devi et al proposed “Brain Stroke Classification Based on MultiLayer Perceptron Using Watershed Segmentation and Gabor Filter” which contributed for identifying MRI images that are stroke and non stroke images [1]. Image classification is a critical step for high-level processing of automatic brain stroke classification. Accurate segmentation and classification of stroke affected regions are essential for correct detection and diagnosis. Features are extracted using Watershed segmentation and Gabor filter. The extracted features are classified using Multilayer

Perceptron (MLP). Experiments have been conducted to evaluate the efficiency of the proposed method with varying number of features.

Rupali Mahajan et al proposed 'Survey on Diagnosis of Brain Hemorrhage by Using Artificial Neural Network" insists usage of two neural network techniques for classification of MRI brain images. Features are extracted using Discrete Wavelet Transformation (DWT) [13] and then the numbers of features were reduced by using principles component analysis (PCA) to the more essential features. During classification two classifiers based on supervised machine learning were used, wherein one was used as forward AN feed and another one was used as back propagation NN feed. The classifier was used to classify the subjects as normal or abnormal MRI brain images.

Nandhini V and Karthick G proposed a method for detecting tumors in the MRI images using clustering algorithms [11]. A cluster can be defined as a group of pixels where all the pixels in certain group defined by a similar relationship. K-means clustering algorithm for segmentation of the image followed by morphological filtering is used for tumor detection in this paper. Noise present in images, is removed using a filter. As there are chances of occurrence of mis-clustered regions after the application of K-means clustering algorithm, morphological filtering is done to detect them. This helps in removing unwanted features with respect to morphology. The classifier is based on PNN (Probabilistic Neural Network) algorithm.

Unlike research on brain segmentation of Magnetic Resonance Imaging (MRI) data, research on Computed Tomography (CT) brain segmentation is relatively scarce as said by Alexandra Lauric and Sarah Frisken [2]. Because MRI is better at differentiating soft tissue, it is generally preferred over CT for brain imaging. However, in some circumstances, MRI is contraindicated and alternative scanning methods need to be used. The methods for soft tissue segmentation of CT brain data with a goal of enhancing the utility of CT for brain imaging is explored. In this study, the effectiveness of existing algorithms for segmenting brain tissue in CT images are considered. Three methods (Bayesian classification, Fuzzy c-Means and Expectation Maximization) were used to segment brain and cerebrospinal fluid. While these methods outperformed the commonly used threshold-based segmentation, our results show the need for developing new imaging protocols for optimizing CT imaging to differentiate soft tissue detail and for designing segmentation methods tailored for CT.

The paper "Intelligent Acute Brain Hemorrhage Diagnosis System" is proposed by Vishal R.Shelke et al aims to help radiologists in the prognosis of the brain Hemorrhage [18]. A novel approach to classify intracranial hemorrhage into three type's viz. Epidural Hemorrhage (EDH), Subdural Hemorrhage (SDH), Hypertensive bleed (HTN) has been presented here. In order to ease the classification, image enhancement tools and median filtering was used in this paper. Further, unique thresholding technique is used to separate out the suspicious hemorrhagic region.

3. PROPOSED METHODOLOGY

This system undergoes the following process. Initially the scanned CT images are pre-processed. It is a sequential set of operations including grayscale conversion, image resizing, edge detection and edge sharpening. This image undergoes morphological operations in order of using markers, sobel operator, binary inversion, closing reconstruction. Then watershed algorithm is used to segment the image to make the processing easier. The proposed system (Figure 3.1) is till segmentation, wherein the segmented image can be fed to classifier such that the features are extracted and helps in diagnosis removing the unwanted noise and errors.

3.1 DATASETS

The datasets consist of 100 CT images of human brain of which 50 images contain hemorrhage and rest without hemorrhage.

3.2 PRE-PROCESSING

Pre-processing is aimed to improve and enhance the image quality by removing the unwanted portions of the scanned image. (Figure 3.2)

a. Grayscale conversion

The CT image is converted to grayscale to make it contrast in a way that is easier to give the exact needed information. This transformation is made to eliminate the colors and to highlight any hemorrhages or abnormalities.

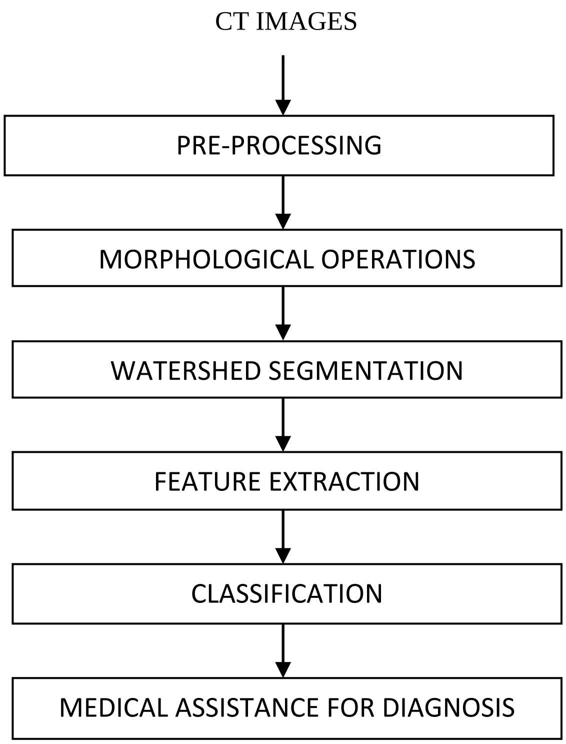

Figure 3.1 Process Flow

b. Resizing

In image processing resizing is done to satisfy the properties of display, storage and other such constraints. The resolution of display devices might have maximum size and the scanned images might all be of different size. So to make it a constant, we resize the image with specifications. The grayscale images are resized as 256x256 pixels.

c. Edge detection

It involves the detection of edges to determine the boundary or to verify the presence of hemorrhage. Canny edge detector with Gaussian filter is used for this purpose. This algorithm is a multistage edge detection algorithm. Apply Gaussian filter to smooth the image in order to remove the noise. Then find the intensity gradients of the image. Apply non-maximum suppression to get rid of spurious response to edge detection followed by application of double threshold to determine potential edges. Then finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

d. Edge sharpening

The edges are made to contrast on the gray scale so that image shall be easy for both morphological operations and image segmentation. Edges are the boundaries of object surfaces. Sharpening refers to highlighting the edges such that if hemorrhage is detected its edges are clear.

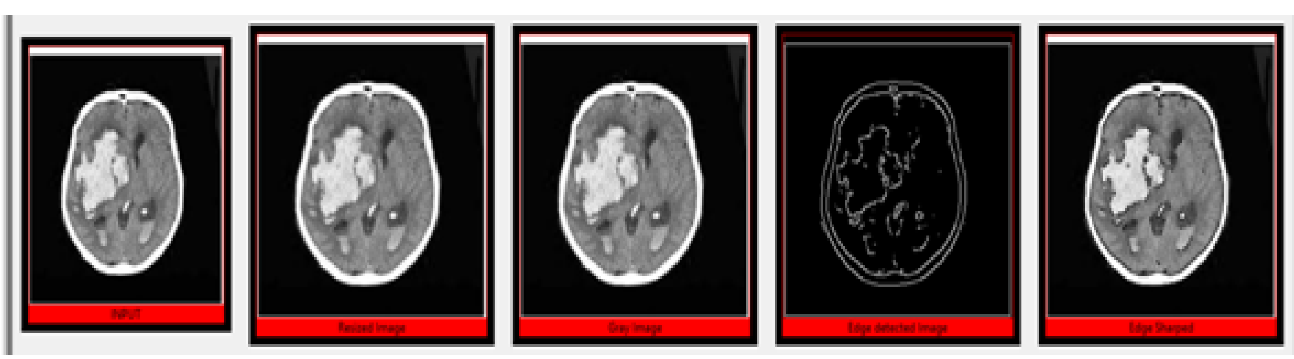

Fig 3.2 Pre-processing

3.3 MORPHOLOGICAL OPERATIONS

Morphological operations are aimed to remove imperfections. The binarized images are further processed by this technique.

a. Sobel operator is used to find the elevation map using the gradients

b. Closing reconstruction

The Closing reconstruction is a dual operation which performs Dilation followed by erosion; dilation is a process of dilating the pixels so that the small holes on the object and the foreground are filled. This process is essential before performing the segmentation.

c. Markers of the background are found using the extreme parts of the histogram of gray values.
d. Binary thresholding is done to remove the unwanted highlighted regions from the Sobel image and this is done with superimposing marker and Sobel image.

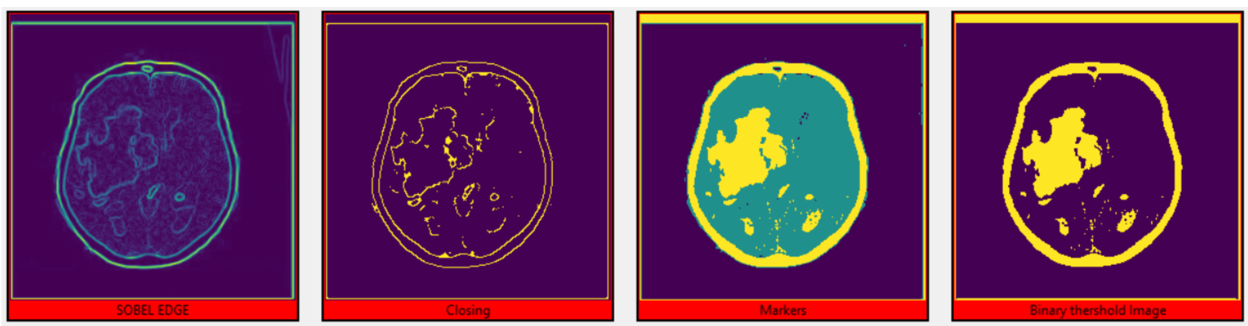

Fig 3.3 Morphological Operations

3.4 SEGMENTATION

Segmentation is the process of partitioning the image into multiple segments so as to render the image easier for further analysis and understanding. The image is broken down into segments to change the representation such that it is easy to locate the object or boundaries in general. The technique used here is watershed segmentation. Watershed transformation also called, as watershed method is a powerful mathematical morphological tool for the image segmentation. It is most commonly used in biomedical and medical image processing. If image is viewed as geological landscape, the watershed lines determine boundaries that separate image regions. The watershed transform computes catchment basins and ridgelines (also known as watershed lines), where catchment basins corresponding to image regions and ridgelines relating to region boundaries.

Segmentation here depends on any of these three: threshold based, edge based and region based. Consider a segmentation function. This is an image whose dark regions are the objects you are trying to segment. Compute the foreground markers which are connected blobs of pixels within each of the objects in the image. Then find background markers that are pixels not being part of any object. Modify the segmentation function so that it only has minima at the foreground and background marker locations. Compute the watershed transform of the modified segmentation function. Gradient transform and distance measures are being used here. The regional maxima of foreground matter is considered and superimposed on original image. The background is converted to edges or the watershed lines. These lines will segment the region of interest. The threshold image is superimposed on the gray image to obtain the segmented output (Figure 3.4).

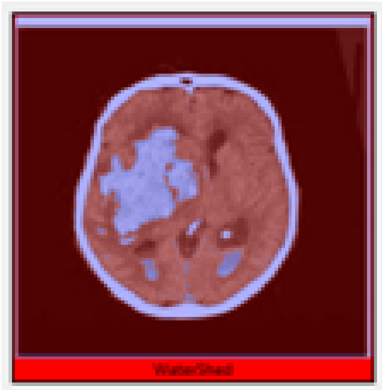

Figure 3.4 Watershed Segmentation

4. PERFORMANCE ANALYSIS

To evaluate the efficiency of the proposed system, a dataset of 100 images provided by Dr. Divyan Paul, Ministry of Health Hospital (Muscat) are considered. 50 of them are positive stroke images (with hemorrhage). Experiments were conducted till segmentation and the following results were obtained.

Table 4.1 Segmentation Result

Result		Predicted value	
		Predicted Positive	Predicted Negative
Actual value	Actual Positive	TP = 49	FN = 1
	Actual Negative	FP = 2	TN = 48

After the calculation of the table values their corresponding rates are found using the formula as follows

Accuracy rate

ACC = (TP+TN)/(TP+FN+FP+TN) (1)

True Positive Rate

TPR = TP/(TP+FN) (2)

False Positive Rate

FPR = FP/(FP+TN) (3)

False Negative Rate

FNR = FN/(TP+FN) (4)

True Negative Rate

TNR = TN/(FP+TN) (5)

Where TP, FP, FN, TN represent True Positive, False Positive, False Negative and True Negative correspondingly. The accuracy rate of the system after segmentation is 97%

5. CONCLUSION AND FUTUREWORK

Automated systems gained a huge level of attention in medical imaging for analysis and classification. Detection of hemorrhage is one such research area where it is diagnosed and the types of it can be found. The system has been successfully trained with Brain CT images and the segmentation part is done to find the Region Of Interest. Watershed segmentation is being employed to get a smoothened image. The boundaries of regions are found to be continuous and there was a problem of over-segmentation. The concept of marker based approach is used to resolve this segmentation problem. Once there is a presence of hemorrhage, it can be classified for the types making it a multi-classification problem. The system is trained for various datasets of Brain CT images with and without hemorrhage. The proposed system has been aimed till segmentation. The output of this phase is being carried to feature extraction and classification further to find the type of hemorrhage.

As an extension to this segmentation the next phase involves classification. If the hemorrhages are detected their features are extracted to find its type. Using the features the image is being classified with any of the classifiers. The system can be analyzed for efficiency using the features that are employed in classification.

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