Region Detection and Segmentation of Brain Hemorrhage using Algorithmic Approach of Image Processing

Krithika M Pai
Dept. of Information and Communication Technology, Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal, Karnataka, India
krithikampai@gmail.com

Abstract
Brain is one of the most important part of the body. Brain Hemorrhage is a severe head injury that deteriorates the performance and function of an individual. Brain Hemorrhage can be detected through CT (Computer Tomography) scan of the brain. CT scan uses narrow X-ray beam which rotates around the part of the body and provides a set of images from different angles and the computer creates a cross-sectional view. It is challenging to detect and segment the region of the brain having Hemorrhage. Hence an automated system would be handy at those times. In the proposed work an attempt has been made to segment and identify the hemorrhaged region of the brain in the CT scan slices of the image. Brain hemorrhage segmentation helps to identify the region of brain hemorrhage which in turn helps to treat the patients at an early stage. The region of brain hemorrhage is appropriately identified from the proposed algorithm.

1. Introduction
Brain is a vital organ in all vertebrate and most invertebrate animals which serves as the center of the nervous system [11]. Brain is very unique as it gives us the power to imagine, solve problems and speak. Brain also controls some of the involuntary movements like breathing, heart rate and voluntary movements like walking, talking, sitting, standing etc. It also controls body temperature, blood pressure and receives information from the sense organs.

Brain hemorrhage is a common stroke type [10] that results in cell death due to poor blood flow. Hemorrhage is caused by bursting of an artery which causes localized bleeding in the tissues surrounding it, which kills the cells in the brain. There are two main types of stroke. These are hemorrhagic stroke and Ischemic stroke. The result of ruptured blood vessel causing bleeding inside the brain is referred to hemorrhage stroke. In Ischemic stroke the arteries in the brain become narrowed or blocked which results in reduced blood flow. The two leading causes of brain hemorrhage are High blood pressure and trauma. High blood pressure weakens the arterial walls leading to rupture. This results in the collection of blood in the brain which leads to stroke. Some other causes may be aneurysm, a ballooning and weakened area in the artery which might get ruptured. Abnormal connections between arteries and veins known as Arteriovenous malformations which are present from birth that may cause brain hemorrhage in later stages of life. The symptoms of a stroke are paralysis, problems in understanding or speaking, dizziness and loss of vision.

One of the main causes of disability in India is stroke. In 2018, stroke was the third main cause of death in India. In 2017, stroke claimed lives of around 62 lakh people. In 2016 it claimed lives of around 60 lakh people globally. In 2015, stroke killed around 63 lakh people, out of which 33 lakh deaths are from hemorrhagic stroke and 30 lakh deaths are from ischemic stroke. This constitutes 11% of the total deaths globally.

2. Related Work
To identify significant information from the images obtained from MRI/CT scan, recently
image processing techniques has gained immense popularity. Literature review mainly focuses on different techniques on filtering and segmentation. Gamage P.T [2] has implemented some of the filtering techniques like Mean filter, Median filter, Wiener filter, Modified hybrid median filter, Hybrid filter, etc. The author has used region based segmentation, Fuzzy C means, K means and level set techniques for segmentation. It is concluded that the median filter is the most common technique used for eliminating salt and pepper noise and also for its reduced complexity. To smoothen Gaussian noise, Gaussian filter is used.

Swapnil R. Telrandhe [3] used median filter and high pass filtering techniques to filter the MRI images. K means based segmentation was used to segment the images.

Kailash D. Kharat et.al [4] used noise removing filters. Some of the feature extraction algorithms like Principal Component Analysis (PCA) and Spatial Gray level dependence matrices (SGLD) have been used.

Ch. Rajasekara Rao et.al [5] used parameters for improving signal-to-noise ratio, which enhanced the visual appearance of MR images. Also noise and undesired parts were removed thus smoothing regions of inner part and maintaining relevant edges. EM based segmentation and Histogram based thresholding methods were used for segmentation. This method included all the edges of tumor.

Marzena Boberek and Khalid Saeed [6] proposed a method for automatic segmentation of, tumor, Gray matter, and White matter in MRI images. The preprocessing methods included noise filter, anisotropic filter and wiener filter. The canny filter producing edges histogram followed by the low-pass digital filter obtaining a smooth curve were found to produce good results.

Nathan Singh and Shivani Goyal [7] used high pass filter for enhancing and determining the edge on preprocessed quality images. Threshold segmentation, Watershed segmentation, Morphological operations techniques were used for segmentation of brain tumour from MRI images.

N.Varunashree and T.N.R Kumar [8] enhanced visual appearance of MR images by reducing the Signal to noise ratio. Also discrete wavelet transform was used which decomposed the images. From gray-level co-occurrence matrix, textural features were extracted followed by morphological operation. In order to classify the tumors from brain MRI images, Probabilistic neural network (PNN) classifier was used.

Bahare Shahangian and Hossein Pourghassem [9] used median filter for de-noising the images. Preprocessing included techniques in which the noise, skull and brain ventricles were removed. Segmentation techniques included the separation of hemorrhages from other parts of the brain using thresholding. Several features were extracted from the hemorrhage region. to improve the classification accuracy, GA based feature selection was used. Then hemorrhages were classified using two different classifiers.

Vincy Davis and Satish Devane [10] proposed an approach for Automatic detection of hemorrhage. Morphological operations were performed to compute the background and foreground markers. The image segmentation was done using watershed algorithm which smoothened the image.

3. Design
Figure 1 depicts the flowchart of the proposed approach.
4. Methodology

4.1. Segment the image using thresholding (40-70)

The pixel value of the image is converted to Hounsfield units. The Hounsfield unit of the blood is in the range of 40-70. Hence the Hounsfield units are threshold to this range. The Hounsfield unit other than the mentioned range is eliminated. Hence it highlights the area where there is blood in the brain with Hounsfield units in range of 40-70. This step plays a major role in segmentation by discarding all the Hounsfield units except for the Hounsfield units of blood.

4.2. Median filtering

The Median Filter is used commonly to remove noise from an image. This is a preprocessing step to improve the quality of the image. Removal of noise is done by the opening function. It can also be termed as erosion followed by dilation. The pixels near the boundary are discarded by applying the Erosion technique. Small white noises are removed by this. This can also be used to detach two connected objects. Dilation increases the white region in the image.

4.3. Identify the region of interest using CCL

The region of interest can be found by connected component labelling (CCL). CCL is also known as blob extraction, region labelling, blob discovery, or region extraction. In Computer Vision, the CCL detects connected regions in binary digital images. The subsets of connected components are uniquely labelled by this algorithmic method. This can also
be done by identifying the largest blob or largest area of the blood (Hounsfield unit is in 40-70 range).

5. Results

All the axial images are displayed to select start and end range of the image to be segmented. The display of all axial image is shown in figure 2.

![Figure 2. Axial view of the CT scan brain images](image)

The selection of start range and the end range is shown in figure 3. The start and end range are selected by observing all the axial images. One among the range of selected images is projected after undergoing each step. The original image is shown in figure 4. This is the 21st axial image among the list of all axial images. The output obtained after thresholding the image for the mentioned range is shown in figure 5. This step eliminates all the hounfiled units other than the hounsfield units ranging from 40-70. The results obtained after median filtering that is after the use of opening function is shown in figure 6. This step eliminates the unwanted noise from the image. After identifying the region of interest using connected component labelling the final results is depicted in figure 7. This image highlights the blood clot in the brain.

![Figure 3. Frame range selection on Matlab](image)
Figure 4. Original image

Figure 5. Segmented image using thresholding

Figure 6. Image after median filtering
Figure 7. Segmented image using Connected Component Labelling (CCL)

This repeats for all the slices mentioned in the range. The results for some of the output within the mentioned range is shown in figure 8 and figure 9. Among the four images the first image depicts the image for which segmentation will be conducted. The second image shows the Hounsfield units of the blood, since it is threshold to that particular range. The third image depicts the results obtained after the elimination of unnecessary noise using median filtering. The fourth image depicts the final result, where only the blood clot is highlighted.

Figure 8. Input and output for sample image 1

Figure 9. Input and output for sample image 2
6. Conclusion

In the proposed work, the brain haemorrhage detection and identification is done for segmentation of brain CT images. In order to test this, CT (computed tomography) dataset was used. The methods used are Thresholding, Median filtering and connected component labelling (CCL). Thresholding removes unwanted areas from the image such as the skull and those areas which has greater and lower Hounsfield unit value than the blood. Median filtering eliminates the salt and pepper noise. Connected component labelling is used to select the largest affected area i.e. the region of interest from the CT images. Appropriate segmentation results are obtained. The segmentation has been implemented in Matlab as well as python.

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