A Survey on Brain Stroke Detection in CT Images Using Image Segmentation

Jyoti Gupta[1], Priyanka[2]
Department of Electronics & Communication Engineering
Deenbandhu Chhotu Ram university Of Science & technology, Murthal, Sonepat, Haryana, India

Abstract - Stroke is characterized by a disturbance in blood flow to the brain resulting either in ischemic or hemorrhagic stroke. Hemorrhage occurs due to rupturing of blood vessels in the brain whereas ischemic stroke is due to a blockage in the blood vessel which inhibits the blood supply to brain. Detection of stroke in early stages make the treatment easier. In this paper, we present a comprehensive survey on various segmentation techniques that are used for the detection of stroke from computed tomography (CT) of brain.

*Keywords -* Brain stroke; Image segmentation; Computed tomography (CT).

I. INTRODUCTION

Stroke occurs when brain stops functioning due to disturbance in the artery that carries blood to the brain. It is defined in medical term as sudden death of brain cells due to lack of oxygen [1]. There must be continuous supply of blood, oxygen, glucose (blood sugar) to the nerve cells within the brain for it to function properly. The parts of brain stop functioning temporarily if the supply is impaired. If the impairment is severe or continuous for long time the brain cells die and damage permanently. Stroke is classified into two categories: ischemic and hemorrhagic stroke. About 85% of all strokes are of ischemic type. It occurs when the blood vessel that carries blood to the brain is blocked due to thrombus Hemorrhagic stroke occurs due to rupturing of weakened blood vessels in the brain. There is possibility that both ischemic and hemorrhagic stroke can occur at the same time [1]. Stroke results in serious long term disability or death. The symptoms of stroke are: weakness or paralysis altered feeling on one side of the body, difficulty in speech, blurred vision, confusion and severe headache [1][2]. The risk factors of stroke are: old age, high blood pressure, transient ischemic attack (TIA), diabetes, high cholesterol, tobacco smoking etc. High blood pressure is the most important risk factor for the stroke to happen. Stroke is diagnosed through various imaging technologies and these are : Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET) and Single-Photon Emission Computed Tomography (SPECT) as shown in fig 1. CT and MRI give physical aspects of the brain where as PET and SPECT shows actually working of brain. Out of these CT and MRI are usually used in the identification of stroke. MRI does not require any radiation but it takes longer time and expensive as compared to CT, the only disadvantages of CT is radiation exposure but despite of that CT scans are extensively used in the radiographic study of brain as they are easily available, cheaper and sensitive to early stroke. As shown in fig 2, In CT images a hemorrhage appears as a bright region and ischemic stroke appears as a dark region [5].
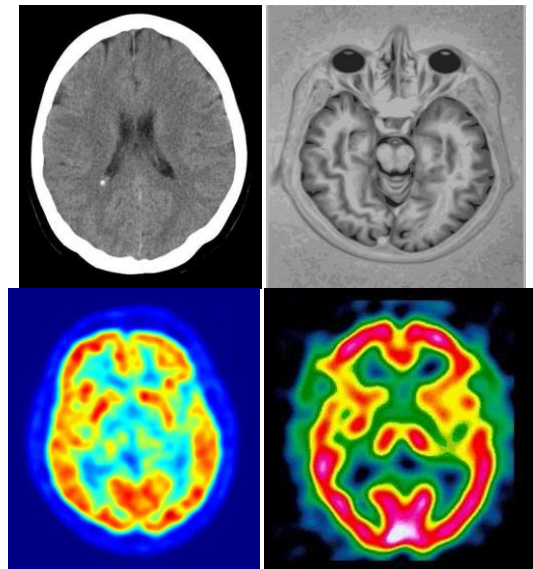
(a) CT (b) MRI (c) PET (d) SPEC
Fig. 1 Representation of brain under Various modalities [4]
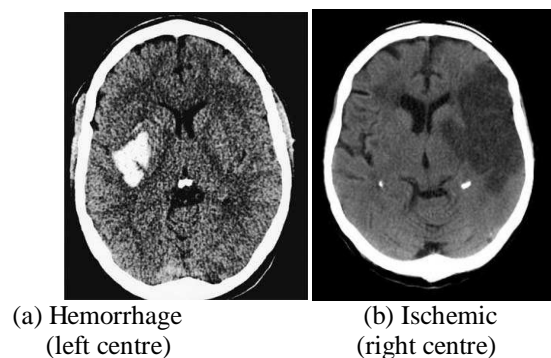
(a) Hemorrhage   (b) Ischemic
  (left centre)   (right centre)
Fig.2 Representation of strokes in CT brain images [4]

II. METHODS OF STROKE SEGMENTATION

Image segmentation is a procedure by which an image is subdivided into the constituent parts or objects that are present in the image. Thus main aim of subdividing an image into its constituent parts or objects present in the image each of the constituent parts or objects present in the image can be analyzed further to extract some information so that extracted information is useful for high level machine vision application. Image segmentation approaches are mainly of two different types: discontinuity based approach and similarity based approach. In discontinuity based approach partition or subdivision of an image is carried out on the basis of some abrupt changes in intensity levels or gray levels in an image so under this major interest is identification of isolated points, lines and edges. In similarity based approach pixels that are similar in some sense are grouped together. Image segmentation groups the region that are similar in terms of pixel characteristics like gray level, color, texture, intensity and other features. Segmentation methods that are included under similarity based approach are: Thresholding and region based segmentation (Region growing, Region splitting and merging).There are some artificial intelligence (AI) techniques also that are used for automatic detection. These artificial intelligence (AI) techniques are supervised and unsupervised. Supervised category includes artificial neural network (ANN) based algorithms and unsupervised category includes clustering based algorithms and two commonly used cluster based algorithms are: K-means (Hard) and Fuzzy C-means (Soft). Thus some of the segmentation techniques that are used for brain stroke detection are: Thresholding, Edge based detection, Region growing, clustering and artificial neural network (ANN).

A. Thresholding

The Thresholding technique is one of the simplest methods used in the segmentation process. Basic requirement for thresholding based segmentation is to choose proper threshold value. The process collects all the pixels with a certain threshold and rejects other pixels which have values less than the threshold. Thus the basic aim of thresholding operation is to create a binary image containing pixel value either 0 or 1. After the application of thresholding operation the stroke region will be isolated from the brain tissue. The stroke region will be more clearly visible in the output image [6].

B. Region Growing

Region growing technique is a well developed technique for the image segmentation. Region growing operation partitions a set of R pixels into a no. of sub regions R1,R2, R3…..Rn operation and this partitioning is done on the basis of intensity information or edges in the image. An operator manually selects a seed point and grows the region starting from the seed points by incorporating all the pixels that are similar to the seed points. An algorithm which is called as split-and-merge is related to region growing algorithm but the difference is that it does not require a seed point. Region growing is sensitive to noise and causes the extracted regions to become disconnected. This problem can be solved by using a homotopic region-growing algorithm.

C. Edge based segmentation

Edge detection is the most commonly used approach for detecting discontinuity in an image. Edge is the boundary between two regions having distinct intensity levels or gray levels. Thus edge based segmentation methods partition an image based on rapid changes in intensity near edges. The result is a Binary image. There are two main edge based segmentation methods on the theory: gray histogram and gradient based method [7]

D. Artificial Neural Network (ANN)

It is a scheme that is based on the process of biological nervous system. It resembles to the functioning of human brain. An artificial neural network is made up of many artificial neurons that are connected together according to a specific network architecture. The main aim of the neural network is to convert the inputs into meaningful outputs. There are several types of neural network architectures used for medical imaging applications but commonly used is the feed forward network. In a feed-forward network, the neurons in each layer are connected with the neurons in the next layer. These connections are unidirectional. It means that the information that is processed by the network can be passed in single direction from the input layer to the output layer through the hidden layer[12].

E. Clustering

Clustering is one of the most useful technique in segmentation that divides the pixels into different groups or clusters in such a way that the pixels belonging to the same group must be similar in some sense while the pixels in different groups must be dissimilar. There are three commonly used clustering algorithms : K means algorithm, fuzzy c-means algorithm and the expectation maximization algorithm[9].

1. K-means algorithm: K-means algorithm is an algorithm which clusters or groups where K<n. The K-means method is numerical, unsupervised, non-deterministic and iterative. The grouping is done by minimizing the square of distance between the pixel and the corresponding centroid. Main drawback of this algorithm is that no. of clusters must be specified initially.

2. Fuzzy C-means algorithm: This technique was originally introduced by Jim Bezdak in 1981[10]. The FCM algorithm is a development of earlier clustering methods. The objective function of FCM algorithm is defined as the sum of distances

between the patterns and cluster centers. This algorithm works by assigning membership to each pixel corresponding to each cluster center on the basis of distance between the cluster center more is its membership towards the particular cluster

center. It gives best result for overlapped pixel set and comparatively better than K-means algorithm.

Table 1. Image Segmentation Methods - A Comparative Study [11]

Segmentation techniques	Description	Advantages	Disadvantages
Thresholding method	It is based on histogram of image to find a particular threshold value.	It is one of the simplest method and there is no need of previous information.	This method is dependent on the peaks on the histogram of an image and spatial information is not considered.
Region based methods	It is based on dividing an image into homogenous regions.	This method is useful when it is easy to define similarity criteria and this method has more immunity to noise.	It is expensive method as far as time and memory is considered.
Edge based methods	It is based on discontinuity detection.	This method is good for those images that have better contrast between the objects.	It is not suitable for those images that have too many edges.
ANN based method	It is based on simulation of learning process for decision making.	There is no need to write complex programs.	There is more wastage of time in training.
Clustering method	This method is based on dividing an image into homogenous clusters.	This method is useful for real problems as fuzzy uses partial membership.	It is not easy to determine membership function.

III.CONCLUSION

Digital image processing plays a major role in today's world. Some of the major fields in which digital image processing finds its application are: Remote sensing, video compression, biomedical field pattern recognisation, microscopic imaging etc. In this paper, we have discussed several image segmentation techniques for brain CT image. Each technique has its merits and demerits. None of the technique is ideal but is application dependent. It is not possible that all the methods are applicable to a particular type of image. This paper provides maximum knowledge to the researchers about Image compression techniques.

IV. REFERENCES

[1] S.Neethu and D. Venkataraman,"Stroke detection in brain using CT images", Springer (2015), volume 324, pp 379-386.

[2] Sudipta Roy, Kingshuk Chatterjee and Samir Kumar Bandyopadhyay,"Segmentation of Acute Brain Stroke from MRI of Brain Image Using Power Law Transformation withAccuracyEstimation", SpringerInternatinal publishing (2014), volume 27, pp 453-461.

[3] Jeena R.S and Dr. Sukesh Kumar," comparative analysis of MRI and CT brain images for stroke diagnosis", IEEE International Conference on Microelectronics, Communication and Renewable Energy at Kanjirapally, ICMiCR-2013 , pp 1-5 , 2013.

[4] Saurabh Sharma, M.S in Computer Science, International Institute of Information Technology Hyderabad, October 2013.

[5] Josef Vymazal, Aaron M Rulseh, Jiri Keller and Ladislava Janouskova," Comparison of CT and MR imaging in ischemic stroke" , Insight into imaging, December 2012, Volume 3, Issue 6, pp 619-627.

[6] Sahoo PK, Soltani S, Wong AKC,"A Survey of thresholding," Computer vision graphics image processing, 1988.

[7] D.Selvaraj and R.Dhanasekaran,"MRI Brain Image segmentation techniques – a review", Indian Journal of Computer Science and Engineering (IJCSE), Vol. 4 No.5, Oct-Nov 2013.

[8] A.M.Khan, Ravi.S," Image Segmentation Methods: A Comparative Study" International Journal of Soft Computing and Engineering (IJSCE), September2013, Volume-3, Issue4.

[9] Engr V.C and Chindu," Medical Image Segmentation Methodologies A Classified Overview', African Journal of Computing and ICT, 2012.

[10]J.C Bezdek,"Pattern recognition with fuzzy objective function algorithm", Punum press, New York, 1981.

[11]Dilpreet kaur and Yadwinder Kaur,"various image segmentation techniques: A review" International journal of computer science and mobile computing (IJCSMC).vol 3, issue 5, may 2014 , pp 809-814.

[12]https://en.wikipedia.org/wiki/Artificial_neural_network