

Computer Aided Detection Of Ischemic Stroke Using Cellular Automata

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ABSTRACT: Computed tomography images are widely used in the diagnosis of ischemic stroke because of its faster acquisition and compatibility with most life support devices. This paper presents a new approach to automated detection of ischemic stroke using cellular automata, midline shift and image feature characteristics, which separate the ischemic stroke region from healthy tissues in computed tomography images. The proposed method consists of five stages namely, pre-processing, segmentation, tracing midline of the brain, extraction of texture features and classification. The application of the proposed method for early detection of ischemic stroke is demonstrated to improve efficiency and accuracy of clinical practice. The results are quantitatively evaluated by a human expert.. A classification with accuracy of 98%, has been obtained by SVM.

KEYWORDS: Cellular automata, computer tomography, svm

I. INTRODUCTION

Stroke or cerebrovascular accident is a disease which affects vessels that supply blood to brain. A cerebro vascular accident (CVA) is a rapidly developing loss of brain functions due to disturbance in blood supply to brain. The stroke occurs when a blood vessel either bursts or there is a blockage of the blood vessel. Due to loss of oxygen, nerve cells in the affected brain area are not able to perform basic functions which lead to death of the brain tissue. Stroke leads to serious long term disability or death.

There are two main types of stroke: ischemic stroke and hemorrhagic stroke, which account for 99% of strokes occurring. The remaining percent can for example be caused by systemic hypo perfusion: the general decrease in blood supply. Ischemic stroke is caused by interruption of the blood supply due to a blood clot (thrombus) blocking the artery and takes account for almost 87% of all stroke cases. There are various reasons why this may happen: thrombosis, embolism and dissection.

In the US, each year, approximately 795.000 people experience a stroke. Approximately 610.000 of these are first attacks, and 185.000 are recurrent attacks. On average, every 40 seconds, someone in the United States has a stroke. A quarter of the people older than 45 will have a stroke and the risk of recurrent stroke within five years of a first stroke is between 30% and 40%. The reason why stroke is such a severe diseases, is that the brain is completely unprepared when blood flow is cut off. In other parts of the body, blood deprived cells can survive up to an hour without dying because of fat and sugar reserves.

II. RELATED WORKS

From the review of related work and published literature, it is observed that many researchers have detected STROKE by applying different techniques like algorithms, logical relations. Researchers have undertaken different phenomena with regards to detect STROKE and attempted to find better result. Today in real world the actual applications deals with clinical practice.

Y. Lee et.al in [1] obtained a scanned brain image of a patient, transforming scanned brain image into digitized brain image removing bone and other artifacts from digitized brain image, generating at least one circular region of interest calculating percentage of zeros from binary mask within circular adaptive region of interest; locating at least one corresponding circular adaptive region of interest on other side of brain image and comparing circular adaptive region of interest with corresponding circular adaptive region of interest based on plurality of texture features. The disadvantages of this method are, we can investigate only a region of interest, require heavy use of high-performance computing platforms and require large amount of time.

C.C. Liao et.al in [3] introduced a Bezier curve is a parametric curve frequently used in computer graphics and related fields. Bezier curves are used to model smooth curves that can be scaled indefinitely. The quadratic curve serves as a good example for discussing the development of the Bezier curve, but really only generates parabolas. This eliminates the curve for many applications where smooth curves with inflection points are necessary. The problem can be addressed by performing exactly the same steps as above, but utilizing the procedure on four control points - resulting in the cubic Bezier curve. The advantages of this method are it provide accurate symmetry line and consumes less time.

T.M. Cover et.al in [5] introduced a system for the classification of stroke region. One of the simplest classification techniques is the k-nearest neighbour (k-NN) classifier. Classification of the input feature vector X is done by determining the k closest training vectors according to a suitable distance metric. Vector X is then assigned to that class to which the majority of that k nearest neighbours belong. The k-NN algorithm is based on a distance function and a voting function in k nearest neighbours, the metric employed is the Euclidean distance measure. The k-NN classifier is a conventional non parametric supervised classifier that is said to yield good performance for optimal values of k. Like most learning algorithms, k- NN algorithm consists of a training phase and a testing phase. Data points are given in an n-dimensional space in the training phase. The labels associated with the data points designate their class in the training phase. In the testing phase, unlabeled data are given and the algorithm generates the list of the k nearest (already classified) data points to the unlabeled point. This classifier returns the class of the majority of that list. It may be said that half the classification information in an infinite sample set is contained in nearest neighbour. The disadvantages of this system are it requires complete statistical knowledge of underlying joint distribution and results of classification are not accurate.

III.METHODOLOGY

In this section, it describes the method to detect stroke using the technique of cellular automata.

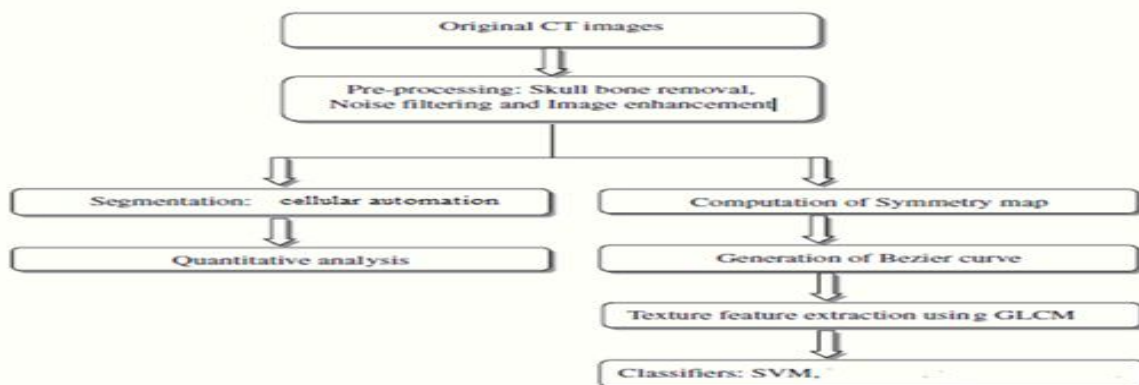


Fig: Basic Block Diagram

A. Preprocessing

In pre processing the bony skull has to be removed with preservation of cranial content of brain. Skull, by virtue of its exceptionally high attenuation values, is first removed using global thresholding. Intracranial contents, including both the brain and cerebral spinal fluid(CSF)containing spaces, are first segmented. We rely on two simple anatomical facts to pick out the brain and the skull in the given CT study: (a)the skull is the largest connected region with bone density in the whole imaging volume;(b)the brain is the largest connected region with brain density within the skull. The CT image is converted to binary image with pixel value (0, 1)using a global threshold. The bony skull of the image is removed with reference to the binary image. Thus in order to detect the abnormality in the brain, the bony skull has to be removed. To reduce noise, median filtering using a3-by-3 square kernel is applied. Median filter is chosen because it is less sensitive to extreme values and able to remove outliers without reducing sharpness of the image. This produces a more homogeneous background in which abnormalities become more conspicuous. The enhancement is needed to increase the contrast between the whole brain and the stroke region. The contrast between the normal brain and lesion region, a sharpening filter is applied to the digitized CT image resulting in noticeable enhancement in image contrast. The maximum filter enhances the image.

B. CellularAutomata

Cellular automata consist of a regular grid of cells, each in one of finite number of states, ON or OFF. Grid can be in finite number of dimension. Classification is based on homogeneity and complexity. Cellular automata has already proven its importance in various fields of cryptography.

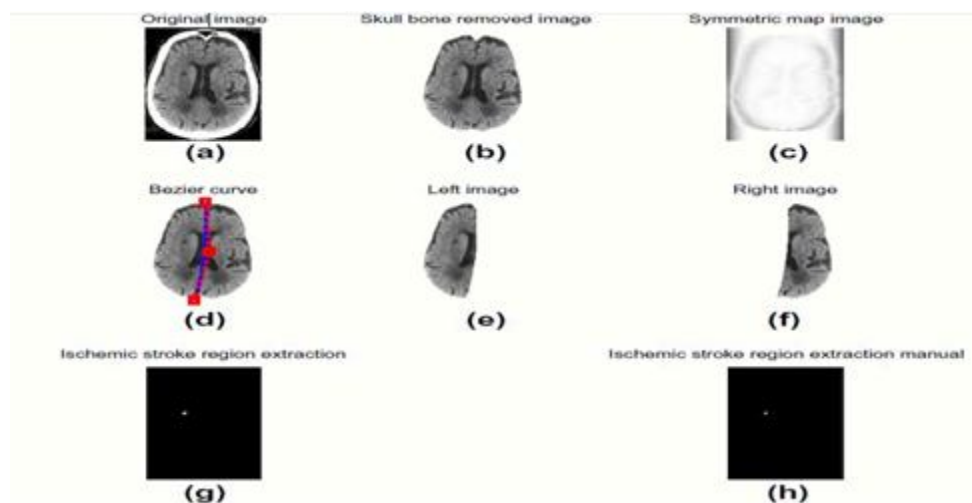


Fig: Stroke extraction process from CT image

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C. Bezier Curve

This curve can be developed through a divide and-conquer approach whose basic operation is the generation of midpoints on the curve. However, this time we develop the curve by calculating points other than midpoints - resulting in a useful parameterization for the curve.

In Generation of bezier curve, the upper and the lower control points represent the parts of tough meninges separating two hemispheres; it can be treated as straight lines and the curved segment in between are fitted by a quadratic bezier curve representing the intervening soft brain tissue. This quadratic bezier curve is drawn using DeCas- teljau method.

D. GLCM

The deformed. Texture is a repeating pattern of local variations in image intensity. The co-occurrence matrix is a statistical method used for texture analysis. As the name suggests, the co-occurrence matrix is constructed from the image by estimating the pair wise statistics of pixel intensity. The use of the co-occurrence matrix is based on the hypotheses that the same grey-level configuration is repeated in a texture. The various texture features including angular momentum, entropy, shade etc. The output of feature extraction is the input of linear SVM classifier.

E. SVM

Support vector machine (SVM) is a powerful supervised classifier and accurate learning technique, is operating with fixed baudrate for the transmitter. SVM is based on the structural risk minimization principle from the statistical learning theory. Its kernel is to control the empirical risk and classification capacity in order to maximize the margin between the classes and minimize the true costs. A support vector machine searches an optimal separating hyper plane between members and non-members of a given class in a higher dimension feature space. The inputs to the SVM algorithm are the features extracted using the GLCM method. In our method, the two classes are normal and ischemic stroke image. Then classification procedure continues to divide the image into normal and abnormal; each subject is represented by a vector in all images.

IV. QUANTITATIVE ANALYSIS

The automatic segmentation results are compared to the manual results. The results are quantitatively evaluated by a human expert. A region of ischemic stroke identified by an experienced radiologist is the ground truth. Each pixel belongs to one of the four classes accordingly: true positive (TP) is correctly classified as positive pixels; false positive (FP) is incorrectly classified as negative pixels; true negative (TN) is correctly classified as negative pixels and false negative (FN) is incorrectly classified as positive pixels. Based on these we calculate the specificity and sensitivity.

$$\begin{aligned}\text{Precision} &= \text{TP}/\text{TP}+\text{FP} \\ \text{Sensitivity} &= \text{TP}/\text{TP}+\text{FN} \\ \text{Specificity} &= \text{TN}/\text{TN}+\text{FP}\end{aligned}$$

V. CONCLUSION

A computer aided detection system capable of identifying small ischemic stroke has been developed. We have developed an automated method for the detection of ischemic stroke in brain CT images using segmentation, texture features and tracing midline shift algorithm. This system detects ischemic stroke on routine non-enhanced brain CT images. Our system has been successfully tested on small lesion causing the ischemic stroke. There is no human intervention. The

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proposed system can help the physicians to better diagnose human brain stroke, for further treatment. The brain region related to a lesion can be exactly separated from the brain image. This system is able to generate accurate quantitative results ready for clinical use. The system helps to improve the accuracy in detection of ischemic stroke and hence it decreases the risk of misdiagnosis and management.

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