Brain Stroke Detection Using Machine Learning

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Abstract—Stroke is one of the common causes of death in the world. Strokes occur due to problems with the blood supply to the brain: either the blood supply is blocked or a blood vessel within the brain ruptures, causing brain tissue to die. A stroke is an emergency, and requires treatment as early as possible. Strokes are classified into threetypes, they are Ischemic strokes, Heamorrhagic strokes and Transient ischemic attacks. In an ischemic stroke, blood supply to part of the brain is decreased leading to death of the brain tissue in that region. Ischemic strokes are again classified as thrombotic and embolic. Several approaches were presented to detect the stroke lesion using manual and semi-automated approaches. Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are the two extensively used imaging techniques for diagnosing it. These approaches involve various stages such as image pre-processing, segmentation, feature extraction, and classification. After extracting the significant features of the image, it must be trained with a proper algorithm to develop a prediction system. These learning models are prepared with different algorithms like Artificial Neural Networks (ANN), Self-Organizing Maps (SOM), Support Vector Machines (SVM).

Keywords— Ischemic stroke, Magnetic resonance (MR) images, Kernelized fuzzy c-means (KFCM) clustering, Support vector machine (SVM) classifier, MATLAB.

I. INTRODUCTION

The brain provides glucose and oxygen and removes waste products upon sufficient blood flow. At the time of stroke the blood flow to the brain is disturbed which leads to insufficient blood supply. A stroke can be of three types haemorrhagic, ischemic and transient ischemic attacks (TIA). Ischemic stroke accounts for a majority of 85% of all strokes, where ICH accounts for 51.7 % of the stroke-related deaths. For detection of Ischemic brain cells, there are two techniques namely computed tomography (CT) and Magnetic Resonance Image (MRI). These methods have the limited accuracy and repeatability, for the early identification of the brain infection, the MRI is more efficient than the CT. The brain stroke detection technique includes methods such as pre-processing, segmentation, feature extraction and classification. There are many techniques for the segmentation and classification of images. A fuzzy clustering approach is used for the process ofsegmentation.

Medical image segmentation techniques based on Atlas are used to convert the segmentation ofthe MR image for extracting the features of the segmented image. We have to introduce the classification techniques for the segmented image to classify the stroke and non-stroke regions.There are different algorithms and classifiers for the segmentation and feature extraction purposes. The Random Decision Forests is a popular classifier, but it can contain errors, noise and image artifacts, which may lead to uncertainties. In this paper, we use then joint execution of the KFCM algorithm and the SVM classifier for the ischemic stroke segmentation and detection. The classifier does this segmentation and classification based on the set of rules which are described using training data. The training data is associated with a specific classifier and the algorithm uses information acquired from this data to predict the class of future data.

The rest of the paper is structured as follows; the proposed methodology is described in section 2. Simulation results are given in Section 3, and the concluding remarks are described in Section 4.

II. METHODOLOGY

Here we implement a crossbred approach for ischemic stroke segmentation and detection using joint execution of KFCM algorithm and SVM classifier. We are using MR images as the input data and the method consists of four stages, pre-processing, image segmentation, feature extraction and classification. The first stage is pre-processing in which the image resizing and the grayscale conversion are executed. In the second stage, segmentation of the pre-processed images is done by the KFCM algorithm. In the third stage, feature extraction of the segmented images is by using the GLCM feature extraction techniques for the left and right side of the brain. Finally, the extracted features are applied as the input to the SVM classifier for classification of the acute and sub-acute stroke lesions. The performance of the classifier is measured in terms of accuracy, sensitivity, reliability and specificity.

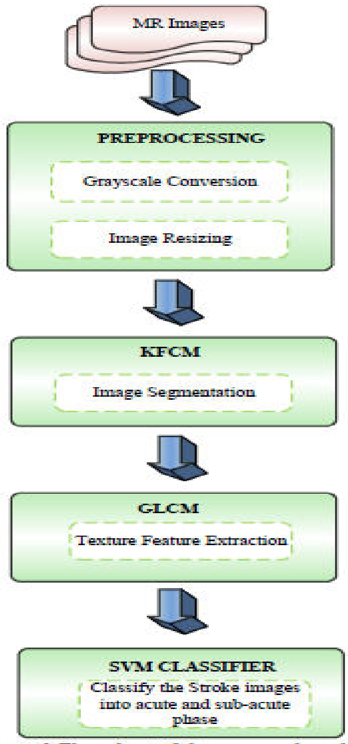

Figure.1 Flowchart of the proposed method

2.1 Pre-processing

In the pre-processing techniques, the quality of the image is improved. This Image segmentation and the classification technique consist of training and the testing phases. It is generated by the pre-processing step. The quality of the image is enhanced by the Image resizing and grayscale conversion.

2.1.1. Grayscale conversion of image

In pre-processing, the contrast image gives the information about the tissues. All the images have the contrast but its level is below the threshold level of the human perception. The image enhancement is required to increase the contrast between the human brain and the stroke region. To make the image contrast, the MR images are converted into grayscale images. The intensity of light at each pixel is identified as per the particular weighted combination of frequencies.

2.1.2. Image resizing

The Image resizing is the important step in pre-processingfor display, storage and transmission purposes of image,. As the size of an image is enlarged, the pixels which contain the image turn more visible, making the image by image softening. According to the requirement of the system, the dimension of the obtained image is changed by the resizing step. For minimizing a grayscale image into 200*200 pixel size the image resizing is required..

2.2 KFCM algorithm for image segmentation

For the segmentation of the pre-processed MR images, the KFCM algorithm is used. In this only gray level between the pixels is considered. The spatial information is not considered by this algorithm. The novel Kernelized Fuzzy C-means algorithm is modified as the original Euclidian distance is replaced by a kernel-induced distance metric by using FCM.

The partition matrix *V* and the centre of the cluster is estimated by adopting the Lagrange multipliers and the partition matrix is given as follows,

$$V_{ik} = \frac{[1/K(p_k,p_k)+K(u_i,u_i)-2K(p_k,u_i)]^{\frac{1}{s-1}}}{\sum_{i=1}^{c}[1/K(p_k,p_k)+K(u_i,u_i)-2K(p_k,u_i)]^{\frac{1}{s-1}}},$$
$$1 \le k \le N, 1 \le i \le c$$

The cluster centre*u* is given as follows,

$$u_i = \frac{\sum_{k=1}^{N} V_{ik}^{s} K(p_k,u_i)p_k}{\sum_{k=1}^{N} V_{ik}^{s} K(p_k,u_i)}, 1 \le i \le c$$

The proposed KFCM algorithm can be depicted in the following steps,

Step 1: Compute the pre-processed image. The pre-processed image is one of the inputs of KFCM

Step 2: Fix *c, s* and set *s>1* and €*>0* for some positive constant.

Step 3: generalize the partition matrix *Vik* and the cluster centre *ui*

Step 4: The value of K *(pk , ui*) is to be estimated.

Step 5: Update the partition matrix *Vik* and the cluster centre*ui*

Step 6: Repeat step (4-5) until ‖*un* – *u0*‖ <€(un – new cluster centre and uo is old cluster centre) is satisfied.

2.4 Classification based on SVM classifier

Here we are using the SVM classifier for the classification, which takes the output of the feature extraction techniques as input and determines which class it actually belonging to. The SVM is a powerful supervised classifier and an accurate learning technique. The classification error minimization and discrimination margin maximization are the main goals of the SVM classifier.

III. SIMULATION RESULTS

The performance of the proposed method is explained by using the medical images and these medical images consists of standard MRI pictures of the brain and the brain tumour images. The MRI images are taken as the source images which contains the acute and sub-acute stages of the ischemic stroke. For examining purposes, we use the real time database and it is gathered from the "Pramodhini Apollo Diagnostics". In the Pre-processing stage the noises exhibited in the image are evacuated. Eye ventricle locales evacuations are essential for the process of precise segmentation. The proposed test experiments are analysed by utilizing the MATLAB.

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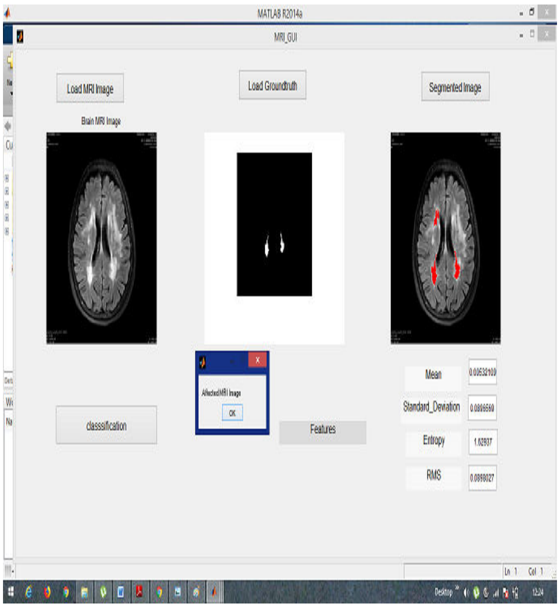

Figure 2: output for the training image

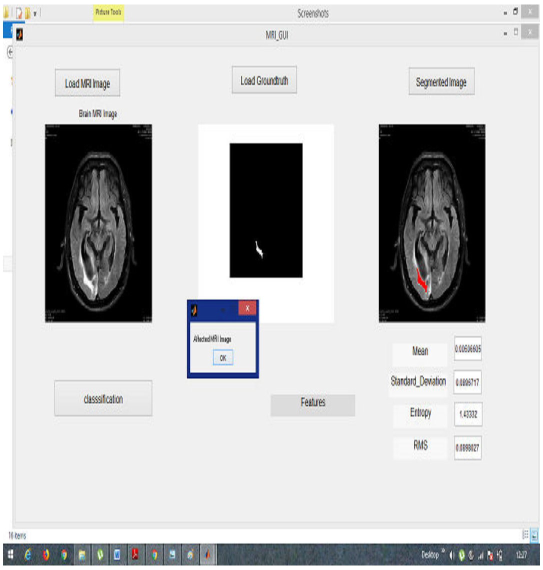

Figure 3: output for the testing image

IV. CONCLUSION

Here, the classification performance of the proposed SVM classifier with KFCM segmentation technique is compared with existing classifier techniques. From the simulation results we can say that the proposed method has better performance in classification of Ischemic stroke lesions and provides better results in the accurate segmentation of the lesion region (i.e, acute and sub-acute phases) than the existing segmentation techniques. Here, the accuracy of the classifier is increased to 99%, by using a soft clustering technique (Kernalized Fuzzy clustering) instead of hard clustering technique (C – Means clustering).The proposed SVM classifier gives good performance when compared to the classical approach. The accurate region of the stroke is identified and detected by using this technique. This method is also utilized to classify the types of the stroke (that means acute stroke or sub-acute stroke). By considering the dataset with scattering lesion tissues, the accuracy of the classifier has to be further improved.

In future, the segmentation and classification requires more improvement, so the improved segmentation and classification algorithm can be made possible in the future.

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