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Machine Learning Algorithms for MR Brian Image Classification

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Abstract: ***Classification of MR brain images accurately is the crucial part in the medical imaging research since brain is a complex structure which needs multiple convergence approaches to classify. In this paper machine learning algorithms like SVM, HMM were employed to classify the brain images with the use of spatial features. Super pixel image segmentation approach is applied to segment the image into distinct super pixel region for which the features are calculated.***

Keywords: Brain classification, SVM, HMM.

I. INTRODUCTION

Brain abnormality is the serious and life threatening issue which is to be diagnosed very accurately. Magnetic resonance (MR) imaging is the most effective technology to project the tissues in the brain. This provides a map of the soft tissue as a resonance of hydrogen nuclei [1] and this is the key factor to distinguish the abnormality of the image.

Since the property of MR imaging relies on property of hydrogen nuclei which is presented in larger volumes in human body makes the imaging technology more accurate to reflect soft tissue contrast details. The nearness of tumor can be distinguished by its effect on the stringy structures causing interruption and removal [2].

Classifications of these images are performed in supervised and unsupervised manner. Though there is a practical demand of unsupervised approach it suffers from many limitations especially when dealing with complex structures like brain tumors. So in this context, this paper is focused on classifying the images with supervised classifiers where it is been trained with an ensemble of training pairs $\{x_i, y_i\}$, where x_i is the training feature vector and y_i is its corresponding label. On other hand this classifier is followed by a random unknown feature which is classified according to the trained criteria.

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This paper involves a pre processing stage where the skull region of MR brain image is removed using image processing morphological operations which is then followed for super pixel based picture division which the picture is divided into 'N' particular districts

and the spatial features are calculated for each super pixel region. This makes the classification more accurate since the complex structures like brain when segmented using region based algorithm may lead to some non region of interest points which cause hindrance in classifying accurately [3].

This paper is sorted out as takes after, section 1 exhibits the need and need of MR brain image classification presenting about the description MR imaging, section 2 presents the related work done so far by different researchers in the current field. Section 3 presents the proposed approach in a brief manner and the outcomes of each process is presented. Section 4 displays the execution of the proposed approach with different classifiers and ending with conclusions.

II. REVIEW CRITERIA

Many researchers are working on different task on MR brain images; this includes extraction of brain region, segmentation and unsupervised/supervised classification. The concepts and work related to the proposed approach were presented in the section. In [4] maitra et. al presented fuzzy C-means clustering algorithm for segmentation in accordance with self organizing maps to classy the abnormalities of them.

In [5] Rajesh et al in presented a rough set theory for image segmentation and a feed forward neural system is utilized to classify the abnormality and also the type of the tumor.In [6] Atiq et.al introduced a stochastic model for estimating the tumor texture, and also presented a factual model using multi resolution analysis. The classification of the abnormality is performed with AdaBoost algorithm based on the complexity and confidence in the samples.

In [7] Solmaz et.al presents 3-dimentional restorative picture division. In this method to recognize the cerebrum tumor in MRI pictures bunching and arrangement strategies are performed. This system could accomplish a lessening in time and memory. The order should be possible with the criteria of dice's and jacquard's coefficient on the cerebrum tumor from MRI pictures recovered from the Brats 2013 database. In [8] E.E.Ulku et al proposed a strategy to recognize the cerebrum tumor utilizing Computer-helped recognition i.e. Computer aided design framework.

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This CAD framework essentially relies upon morphological image processing and histogram equalization techniques. In this paper he compared six classification algorithms for evaluating the CAD system accuracy.

In [9] Pavel Dvorak et al present a procedure that decides if the information attractive reverberation imaging picture of cerebrum contains a tumor or not. It's finished by checking the left-right symmetry of the mind that is considered as supposition for solid cerebrum.

In [10] Ahmeed et. al, presented an integration of temper based K-mean clustering and Fuzzy C- means to segment the MR brain images and the classification abnormality is performed with SVM.

III. PROPOSED APPORCH

This generalized block diagram of the work is depicted in the Fig 1.

Fig 1: Generalized block diagram of the proposed work

A. Input MR brain image

The input brain images are collected from multiple resources like BRATS [11] image database, brain Atlas [12] which are in DICOM format. The images are T1- weighted denoised images belong to different diseases containing the tumors of multiple sizes.

B. Pre-Processing

In this step the input image skull is removed using the image processing morphological operation as stated in [13], [14], [15].

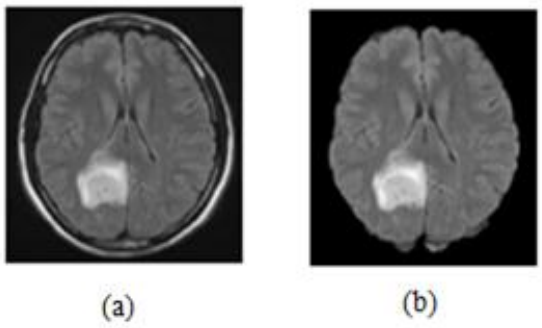

Fig 2: (a) abnormal Image Slice

(b) Resultant image after pre-processing

C. Segmentation

In this work super pixel base image division is utilized to segment the MR image into 'N' distinct super pixel regions. To achieve this SLIC super pixel algorithm [16] is used, this is a K-means clustering method and able to assign each pixel to a super pixel according to their variations in intensities and spatial locations. It not only provides better segmentation results but also minimizes the processing of unwanted region of pixels. Below is the process involved for super pixel algorithm, the input image is pre processed for removing the skull part from the MR brain image and thus obtained image is transformed into pseudo color transformed image, since the super pixel SLIC algorithm is applied for color images and the partitions are projected onto the input image:

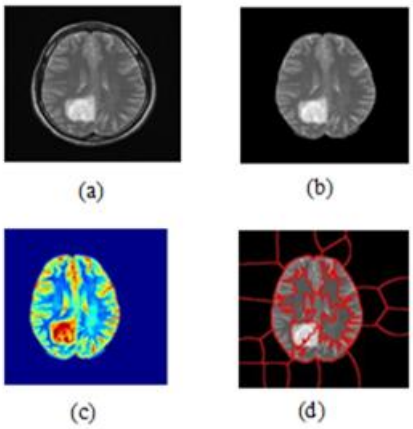

Fig 3: (a) Input MR Brain image

(b) Pre processed image

(c) Pseudo color transformed image

(d) Super pixel segmented image.

D. Feature Extraction

First order moment features like Contrast, Homogeneity, Energy, Skewness, Kurtosis, and Inverse difference moment were calculated as stated in [17]. The second order statistics include, Contrast visibility, spatial frequency and energy of gradient as stated in [18]. These features are calculated for each super pixel regions which are then fed to classifier.

E. Classification

The proposed work consists of training and testing phase, in the first stage the classifier is been trained for both normal and abnormal images and the feature vectors corresponding to it were trained with label matrix of {-1, +1}. In this work two classifier SVM (bolster vector machines) and HMM (Hidden Markova models) were utilized to assess the execution of the proposed work [19][20][21][22].

IV. RESULT AND DISCUSSION

To assess the execution of the proposed work, 80 abnormal and 80 normal images collected from [11] and [12]. These images are preprocessed, pseudo color translated and processed for super pixel image segmentation for n=150, for each region the feature are calculated which are normalized and fed to the SVM/HMM. The ROC curve is presented in Fig 4, which depicts that the performance of classification with HMM is 20% better than compared against with SVM.

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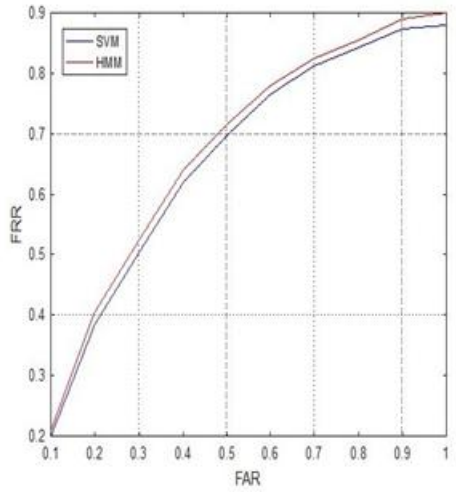

Fig 4: ROC curve performance of the proposed approach.

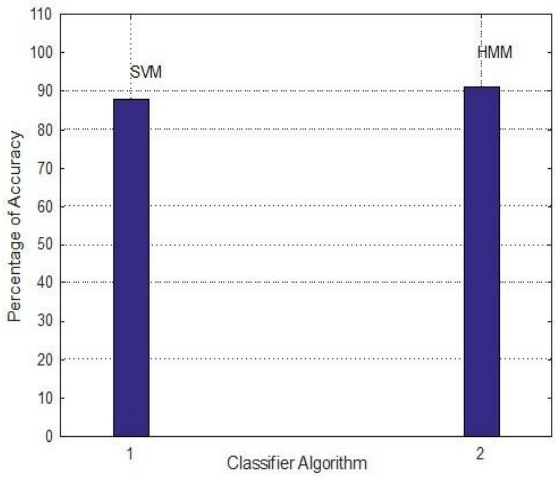

Fig 5: Performance of accuracy ofthe proposed approach.

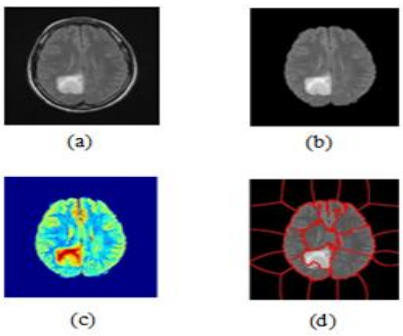

Fig 6: (a) input MR Brain image

(b) Pre-processed image

(c) Pseudo Color transformed image

(d) Super Pixel segmented image

V. CONCLUSION

Super pixel MR brain image segmentation with machine learning algorithm based classification is presented in this paper. The proposed work involves several algorithms which are integrated together to form a clear frame work for image classification. It is found that HMM based classification proved to be more accurate for the proposed work, this work can be further extended with different datasets of image that may include real time dataset and also the performance of the proposed framework will evaluated with deep neural networks (DNN).

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