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Texture Characterization and Classification to Detect Brain Tumor

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Abstract: In the field of medical sciences, brain tumor detection has immense significance. Extraction of peculiar tumor portion along with certain features is possible with the use of methods that come under image processing. In the recent years techniques like segmentation and morphological have been undertaken to detect the set of unusual cells that grow in the brain which might be malignant or benign. This paper deals with characterization of texture to obtain Haralick features, with texture being the principle attribute of an image and finds lot of application in image processing. This involves the use of SVM classifier in the algorithm to classify texture in order to detect brain tumor. It has been tested for 70 images and statistical parameters have been calculated and the obtained accuracy is 97.1%, precision is 98.4% and sensitivity is 98%.

Keywords: GLCM, Haralick features, SVM Classifier, Texture Defect Detection

I. INTRODUCTION

Clustering of anomalous cells in the brain is referred to as brain tumor and its cause is unknown even today. There are more than hundred and twenty brain tumours and its treatment in turn depends on where it is located in the brain and the degree with which it is growing. It is diagnosed by taking CT, MRI or PET scan of the patient. Accurate diagnosis and evaluation will lead to better treatment. Several segmentation techniques have come up in the recent years to avoid more burden required for computational processing of medical scans [7], [8],[10]. Thresholding methods [13], [14] that involve the use of edge detector operator and filter like median filter are often used to mark the region of tumor in brain also known as region of interest ,[15] along with its area.

A. LITERATURE SURVEY:

Author [1] in **"Detection of Brain Tumor from MRI images by using segmentation and SVM"** proposed a technique that uses K-means segmentation and unsupervised SVM method for the detection of tumorous region in the brain from MRI images. Further, to obtain more information on the tumor region object labelling algorithm and skull masking has been used.

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Author [2] in **"Tumor Detection and classification of MRI Brain Image using Different Wavelet Transforms and Support Vector Machines"** propounded a method that uses distinct wavelet transforms and Support Vector Machines to distinguish between a normal brain and a tumor brain with good computation speed.

Author [3] in **"A New Method for Brain Tumor Segmentation Based on Watershed and Edge Detection algorithms in HSV Colour model"** used watershed algorithm and Canny edge detector to discern brain tumor. The algorithm is implemented using MATLAB tool and is based on HSV color model.

Author [4] in the paper entitled as **"Detection Brain Tumor in Magnetic Resonance Images using Hidden Markov Random Fields and Threshold techniques"** presented a hybrid approach that detects brain tumor using HMRF and thresholding methods. The method has been carried out on three different patient data sets using MATLAB as a platform.

In [5], HCSD, feature extraction, classification method and K-means clustering methods have been used to accurately segment brain tumor tissue. The pre-processing stage extracts brain and eliminates noise. This followed by the identification of tumor by K-means. HCSD differentiates between healthy tissues and tumor tissues and repudiated healthy tissues. The obtained result is verified using KNN classifier.

In [6] K-means clustering algorithm is applied on the MRI scanned image followed by the application of morphological operator. The software used is SCILab and the method proposed computes the area of tumor in the brain.

In [9], a technique that involves the use of fractional filter to detect benign brain tumor has been proposed. A data set consisting of three types of brain tumor was taken and proposed algorithm implemented in MATLAB tool was applied to the images.

In[11] the author proposed an approach for better segmenting of gray scale images so as to reduce undesired noise and colour variations. The method involves enhancing the image followed by application of filter and segmentation. In [12], a machine learning technique that comes under neural networks was implemented. The method involves collecting data followed by pre-processing , application of filter ,segmenting the image, extracting the feature and finally classifying and identifying using convolutional neural networks.

II. METHODOLOGY

The complete technique is subdivided into two parts where the first art involves making the image suitable for further processing that is pre-processing the image. The second part constitutes texture training as to acquire meaningful information about the tumor.

Firstly, an input image that has brain tumor is taken, followed by resampling the image to ensure that the image has equal dimensions. Resampling the image will not affect its intensity. Colour plane extraction is used to remove the excess brightness of the image and square transformation is applied so that every pixel intensity value is squared. The above steps come under image pre-processing which make sure that the MRI image taken is suitable for the further supervised algorithm to be applied. Robust algorithm can be produced if the skull in the MRI image is removed for which morphological operations have been used.

The second part of the proposed technique involves Texture Training Interface that deals with characterising the defect and classifying texture processes. For characterising the defect, haar wavelet transform is chosen so that accurate Haralick features are obtained. Haralick features are calculated by computing a grey level co-occurrence matrix. GLCM is indicative of how frequently various combinations of pixel grey levels turn out in an image. The chosen classifier enumerates the haralick features depending on the GLCM. For the texture classifier, haralick features is must as it will not identify defect in texture unless it is found in feature space. A co-occurrence level corresponding to co-occurrence matrix is calculated and the minor texture defect equivalent to the window size is detected. In case of high co-occurrence level the time required to process will accordingly increase.

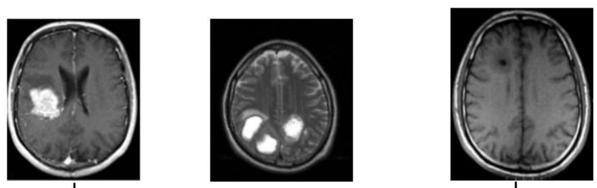
In addition to the A and B window size and co-occurrence level it is essential to form a displacement vector that gives relation between various pixel intensities that characterise texture.

SVM classifier is taken as texture classifier. For better results, before training the classifier, certain settings are to be adjusted. The default value of tolerance to calculate support vectors is 0.001.This default value is to be increased if the classifier does not yield expected results,that is each variation in the texture possible is not represented by the trained samples. The values of cross-validation score ranges from 0-1000 and this is indicative of the accuracy of the classifier used. Therefore higher the value more is the robustness of the algorithm. The algorithm is said to be stable if minute variations occur where as it is unstable if large variations occur. The sample taken is a texture or comprises texture defect is determined by the window the algorithm uses. Min score is another setting that represents minimum score required to classify a sample as a texture defect. After required adjustments to the settings mentioned above, the algorithm is then trained by considering images and pre-processing them.

Region of interest is draw and the sample is added to train the algorithm. To almost 30 images this process is applied and around 210 samples have been collected.

Fig: (a)

Fig: (b) Input Images



(Tumor Image) Fig: (c) Output of the classifier: (Tumor Image) (Non –Tumor Image)

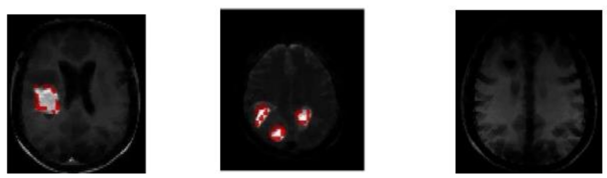
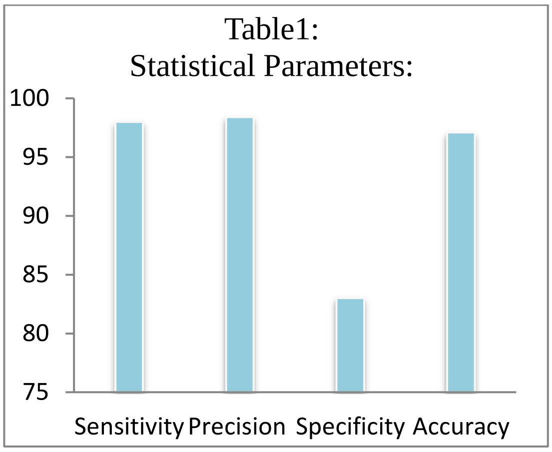


Table 2:		
TRUE CONDITION		
CONDITION POSITIVE	CONDITION NEGATIVE	Accuracy 0.971
True Positive 63	False Positive 1	Precision 0.984
False Negative 1	True Negative 5	Negative Predicted Value 0.83
Sensitivity 0.98	FPR 0.16	False Discovery Rate 0.015
FNR 0.015	Specificity 0.83	

Homogeneity, entropy and contrast are among the thirteen haralick texture features that are repeatedly used to give information related to spatial distribution of texture image in brain tumor detection algorithm. Fig (b) represent input images with and without tumor and fig (c) represents output of the classifier. The algorithm proposed accurately identifies tumor region and the following are the statistical parameters obtained.



III. RESULTS AND DISCUSSION

The proposed methodology in the paper aims to automatically characterise and classify brain tumors. The results of the simulated data and the segmentation done on the images are promising. There will be a reduction of manual intervention along with the decrease in the processing speed of proposed approach of segmentation and detection of textural defects thereby yielding results with good accuracy and sensitivity.

On 70 images this technique has been tested and the results have been tabulated as shown below. Using this technique we have achieved an accuracy of 97.1%, sensitivity of 98% and precision of 98.4%.

IV. CONCLUSION

To conclude, there is a lot of scope in future to develop sophisticated algorithms with the use of unsupervised learning techniques where the portion of anomalous cells in brain tumor can not only be detected but also the stage of the brain tumor can be analysed. The accuracy of algorithms developed using machine learning techniques is better and the results are more promising.

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