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Detection and Classification of Brain Tumor

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Abstract

The main idea behind this project is to detect and classify Brain Tumor using MRI images. Brain Tumor is an abnormal intracranial growth caused by cells reproducing themselves in an uncontrolled manner. The algorithm incorporates steps for pre-processing feature extraction and image classification using neural network techniques. Human investigation is the routine technique for brain MRI tumor detection and tumor classification. Interpretation of images is based on organized and explicit classification of brain MRI and also various techniques have been proposed. Information identified with anatomical structures and potential abnormal tissues which are noteworthy to treat are given by brain tumor segmentation on MRI, the proposed system uses the adaptive pillar K-Means algorithm for successful segmentation and the classification methodology is done by the two-tier classification approach. The proposed two-tier classification system classifies the brain tumors in double training process which gives preferable performance over the traditional classification method. The proposed system has been validated with the support of real data sets and the experimental results showed enhanced performance.

Keywords*: - Brain tumor, brain tumor segmentation, convolutional neural networks, deep learning, glioma, magnetic resonance imaging*

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INTRODUCTION

A brain tumor is an intracranial solid neoplasm which is defined as an abnormal growth of cells within the brain or the central spinal canal [1]. Brain can be malignant (cancerous) or benign (non-cancerous). Benign tumors have a homogenous structure which did not contain cancer cells and they may be either radio logically monitored or completely removed surgically and they do not persist again. The structure of malignant tumors is heterogenous and it contains cancer cells which can be treated with chemotherapy, radiotherapy and they are life threatening. Neurology and basic neuroscience have been significantly advanced by utilizing imaging tools that enable in monitoring of the brain.

MRI is a critical component in diagnosis and treatment planning which endow significantly increased knowledge of normal and diseased anatomy for medical research. MRI is efficient as compared with all other imaging techniques in the application of the brain tumor detection and identification.

Computer aided diagnosis is required to avoid human based diagnostic error such as missing diagnosis and is laborious when a large number of brain MRI are examined.

METHODOLOGY

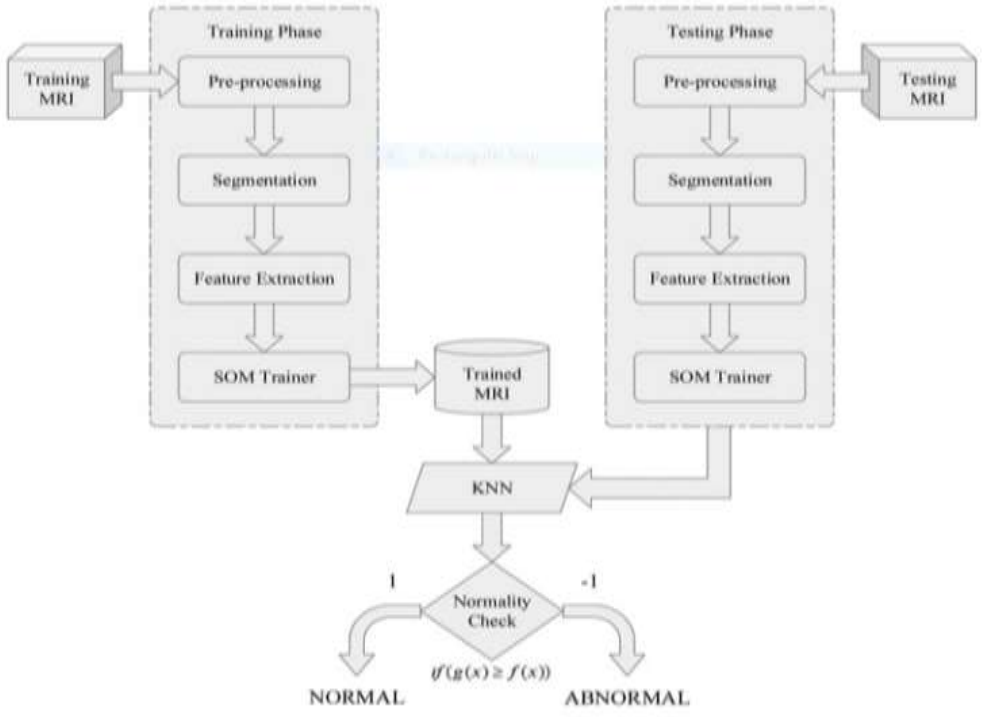


Figure:-1 Flow Chart for Brain Tumor Classification

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A. Image Acquisition

The MRI images of brain tumor are collected. The images are converted to gray scale images for further processing.

B. Image Enhancement Techniques

It refers to accentuation or sharpening of image features such as boundaries, or contrast to make a graphic display more useful for display & analysis. This process does not increase the inherent information content in data. It includes gray level & contrast manipulation, noise reduction, filtering. Image enhancement is done by following methods.

1. Gaussian Filter Method

Gaussian filter is said to be a linear filter and mostly used to blur the images and reduce the noise.

2. Median Filter Method

The median filter is a non-linear digital filtering technique, is often used to remove noise. Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise. The median filter is normally used to reduce noise in an image, somewhat like the, mean filter. However, it often does a better job than the mean filter.

C. Feature Extraction

Feature extraction is the special form of dimensionality reduction. When the input given is huge and difficult to handle to an algorithm and sometimes suspected to be redundant then the input data is transformed into a reduced set of features. It is used to identify brain tumour where it is exactly located and helps in predicting next stage.

Feature Extraction can be done into two forms i.e. Texture and Geometric.

Some of the features extracted in this paper are:

Contrast: It is a measure of intensity contrast between a pixel and its neighbor over the whole image.

Energy: It represents textual uniformity i.e. it measures pixel pair representation.

Entropy: Entropy is measure of uncertainty in a random variable

Shape

Colour: Colour is a component of light which is separated when it is reflected off of an object. Colours can be identified numerically by their coordinates.

Intensity: Intensity is a purity or strength of colour.

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D. Classification

Classification is performed using conjugate gradient descent backpropogation method [5]. This Algorithm is part of Neural Network.

The basic backpropagation algorithm adjusts the weights in the steepest descent direction (negative of the gradient). This is the direction in which the performance function is decreasing most rapidly. It turns out that, although the function decreases most rapidly along the negative of the gradient, this does not necessarily produce the fastest convergence. In the conjugate gradient algorithms, a search is performed along conjugate directions, which produces generally faster convergence than steepest descent directions.

This is divided into 3 parts:

- Training
- Testing
- Validation

Data is trained based on previous data relations i.e. from feature to class label. Class Label is binary classification i.e. Normal and Tumorous. Activation function develops the relationship between feature and class label [6]. Any unknown data provided, system will predict whether it is Normal or Tumorous based on function developed with this relation. Once Testing is completed it validates for the accuracy. Classifier Performance Validation is used for validation.

Three Parameters are considered for validation –

- Accuracy
- Sensitivity
- Specificity

Accuracy: Percentage of accuracy in detecting normal and Tumorous samples. Above 60% is acceptable. It should be above False Positive.

Specificity: Number of samples 'n' detected as Tumorous out of total 'x' samples of Tumor.

Sensitivity: Number of samples 'n' detected as Normal out of total 'x' samples of Normal.

This is measured using performance (mean square error). After that confusion matrix is calculated. Confusion Matrix is derived for all Training, Testing, Validation and Overall (As Shown in Figure below). Finally, ROC is plotted where midline is drawn. Both the classes should not go towards false positive. If it's above false positive, it's a valid classifier.

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E. Segmentation Using K-Means Clustering

The K-Means clustering technique is a pixel-based method [2], it is one of the simplest techniques, and its complexity is relatively lower than other region-based or edge-based methods. Further, K-means clustering is suitable for biomedical image segmentation as the number of clusters is usually known for images of particular regions of the human anatomy. Combined with the existing methods and aiming to get better results, it is useful to take segmentation method into account. There is a two-phase iterative algorithm to minimize the sum of point-to-centroid distances [3]. In this method, we are grouping the data and to select the mid value, then we are cluster the data in k-means cluster the grouping data are also present in another group of data, but fuzzy and c-means method it is not possible to group same data present in another cluster so we are avoiding fuzzy c-means and c-means clustering algorithm, instead we used k-means clustering method. It produce good result in segmentation techniques and helpful in our feature extraction.

Steps for the algorithm are as follows:

1. Give the no of clusters as k.
2. Randomly select k cluster centres.
3. Calculate mean or centre of the cluster.
4. Calculate the distance between each pixel to each cluster centre.
5. If the distance is near to the centre then move to that cluster.
6. Otherwise move to the next cluster.
7. Re-estimate the centre.
8. Repeat the process until the centre doesn't move.

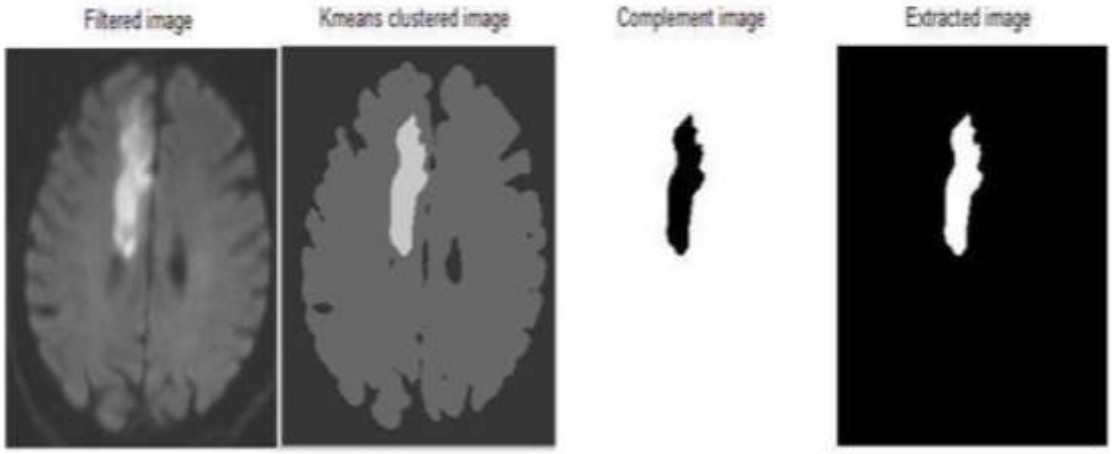


Figure 2: Describing the use of K-Means Algorithm

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RELATED WORK

Brain tumor segmentation and classification is an essential technique for right on time tumor diagnosis and radiotherapy planning. Some of the recent research work related to the Brain tumor classification is listed as follows:

- M. C. de Andrade, 2004, introduced an interactive algorithm for image smoothing and segmentation. This method combines some known image smoothing and segmentation methods of mathematical morphology and PDE-based level set frames. The segmentation was a region growing and automatically detect all image minima using a property inherited from the watershed transformation (NHW). A merging mechanism was used to change the image topology which reduces over-segmentation and the need of preprocessing. Accurate and fast segmentation results were achieved for gray and color images in any number of dimensions using this method.

- Debnath Bhattacharyya and Tai-hoon Kim, 2011, proposed [14] an image segmentation method to indentify or detect tumor from the brain magnetic resonance imaging (MRI) for further consideration of medical practitioners. Thresholding methods have different result in each image. So a set of image segmentation algorithms was proposed by which detection of tumor can be done uniquely on brain tumor images.

- Farjam 2012, proposed a template-matching method to detect metastases on conventional MRI for screening purposes. The result was improved on the spherical template generation process by varying tumor size, lesion shape and intensities to achieve more accurate detection rates. The most common way to quantitatively evaluate segmentation results is to calculate the overlap with the ground truth. Usually, Dice Similarity Coefficient (DSC) or Hausdroff Distance are used. DSC can range from 0 to 1 with 0 indicating no overlap and 1 indicating perfect-overlap. Another method is to assess results on a synthetic dataset including ground-truth. Although synthetic data lacks important characteristics of real images, it has been used by many groups for initially assessing both segmentation and registration methods on healthy datasets.

RESULTS AND DISCUSSIONS

The brain tumour identification from a MRI is a complex process hence artificial intelligence is applied to detect the exact

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tumour position in a brain MRI. In this paper we are developed a novel technique for the tumour segmentation and classification in brain MRI. Brain tumour is most treatable and curable if captured at the initial stages of the infection. This locates exorbitant pressure on the brain, causing an incremented intracranial pressure and can cause permanent brain damage and eventually death. Untreated or progressive brain cancer can only spread inward because the skull will not let the brain tumour expands outward. Only invasive techniques such as biopsy and spinal tap methods can determine whether the brain tumour is cancerous or non-cancerous. However the system designed in this work avails segmenting the MR image with Adaptive Pillar K means clustering algorithm and classifying cancerous and non-cancerous brain tumours automatically by the two-tier classifier approach, which uses the statistical texture features extracted by DWT. All classification result could have an error rate and on occasion will either fail to identify an abnormality, or identify an abnormality which is not present. It is common to describe this error rate in terms of true and false positive and true and false negative as follows:

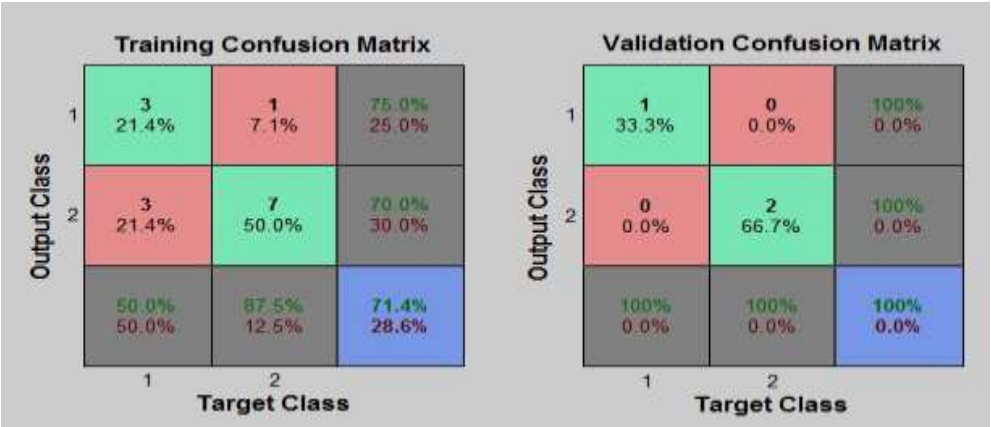
True positive (TP): the classification result is positive in the presence of the clinical abnormality.

True negative (TN): the classification result is negative in the absence of the clinical abnormality.

False positive (FP): the classification result is positive in the absence of the clinical abnormality.

False negative (FN): the classification result is negative in the presence of the clinical abnormality.

Thus the results obtained in the form of Confusion Matrix are as follows:



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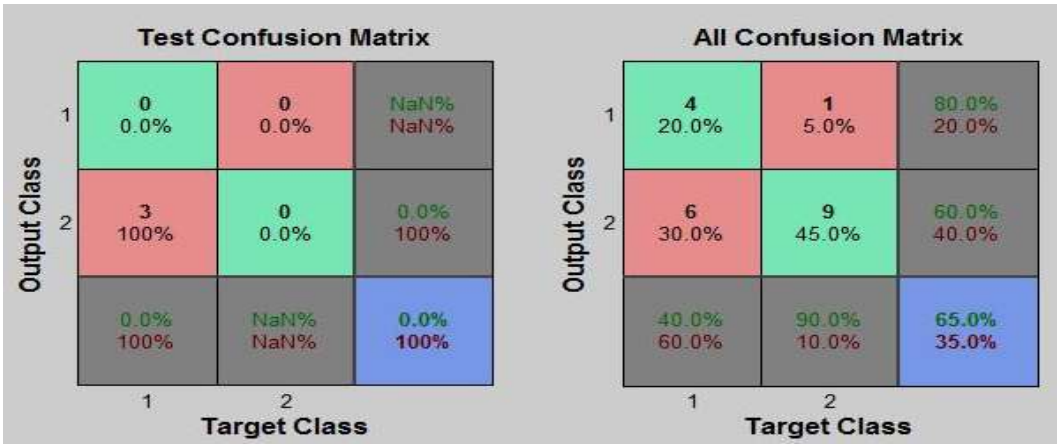


Figure 3: Confusion Matrix for the dataset provided

The graph for the results can be illustrated with the help of the ROC Graph

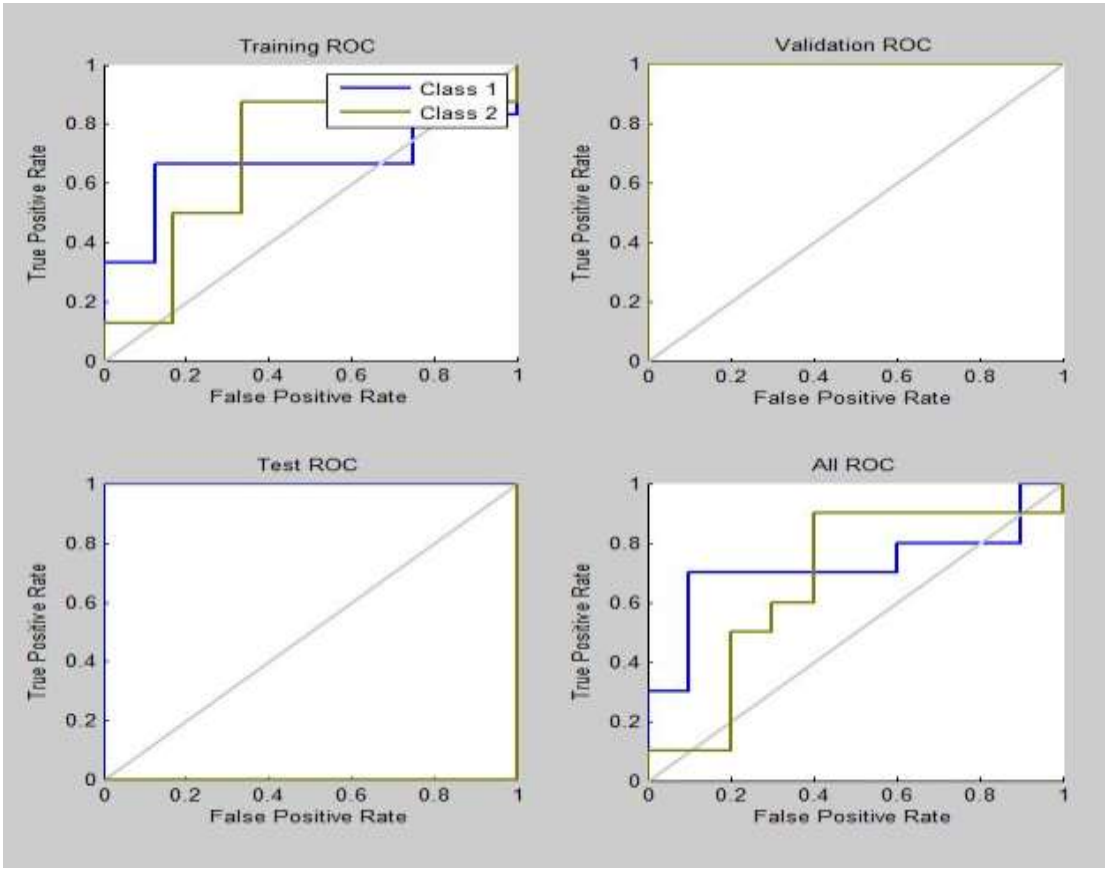


Figure 4: ROC Graph as the output

CONCLUSION

Finally feature was extract and compared with these standard metrics. Thus the proposed method performs better than the existing works. We have extracted nearly 20 MRI images in our project. In future 3D assessment of brain using 3D slicers with python can be developed.

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REFERENCES

1. Qurat-Ul-Ain, L.G, Kazmi,:"Classification and Segmentation of Brain Tumor uing Texture Analysis", Recent Adv. Artif. Intell. Knowl. Eng. Data Bases, 2010, 10, pp. 147–155

2. Khalid, N.E.A., Ibrahim, S., Haniff, P.N.M.M.: 'MRI brain abnormalities segmentation using K-nearest neighbors (k-NN)', Int. J Comput. Sci. Eng. (IJCSE), 2011, 3, (2), pp. 980–990

3. Aslam, H.A., Ramashri, T., Ahsan, M.I.A.: 'A new approach to image segmentation for brain tumor detection using pillar K-means algorithm', Int. J. Adv. Res. Comput. Commun. Eng., 2013, 2, (3), pp. 1429–1436

4. Maity, A., Pruitt, A.A., Judy, K.D.: 'Cancer of the central nervous system' (Clinical Oncology, 2008, 4th Edn.)

5. Sezgin M. and Sankur B., Survey over image thresholding techniques and quantitative performance evaluation, Journal of Electronic Imaging, Vol. 13, No. 1, pp. 146–165. 2004.

6. Rastgarpour M., and Shanbehzadeh J., Application of AI Techniques in Medical Image Segmentation and Novel Categorization of Available Methods and Tools, Proceedings of the International Multi Conference of Engineers and Computer Scientists 2011 Vol. I, IMECS 2011, March 16-18, 2011, Hong Kong.

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