BRAIN TUMOUR DETECTION IN MRI USING DEEP LEARNING

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Abstract. Tumour is the assortment or mass growth of abnormal cells within the brain. Individuals are still dying because of brain tumour. So early and accurate detection of brain tumour will scale back the death rate. The computer-aided application will help to give accurate detection of brain tumour. The process of performing some operations on image to get useful information is called image processing. At present image processing is rapidly growing technology. It consists of various types of imaging methods, like MRI, Computer Tomography Scans, X-Rays. By this, we can find small abnormalities in the human body and brain. The main process of image processing is to extract accurate information from the image. In this paper, the GLCM texture feature and Haralick texture features of the images are extracted. Then the calculated features are given as an input to machine learning classifiers and AlexNet to classify the MRI images of the brain. This work achieved with three steps, there are preprocessing, feature extraction, and classification. Finally, the methods are analysed and it has been found that MLP is the best accuracy classifier.

Keywords: Feature Extraction, GLCM, Haralick texture Feature, MLP, AlexNet.

1. Introduction

The goal of image processing is to obtain the characteristics from the corresponding image. It plays a key role in MRI medical image processing. Detecting any disease in advance will help for better treatment and increasing the immortality rate. Identification, detection, classification of brain tumour from MRI images are a prolonged process. So we are going for computer-aided application. The human brain is the most critical and composite organ of our central nervous system. The brain is protected by the skull and is very rigid. The cerebral cortex contains 15-33 billion neurons, each neuron connected to a thousand other neurons. Any growth inside such a restrained complex part may induce difficulties. Reason for the brain tumour incalculable [1,2]. But there are two major reasons for brain tumour: (i) Radiation (ii) Rare genetic conditions. The most common indications of brain tumours are headache, paralysis, itching in the legs and arms attacks, loss of consciousness, memory loss, changes in mood and personality, control problem in the body, changes in vision and hearing. There are two common classifications of Brain tumour: (i)Primary Brain tumours originate and stay at the brain. (ii) A secondary Brain tumour is so common

[3]. In this cancer cells originates from somewhere in the body like lungs, breasts, kidney and travels to the brain. Some Brain tumours contain cancer cells. Benign brain tumours don’t have cancer cells. They are coming under a primary brain tumour class. They grow slowly can often be removed and rarely spread to the brain cells around. Depending on where they are located in the brain, they can be life-threatening. Malignant tumours may have cancer cells, and they come under primary or secondary tumours. Malignant tumours rarely spread beyond the brain or spinal cord. Detecting malignant tumour is more difficult than a benign tumour[6].

In this paper, the image dataset is classified using AlexNet and classifier. In the proposed work, the brain tumour detection is carried out in three steps: (i) Preprocessing (ii) Feature Extraction (iii)Classification. Preprocessing is which includes feature detection and feature extraction resulted by training the models on different classifier based on the selected characteristics and lastly calculating the correctness and performance of classifiers. The outcomes of this work are to analyse an image with a tumour or not.

2. Literature Survey

Kharrat, et.al [4] purpose composite method to classify the tumourous and non-tumourous Brain MRI using Genetic Algorithm and Wavelet-based characteristic extraction. In this approach, they employed the SLGDM texture feature to obtain the characteristics from the tumour and non-tumour tissues from the brain MRI. The obtained characteristics are given as an input to the SVM classifier to classify the Brain MRI.

N.Nandha, et.al [5] emphasises the importance of the image processing and diagnosing the brain tumour in the earlier stage. By segmenting the tumour region from the brain MRI the accuracy has been improved in their method. In this paper to diagnose Brain tumour image processing clustering algorithms are employed. The detection of brain tumour is carried out by two-phase in this method. In phase one is implementing preprocessing and enhancement of the images, and phase two carried out by segmentation and classification.

Ehab F. Badran, et.al [6] introduced a computer-based system for defining tumour area within the brain using MRI. The algorithm proposed in this paper was carried out in the ensuing steps, Preprocessing, Segmentation and Feature extraction. This paper explains the feature extraction clearly.

Shirly Sundar Singh, et.al [8] proposed a method to the diagnosis of Disc Bulge and Disc Desiccation are considered, in this paper, they proposed LS-RBRP+HOG to detect and classify the MRI. LS-RBRP is a spatial region statistical texture-based characteristic extraction method which extracts the characteristics in the rhombus pattern of the image. Random Forest classifier is used to classify the image.

3. Proposed Method

The principal approach of this method is to discover the tumour in brain MRI. In this paper distinct types of MR Images used to detect the normal and abnormal brain. The dataset is taken as input have two sets of images, one is normal brain MRI and another folder contains abnormal tumour brain MRI. Figure 1 presents the tumorous and non-tumorous brain MR Image.

Healthy **Brain MRI** **Abnormal Brain MRI**

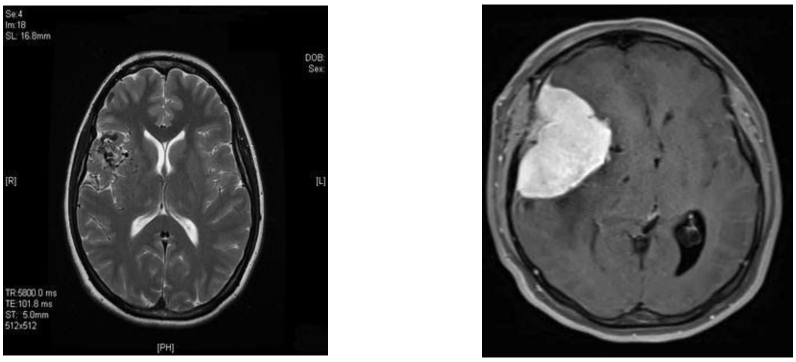

Fig 1. MRI of tumorous and non-tumorous Brain

Figure 2 displays the complete procedure for the proposed algorithm.

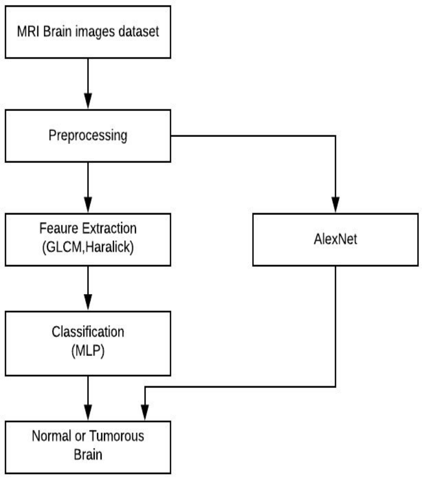

Fig 2. Algorithm of Detection and classification

1.1 Preprocessing

Data preprocessing is transforming the normal raw data into an understandable data format. Inconsistent data will cause so many errors. Data preprocessing is a wise method of resolving unwanted errors in the dataset.

1.1.1 Grayscale Imaging

In this paper, MR Image dataset is used as input. Mainly this brain MRI is converted to a grayscale image. In this normal MRI is converted into a grayscale image for better accuracy. The grayscale image is basically black and white image. In the grayscale image, Red Green Blue equally spread. It contains only luminance information and not colour information. That is the main reason grayscale imaging method is used. Luminance is more important in distinguishing visual features. To identify important edges or feature grayscale image helps wisely.

1.2 Feature Extraction

Feature extraction could be a set of ways to extract necessary features from corresponding MRI. The feature extraction could be a method to depict the figure as a composite as well as a distinctive sort of values or matrix-vector. Features extracted in this papers are GLCM+Haralick texture features.

1.2.1 GLCM Texture Feature

Grey-Level Co-Occurrence Matrix(GLCM) is that the method to extract the second-order applied math texture 00. The input image is composed of the pixel, each pixel with an intensity. The GLCM stored as i x j x n matrix, where n is the sum of GLCM calculated because of dissimilar positioning and dislocations used in the algorithm and i, j is the rows and columns of the matrix. In GLCM row-count and column-count are equivalent to the number of gray level in the corresponding picture. By using GLCM method the basic features contrast, correlation, energy, homogeneity are extracted, and other features like mean, RMS, standard deviation, entropy also extracted.
GLCM evaluate the spatial relationship of the pixel.

a.Syntax:

```
glcms = graycomatrix(I)
glcms = graycomatrix(I,Name,Value,...)
```

b.Description:

glcms = graycomatrix(I) forms a gray-level co-occurrence matrix(GLCM) from image I. Although the function graycoprops() measures four parameters Homogeneity, Contrast, Correlation, Energy, in Matlab Image Processing Toolbox, we extracted some other features too. Table 1 shows the extracted GLCM texture characteristic of the image data set.

Table 1 Extracted GLCM Texture Feature of the image data set

id	Contrast	Correlation	Energy	Entropy	Homogeneity	Mean	RMS	std	class
img1.jpg	1.36	0.67	0.10	0.34	0.76	504	928	1210	yes
img2.jpg	1.23	0.75	0.29	0.00	0.87	504	1160	2130	no
img3.jpg	0.71	0.79	0.27	0.20	0.88	254	586	1020	no
img4.jpg	0.15	0.60	0.55	0.66	0.93	254	631	1500	no

1.2.2 Haralick Texture Feature

Haralaick Texture feature is well-known texture feature is the function of normalized GLCM. This also depends on the gray levels in the image. It is a widely used texture measure algorithm. The starting point for these features is the GLCM. This is an *N* dimensional square matrix with, where *N* denotes the number of gray levels in the image. Value [x,y] of the corresponding matrix is measured by sum up the amount of times value of x adjacent with value y and then furcate the total matrix over the count of the comparison done.Table 2 shows the extracted Haralick texture feature of the image data set.

Table 2. Extracted Haralick Texture Featureofm the image data set

id	Contrast	Correlation	Energy	Entropy	Homogeneity	Mean	RMS	std	class
img1.jpg	1.36	0.67	0.10	0.34	0.76	504	928.01	1211.28	yes
img2.jpg	1.23	0.75	0.29	0.00	0.87	504	1155.38	2128.46	no
img3.jpg	1.31	0.62	0.24	0.00	0.84	504	1109.80	1941.92	no
img4.jpg	0.21	0.46	0.52	0.66	0.90	504	1212.55	2887.41	no

1.3 Classification

Following the characteristics are extracted and elected, the classification action using DNN is done on the followed feature vector and preprocessed images given as input to AlexNext. Classification is achieved through applying a 10-fold cross-validation procedure for developing and training the DNN of 7 hidden layers structure. Likewise, to evaluate the performance of this chosen classifier, WEKA is used to import the machine learning classification algorithm.

1.3.1 AlexNet

AlexNet is the familiar Convolutional Neural Network architecture. In this paper, this architecture has a multi-layered architecture which holds five convolutional layers, three Max pooling layer, three Fully connected layers, and Seven Rectified Linear Unit. AlexNet is a dominant architecture, it can detect nearly 1000 various objects in the image.

1.3.2. Multilayer Perceptron

Multilayer Perceptron(MLP) is a feedforward Artificial Neural Network which takes a set of inputs and generates a set of outputs. MLP especially suits for a simpler dataset. It connects the multiple layers in a directed graph, it means signal passes trough perceptron in only one way, backpropagation suits for supervised learning. Its resembles the characteristics of a fully connected layer where each perceptron in the network connects to every other perceptron. It subsists of three layers: (i) Input layer, (ii) Output layer, (iii) Hidden layer.

4. Experimental Result

Dataset

The dataset contains 2 folders: yes and no which contains 256 Brain MRI Images. The folder yes contains 152 Brain MRI Images that are tumorous and the folder no contains 94 Brain MRI Images that are non-tumorous. Each image resolution is 128x128.

Results

Here all the algorithms implemented and their confusion matrix is added. Result of all algorithms implemented is shown in below Table 3.

The result after the training process of AlexNet is shown in the following Figure 3.

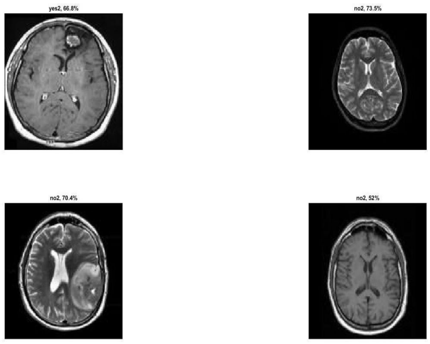

Fig 3 The result after the training process of AlexNet

Results of MLP algorithm implementation:

Confusion Matrix

a	b	← classified as
125	25	a = yes
19	78	b = no

Table 3 Classification Results(10 fold cross-validation)

S.NO	Algorithm	Accuracy	Error Rate
1	AlexNet	64.86%	35.14%
2	MLP	82.18%	17.81%

5. Conclusion

The detection and classification of brain tumour is a very challenging area. In this paper, a classifier is developed using a hybrid feature extraction algorithm which combines GLCM with Haralick and fed into MLP for classification of normal and abnormal tumors. The proposed hybrid approach gives accuracy measures of 82.18% which is better in classification when compared with AlexNet.

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