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RESEARCH ARTICLE

Detection and Classification of Brain Tumor using BPN and PNN Artificial Neural Network Algorithms

Naveena H S[1], Shreedhara K S[2], Mohamed Rafi[3]
[1]P G Scholar, Department of Computer Science, UBDTCE (VTU), India
[2]Professor, Department of Computer Science, UBDTCE (VTU), India
[3]Professor, Department of Computer Science, UBDTCE (VTU), India
[1] ashacssit09@gmail.com, [2] ks_shreedhara@yahoo.com, [3] rafimohamed17@gmail.com

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***Abstract*— A brain tumor, defined as an abnormal growth of cells within the brain or the central spinal canal. We exploit the capability of artificial neural network approach namely Back propagation neural network (BPN) and Probabilistic Neural network (PNN) to classify brain MRI images to either cancerous or noncancerous tumour. Image segmentation plays a significant role in image processing as it helps in the extraction of suspicious regions from the medical images. In this paper we have proposed segmentation of brain MRI image using K-means clustering algorithm. The extraction of texture features in the detected tumor has been achieved by using Gray Level Co-occurrence Matrix (GLCM).The proposed methodology worked in two stages Training and Testing. Both the testing and training phase gives the percentage of accuracy on each parameter in neural networks, which gives the idea to choose the best one to be used in further works.**

***Keywords*—Brain Tumor, MRI, Gray Level Co-occurrence Matrix, Texture Features, Back Propagation Network and Probabilistic Neural Network.**

INTRODUCTION

A brain tumor is any intracranial tumor generated by ab-normal and uncontrolled cell division, normally found any-where in the brain. Benign brain tumors contain cells that look healthy, just like normal cells [1]. They have growth slowly, are not likely to spread, although these tumors may cause damage if they initiate to interfere with normal brain function. On the different, malignant brain tumors have irregular borders and made up of abnormally shaped cells [1].The problem statement of the project can be defined as a brain tumor is an abnormal growth of cells within the brain or the central spinal canal. So tumor detection needs to be fast enough as the patient cannot recover if the damage is more than 50%. For detecting this tumor CT or MRI scan is done. This CT or MRI scan images are taken for this project to process it.

The main objective is Brain tumor detection and classification system is introduced in this paper. The system uses image processing and neural network techniques to detect tumor and to classify the type of tumor. The histogram equalization, image adjustment, thresholding functions are used for detection of tumor. BW label function is used for the determination of centroid of the tumor. Dilate operator are also used to make boundaries of the tumor look continues. In this paper Neural network methods are used for classification of tumor in MR images. In the neural network we are using back propagation method. The two layer feed forward network is trained with back propagation for the classification of tumors. But our proposed system is based on

GLCM based feature extractions are proposed for that will get a better classification result. Magnetic Resonance Imaging (MRI) is an advanced medical imaging technique used to produce high quality images of the parts contained in the human body MRI imaging is often used when treating brain tumors. In this approach first segment the input image using image processing techniques. We describe two stages for this technique namely the Training and Testing. Back propagation network (BPN) and probabilistic neural network (PNN) based classifier are used to classify the type of tumor in MRI image.

IMAGE PROCESSING TECHNIQUES

Image processing techniques are used to perform image segmentation on input image. The image processing techniques which is used in this system is shown in fig 1.

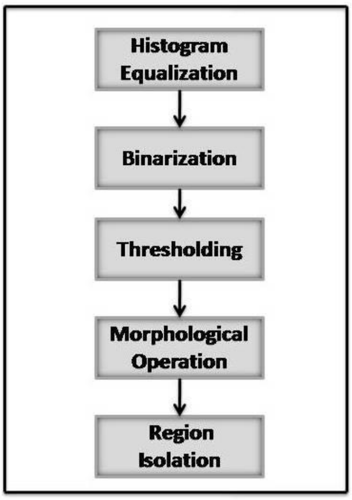

Fig 1 Image processing technique

The image processing techniques are used in this system is to isolate the tumor region from the rest of the image or separate the tumor region. The first step is to perform histogram equalization on the MRI image. The given MRI is equalized using histogram. The Histogram of an image shows the relative frequency of occurrences of pixel in a given MRI image. Image binarization converts an image into 0 to 255 gray levels to a black and white image. The easiest way to use image binarization is to select a threshold value, and classify all pixels with values above this threshold as white and all other pixels as black.For this Thresholding has been used for segmentation as it is most appropriate for the present system in order to achieve a binarized image with gray level 1 representing the tumor and gray level 0 representing the background [2]. For the binarization of equalized image a thresholding technique is used as shown below: Binarized Image bi, j = 255 if e (i, j) > T else bi, j = 0 Where e (i, j) is the equalized MRI image and T is threshold resultant for the equalized image. The fundamental enhancement needed is to increase the contrast between the whole brain and the tumor. Contrast between the brain and the tumor region may be present but below the threshold of human perception [2].K-Means is the one of the unsupervised learning algorithm for clusters. Clustering the image is grouping the pixels according to the some characteristics. In the k-means algorithm initially we have to define the number of clusters k. Then k-cluster center are chosen randomly. The distance between the each pixel to each cluster centers are calculated. The distance may be of simple Euclidean function. Single pixel is compared to all cluster centers using the distance formula. The pixel is moved to particular cluster which has shortest distance among all. Then the centroid is reestimated. Again each pixel is compared to all centroids. The process continuous until the center converges. Morphological operation is used as an image processing tools for sharpening the regions and filling the gaps for binarized image [2].Finally the tumor region is isolated from the given MRI image.

GRAY LEVEL CO_OCCURRENCE MATRIX

In statistical texture analysis, texture features are computed from the statistical distribution of observed combinations of intensities at specified positions relative to each other in the image. According to the number of intensity points (pixels) in each combination, statistics are classified into first-order, second-order and higher-order statistics. The Gray Level Coocurrence Matrix (GLCM) method is a way of extracting second order statistical texture features. The GLCM was firstly introduced by Haralick. A gray-level co-occurrence matrix (GLCM) is essentially a two-dimensional histogram. The GLCM method considers the spatial relationship between pixels of different gray levels [3]. The method calculates a GLCM by calculating how often a pixel with a certain intensity i occurs in relation with another pixel j at a certain distance d and orientation ϴ [3]. A co-occurrence matrix is specified by the relative frequencies P (i, j, d, ϴ). A co-occurrence matrix is therefore a function of distance d, angle ϴ and grayscales i and j. In our proposed system MRI image can be decomposed into patterns with regular textures. So we should be able to represent these regular texture regions by using co-occurrence matrices. To do so, we utilize the co-occurrence matrices in angles of 0°, 45°, 90°, and 135°.

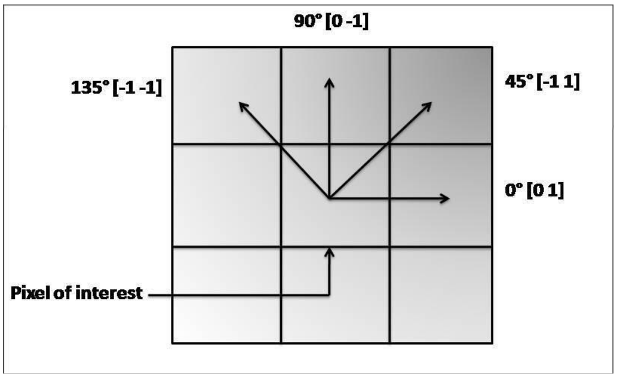

Fig 2 Direction for generation of GLCM

EXTRACTION OF TEXTURE FEATURES OF IMAGE

Generally texture is a feature used in the analysis and interpretation of images. Texture is described by a set of local statistical properties of pixel intensities [3]. When the GLCM is generated, the textures feature could be computed from the GLCM. The seven common textures features discussed here are Energy is the sum of squares of entries in the GLCM. Energy use each Pij as a weight for itself. It measures the textural uniformity that is pixel pair repetitions. It detects disorders in textures. Energy reaches a maximum value equal to one. Contrast is the difference between the highest and the lowest values of a contiguous set of pixels. It measures the amount of local variations present in the image. Homogeneity is to measure the distribution of elements in the GLCM with respect to the diagonal. It has maximum value when all elements in the image are same. Homogeneity decreases if contrast increases while energy is kept constant. Dissimilarity -In the Contrast measure, weights increase exponentially (0, 1, 4, 9, etc.) as one moves away from the diagonal. However in the dissimilarity measure weights increase linearly (0, 1, 2,3 etc.). It gives the measure of much dissimilar are of two neighboring pixels. Entropy shows the amount of information of the image that is needed for the image compression and measures the loss of information or message in a transmitted signal and also measures the image information. Maximum Probability is simple statistic records in the centre pixel of the window the largest Pi value in the matrix. High MAX values occur if one combination of pixels dominates the pixel pairs in the window. Inverse Difference Moment (IDM) is the local homogeneity. It is high when local gray level is uniform and inverse GLCM is high. Variance increases when the gray level values differ from their mean.

Energy	$F1 = \sum_{i,j=0}^{N-1} P_{i,j}^2$
Contrast	$F2 = \sum_{i,j=0}^{N-1} P(i,j) * (i-j)^2$
Homogeneity	$F3 = \sum_{i,j=0}^{N-1} \frac{P(i,j)}{1+(i-j)^2}$
Dissimilarity	$F4 = \sum_{i,j=0}^{N-1} P(i,i) * \lvert(i-j)\rvert$
Entropy	$F5 = \sum_{i,j=0}^{N-1} P(i,j) * [-\ln(P(i,j))]$
Maximum Probability	$F6 = \max i,j\ P(i,j)$
Inverse	$F7 = \sum_{i,j=0}^{N-1} \frac{P(i,j)}{(i-j)^2}$

Fig 3 Computation of texture features

BACK PROPAGATION ARTIFICIAL NEURAL NETWORK

Back propagation is a supervised learning method. In supervised learning, each input vector needs a corresponding target vector. Input vector and target vector are presented in training of the network. The output vector which is result of the network is compared with the target output vector then an error signal is generated by the network. A Back propagation network, as shown graphically is a fully connected, layered, feed forward neural network. Activation of the network flows in one direction only: from the input layer through the hidden layer, then on to the output layer. Back propagation network typically starts out with a random set of connection weights. The network adjusts its weights based on some learning rules. After extensive training, the network will eventually establish the input-output relationships through the adjusted weights on the network.

Algorithm stages for BPN:
1. Initialization of weights
2. Feed forward
3. Back propagation of Error
4. Updation of weights and biases [5, 6].

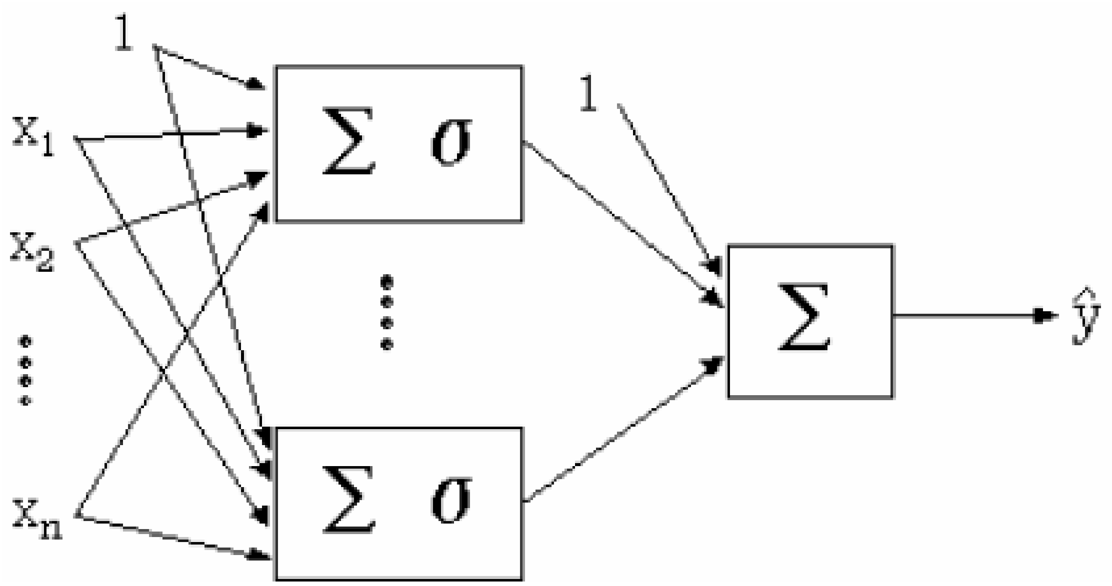

Fig 4 Neural network Feed forward architecture

PROBABILISTIC NEURAL NETWORK

Probabilistic neural networks (PNN) are a kind of radial basis network suitable for classification problems and it is primarily a classifier since it can map any input pattern to a number of classifications. When an input is presented, the first layer computes distances from the input vector to the training input vectors and produces a vector whose elements indicate how close the input is to a training input. The second layer sums these contributions for each class of inputs to produce as its net output a vector of probabilities. Finally, a compete transfer function on the output of the second layer picks the maximum of these probabilities.

PROPOSED METHODOLOGY

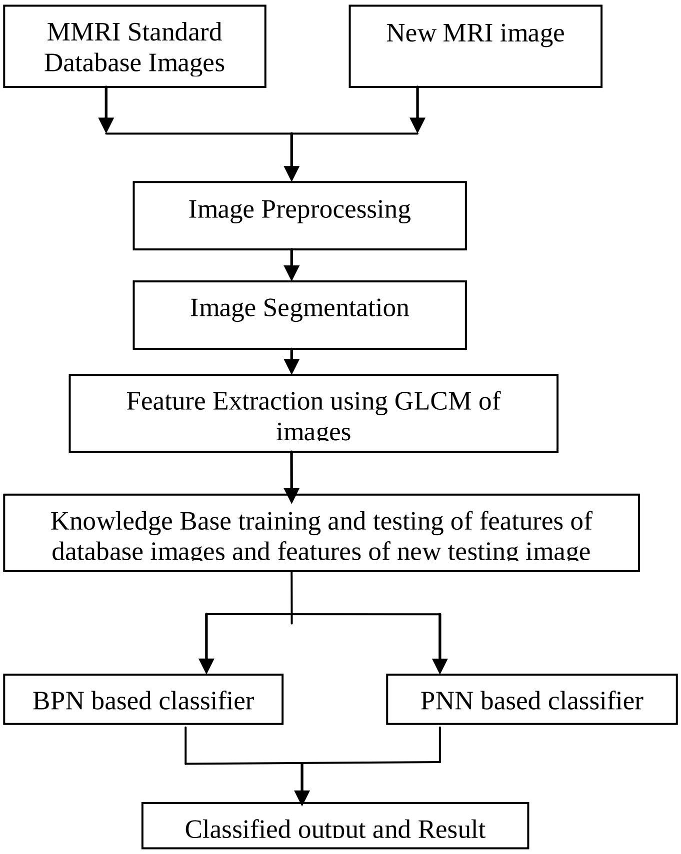

Fig 5 Block Diagram

The method used for MRI brain tumor image classification is shown in Fig 4. In this paper extracting the texture feature for unknown image sample and use neural network to detect the type of this image or the type of brain tumor using a neural network and the approach applied for different MRI images. We propose a brain cancer classification method based on Gray level co occurrence matrix (GLCM) with a neural network to recognize a certain class.

The necessary points are allocated below:

- Image segmentation using image processing techniques perform for the input image.
- Texture Features extraction using GLCM Matrix in different Direction (i.e. at 0º, 45º, 90º and 135º).
- Train a neural network on different image samples for certain class (i.e. gradeI, gradeII, gradeIII).
- Test unknown image sample by calculate the texture features by GLCM and used a neural network to detect and classify it.

Table-1 Feature Extraction

Type	ASM	Contrast	IDM	Dissimilarity	Energy	Prob	Inverse
I	36308	913912	-968.112	179.8284	15016	84	7.904327
I	33374	1134920	-828.227	126.6727	17276	60	15.30695
I	33592	573452	-1040.98	262.8594	10800	92	2.063042
I	33458	973078	-866.955	140.1292	15970	74	17.18983
II	4746	1649184	-71.5462	44.94372	25900	5	27.27822
II	4166	2062032	-24.9533	28.70642	27356	2	2.678552
II	4396	1518546	-59.9776	44.69275	23462	4	0.637291
II	4142	2411008	-24.6135	29.90878	30104	3	6.457354
III	7428	396898	-200.463	100.4595	11890	10	0.270408
III	6378	639234	-129.659	55.78458	15214	4	0.111111
III	6532	427344	-157.524	72.94151	12032	5	0.005917
III	6410	699280	-107.478	49.49004	16176	4	4.963653

The proposed system consists of two stages as below:

- Training Phase
- Testing Phase

A. First Stage

In Training Phase the ANN is trained for recognition of different types of brain cancer. The known MRI images are first processed through various image processing steps such as Histogram Equalization, Thresholding, and morphological operation etc. and then textural features are extracted using Gray Level Co-occurrence Matrix. The features extracted are used in the Knowledge Base which helps in successful classification of unknown Images. These features are normalized in the range -1 to 1 and given as an input to Back Propagation Neural Network (BPN) Based Classifier. In case of Probabilistic Neural Network these features are directly given as an input to PNN based classifier.

B. Second Stage

To test unknown MRI image sample and classify, two steps are performed, the first one is segmented the image and calculate the GLCM for each input MRI image. The obtained GLCM is used to extract features. The second step is train the above features with the desired values of neural networks to determine the MRI image belong to which grade of brain tumor. BPN and PNN artificial neural networks are used for classification.

EXPERIMENTAL RESULTS AND DISCUSSION

The proposed technique was implemented on MRI dataset. The algorithm described in this paper is developed and successfully trained in Matlab version R2013a using a combination of image processing and neural network toolbox. For evaluate the proposed algorithm we used the classification accuracy which is shown in table 2 and 3.The overall accuracy of the proposed system is 79.02% in case of BPN based classifier and 97.25% in case of PNN classifier.

Table-2 Classification accuracy results for BPN based classifier

Class	Test Image	Correctly Classified Image	Incorrectly Classified Image	Classification Accuracy
GradeI	14	11	3	78.57%
GradeII	13	10	3	76.92%
GradeIII	6	5	1	83.33%

Table-3 Classification accuracy results for PPN based classifier

Class	Test Image	Correctly Classified Image	Classification Accuracy
GradeI	14	14	100%
GradeII	13	12	92.3%
GradeIII	6	6	100%

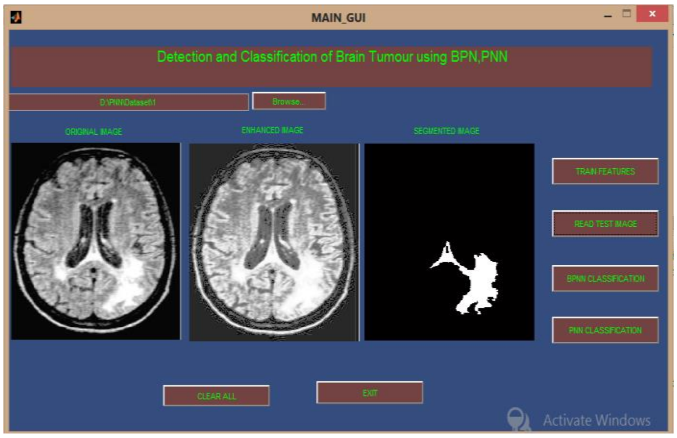

Fig 6: After Preprocessing and Segmentation of diseased brain MRI image

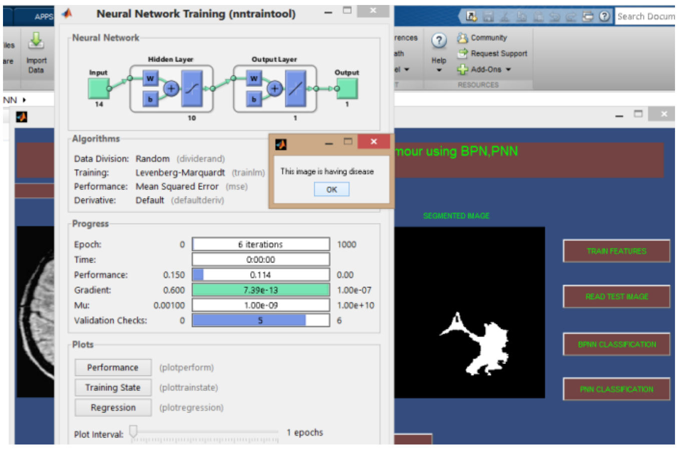

Fig 7: Training and Classification Using BPN

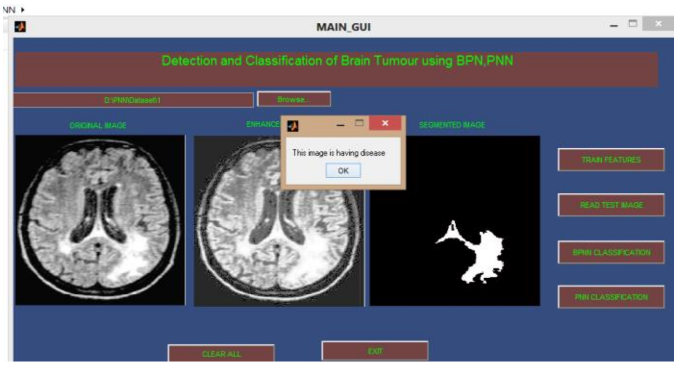

Fig 8: Classification based on PNN

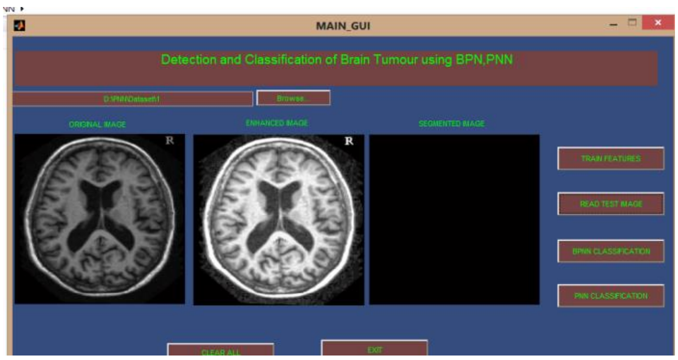

Fig 9: After preprocessing of normal brain MRI image

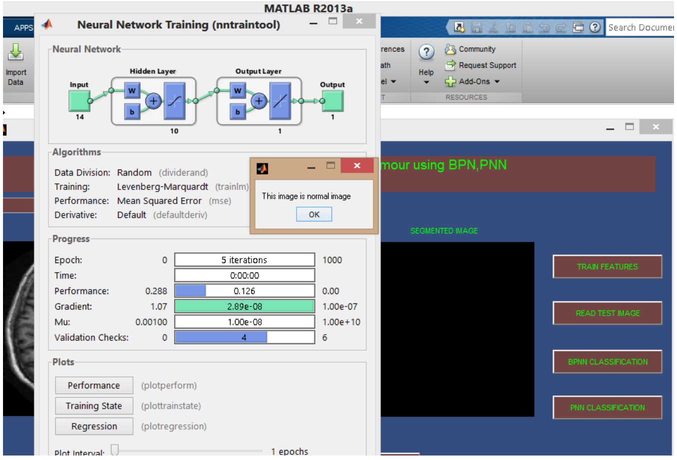

Fig 10 Training and Classification Using BPN

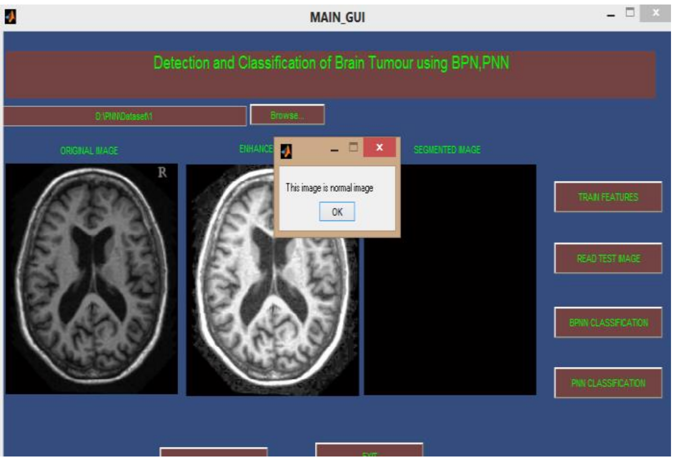

Fig 11 Classification based on PNN

CONCLUSION

This paper describes detection and classification of Brain Cancer using Artificial Neural Network approach namely, Back propagation network (BPNs) and Probabilistic neural network (PNN). The proposed system worked in two stages firstly Training and secondly Testing. The image processing tool such as histogram equalization, binarization, thresholding, morphological operation and region isolation are perform on Training. Texture features are used in the Training of the Artificial Neural Network. Co occurrence matrices at 0º, 45º, 90º and 135º are calculated and Gray Level Co-occurrence Matrix (GLCM) features are extracted from the matrices. The above process efficiently classifies the tumor types in brain MRI images. The system can be designed to classify other types of cancer. The further scope of the system is to improved ANN architecture by using other approach.

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