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Classification of brain tumours using artificial neural networks

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ABSTRACT
Magnetic Resonance (MR) brain Image is very important for medial analysis and diagnosis. These images are generally measured in radiology department to measure images of anatomy as well as the general physiological process of the human body. In this process magnetic resonance imaging measurement are used with a heavy magnetic field, its gradients along with radio waves to produce the pictures of human organs. MR brain image is also used to identify any blood clots or damaged blood veins in the brain. A counterfeit neural organization is a nonlinear information handling model that have been effectively used preparation models for tackling administered design acknowledgment assignments because of its capacity to sum up this present reality issues. Artificial Neural Networks (ANN) is used to classify the given MR brain image having Benign or malignant tumour in the brain. Benign tumours are generally not cancerous tumours. These are also not able to grow or spread in the human body. In very rare cases they may grow very slowly. Once it is eliminated, they do not come again. On the other hand, malignant tumours are cancer tumours. These tumour cells are grown and also easily spread to other parts of the human body. Benign also known as Harmless. These are not destructive. They either can't spread or develop, or they do as such leisurely. On the off chance that a specialist eliminates them, they don't by and large return. Premalignant In these growths, the cells are not yet harmful, however they can possibly become threatening. Malignant also known as threatening. Malignant growths are destructive. The cells can develop and spread to different pieces of the body. In our proposed framework initially, it distinguishes Wavelet Transform to separate the highlights from the picture. Subsequent to separating the highlights it incorporates tumour shape and power attributes just as surface highlights are distinguished. Finally, ANN to group the information highlights set into Benign or malignant tumour. The main purpose as well as the objective is to identifying the tumours weather it belongs to Benign or Malignant.

Section: RESEARCH PAPER

Keywords: Artificial neural networks; brain tumour; classification; magnetic resonance brain image; wavelet transform

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1. INTRODUCTION

If any person having a brain tumour, the doctor may recommend a number of tests and procedures to identify the tumour which are present in the brain or it may be spreads into any parts of the body. If the tumour has found in the brain the doctor takes the biopsy and collecting the sample tissue and conduct the examination. In certain situations, the person may be affected to paralysis of their body. In this situation before testing of biopsy Magnetic Resonance (MR) [1] brain images were taken to study whether the tumour may be benign tumour or malignant tumour. There are two different types of tumours mainly found in the MR brain image those are benign tumour and malignant tumour [2] [3]. The stages of the study for our proposed work are Magnetic Resonance Imaging (MRI), Feature extraction and Classification. In the following sub sections, we have described the benign and malignant tumours.

1.1. Benign Tumour

A tumour is an irregular improvement of cells that fills no need. A caring tumour is positively not a destructive tumour, which is harmful development. It doesn't assault near to tissue or spread to various bits of the body the way here harmful development can. Generally speaking, the stance with obliging tumours is superb. A harmless growth is certainly not a dangerous growth, which is disease. It doesn't attack close by tissue or spread to different pieces of the body the manner in which disease can. As a rule, the standpoint with harmless growths is excellent. Be that as it may, harmless growths can be not kidding assuming they push on fundamental designs like veins or nerves. Consequently, now and again they require treatment and different times they don't. In any case, liberal tumours can be dead serious if they push on fundamental structures, for instance, veins or nerves. Along these lines, at times they require treatment and various events they don't. The specific reason for a benign tumour is frequently obscure. It creates when cells in the body partition and develop at an exorbitant rate. Commonly, the body can adjust cell development and division. At the point when old or harmed cells pass on, they are consequently supplanted with new, sound cells. On account of tumours, dead cells remain and structure a development known as a tumour. Cancer cells fill in a similar way. Nonetheless, in contrast to the cells in amiable tumours, harmful cells can attack close by tissue and spread to different pieces of the body.

1.2. Malignant Tumour

Harmful tumours [4] are cancer-causing. They make when cells grow uncontrollably. In case the cells continue to create and spread, the contamination can get dangerous. Dangerous tumours can grow quickly and spread to various bits of the body in a cycle called metastasis. The malignancy cells that transition to different pieces of the body are equivalent to the first ones, yet they can attack different organs. In the event that cellular breakdown in the lung's spreads to the liver, for instance, the malignancy cells in the liver are still cellular breakdown in the lung's cells. Various sorts of malignant tumours start in various kinds of cell. The expression malignant demonstrates that there is moderate to high likelihood that the growth will spread past the site where it at first creates. These cells can spread by movement through the circulation system or by movement through lymph vessels

Malignant tumour demonstrates that there is moderate to high likelihood that the tumour will spread past the site where it at first creates. These cells can spread by movement through the circulation system. A harmful cerebrum tumour is a carcinogenic development in the brain. It's unique in relation to a kind mind tumour, which isn't malignant and will in general develop more slowly. Malignant mind tumours contain disease cells and frequently don't have clear lines. They are viewed as hazardous in light of the fact that they develop quickly and attack encompassing cerebrum tissue.

In the existing mechanism MR brain image were taken and biopsy test was conducted that is known as Follicular Dendritic Cell Tumour (FDCT) pathology test. FDCT test is performed for removal of noise and then extracted the features from that MR brain image. After extracting the features from the image then Support Vector Machine (SVM) classification algorithm is applied to classify the features and characteristics. But in the SVM the accuracy and speed of them is very slow. The results may not be clear and accurate. By understanding this problem, we are proposed a new classification algorithm called as Artificial Neural Networks (ANN). ANN is used to improve the accuracy of the classifier and classifier speed may be increased.

2. OUR PROPOSED METHODOLOGY AND ITS DISCUSSION

The proposed ANN extracts the features from the brain image and classifies the brain tumour into multiple images. There are three stages in our proposed methodology to observe whether the tumour is benign or Malignant they are:

a) Pre-Processing
b) Feature Extraction
c) Classification

2.1. Pre-Processing

In this headway the proposed framework utilizes the Median Filter. Middle Filter eliminates the turmoil from the MR cerebrum image. Noise on the image means undesirable data present in the MR brain image. Median Filter has very protective capacity and heftiness. It diminishes the Salt and Pepper noise in the MR brain image. It also reduces the blurring of an image by applying smoothing technique. The main observation of Median Filter is it replaces the current point in the image to median value of the brightness of nearby pixel i.e. supplanting each neighbour an incentive with the middle estimation of the pixel. Median Filter also eliminated the impulse noise. So, Median Filter is a suitable pre-processing method in our proposed method.

2.2. Feature Extraction

After pre-processing is completed the noiseless MR brain image was generated by applying the Median Filter technique then features are extracted from that image. Feature Extraction means, it is a process of identifying the set of features in an image. Features are obtained from Colour, Shape and Texture. Good Features are having produces the informative distinctive, Accuracy, Locality, Reliability, Quality, Robustness and Efficiency. All these are observing in the classification process. Still the Feature Extraction is quite challenging issue to identify the current features of an image. Many feature extraction techniques are available. In our proposed method we have used DB4 (Daubechies 4) wavelet transform for extracting the features like Standard Deviation, Minimum and Maximum value in wavelet transform. DB4 wavelet transform is used in our proposed method for extracting the features.

2.3. Classification

After extracting the features from the image by applying DB4 wavelet transform technique. The input feature extraction values are used for classification. In the real time many classification algorithms/techniques are available in the existing system they were used SVM [5] classification technique but the accuracy is not up to the mark. Processing also slow and will take a huge time. To overcome these problems, we are using Artificial Neural Network classifier for image classification in our proposed method. In this ANN, we use back propagation neural network. Neural Network classification is done by using multilayer perceptron algorithm. After applying all these algorithm/techniques we will set the output as benign or malignant tumour on the MR brain image.

3. DB4 WAVELET TRANSFORM

The Daubechies wavelet changes are described as the Haar wavelet change by enlisting midpoints and differences to

methods for scalar things with scaling signs and wavelets the single qualification between them involves in how these scaling signs and wavelets are portrayed. For the Daubechies wavelet [6] changes, the scaling signs and wavelets have somewhat longer backings, i.e., they produce midpoints and contrasts utilizing just a couple of more qualities from the sign. The Daubechies D4 change has four wavelet and scaling capacity co-efficient. The following formula shows the scaling capacity of the coefficient.

$$h_0 = \frac{1+\sqrt{3}}{4\sqrt{2}}, h_1 = \frac{3+\sqrt{3}}{4\sqrt{2}}, h_2 = \frac{3-\sqrt{3}}{4\sqrt{2}}, h_3 = \frac{1-\sqrt{3}}{4\sqrt{2}}. \quad (1)$$

Every movement of the wavelet change applies the scaling ability to the data input, if the main instructive assortment has *N* regards and the scaling limit will be applied in the wavelet change step to learn *N2* smoothed characteristics in the organized wavelet change and the smoothed characteristics are taken care of in the lower half of the *N* part input vector. This can be represented as follows.

$$\{g_0 = h_3; g_1 = -h_2; g_2 = h_1; g_3 = -h_0\} \quad (2)$$

The wavelet change applies the wavelet ability to the data if the primary instructive assortment has *N* regards. The main enlightening file has N regards and the wavelet limit will be applied to figure *N/2* differentiations. The scaling and wavelet limits are dictated by taking the internal consequence of the co-efficient and four data regards. The conditions are shown following formula.

$$\begin{aligned} a_i &= h_0\, s_{2i} - h_1\, s_{2i-1} - h_2\, s_{2i-2} - h_3\, s_{2i-3} \\ a[i] &= h_0\, s[2i] - h_1\, s[2i-1] - h_2\, s[2i-2] \\ &\quad - h_3\, s[2i-3] \end{aligned} \quad (3)$$

Daubechies D4 Wavelet function:

$$\begin{aligned} c_i &= g_0\, s_{2i} - g_1\, s_{2i-1} - g_2\, s_{2i-2} - g_3\, s_{2i-3} \\ c[i] &= g_0\, s\,[2i] - g_1\, s[2i-1] - g_2\, s[2i-2] \\ &\quad - g_3\, s[2i-3] \end{aligned} \quad (4)$$

Each iteration in the wavelet step calculates a scaling value and a wavelet function value.

4. ARTIFICIAL NEURAL NETWORK

A neural organization comprises of formal neurons which are associated so that every neuron yield further fills in as the contribution of for the most part more neurons correspondingly as the axon terminals of a natural neuron are associated by means of synaptic ties with dendrites of different neurons. The quantity of neurons and how they are interconnected decides the engineering of neural organization. Counterfeit neural organizations are one of the primary instruments utilized in artificial intelligence. As the neural a piece of their name recommends, they are cerebrum enlivened frameworks which are planned to reproduce the way that we people learn. Neural organizations comprise of information and yield layers, just as a concealed layer comprising of units that change the contribution to something that the yield layer can utilize. They are astounding instruments for seeing examples which are far as excessively mind boggling or various for a human software engineer to concentrate and show the machine to perceive.

The multi-layered neural organization is the most generally applied neural organization, which has been utilized in many explores up until this point. A back-engendering calculation can be utilized to prepare these multilayer feed-forward organizations with differentiable exchange capacities. It performs work estimate, design affiliation, and example arrangement. The term back proliferation alludes to the cycle by which subsidiaries of organization blunder, concerning network loads and inclinations, can be registered.

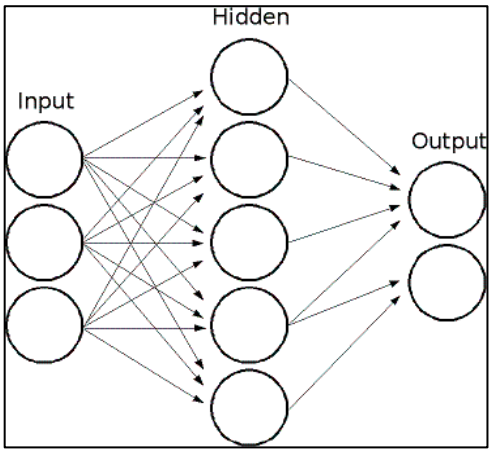

Figure 1. Artificial Neural Network.

The preparation of ANNs by back proliferation includes the following three phases:

(i) The feed forward of the info preparing design,
(ii) The estimation and back spread of the related mistake,
(iii) The change of the loads.

This cycle can be utilized with a number of different enhancement procedures. The following figure shows the Artificial Neural Network [7]-[10] procedure it contains the input data, hidden layer processing and then produces the output.

A neural network has at least three layers that are interconnected. The main layer comprises of information neurons. Those neurons send information on to the more profound layers, which thus will send the last yield information to the last yield layer. All the inward layers are covered up and are shaped by units which adaptively change the data got from layer to layer through a progression of changes. Each layer demonstrations both as an information and yield layer that permits the ANN to see more unpredictable items [11]-[15]. All things considered; these inward layers are known as the neural layer. Figure 1 depicts an Artificial Neural Network.

5. RESULTS

Based on our proposed method and as per the above discussions we took a series of benign and malignant Tumour images are as input MR images. A malignant tumour is a quickly developing malignancy that spreads to different zones of the cerebrum and spine. By and large, brain tumours are evaluated from one to four, as indicated by their conduct, for example, how quick they develop and that they are so prone to develop back after treatment. A malignant tumour is either grade three or four, though grade one or two tumours are generally classed as kind hearted or non-destructive. Most harmful tumours are an optional malignant growth, which implies they began in another piece of the body and spread to the cerebrum. Essential cerebrum tumours are those that begun in the mind. The Figure 2 shows the series of benign tumour images and Figure 3 shows the series of malignant tumour images which are considered as input images to our method.

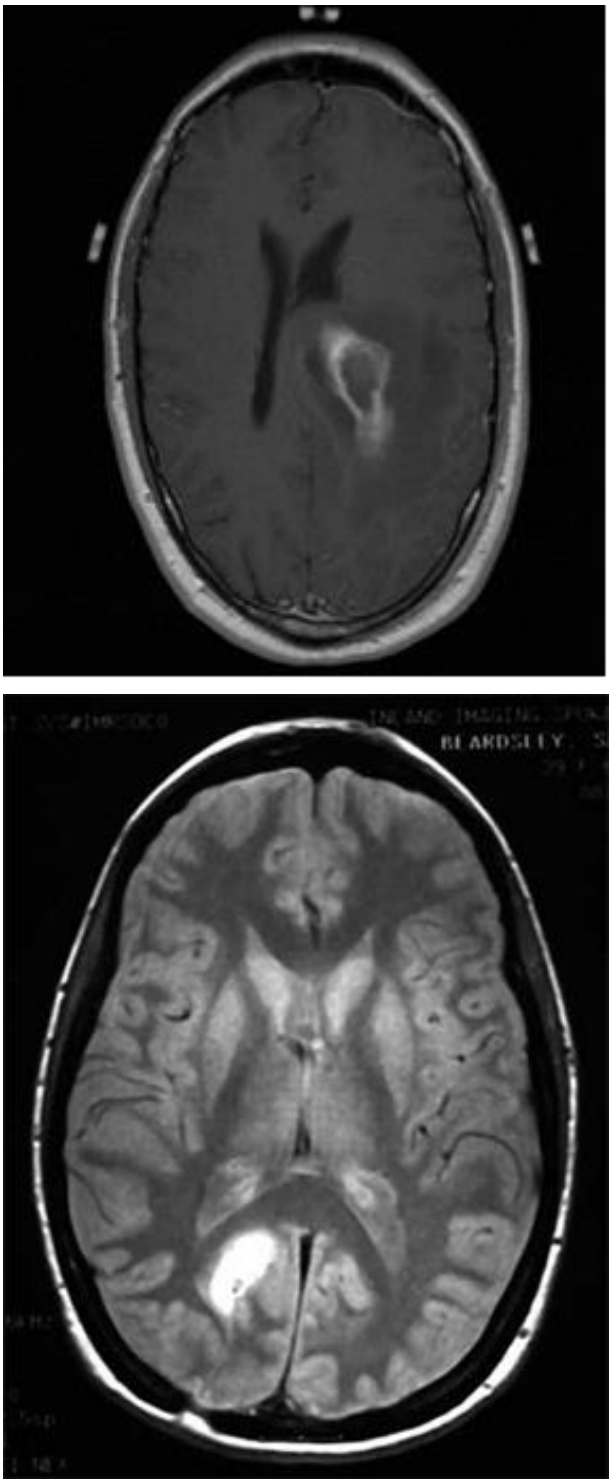

Figure 2. Series of benign tumours in brain MR images (Input images).

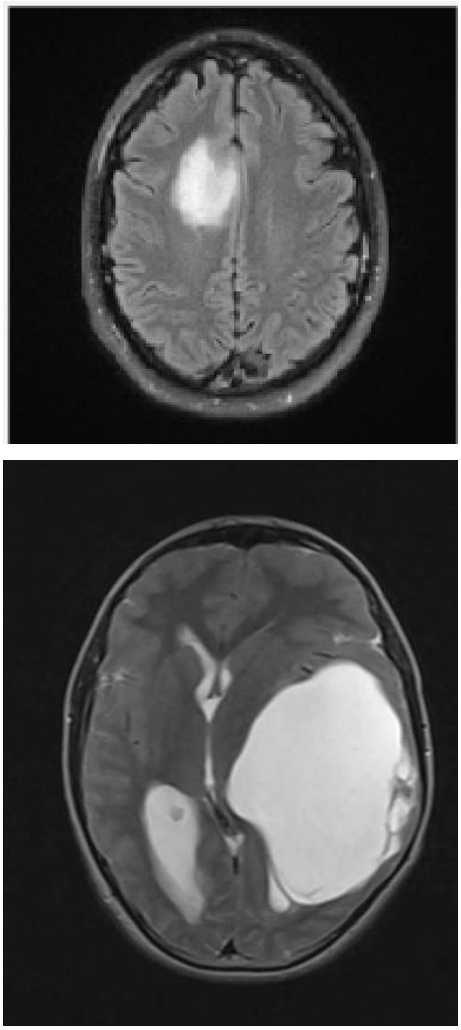

Figure 3. Series of malignant tumours in brain MR images (Input images).

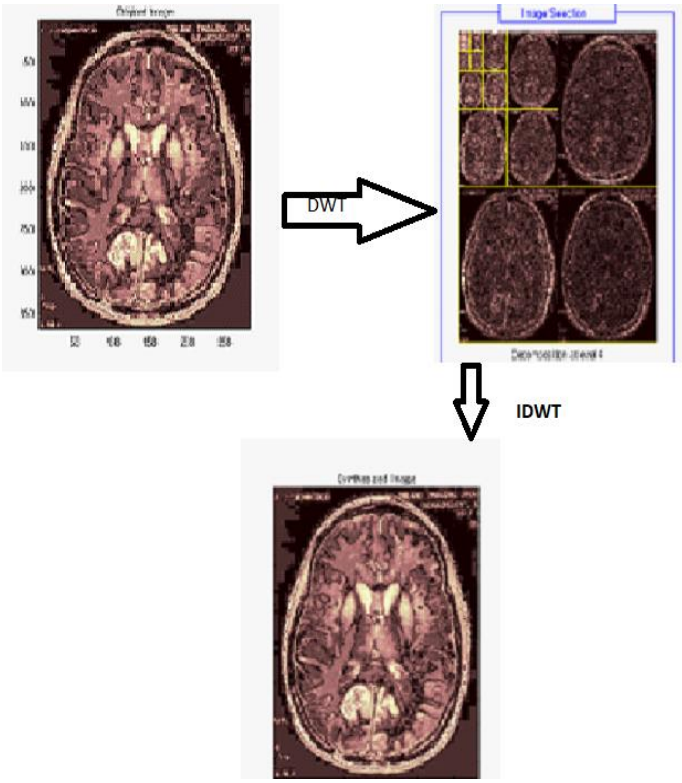

Figure 4. After applying DB4 wavelet transform.

After taking input MR image, we have applied our proposed Pre-processing method, Feature Extraction and Classification Techniques to find weather the resultant image having benign Tumour or malignant Tumour. Initially we have taken the original Gray Scale image in the pre-processing method. Gray scale image is converted into Binary image after then cleaned the binary image by applying smoothing technique. Noise was reduced by applying the pre-processing method. Subsequent to pre-processing to identify the features in the MR image, we are using DB4 wavelet transform method to identify the features and also extracted the feature in the given image. Here salt and

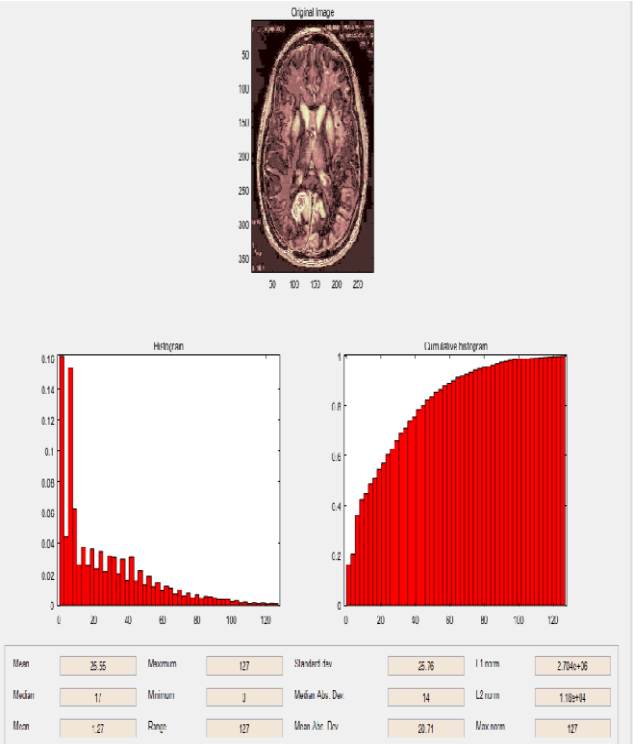

Figure 5. Histogram representation.

Table 1. Stratified non-validation.

S. no	Summary	Validation	% of validation
1	Correctly classified instances	15	75
2	Incorrectly classified instances	5	25
3	Kappa statistic	0.5	-
4	Mean absolute error	0.3299	-
5	Root mean square error	0.5034	-
6	Relative absolute error	65.9703%	-
7	Root relative squared error	100.6852%	-
8	Total number of Instances	20	-

pepper noise also reduced in this technique. After identifying the features, finally proposed classification technique like ANN was applied and observes the parameters Standard Deviation, Maximum Value and Minimum Value to classify image either benign or malignant.

Figure 4 shows the pre-processing working procedure and Extracting the Feature by using DB4 wavelet transform. It shows how the original Grayscale input image is converted into a Binary image and then the cleaned binary image after then applying the DB4 wavelet transform.

The histogram representation is shown in Figure 5. It shows the highest and lowest pixel values of a binary image and it also shows the parameter values of Standard Deviation, Maximum Value and Minimum Value.

Table 3. Confusion Matrix.

a	*b*	← Classified as
8	2	*a = M*
3	7	*b = B*

Table 1 represents the stratified non-validation. Table 2 represents Detailed Accuracy by class. Confusion Matrix is shown in Table 3 which represents the classification of given input images that produce the benign or malignant tumour output by applying ANNs [16], [17]. The event of cerebrum tumours in India is consistently rising. An ever-increasing number of instances of cerebrum tumours are accounted for every year in our country among individuals of changed age gatherings. Brain tumours were positioned as the tenth most basic sort of tumour among Indians. There are more than 32,000 instances of brain tumours announced in India every year and in excess of 28,000 individuals purportedly pass on because of cerebrum tumours yearly. A Brain tumour is a genuine condition and can be deadly if not identified early and treated. In the results we have disclosed the category of tumour that is either Benign or malignant tumour using our methodology so that we can predict the type of cancer in advance.

Table 4 shows the Distinctive features of a DB4 wavelet transform like Standard deviation, Minimum and Maximum values of a series of MR images. Based on these values the system easily classifies benign tumour or malignant tumour.

6. CONCLUSION

Our proposed method is utilized for identifying e tumour from the given MR mind pictures and grouping whether it is benign (normal) tumour or malignant (cancer causing) tumour at the beginning stage. In the new patterns this framework/method assumes a significant job to distinguish the Brain Cancer in the beginning at very early stage which diminishes the death rate. The degree of things to come improvement in this endeavour is that we would connect data be able to base so colossal number of pictures can be used in distinguishing the threatening development. We can improve its exactness by utilizing various calculations of Counterfeit neural organizations like convolution neural organizations, uphold vector machine and others. This Computer Aided Classification System of our method takes any MR cerebrum filter picture, examinations it, and gives the yield as disease tainted mind if the sweep picture contains harmful tumour or probably gives yield as the cerebrum is malignant growth free if the output picture contains survival rate to some extent favourable tumour. As a whole we have succeeded in identify the tumour used in the given input MR images. We have successfully deployed our proposed methodology and able to classify the tumour weather it is a benign or malignant using Artificial Neural Network. This methodology truly supports the patients as well as doctors to identify the tumour in a little bit advance which might save the lives.

Table 2. Detailed Accuracy by class.

TP Rate	FP Rate	Presidion	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
0.800	0.300	0.727	0.800	0.762	0.503	0.700	0.735	M
0.700	0.200	0.728	0.700	0.737	0.503	0.700	0.724	B
0.750	0.250	0.753	0.750	0.749	0.503	0.700	0.729	← Weighted AVS

Table 4. Distinctive features of a set of Images.

Sl. No	1	2	3	4	5	6	7	8	9
Max 1H	210.2	77.36	131.1	206.8	137.1	110.6	93.98	120.9	129.4
Min 1H	-55.6	-96.15	-151.6	-161.9	-141.78	-118.3	-120.2	-141.7	-105.9
SD1H	11.5	9.657	14.8	16.03	14.11	9.67	9..657	14.21	11.69
Max 1V	169.9	76.33	115.4	218.5	131.9	79.18	94.74	132.6	114.5
Min 1V	-239.4	-57.54	-115.6	-242.8	-126.9	-99.18	-99.68	-178	-110.7
SD1V	11.21	9.009	10.81	19.18	13.05	8.814	11.09	21.6	14.59
Max 1D	112.8	24.22	54.88	110.9	52.09	53.31	44.47	68.54	36.22
Min 1D	-0.597	-25.92	-48.83	-93.87	-56.78	-73.87	-42.41	-79.63	-47.09
SD1D	4.803	2.709	4.8148	7.208	5.539	4.262	4.145	6.334	4.186
Max 2H	369.1	315.3	218.6	324.5	356.6	250.3	257.3	417.5	302.6
Min 2H	-354.8	-240.6	-216.1	-465.8	-375.3	-446.5	-195.4	-284.2	-251.3
SD2H	38.02	37.87	39.66	47.23	51.1	30.99	29.67	43.83	41
Max 2V	342.6	306.4	218.4	367.2	344	184.3	243.4	384.1	296.3
Min 2V	-275.2	-244.6	-299.8	-390	-315.6	-187.9	-238.3	-313	-214.6
SD2V	46.6	35.39	35.95	53.32	47.48	30.15	33.09	63.09	54.28
Max 2D	100.9	107.3	90.2	173.6	188.7	157.2	135.2	177.7	242.2
Min 2D	-122.4	-126.5	-144.3	-190.6	-199.6	-117.8	-126.6	-167.7	-162.9
Sd2D	16.55	14.9	19.01	25.31	23.67	17.62	17.75	27.46	33.58
Max3	1066	1132	1107	1118	1114	1117	1128	1014	1082
Min3	-28.66	-122.7	-91.2	8.373	-121.3	-105.9	-114.6	-148.6	-112.3
SDB	255.3	245.2	282.6	217.7	203.4	171.3	212.2	248.3	254
E	97.83	97.86	96.73	95.92	93.16	96.23	98.63	9418	96.33
Image?	M	M	M	M	M	B	B	B	B

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