Artificial Neural Network based Brain Cancer Analysis and Classification

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ABSTRACT
A Brain Cancer is very serious disease causing deaths of many individuals. The detection and classification system must be available so that it can be diagnosed at early stages. Cancer classification has been one of the most challenging tasks in clinical diagnosis. At present cancer classification is done mainly by looking through the cells' morphological differences, which do not always give a clear distinction of cancer subtypes. Unfortunately, this may have a significant impact on the final outcome of whether a patient could be cured effectively or not. This paper deals with such a system which uses computer based procedures to detect tumor blocks and classify the type of tumor using Artificial Neural Network Algorithm for MRI images of different patients. Different image processing techniques such as histogram equalization, image segmentation, image enhancement, morphological operations and feature extraction are used for detection of the brain tumor in the MRI images of the cancer affected patients.

Keywords
Artificial Neural Network, Brain cancer, Detection technique for cancer, Magnetic Resonance Image.

1. INTRODUCTION
Imaging is an essential tool of medical science to visualize the anatomical structures of the human body [1, 2]. Several new complex medical imaging techniques, such as X-ray, magnetic resonance imaging (MRI), and ultrasound, strongly depend on computer technology to generate or display digital images. MRI is especially true to classify brain tissues whether it is the cancerous or not. A tumor is a mass of tissue that grows out of control of the normal forces that regulates growth [3]. Manual classification of magnetic resonance (MR) brain tumor images is a challenging and time-consuming task [4]. The most important advantage of MR imaging is that it is non-invasive technique. Presently available systems can only detect location and size of tumor but do not provide any knowledge about the type of tumor. Many cancer forms can only be diagnosed after a sample of suspicious tissue has been removed and tested. Pathologists view pathologic tissues, typically with brig field microscopes, to determine the degree of normalcy versus disease. This process is time consuming, and fatiguing. It is very necessary to diagnose the patients properly and exactly. The algorithm must be divided into various stages and accordingly the algorithm has to train also. The cancer diagnosis must be fully automatic with zero error is essential as it directly related with human being. The diagnosis criteria are subdivided into four stages and they are as shown in Figure 1. With computer techniques, multidimensional digital images of physiological structures can be processed and manipulated to help visualize hidden diagnostic features that are otherwise difficult or impossible to identify using planar imaging methods. The use of computer technology in medical decision support is now widespread across a wide range of medical area, such as cancer research, heart diseases, brain tumors etc.

Different body parts MRI image needs different type of segmentation. The most common class of methods is statistical classification using multi-parameter images [5]. These methods are highly intensity based and hence the accuracy is very low. Warfield et al. [6] combined elastic atlas registration with statistical classification. Marcel Prastawa [7] used a modified spatial atlas for classification which includes prior probabilities for tumor and edema. Another group of researchers highly depend on computational intelligence for MR brain tumor classification which guarantees high accuracy. Zumray et.al [8] elaborates the inferior results of multilayer perceptron for the biomedical image classification problem. The Self Organizing Feature Map (SOFM) ANN based algorithms [9] shows excellent results in the classification of brain tumor images. Hopfield neural networks (HNN) [10] prove to be efficient for unsupervised pattern classification of medical images, particularly in the detection of abnormal tissues.

If Artificial Neural Network and Graphical User Interface successfully completed and used in the system, it will be very easy to detect and classify the tumor. Brain Cancer Detection and Classification System use conceptually simple Classification method using the Nero Fuzzy logic. Texture features are also can be used in the Training of the Artificial Neural Network.

2. METHODOLOGY
The work carried out involves processing of MRI images of brain cancer affected patients from the local CANCER Research Hospital, for detection and Classification on different types of brain tumors. The image processing techniques like histogram equalization, image segmentation, image enhancement and then extracting the features for Detection of tumor. Extracted feature are stored in the knowledge base of ANN. A suitable Nero Fuzzy classifier is developed to recognize the different types of brain cancers. The system is designed to be user friendly by creating proper Graphical User Interface (GUI).

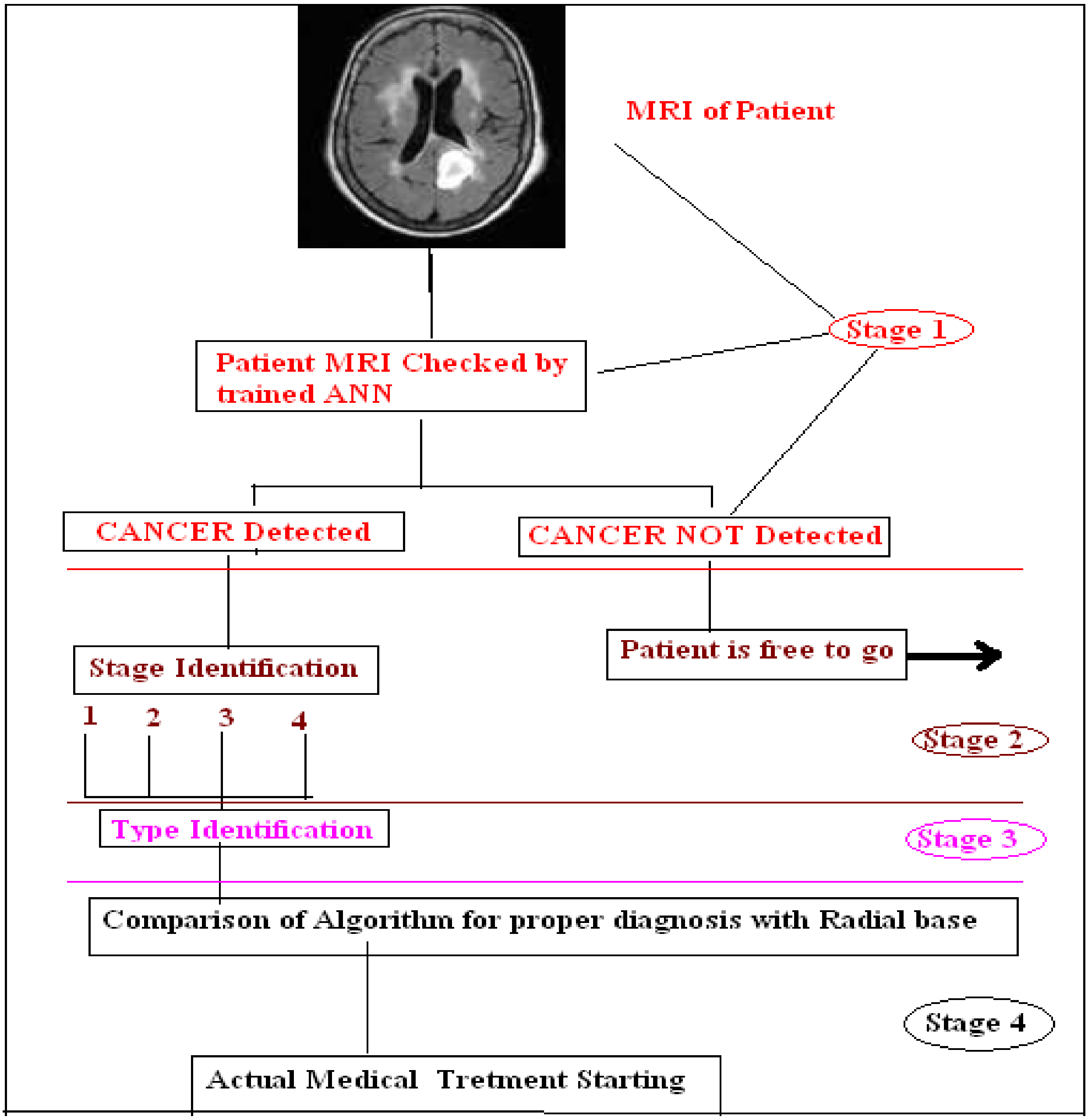

Fig 1: Stages for ANN algorithm to train

2.1 Sample data collection

The data of around 38 patients is collected from local CANCER Research Centre and the MRI images are scanned and processed by various methods.

3. ALGORITHMS USED FOR STAGE

The stage 1 identifies the patient is affected by cancerous growth of tumor or not by checking the MRI images of patient. The algorithm used to check whether the patient is having cancer or not is designed by pre-data available at the research center. Assuming 4 patients to train the Algorithm we have designed the following algorithm.

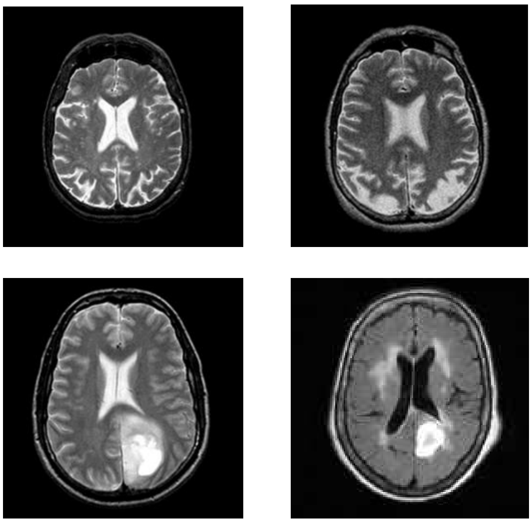

Fig 2: Sample MRI images of patients

```
No. of inputs=4;
   I= [ ];
   For j=1:no_inputs
          Path= ['train\'num2str (j)'.jpg']
          im= imread(path);
          im= rgb2gray(im);
          [a h v d ]= dwt 2(im, 'haar');
          [aa h v d ]= dwt 2(a, 'haar');
          m = mean (aa, 2);
          n = size (aa, 2);
          A = [ ];
          For ii = 1:n
                         Temp = double (aa(:, ii) )- m;
                         A = [A temp];
                   end
                   L= A'*A;
                   [Vec D]= eig(L);
                   L_eig_vec = Vec(: , end);
                   Eigenfaces = A * L_eig_vec;
                   I (: , j) = Eigenfaces;
          End
          Figure;
          Subplot (2,2,1)
          Plot (I(:, 1))
          Subplot (2,2,2)
          Plot (I(:, 2))
          Subplot (2,2,3)
          Plot (I(:, 3))
          Subplot (2,2,4)
          Plot (I(:, 4))
```

4. TRAINING & TESTING PHASE OF ANN

ANN always works on Training Phase and Testing Phase. In Training Phase the ANN is trained for recognition of different types of brain cancer. The known MRI images of cancer affected patients are first processed through various image processing steps and then textural features are extracted using Gray Level Co-occurrence Matrix. The features extracted are used in the Knowledge Base for algorithm which helps in successful classification of unknown Images. The extracted features are compared with the features of Unknown sample Image for classification. Texture features or more precisely, Gray Level Co- occurrence Matrix (GLCM) features are used to distinguish between normal and abnormal brain tumors. Five co-occurrence matrices are constructed in four spatial orientations horizontal, right diagonal, vertical and left diagonal (0, 45, 90, and 135) [4, 2]. A fifth matrix is constructed as the mean of the preceding four matrices. The extracted features are shown in table 1.

Table 1: Extracted Features

ASM	Contrast	Entropy	IDM	Dissim ilarity	I/P 1	I/P 2
1.08E+05	3.17E+05	-1616.4	2.35E-07	8435	0	0
1.92E+05	7.80E+05	-2442.6	6.44E-07	9267	0	0
3.57E+05	6088E+05	-3641.8	3.60E-07	7886	0	1
3.09E+05	8.15E+05	-3227.9	2.79E-07	8979	0	1
2.65E+05	1.48E+06	-2990.9	5.00E-06	23152	1	0
2.79E+05	7.56E+05	-3053.5	5.11E-07	9071	1	0
5.15E+05	2.49E+05	-4649.5	2.00E-07	2400	1	1
4.32E+05	4.98E+05	-4139.9	3.56E-07	5227	1	1

ANN'S are networks are usually having nodes. The input of a specific node is the weighted sum of the output of all the nodes to which it is connected. The output value of a node is, a non-linear function of its input provided. The multiplying weighing factor between the input node j and the output node i is called the weight w_{ji}. ANN is a system whose parameters are changed during operation, normally during Training phase. After the training phase the Artificial Neural Network parameters are fixed and then testing phase is done. Presentation of output of the neural network is compared to the desired output and an error is computed [11, 12]. This error is then fed back as feedback input) to the Artificial Neural Network and used to adjust the weights such that the error must be decreased at each iteration and the neural model gets closer and closer to producing the desired output. This process is known as Training.

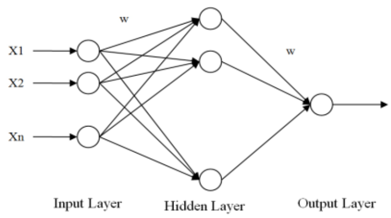

Fig 3: The architecture of used ANN

The Training of these networks consists in finding a mapping between a set of input values and a set of output values. The mapping is adjusting the value of the weights w_{ji}; using a learning algorithm, the most popular of which is the generalized delta rule [5]. After the weights are adjusted on the training set, their value is fixed and the ANN's are used to classify unknown input images.

$$\mathrm{Ep} = \frac{1}{2}\sum_{j} (t_{pj} - o_{pj})^2$$

Where,

p - One input vector
t_p - target output vector
o_p - observed output vectors

5. RESULT

The developed software efficiently classifies the input MRI image of Brain Cancer affected patients into a Grade of Astrocytoma type of Tumor. The MRI images of patients affected by Brain Cancer are used during Recognition/Testing phase. ANN system can be train and tested by providing various sample data (MRI images of patients) and a rigid system is under developing phase for the actual use. The classification, identification and type of tumor can also be done with the help of same ANN system. The test results are in agreement with the opinion of the Doctors and provide a confirmation test for cancer detection.

6. CONCLUSION

The system has been tested only with the above sample images. The system can be designed to classify other types of cancers as well with few modifications. The scope of the system can further be improved by using other types (e.g. PET, MRS, CTS) of Images. It is essential to use large number of patient's data which will improve the accuracy of the system. More features that could be added to the system include metabolic and genetic data as well as anatomical attributes of the brain.

7. REFERENCES

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