Classification of Medical Content Based Image Retrieval(MCBIR) using Feed Forward Neural Network

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Abstract: This paper presents research work related to Content Based Image Retrieval with focus on medical images. This is an extension to search based on text query wherein images are applied as text query. This works extends to image based query. This study handles the problem related to the difficulty of handling high level image content from low level image features. Retrieval method based on relevance feedback require human interaction.

The proposed approach uses fusion of texture and shape features. Texture features used were mean, variance, standard deviation, contrast, energy etc. whereas shape features used are area, perimeter, circularity, aspect ratio etc. Euclidean and Manhattan distance were used to extract relevant images from database. Successively artificial neural network was applied for image classification. The proposed approach with composite features was experimentally compared with existing approach on data set of 250 images and was found effective and superior for medical classification. The classification accuracy is calculated based on data set. The classification accuracy is reach to 100% for every category of medical image.

Keywords: ***Medical Content Based Image Retrieval (MCBIR), texture and shape feature, neural network, classification.***

I. INTRODUCTION

Various category of medical images are endoscopy, Magnetic Resonance Imaging (MRI), X-ray, Computed Tomography (CT) scan, Position Emission Tomography(PET) scan are developed in various medical center as well as in various health centers [2]. A huge volume of medical images are daily generated in medical centers by several equipment such as CT, MR, X-ray, among others. CBIR refers to techniques that retrieve images based on their content, as opposed to based on metadata.

MCBIR helps to retrieve the images from the databases. Medical images are purpose to highly different and collected of variety in structures[4]. So there is a require for feature calculation, similarity calculation and categorization of images for simple and proficient retrieval. Hence, the classification of medical images into different imaging category is necessary **to do** proper retrieval. A successful categorization and indexing of images based on category, body part, orientation, etc. will greatly imporves the performance of CBIR systems by filtering out the images of irrelevant classes and reducing the search space. So, image classification is an important stage in a CBIR system.

To do classification on retrieval result various algorithm like Naïve Bayes classifier, Support Vector machine, Decision Tree, Neural Network based classifier have been used. To do classification on retrieval result classification algorithms Artificial Neural Network (ANN) give good result compare to others. Neural Network classifiers have been finding extensive use in the areas of image classification according to imaging modalities, body part, normal and abnormal[1]

II. CLASSIFICATION ALGORITHM (NEURAL NETWORK)

Artificial neural network models have been studied for many years in the hope of achieving human-like performance in several fields such as image understanding.

An input layer, a hidden layer and an output layer are three layer in the the architecture of the neural network. The number of elements existing in one transaction in the database is equal to the no of nodes in the input layer. While the output layer was consisting of one node.

The classification for the image into the different classes gives the node for the output layer. It classifies images as relevant or not relevant classes. For each training transaction the neural network receives in addition the expected output. In the training phase, the internal weights of the neural network are adjusted according to the transactions used in the learning process. This permits the changes of the weights. In the next step, to classify the new images we have to trained neural network.[v]

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The main architectures of artificial neural networks, considering the neuron disposition, as well as how they are interconnected and how its layers are composed, can be divided as follows: (i) single-layer feed forward network, (ii) multilayer feed forward networks

2.1. MULTIPLE-LAYER FEED FORWARD ARCHITECTURE

Differently from the first network feed forward networks with multiple layers are composed of one or more hidden neural layers (Fig. 1). They are created in the solution of classification problems, like those related to function estimate, pattern classification, system identification, process control, optimization, robotics, and lot many etc..

Figure 1 shows a feed forward network with multiple layers created of one input layer with n sample signals, two hidden neural layers consisting of n neurons respectively, and one output neural layer created of m neurons representing the respective output values of the problem being analyzed.

Among the main networks using multiple-layer feed forward architectures are the Multi layer Perceptron (MLP) and the Radial Basis Function (RBF), whose learning algorithms used in their training processes are respectively based on the useful delta rule and the competitive/delta rule. From Fig. 1, it is possible to understand that the volume of neurons created with the first hidden layer is generally different from the number of signals composing the input layer of the network. In fact, the number of hidden layers and their amount of neurons depend on the nature and complexity of the problem being mapped by the network, as well as the quantity and quality of the available data about the problem. Nonetheless, likewise for simple-layer feed forward networks, the amount of output signals will always coincide with the number of neurons from that respective layer.They are highly accurate predictive models which can be applied for large range of problems.[i]

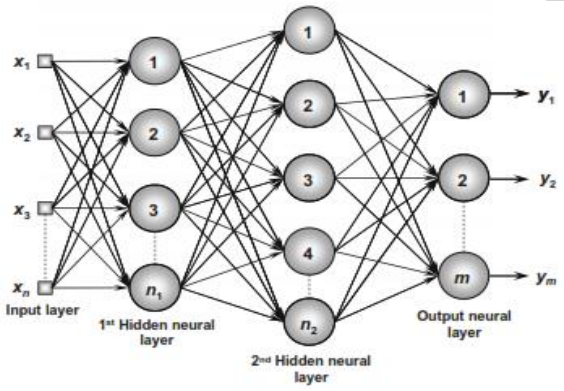

Fig. no.1 Feed forward network with multiple layers

Based on the type of Neural networks can be classified as feed forward and feedback models. In this study we concentrate on feed forward networks with supervised learning. For the study Gaussian Fuzzy Feed Forward Neural Network architecture is given below.

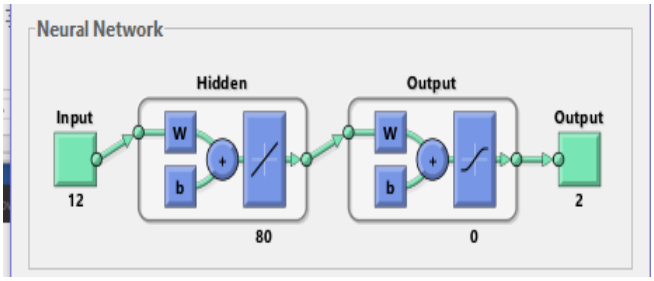

Fig.no. 2 Feed forward network with multiple layers

2.2 NEURAL NETWORK PARAMETER

Learning Rate

Data type is Real value in between 0 to1 and typical value is 0.3

Meaning of Learning Rate. It is a parameter of tranning that handle the size of load and bias variations in learning with different training algorithm.[ii]

Momentum

Data type is Real value in between 0 to1 and typical value is 0.9

Meaning of Momentum simply update to the current one with increases a portion m of the earlier weight. It is a parameter that used to check the system that meeting to a local minimum. The higher value of this parameter can support to more the speediness of meeting for system. When this parameter value is more increase then generate a hazard of overshooting the least, which the system to turn into unbalanced. When this parameter value is low cannot reliable to reduce local minima, and can slowly reduce the training of the system.

Training type

Data type is Integer value in between 0 to1 and typical value is 1

Meaning of traning type with 0 and 1 and 0 = train by epoch, 1 = train by minimum error

Epoch

Data type is Integer value in between 1 to ∞ and typical value is 5000000

When training by minimum error, this represents the maximum number of iterations. Meaning of Epoch is determines when training will stop once the number of iterations exceeds epochs.

Minimum Error

Data type is Real value in between 0 to 0.5 and typical value is 0.01

Meaning of Square root of the sum of squared differences between the network targets and actual outputs divided by number of patterns. Minimum mean square error of the epoch.

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Transfer function

The transfer function of a neuron is chosen to have a number of properties which either enhance or simplify the network containing the neuron. Crucially, for instance, any multilayer perceptron using a *linear* transfer function has an equivalent single-layer network. A non-linear function is therefore necessary to gain the advantages of a multi-layer network.

Step function

The output *y* of this transfer function is binary, depending on whether the input meets a specified threshold, *θ*. The "signal" is sent, i.e. the output is set to one, if the activation meets the threshold. This function is used in perceptrons and often shows up in many other models. It performs a division of the space of inputs by a hyperplane. It is specially useful in the last layer of a network intended to perform binary classification of the inputs. It can be approximated from other sigmoidal functions by assigning large values to the weights.[vi]

Linear combination

In this case, the output unit is simply the weighted sum of its inputs plus a *bias* term. A number of such linear neurons perform a linear transformation of the input vector. This is usually more useful in the first layers of a network. A number of analysis tools exist based on linear models, such as harmonic analysis, and they can all be used in neural networks with this linear neuron. The bias term allows us to make affine transformations to the data.

Sigmoid

A fairly simple non-linear function, the sigmoid function such as the logistic function also has an easily calculated derivative, which can be important when calculating the weight updates in the network. It thus makes the network more easily manipulable mathematically, and was attractive to early computer scientists who needed to minimize the computational load of their simulations. It was previously commonly seen in multilayer perceptrons. However, recent work has shown sigmoid neurons to be less effective than rectified linear neurons.[6]

Based on the type of Neural networks can be classified as feed forward and feedback models. In this study we concentrate on feed forward networks with supervised learning. For the study Gaussian Fuzzy Feed Forward Neural Network architecture is given below.[iii]

In the neural network has input it is the feature vector of images. Based on feature the network is trained and tested with given number of samples and try to get the best output with classified the image into the two classes. To the best output the transfer function is change in neural network with Gaussian fuzzy function in the layer. The first classification divide into relevant and no relevant classes. Then again the neural network is train with relevant images feature vector and test again with number of samples and get the best output with classified image into the two classes like normal and abnormal images.

III. CLASSIFICATION PARAMETER

The confusion matrix can be used to determine the performance of the system. This matrix describes all possible outcomes of a prediction results in table structure. The possible outcomes of a two class prediction be represented as True positive (TP), True negative (TN), False Positive (FP) and False Negative (FN). The normal and abnormal images are correctly classified as True Positive and True Negative respectively. A False Positive is when the outcome is incorrectly classified as positive when it is a negative. False Positive is the False alarm in the classification process. A false negative is when the outcome is incorrectly predicted as negative when it should have been in fact positive.[5]

In our system consider,

TP= Number of Abnormal images correctly classified

TN= Number of Normal images correctly classified

FP= Number of Normal images classified as Abnormal

FN= Number of Abnormal images classified as Normal.

- Accuracy: The fraction of test results those are correct.

(TN+TP)/FP+TN+FN+TP

IV. CLASSIFICATION ACCURACY FOR NEURAL NETWORK

Based on the type of Neural networks can be classified as feed forward and feedback models. In this study we concentrate on feed forward networks with supervised learning. For the study Gaussian Fuzzy Feed Forward Neural Network architecture is given below that show in fig no.3

Input Neuron	300
Output Neuron	2
Number of hidden layer	80
Number of processing elements	98
Transfer function of hidden layer	Fuzzy Gaussian
Step size	0.1
Momentum	0.7
Maximum Epoch	1000

In the neural network has input it is the feature vector of images. Based on feature the network is trained and tested with given number of samples and try to get the best output with classified the image into the no of classes. To the best output the transfer function is change in neural network

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with Gaussian fuzzy function in the layer. The first classification divide into 7 different classes. This classification can help easy to manage the image with database so searching can be done faster. Due to this classification database is arrange as per the category of image and retrieval can done faster. This 7 multi class classification done with texture, shape and composite features.

In the neural network has input it is the feature vector of images. Based on feature the network is trained and tested with given number of samples and try to get the best output with classified the image into the two classes. To the best output the transfer function is change in neural network with Gaussian fuzzy function in the layer. The first classification divide into relevant and no relevant classes. Then again the neural network is train with relevant images feature vector and test again with number of samples and get the best output with classified image into the two classes like normal and abnormal images.

This neural network architecture is tested with texture, shape and composite features and generate the confusion matrix. The architecture with composite feature show in the fig no.4. The classification result we get from confusion matrix. Based on confusion matrix we can calculate the classification accuracy. In the table no 1 give classification accuracy with composite features.

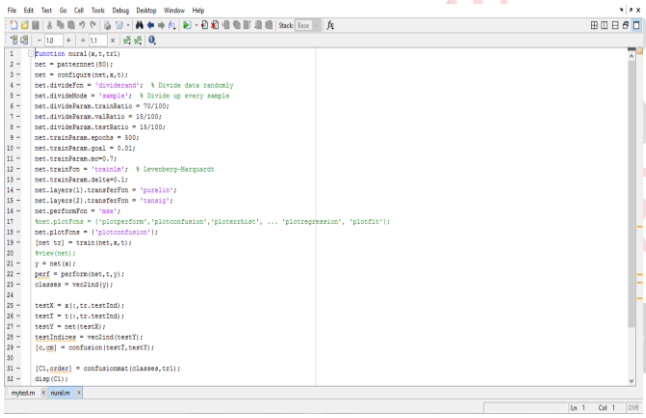
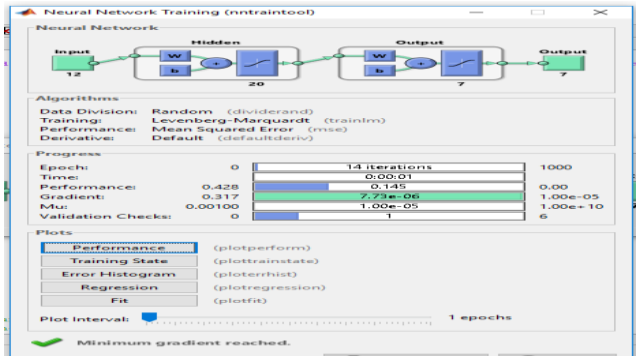


Fig. no. 3. Architecture of neural network for MCBIR



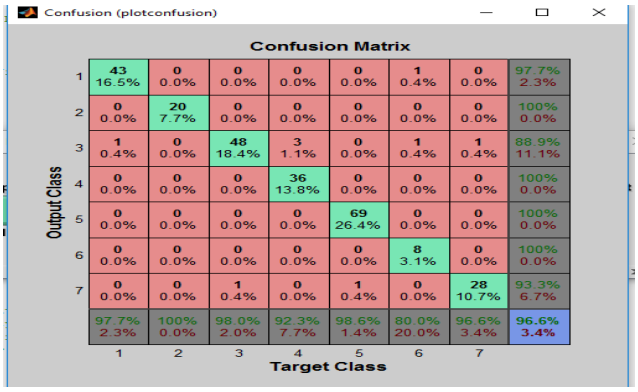


Fig. no.4. Multi class classification result with composite features for all types image of MCBIR

Composite=Texture+Shape Feature	Accuracy with Euclidian Dist	Accuracy with Manhattan Dist
Hand	100%	100%
Heart	100%	100%
Shoulder	100%	100%
BrainMri	100%	100%
Spine	100%	100%
Chest	100%	100%
BrainCT	100%	100%

Table no 1: Classification Accuracy with composite Feature

V. RESULT

In this paper, we have proposed a novel algorithm for the medical CBIR and classification. We have named our system with medical CBIR with neural network classification. We considered medical images with 6 category, more number of features and different distance formula in our work. Our algorithm used texture and shape features with combination for the retrieval result and classification accuracy.

The main advantage of our system that with the help of composite(texture and shape) feature precision and recall we get nearer to 100% and classification with neural network with composite feature give 100% accuracy.

In the research work the classification accuracy also we get more 100% for the composite feature that shown in fig.5. In that case when the no of image are increased in database then retrieval accuracy and classification accuracy is not decrease.

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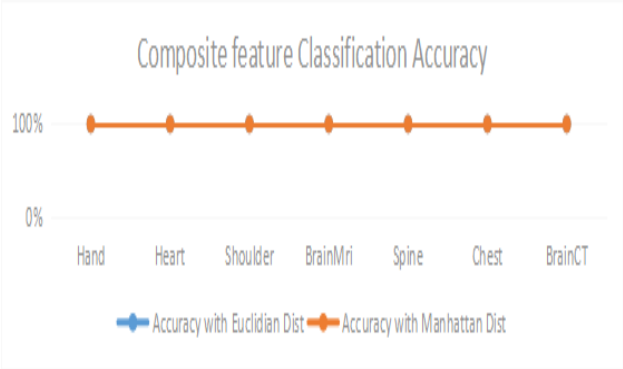

Fig. no. 5 Classification accuracy with Composite Feature

VI. CONCLUSIONS

This research work has cover information on the CBIR useful in medical area, the popular of the MCBIR systems have emerged as up gradation of the CBIR systems. The purpose of medical image databases is to give an effective resource for managing, penetrating, and indexing with higher collected of medical images.

Medical content based retrieval is a talented method to get retrieval and has generated a various methods using texture and shape feature. CBIR approach provides semantic retrieval and effective feature extraction with precise techniques of shape and texture. The overall performance of neural network algorithms in this research work was analyzed based on the classification accuracy.

The primary aim of work is maximum retrieval with classification in MCBIR. The research work give the maximum retrieval if number of images are higher as per the category. So texture and shape both composite feature are helpful to retrieve the maximum for all the category of image. The neural network give the maximum classification accuracy for medical retrieval image.

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