

FUZZY BASED CT SCAN BRAIN IMAGE CLASSIFICATION

Monali Y. Khachane

YashwantraoChavan School of Rural Development ShivajiUniversity,Kolhapur monalikhachane@gmail.com

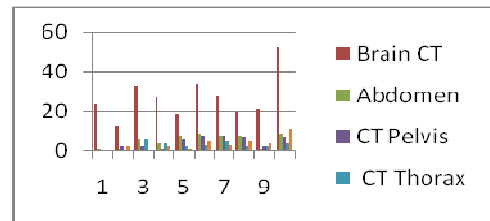
Abstract- In this paper a novel fuzzy rule based CT scan image classification system is proposed. Principle intends to propose this framework is to minimize rate of false detection. Mean and standard deviation of the image is utilized to planned the proposed framework and arrange the images into normal and abnormal. Proposed methodology is contrasted and twofold classifiers k-NN (k=1, 3, 5, 7) and SVM (linear, quadratic, rbf, mlp).The exploratory outcomes demonstrate that the proposed framework is effectively minimized the rate of false positive. The characterization exactness of k-NN is 94% where k=1. SVM (quadratic) and SVM (rbf) demonstrates 88% grouping rate. Classification rate for proposed framework is 89% and for improved methodology 92 % with less number of false detection pictures.

Keyword--CT(Computed Tomography);k-NN(k-Nearest Neighbor);SVM(Support Vector Machine)

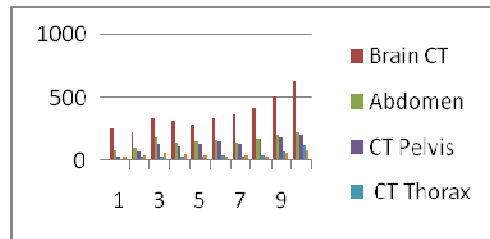
I. INTRODUCTION

Computed Tomography produce cross sectional pictures of body parts utilizing X-Rays. From most recent three decades there is continues expansion in CT imaging for more accurate and proper diagnosis. Presently all aspects of body is imagined through CT examination. CT help radiologist to arranged appropriate treatment. In [1] demonstrates the rate of development in CT imaging for the five most regularly performed adults and pediatric examinations as indicated in Figure1. CT exam information demonstrates the rate of brain imaging is all the more when contrasted with different examinations and expanding consistently in both cases. Brain CT outputs are needed to recognize head injuries, strokes, cerebrum tumors and other brain disorders. Vast quantities of images are produced for a patient CT scan. Radiologist investigates every one of these image to determine certain sort of irregularity is available inside of these cuts or not. Examination of such huge information is extremely tedious assignment and required consistency. In this paper researcher described rule based system to make contrast in the normal and abnormal cuts with the goal that radiographers can focuses on the unusual cases. The proposed exploration work is compared with supervised learning approaches SVM and k-NN. This exertion is not for mechanized determination reason but rather for giving help to the radiographers. So that their workload can be decreased and they can make more appropriate determination.

Whatever is left of the paper is composed as takes after. In Section II thorough review of literature is conducted and finding is noted. In Section III researcher mentioned the utilized exploration technique. Results and Discussion are in area IV and Section V contains conclusion of examination work.



(a)



(b)

Fig. 1 Number of CT examinations per year for the five most commonly performed

(a) adult examination (b) paediatric examination

State of the Art

Distinctive classifiers used for Medical image classification are looked into. For this exploration we investigated the literature and ordered the literature on the basis of characterization method utilized for classification. The majority of the researcher favored SVM and k-NN classifiers for their examination. Few of them utilized fuzzy based frameworks and FCM however these strategies utilized for division.

SVM based Classification

In literature SVM classifier is used for MRI brain image classification [2-7]. H. Selvarajet. al [2]used Least Squares

Support Vector Machines (LS-SVM) and obtained 98% accuracy when compared with other classifiers like k-NN, MLP, SVM (linear), SVM(RBF). Rajeswari. S. et. al. [3] extracted texture features using GLCM and Sequential Forward selection algorithm is used to select the discriminate features. 65% accuracy is achieved for their proposed framework. Rajalakshmi et. al [4] used hybrid clustering segmentation and wrapper based features selection. Multi-class support vector machine (SVM) is used to classify images into normal, benign and malignant gives 92% accuracy. A. Jayachandran et. al [5] used Fuzzy Support Vector Machine (FSVM) classifier. They used anisotropic filter for noise reduction and extracted texture features which are reduced by using PCA and Supervisor classifier based FSVM has been used to classify images as normal and abnormal. Experiment is conducted on 80 real T1 weighted MRI images shows classification accuracy 95.8%. Daljit Singh et. al [6] extracted features with GLCM gives 100% accuracy with SVM -RBF kernel function for MRI images and 91.6% for natural images. R. Guruvasukiet. al [7] proposed the system which uses multiple image queries for finding desired images from the database. They preprocessed image using median filter and extract texture features using GLCM and shape features from image. SVM classifier is used to classify the image into normal, benign and malignant.

k-NN based Classification

Literature [8-11] utilized k-NN classifier for CT or MRI image classification. El-Sayed A. El-Dahshan et. al [8] proposed two different MRI image classification techniques. DWT is used for feature extraction and PCA for feature reduction. Achieved classification accuracy with feed forward back-propagation artificial neural network (FP-ANN) is 95.6% and with k-NN classifier it is 98.6%. P. A. Charde et. al [9] extracted edge based shape features and texture features using Gabor filter. With k-NN classifier 96.3% rate is achieved where $k=11$ for CT brain images. Sahar Jafarpour et. al [10] classified T2 MRI images by extracting GLCM texture features. Classifiers used for their research are ANN and k-NN both gives 100% accuracy. R. J. Rmateket. al. [11] achieved 80% accuracy for texture feature based CT brain image classification for k-NN classifier. Their results are compared with SVM (linear) and SVM (rbf) classifiers.

Fuzzy rule based and clustering based classification

The researchers [12-16] used fuzzy based systems or FCM for their research work. R. Arunet. al [12] classified brain tumor into metastases, meningioma, glioma and astrocytoma Tentative. Hybrid classification technique using Fuzzy logic and Neural Network is proposed. They extracted min, max, and mean gray values from MRI brain tissue images and forwarded these features to classifiers. 93.3% rate is achieved. V. Joseph Peter et. al [13] presented liver fibrosis image segmentation and classification. They used Markov Random Field, Genetic Algorithm with modified k means and fuzzy c means, and Back Propagation Neural network. Their experimental results show that GA with fuzzy c means algorithm performs better than the other existing methods. Karmakar, Gour C et. al. [14] conducted a survey of various fuzzy rule based techniques for segmentation. The author

concluded that the most difficult task of fuzzy image segmentation is to determine the shape and parameters of the membership functions. Earlier research shows that fuzzy rule based image segmentation techniques seem promising but they are very much application specific and very difficult to define and select fuzzy rules that cover all voxels/pixels. Jayashri Joshi et. al [15] presented a statistical structure analysis based tumor segmentation scheme, which focuses on the structural analysis on both tumorous and normal tissues. Author designed the approach to investigate the differences of texture features among macroscopic lesion white matter (LWM), normal appearing white matter (NAWM) in magnetic resonance images (MRI) from patients with tumor and normal white matter (NWM) using ANN and FCM for classification. The accuracy achieved for six test images is more than 97%. Sivaramakrishnan et. al. [16] proposed the method for efficient detection of brain tumor region from cerebral image using Fuzzy C-means clustering and histogram. The histogram equalization calculates the intensity values of the gray level images and decomposition of image are extracted using principal component analysis is used to reduce dimensions of the wavelet co-efficient. FCM is used to segment suspicious tumor region.

Earlier research shows that many of the researcher used SVM and k-NN for classification purpose. Fuzzy systems and FCM is used for image segmentation. Binary classifiers classify the data into one of the defined class and it increased false positive rate. The power of fuzzy is that it allows the data to belong into more than one class. Hence, we decided to design the fuzzy system so that the number of false detected images reduced. We compared the proposed system with SVM with different kernels (linear, rbf, quadratic, mlp), k-NN with $k=1,3,5,7$.

Material and Data

The real data is gathered from the radiology centers from Jalgaon and utilized for this exploration work. 100 brain axial cuts are chosen for the analysis from which 50 are normal and 50 are abnormal slices. 50% data is utilized for training and half for testing. Fig 2 shows the sample data used for experiment.

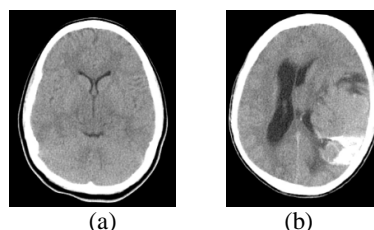


Fig. 2 CT image (a) Normal Brain slice (b) Abnormal brain slice

CT scan machines utilized x-ray source for representation of diverse tissues of brain. The blood and bone seem white in light of the fact that blood and bone assimilate x-ray at a high rate. Air and water seem dark. Brain tissue seems gray. The abnormalities like fresh blood, blood clots like tumor seem brighter than brain tissues.

Feature extraction is one of the essential stages in image analysis. These components are utilized to order the information into normal and abnormal. For this examination we extracted just two statistical features mean and standard

deviation of picture. The mean and standard deviation formulas as indicated in eq. 1 and eq.2 resply.

$$Mean(m) = \frac{1}{N^2} \sum_{i,j=1}^N p(i,j) \tag{1}$$

$$StandardDeviation(Std) = \sqrt{\frac{1}{N^2} \sum_{i,j=1}^N [p(i,j) - m]^2} \tag{2}$$

The accuracy and error rate for the proposed system is calculated by eq. 3 and eq. 4

$$Accuracy \% = \frac{TP+TN}{N} \times 100 \tag{3}$$

$$error \% = \frac{FP+FN}{TP+TN+FP+FN} \times 100 \tag{4}$$

Where

N –Total Number of images (positive and negative)

True Positive, (TP) - Sick people diagnosed as correctly sick.

False Positive, (FP) - Healthy people erroneouslydiagnosed as sick.

True Negative, (TN)-Healthy people correctly diagnosed as healthy.

False Negative, (FN)-Sick people erroneouslydiagnosed as healthy [11].

Research Methodology

Training is carried out to design Fuzzy based CT image classification framework as indicated in Fig 2. In preprocessing stage image is converted into grayscale. Other preprocessing strategies like noise removal and image enhancement is not connected on images. In Feature Extraction stage mean and standard deviation elements are extracted from images and put away into feature database. In Third stage design of rule based framework this feature database is utilized to design membership functions and rules for image classification.

Two I/P variables mean and std and one output variable class is designed. For mean and std variable four trapezoidal membership functions namely low, Med, Med1, high are designed. The range of these variables is [0 100].For output variable class two triangular functions Norare (Normal) and Abn (Abnormal) designed. Rule base is heart of fuzzy rule based systems.

8 different rules are designed for classifications are as follows.

1. If (Mean is low) and (std is med) then (Class is Abn) (1)
2. If (Mean is Med) and (std is med) then (Class is Abn) (1)
3. If (Mean is high) and (std is med1) then (Class is Abn) (1)
4. If (Mean is high) and (std is high) then (Class is Abn) (1)
5. If (Mean is Med) and (std is low) then (Class is Nor) (1)
6. If (Mean is Med1) and (std is med) then (Class is Nor) (1)
7. If (Mean is Med) and (std is med1) then (Class is Nor) (1)
8. If (Mean is Med) and (std is med) then (Class is Nor) (1)

In testing phase query image is converted into grayscale image. Features mean and std are extracted from query image and these features are passed to the Fuzzy based CT image classification system as input. Mean and Std input is fuzzified using the designed membership functions and rules are applied on this fuzzified data and class of image is decided.

Results and Discussion

Analysis is completed to assess the execution of the supervised classifiers and proposed rule base framework on 100 Brain CT pictures. The processing of abnormal brain image Fig 2(b) is explained here for proposed system. The image is converted into grayscale and feature are extracted (Feature = [70.7129 89.0556]).These features are fuzzified by the proposed system and rules are applied on the data([Mean is high and Std is med1 then class is Abn]). The class for the image is decided (Class=0(Abnormal)). The SVM classifier is applied on the same set of test data using different kernel (linear, quadratic, rbf, mlp) and k-NN with different k values k=1,3,5,7. Table 1 shows the comparison of the results obtained by applying SVM, k-NN and proposed system.k-NN and SVM are twofold classifiers. Both classifiers characterize the information into any one class from given classes. While,Fuzzy theory based framework permit the picture to stay unclassified.

For k=1; 25 typical pictures are named normal. But 22 out of 25 are sorted as abnormal and 03 are classified as normal. Classification rate for k-NN where k=1 is 94% with error rate 6%.For k=3, 5, 7; 25 normal images are delegated normal and 20 images out of 25 are named abnormal 05 images are named normal. Characterization precision for k-NN where k=3, 5, 7 is 90% and error rate is 10%.For SVM with linear kernel 23 out of 25 are classified as normal 02 classified as abnormal.19 out of 25 are classified as abnormal and 06 are classified as normal. The classification rate for SVM (linear) is 84% and error rate is 16%. For SVM (quadratic) and SVM (rbf) 25 normal images are classified as normal but 19 out of 25 abnormal are classified as abnormal and 06 wrongly classified as normal. Classification rate for SVM (quadratic) and SVM (rbf) is 88% whereas the error rate is 12%. The classification rate for SVM (mlp) is 82% and error rate is 18%. 23 images classified as normal 02 wrongly classified as abnormal.18 abnormal images are correctly classified and 07 are wrongly classified as normal.

Whereas in case of proposed system 24 images out of 25 are correctly classified as normal and 01 image remained unclassified which is a not false positive or false negative.20 image correctly recognized abnormal 05 wrongly recognized as normal. The classification accuracy is 88% and error rate is 10%.

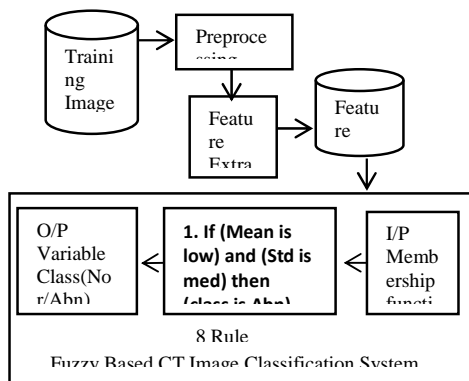


Fig. 3 Training Phase

TABLE I. COMPARISON OF SUPERVISED CLASSIFIERS WITH PROPOSED SYSTEM

Classifier			Normal	Abnormal	Unclassified	Accuracy %	Error rate %
k-NN	K = 1	Normal	25	00		94	6
		Abnormal	03	22			
	K = 3	Normal	25	00		90	10
		Abnormal	05	20			
	K = 5	Normal	25	00		90	10
		Abnormal	05	20			
	K = 7	Normal	25	00		90	10
		Abnormal	05	20			
SVM	linear	Normal	23	02		84	16
		Abnormal	06	19			
	quadratic	Normal	25	00		88	12
		Abnormal	06	19			
	rbf	Normal	25	00		88	12
		Abnormal	06	19			
	mlp	Normal	23	02		82	18
		Abnormal	07	18			
Fuzzy Rule Based System	Proposed System	Normal	24	00	01	88	10
		Abnormal	05	20			

CONCLUSION

This paper presents a novel fuzzy based CT image classification system. One of the most important limitation of binary classifiers is these classifiers classify the data into one of two defined classes; because of this the false detection rate is increased. Fuzzy based systems allow the data to belong two classes with certain degree. This mechanism is used to minimize the false detection rate. The proposed system is compared with k-NN and SVM classifiers. The classification

rate of k-NN classifier is 94% for k=1 and 90% for k=3,5,7. Classification accuracy achieved for SVM(linear) is 84% and 88% for SVM(quadratic) and SVM(rbf).For SVM(mlp) accuracy is 82%.For proposed system the classification rate is 88%.Though proposed fuzzy systems are allowed to remain the images unclassified and minimizing the risk of wrong diagnosis still high accuracy with less or 0% of false detection is needed. In future the work will carried out to increase the Accuracy and minimizing false detection.

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