GLCM – SVM based Classification of Brain MRI with K-Means Clusters

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Abstract: In this proposed method, MR Brain image segmentation technique based on K-means clustering combined with Discrete Wavelet Transform (DWT) based feature extraction and Gray Level Co-Occurrence Matrix (GLCM) based feature selection approach has been presented. A Perfect Radial Basis Function (RBF) - Support Vector Machine (SVM) Classifier has been selected for this process. The Performance of the classifier was estimated through accuracy based on the fractions selectivity and sensitivity. Accuracy of the proposed classifier was found to be 93%. Moreover, in this proposed method, instead of selecting the cluster centres in a random manner, Histogram technique was used.

Keywords: Centroid selection, Discrete Wavelet Transform (DWT), GLCM feature selection, Histon formation, K-means clustering, RBF-SVM Classifier.

I INTRODUCTION

Tapas Kanungo *et al*. (2002**)** analyzed and implemented the clustering techniques with K-Means for pattern recognition to reduce the distance from the data point to its closest center [1]. Jing- Hao Xue *et al*.(2003**)** proposed an integrated method for unsupervised segmentation of Magnetic Resonance brain images. In that method the image was de-noised by using the wavelet filter and segmented with minimum error [2]. Laszlo Szilagyi *et al*. (2011) explained briefly the combined c- means clustering for the compensation of Intensity Inhomogeneity[3]. Kuntimad *et al*. (1999) Presented a perfect image segmentation with pulse coupled neural networks [4]. Jussi Tohka *et al*.(2010) implemented a noval method for the classification of tissues in Magnetic Resonance brain images [5]. Li-Hong Juang and Ming-Ni Wu (2010) introduced tumor objects tracking method for MR Brain images with K-Means clustering [6].

Dongxiang Chi (2011) explained about the SOM-K and SOM- KS segmentation techniques and it is observed that both the methods can achieve better segmentation results with less computational time [7]. In the proposed method k-means clustering approach has been selected due to its low computational complexity.

II PROPOSED METHODOLOGY

In this proposed technique, the input MR Brain image is pre- processed by using median filter, with the help of histogram based Centre initialization algorithm three clusters are formed to extract the Region Of Interest (ROI).

Then three level DWT technique is used to extract the features in terms of its eigen values and eigen vectors, the Gray Level Co-Occurrence Matrix (GLCM) method is used for its dimensionality reduction and to select the salient features. These selected features are given to Supervised Radial Basis Function - SVM classifier as inputs to identify the given input as either normal or abnormal. The following flowchart (Fig.1) presents the proceeding steps for this work.

III CLUSTERING TECHNIQUES

A. Initialization of centroids**:**

A Histogram is a powerful technique used with image enhancement and segmentation. It is a graphical representation of the intensity values of pixels in an image. There may be 256 different intensity levels with 8-bit grayscale image and the Histogram of that image gives the details about the distribution of the intensity range of 256 pixels. In this proposed method, the concept of median filtering is used for noise removal by smoothing the intensity variation between a pixel and its nearby. The Histon is constructed as follows, Thamaraichelvi B *et al*.(2015) [8].
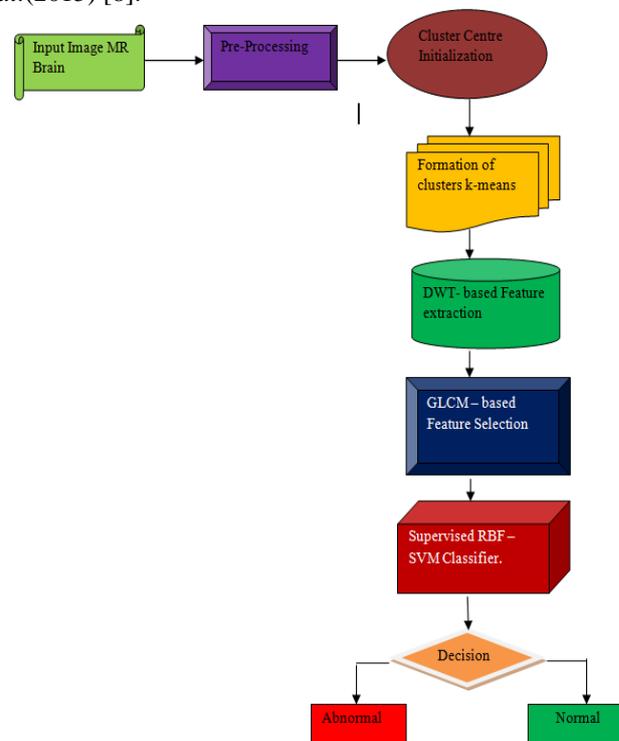

Fig. 1.   Schematic diagram for the proposed method

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$$H(t) = \sum_{m=1}^{M'} \sum_{n=1}^{N'} (1 + A(m,n))\delta(I'(m,n) - t), \quad 0 \le t \le S - 1$$

$$J_{k-means} = \sum_{r=1}^{R} \sum_{i=1}^{S} \left\| s_i - C_r \right\|^2 \quad (2)$$

Where, '$\delta(.)$' is the impulse function and 'S' represents the intensity levels.

B. K-means cluster:

K-Means clustering is the simplest method with minimum computational complexity. It is an unsupervised method used for bio-medical image segmentation process when the number of clusters is well known Radha *et al.* (2011) [9]. It is also called as partitioning algorithm. The Objective Function is given by,

Where 's_i' represents data points and 'C_r' means cluster centre, with these concepts, this technique has been considered for this analysis.

C. K-Means Clustering Algorithm

1. Cluster centres must be initialized.
2. The data points are divided into a 'k' number of clusters and also randomly assigned to the clusters.
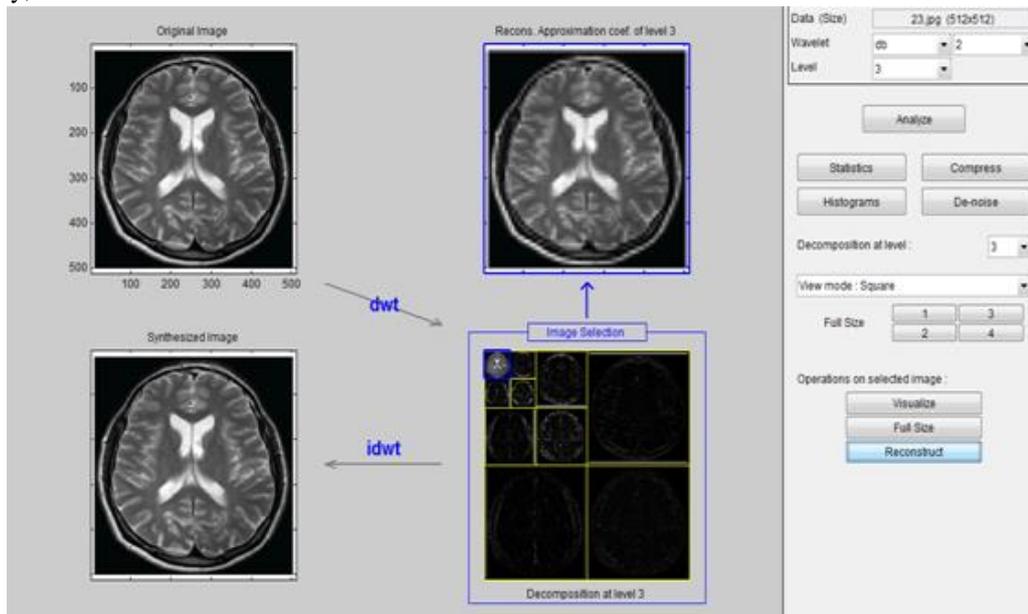
Fig. 2. A Common Method to find 3 Level DWT Decomposition

3. The Euclidean distance from the data point to the mean of each cluster was calculated for all clusters.
4. The data points are allocated to the closest cluster.
5. The process continued till all the data points are allocated to the nearest cluster.

IV FEATURE EXTRACTION AND SELECTION

S.Chaplot *et al.* (2006) explained that in Fourier transform an image has been represented by its frequency contents, but in Wavelet transform an image has been decomposed into different frequency levels with spatially localized [10]. Doubechesis-2 Wavelet in level 3 is selected for this work and the image is of size 512x512 and 1mm thickness each. Fig. 2. shows the 3 level decomposition of the original image.

The Wavelet decomposition technique uses the sub-band LL for the next level. Totally, 4096 coefficients have been extracted from the LL sub-band with the help of db-2 Wavelet tool.

The features are then selected through GLCM method which is a statistical approach used to select the second order textural features. Mohanaiah *et al.* (2013)

explained about this method mainly used to identify the spatial relationship between a pixel with its immediate neighbouring having a distance 'd' in the direction 'θ' [11]. According to Haralick *et al.* (1973) the features that can be extracted through GLCM are entropy, correlation, energy, contrast, Mean, Standard -deviation, Variance etc., The selected features are then given to the classifier [12].

V RESULT AND DISCUSSION

The selected image is of size "512x512" and thickness "1" mm in each. The images are preprocessed with the help of median filter. A kernel of size '3x3' has been preferred and applied over the entire image to collect the details about the neighbour-hood pixels. Three intensity levels are created for the brain tissues like GM, WM, CSF respectively. The accuracy of the segmentation along with classification was evaluated based on the terms TP,TN,FP,FN. The following figure depicts the outcome of the application of k-means clustering. Fig. 3(i) shows the real input images, fig. 3(ii) gives the outcome of median filtering process and fig. 3(iii)

clearly represents the output of k-means clustering for normal brain images. Table 1. gives the quantitative evaluation of the proposed clustering technique and Table 2. represents the result of glcm based feature selection method for normal brain images. Fig. 4(i) shows the real input images, fig. 4(ii) gives the outcome of median filtering process and fig. 4(iii) clearly represents the outcome of the preferred clustering for abnormal images. Table 3. gives the evaluation of the selected clustering technique for abnormal MR images. Table 4. represents the result of glcm based feature selection method for abnormal brain images. Totally 40 normal cases and 50 abnormal cases were analysed. The outcome of the preferred RBF- SVM classifier was analysed from the Table 5 and it can detect 47 abnormal and 36 normal cases correctly by giving an accuracy of around 93%.
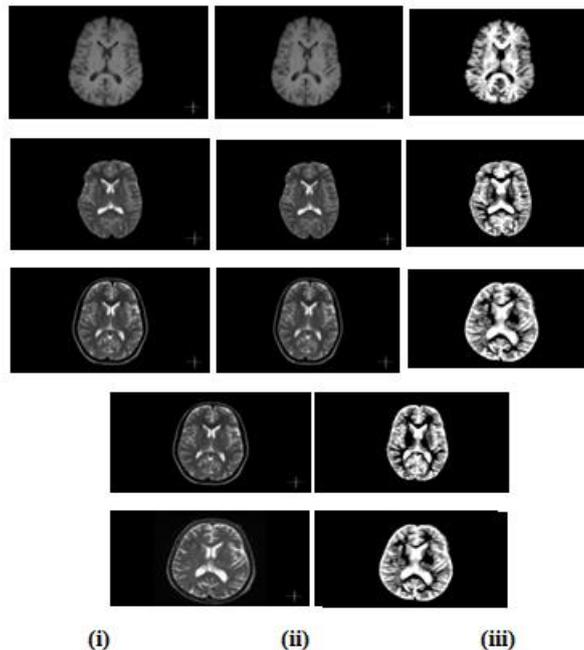

Fig. 3. Normal MR Brain Image Analysis (i) Five Real Input Images (ii) Median Filtered Images (iii) Segmented Images.

Table 1. Quantitaive Evaluation for Normal MR Brain Images (iii) K-Means Technique

Images	Sensitivity %	Specificity %	Accuracy %	Similarity	MCR %	Execution Time (sec.)
1	55.41	52.28	56.88	0.4786	43.12	4.62789
2	59.09	56.82	57.63	0.4956	42.37	3.54867
3	54.89	50.43	54.34	0.3406	45.66	3.43372
4	60.35	58.72	60.52	0.3524	39.48	3.58846
5	65.92	59.48	63.86	0.4956	36.14	3.07963

Table 2. GLCM based Feature Extraction Method for normal MR Brain Images

GLCM Features	Data 1	Data 2	Data 3	Data 4	Data 5
Contrast	0.85505	0.68575	0.59655	0.79166	0.871

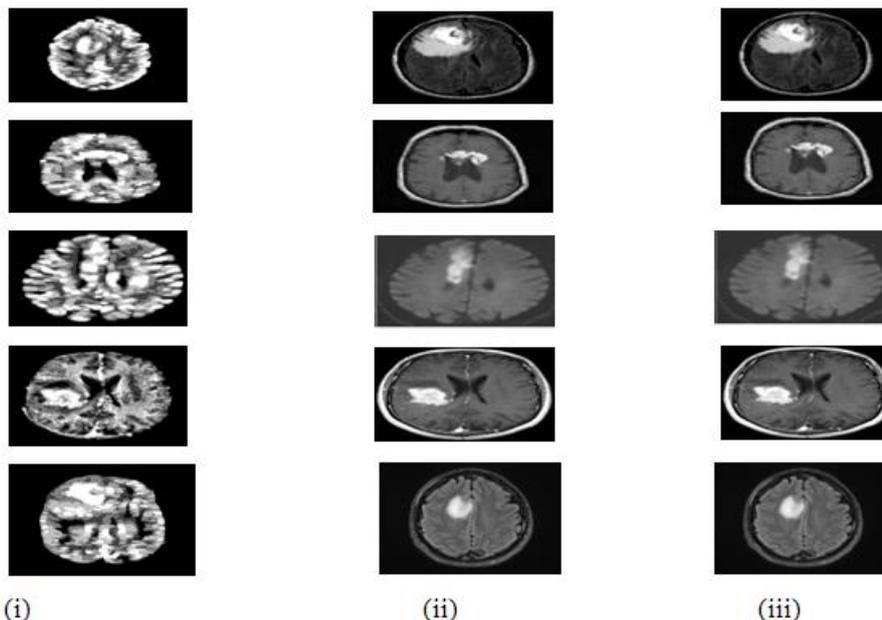|					
Correlation	0.91402	0.77256	0.85992	0.88091	0.89269
Energy	0.13433	0.09337	0.12157	0.12595	0.11379
Standard deviation	0.16337	0.17514	0.20064	0.16654	0.16618
Entropy	2.5246	2.7689	2.6457	2.5921	2.6655

Fig. 4. Abnormal MR Brain Image Analysis (i) Five Real Input Images (ii) Median Filtered Images (iii) Segmented Images

Table 3. Performance Evaluation for Abnormal MR Brain Images (iii) K-Means Technique

Images	Sensitivity %	Specificity %	Accuracy %	Similarity	MCR %	Execution Time (sec.)
1	60.74	52.87	55.63	0.3574	44.37	3.86939
2	52.69	50.93	51.02	0.3401	48.98	3.28361
3	63.86	59.26	61.3	0.4391	38.7	3.25279
4	50.47	46.28	45.39	0.2338	54.61	3.36634
5	54.83	48.24	50.08	0.2972	49.92	3.95304

Table 4. GLCM based Feature Extraction Methods for abnormal MR Brain Images

GLCM Features	Data 1	Data 2	Data 3	Data 4	Data 5
Contrast	0.82583	0.51278	0.50149	0.77428	0.57393

Correlation	0.91277	0.91065	0.90111	0.93807	0.92424
Energy	0.09358	0.09402	0.11798	0.14076	0.29116
Standard deviation	0.28153	0.21394	0.2011	0.22587	0.23057
Entropy	2.8531	2.7939	2.6354	2.503	2.2396

Table 5   Performance Evaluation of SVM Classifier

Sl.no.	Classification Technique	True positive	True negative	False positive	False negative	Sensitivity	Specificity	Accuracy (%)
1.	RBF- SVM	47	36	4	3	0.94	0.925	93 %

Total Number of Normal Cases 40/ Abnormal Cases 50

V. CONCLUSION

The present work is focussed towards the segmentation and classification of brain tissues for tumor deduction. This work includes five stages. Median filtering, clustering, feature extraction, feature selection and classification. This proposed work produces the classification accuracy as around 93%. This work can also be extended to diagnose the diseases in MR brain -images using hybrid combination of swarm evolutionary methods.

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