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MEM BASED BRAIN IMAGE SEGMENTATION AND CLASSIFICATION USING SVM

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ABSTRACT

Computer aided diagnostics plays an important role in clinical routine. The application of new technology to different imaging modalities creates a more challenge. Image processing plays a vital role in medical applications. Brain is the majestic organ in the human body. The central nervous system consists of a brain, and spinal cord, which is a the major control network for the body's functions and abilities: conscious communication with our body and automatic operation of vital organs. It controls all over the body tissues. The brain is divided in to regions that control various functions, such as movement, speech and balance. Damage to a region may affect the some functions related to movement, difficulty speaking, or loss of coordination in all activities. Brain tumor is an irregular growth of new tissues in the brain. If that tissue is not treated well, spreading with other tissues will resulting in cancer. In proposed system, Modified Expectation Maximization (MEM) algorithm implemented for segmentation and SVM classifier applied for image classification.

Keywords: brain image, CLAHE, MEM, GLCM, SVM.

1. INTRODUCTION

Computer-aided diagnostic (CAD) system helps radiologists in detecting and analyzing Tumors. The ability to turn detection into diagnostics by ranking the areas of interest detected on a images by probability of malignancy, is a breakthrough in the field of CAD system. This is important for both physicians and patients because as evaluation becomes more exact, the number of unnecessary procedures is greatly decreased. A CT Scan (Computed tomography) is useful for viewing bone structures. MRI is suited for examining soft tissues. The time taken for CT scans is less than 5 minutes. An MRI, on the other hand, 30 minutes is necessary. MRI scan is a substantial noninvasive medical diagnostic tool that uses a radiology technique. It is a painless diagnosis and has the advantage of avoiding X-ray radiation exposure over the CT scan. The image and resolution produced by MRI scan is quite exhaustive and can detect miniature changes of structures within the body. The images are originated using super conducting magnets and pulsed radio waves. MRI is more versatile than the X-ray and is used to determine a large diversity of medical conditions.

Automatic detection and diagnosis is necessary for planning and treatment. Manual segmentation and classification is time consuming at the same time subject to make error. There are two critical problem is existing .The first problem is differentiating the abnormal tissue from normal tissue and second is finding the boundary precisely. Brain tumor is the major disease which doesn't have any complete solution. Brain tumors can be classified into two types. 1. Benign tumors 2. malignant tumors. Benign brain tumor cells are growing slowly and having distinct boundaries. They do not spread other areas in the body. Surgery alone may cure this kind of tumor. The malignant tumor leads to life threatening. It is made up of cancerous cells can destroy healthy tissue so these areas are not working properly. Malignant tumors are very dangerous than benign tumors it leads to cancer.

Malignant tumors of the brain affect over 50,000 adults in the country each year and rate has been rising for the last 50 years. Brain tumors are the second leading cause of cancer related deaths in children and male. As a brain tumor cells are growing in the back of the brain it can cause vision problems. If it is in the sides of the brain it can cause speech or movement.

Padma et al proposed segment the CT images using the feature extraction techniques are Dominant Gray Level Run Length Matrix (DGLRLM) and Spatial Gray Level Dependence Matrix (SGLDM). T. Logeswari et al proposed to segment the tumor from the MRI image using Hierarchical Self Organizing Map (HSOM).The performance of the MRI image in terms of weight vector and execution time and tumor pixels are detected. B.K. Saptalakar et al introduced brain tumor detection based on segmentation through watershed technique. Madhusudhanareddy et al proposed detection of tumor using image adjustment, histogram equalization and classify the tumor into different grades based on Artificial Neural Network. Sridhar D et al introduced feature extraction from the MRI image using Discrete Cosine Transform (DCT) and classification based on the Probabilistic Neural Network technique. Mohammed Sabbih Hamoud al-Tamimi et al introduced a comprehensive review of the methods and techniques are used to detect brain tumor through MRI image segmentation. R.S. Rajkumar et al proposed the brain tumor segmentation using Cellular Automata based seeded segmentation and Neural Networks. Pabitra Roy et al proposed a method to find appropriate threshold intensity value which is near the intensity value of the tumor using standard deviation and the average intensity. The disadvantage in GLCM is its high dimensionality. This made GLCM is complex in nature and that's why they are not suitable to real-time applications, image mining and other problems.

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Based on the above literature the segmentation accuracy can be achieved by using other technique. To improve the segmentation was done by using MEM algorithm. The number of feature calculation improved by using GLCM to get the classification accuracy.

2. METHODOLOGY

This proposed system is divided into three different phases. 1. Preprocessing 2. Segmentation 3.Classification.The input RGB image is converted into gray scale image in the range of 0 to 255 for further processing.0 represent black color and 255 represent white color.

In this paper the first phase preprocessing step was done by filtering and enhancement. The aim of pre-processing is that it suppresses unwanted distortions or enhances some image features important for further processing. Median filters have advantage over mean filter by preserving edges. No reduction in contrast because the output values consist only those present in the neighborhood and less sensitive. Enhancement is defined as processing of image to bring out specific features of an image and highlight certain characteristics of an image. Enhancement process was done by using contrast-limited adaptive histogram equalization (CLAHE) algorithm. Histogram is a graphical representation of pixel distribution as a function of tonal variation. While performing Adaptive Histogram Equalization (AHE) small intensity range region being processed then the noise in that region also get enhanced. It can cause some kind of artifacts to appear on those regions. To overcome the appearance of such artifacts a modified AHE called CLAHE can be used. The difference between AHE and CLAHE is that clip the histogram before the computation of its CDF as the mapping function is performed. In CLAHE algorithm steps are given below:

(i) Calculate a grid size based on the maximum dimension of the image.

(ii) Identify grid points on the image starting from top left corner. Each grid point is separated from the grid size pixels.

For each grid point calculate the histogram of the region around it.

(iii) If a clipping level is specified clip the histogram computed above to that level and then uses the new histogram to calculate the CDF.

(iv) After calculating mappings for each grid point, repeat the step 6 to 8 for each pixel in the input image.

(v) For each pixel find the four closest neighboring grid points that surround that pixel.

(vi) Using the intensity value of the pixel as an index, find its mappings at the four grid points based on their cdfs.

(vii) Interpolate among these values to get the mapping at the current pixel location. Map this intensity to the range [min: max] put it in the output image.

The second phase, Segmentation is nothing but partitions an image into distinct regions containing each pixels with similar attributes. To study a specific object in an image, its boundary can be highlighted by an image segmentation procedure. The objective of the image segmentation is to simplify the representation of pictures into meaningful information by partitioning into image regions. Image segmentation is a technique to locate certain objects or boundaries within an image. In segmentation process, the Fuzzy c-means clustering algorithm has a disadvantage of generate coincident clusters and it requires the user to specify number of clusters in advance and it depends on initial conditions. In k means clustering algorithm has the disadvantages of at every pass the data value is assigned to the nearest partition based on Euclidean distance of intensity. Each successive pass the data value can switch partition it leads to changing the values of the partition at every pass. EM algorithm takes the argument of the whole image. To overcome the disadvantages of existing algorithms Modified Expectation Maximization (MEM) algorithm is implemented. In MEM algorithm data value is associated with the partition based on the weights how the data value is strongly associated with the particular partition. The replicated matrix is used for comparing each pixel by pixel so the hidden data's will be displayed clearly. Segmentation result is accurate compare with other techniques. MEM algorithm procedures are given below:

(i). Initialize the expectation step and maximization step parameter.

(ii). Increasing the maximization step by one.

(iii). Concatenating the input image.

(iv). Replicating the Expectation and Maximization matrices.

(v). Calculating the difference between input image and replicated image.

(vi). Calculating new Expectation and maximization step position. Iterating the Expectation and Maximization step value.

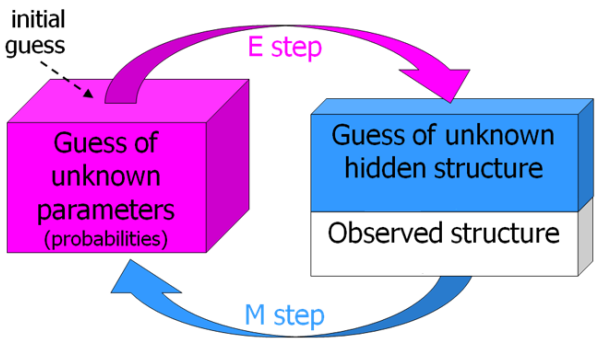

Figure-1. MEM algorithm.

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In modified EM algorithm the following procedures were followed.

- **Expectation step:** Use current parameters (and observations) to reconstruct hidden structure
- **Maximization step:** Use that hidden structure (and observations) to estimate parameters
- Repeat until convergence

In modified EM algorithm the replicated matrix is used for comparing each pixel by pixel so the hidden data's will be displayed clearly. Segmentation result is accurate compare with other techniques.

Third phase contains the classification. It is based on the feature calculation using Gray-Level Co-Occurrence Matrix (GLCM). Transforming the input data into the set of features is called feature extraction. It will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input. Some of the features [9] are given below:

(i) Energy: It provides sum of squared elements in the GLCM. It is also known as uniformity or angular second moment.

$$\text{Energy}=\sum_{i\,j\,=0}^{N-1}(P\,ij)^2$$

(ii) Entropy: Entropy is an estimate of the uncertainty in a random variable.

$$\text{Entropy}=\sum_{i,j=0}^{N-1}-I\,n\,(p\,ij)\,p\,ij$$

(iii) Contrast: It is termed as the separation between the maximum and minimum pixel intensity in an image.

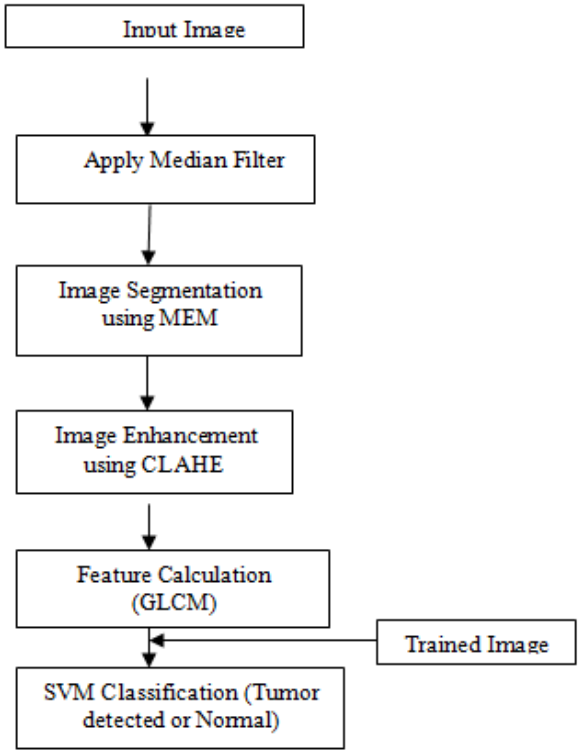

Figure-2. Block diagram of proposed system.

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Table-1. Features calculations based on GLCM and segmentation based on MEM.

S. No.	Contrast	Correlation	Energy	Entropy
Image1	0.297	0.130	0.178	0.956
Image2	0.291	0.938	0.212	1.026
Image3	0.284	1.031	0.203	0.743
Image4	0.218	0.395	0.132	0.683
Image5	0.239	0.377	0.130	0.935
Image6	0.278	1.060	0.193	0.521
Image7	0.287	0.468	0.113	0.864
Image8	0.275	1.066	0.197	1.451
Image9	0.284	1.031	0.203	0.970
Image10	0.291	0.938	0.212	0.832
Image11	0.303	0.229	0.136	1.275
Image12	0.295	0.126	0.180	0.498
Image13	0.297	0.130	0.178	1.083
Image14	0.259	0.170	0.161	0.739
Image15	0.295	0.188	0.155	0.914
Image16	0.289	0.177	0.157	1.086
Image17	0.303	0.229	0.136	0.849
Image18	0.218	0.395	0.132	1.106
Image19	0.239	0.377	0.130	0.958
Image20	0.295	0.132	0.174	1.038
Image21	0.289	0.177	0.157	0.895
Image22	0.295	0.188	0.155	0.584
Image23	0.259	0.170	0.161	1.261
Image24	0.295	0.132	0.174	0.807
Image25	0.295	0.126	0.180	0.962
Image26	0.372	0.252	0.312	0.496
Image27	0.217	0.140	0.369	1.031
Image28	0.137	0.913	0.176	0.739
Image29	0.295	0.354	0.241	0.692
Image30	0.284	0.308	0.252	0.793

$$\text{Contrast} = \sum_{i\,j=0}^{n-1} P_{i\,j}\,(i-j)^2$$

(iv) Correlation: It is an gauge of how correlated a pixel to its neighbor over the whole image

$$\text{Correlation} = \sum_{i\,j=0}^{n-1} P_{ij}(i-u)\,(j-u)/o2$$

(v) Area: It imparts the number of pixels in the region of interest.

CLASSIFICATION

The images were classified using Singular value decomposition algorithm. In this method the Support Vector Machine (SVM) is a technique for classification and regression. Originally the SVM was devised for binary classification, or classifying data into two types.

Then the values are splitter into True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN) to find the accuracy.

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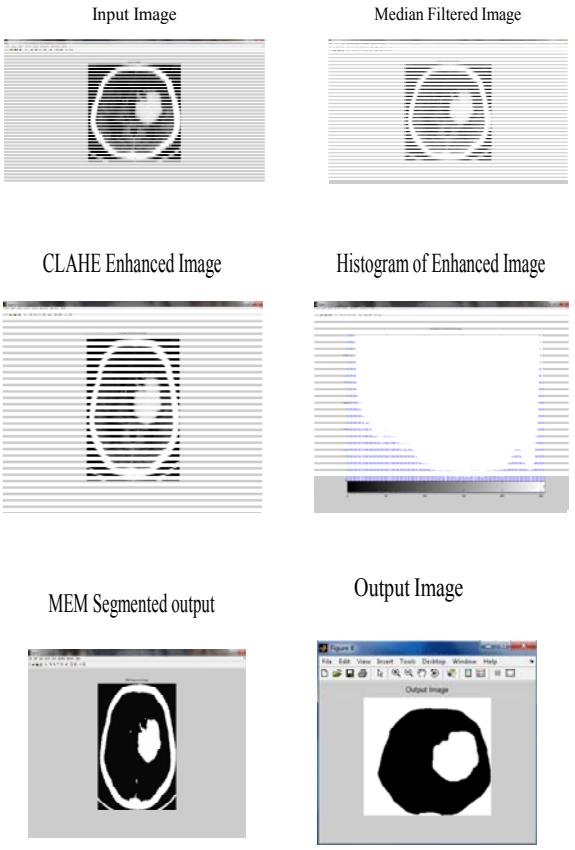
Table-2. Features calculations based on glcm and segmentation based on K Means Algorithm.

S. No.	Contrast	Correlation	Energy	Entropy
Image1	0.0068	0.9425	0.8753	0.3386
Image2	0.0099	0.9291	0.8508	0.3851
Image3	0.0159	0.9133	0.8008	0.4753
Image4	0.0114	0.9393	0.8016	0.4834
Image5	0.0145	0.9572	0.6475	0.7512
Image6	0.0127	0.9395	0.7774	0.5266
Image7	0.0218	0.9337	0.6503	0.7351
Image8	0.0127	0.9102	0.8459	0.3896
Image9	0.0068	0.9240	0.9037	0.2731
Image10	0.0113	0.9475	0.7738	0.2675

3. RESULTS AND DISCUSSIONS

The proposed system accurately segmented the brain tumor from the MRI input image. Then the brain tumor affected image and normal image is separated by using classification. High accuracy and high performance was the advantages of SVM over other classification techniques.



4. CONCLUSIONS

The existing Image segmentation method using kMeans algorithm and classification based on GLCM In this paper the brain MRI image is segmented using MEM and features are calculated using SVM and classification based on GLCM. The proposed method Correlation, Energy is calculated and compared with Existing method. Table-1 gives features of Segmentation by MEM and the feature calculation using SVM, classification based on GLCM. Table-2 segmentation based on K-Means algorithm and classification Using GLCM. Although SVMs does not deliver a Para-metric score function, its linear approximation can deliver an important support for identifying the mechanisms linking different financial ratios with the final score of a company. For these reasons SVMs are regarded as a useful tool for effectively complementing the information gained from classical linear Classification techniques.

The proposed algorithms give better accuracy and classify the human brain into disease detected or normal. The segmentation gives tumor part alone is segmented from the input image in accurately. In this proposed system 30 MRI images are extracted and the result was compared with 10 MRI images using K-means algorithm and classification Using GLCM.

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