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An Effective Segmentation Approach of Medical Images Based on Beta Mixture Model

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Abstract--- Image segmentation aims at investigating and the Images with respect to the pattern of the pixels. Many Models are addressed in this direction. Among the various focused areas of segmentation, medical segmentation has gained importance; this is due to the fact that proper categorization of the pixels helps in the identification of the diseases. However, for successful segmentation one require to judge suitable features. In this paper, mainly we are proposing a Bivariate Beta Mixture Model (BMM) for segmenting the medical images by considering the Bivariate features. In order to implement the model, Berkley Bench Mark dataset is considered. This proposed model Performance is evaluated by using PSNR, MSE, IF, Average difference (AD).

***Keywords*---** Beta Mixture Model, Berkley Images, IF, PSNR, MSE, Image Segmentation

I. INTRODUCTION

In image processing, image analysis is a branch that deals with image segmentation. The objective of segmentation is to transform the depiction of image suitable for effective analysis. In this process, it helps towards the identification of the deformities and the location of these deformities. Every image is divided into different regions and it is jointly roofed by the set of regions, the segmentation process helps to identify the underlined regions. Therefore, in medical image analysis, segmentation plays a vital role to find the different diseases in clinical findings. The challenging task of the medical images is segmentation of images which suffers with problems related to contrast, noise and diffused boundaries. The structure of the brain can be examined through Computed Tomography (CT) or Magnetic Resonance Imaging (MRI). MRI Scans are mostly preferred because of its non-ionizing property. Of late the mortality related with brain tumors are increasing. Therefore, to increase the survival rate, the causes of the deformities are to be identified more effectively.

Several models have been proposed in the literature for segmenting the images effectively based on parametric and non – parametric Models. Among the Non – parametric classifier models Artificial Neural Networks (ANN) [1][2][3], Support Vector Machines (SVM) [4][5][6], K-Nearest Neighborhood (KNN)[7][8] are mostly highlighted. Among the parametric models effective research is carried out by proposing new models based on GMM [9] [10], New Symmetric distribution [11][12], beta mixture model, log normal distribution[15]. However, parametric Models are identified to be more effective than nonparametric models depending on the works of Sonams [18], and Vrushali Borase [19] supplemented this fact.

The main criterion for segmenting the images effectively is to highlight the damaged pixels from the set of image pixels. These distortions help in recognizing tumors from the medical images and in many other practical situations, such as weather forecasting, where each pixel has a role to play. Therefore, to categorize the abnormalities appropriately, Fuzzy C- means algorithm can be implemented. The main advantage is to identify the normal pixel, partially damaged and fully damaged. In every region each pixel is considered and given as inputs to the BMM.

The main advantage behind the consideration of Beta Mixture model is that, it can handle the images having asymmetric shapes and symmetric shapes more appropriately. For effective segmentation features like color and shape play a vital role. The remaining paper is presented as follows:

In section 2 of the paper the related work is presented, in section 3 a brief introduction about the probability density function (PDF) of the beta mixture model Distribution is presented, in section 4 of the paper the concept of Fuzzy C means Clustering algorithms are highlighted, in section 5 the data base considered for proposing the model is highlighted, section 6 describes the feature extraction methodology, in section 7 the experimentation together with the performance evaluations are highlighted. The concluding section 8 summarizes the paper.

II. RELATED WORK

With the increase in the number of diseases, research in the area of medical analysis has gained momentum. Many researchers have proposed models for effective segmentation. Models have been proposed in which the image is clustered into two groups, the WM and GM and CSF are clustered into one group and the tumor is clustered into the other group. The main disadvantage of the model is that the deformity should be in the adjacent second group only. Effective segmentation results cannot be achieved by this model.

To overcome the disadvantages while segmentation the images, having low contrast, the concept of fusion is considered. Some authors have proposed the models based on spatial relationship between the pixels, however in this model we have considered the weighted function and the segmentation process is carried out. In doing so, they have ignored the objective assessment. Models based on Convolution Neural Networks, are proposed to discriminate the bone and nonbone, this methodology proposed could successfully identify the bones, while it failed in case or recognizing the non-bones having irregular shapes. K-Means clustering algorithm [13], EM algorithm and normalized cuts are also utilized. However, these methods are proved to be good, if cluster count is low, and failed to maintain the accuracy in case of higher number of clusters, and the execution time associated with the N-Cut algorithm is too high. K-Means based segmentation algorithm is also considered, but its efficiency totally depends on the number of clusters and failed to find an optimal cluster many other models have been proposed for segmentation based on the Mixture models, but they have considered only the unique feature. To overcome the above disadvantages and to have effective segmentation results, in this paper, Bivariate features are considered.

III. BIVARIATE BETA MIXTURE MODEL

Beta Mixture Model is considered for effective segmentation of the Medical Images. Then features selected are given as input to the model and the outputs derived will help to cluster the image data into different regions.

The probability density function and pixel X follows a multivariate beta mixture model is as follows:

f(x;μ,σ,δ)=2φp(x;μ,σ)θ1³δT σ−1(x−μ); 0,1−δTσ−1δ (1)

Where μ is a location vector, σ is a scale matrix, and δ is a beta mixture model vector. Let φp(.;μ,σ) be the density of the covariance matrix σ, p variate normal distribution with mean vector μ and the corresponding distribution function is θ p(.;μ,σ).

IV. Fuzzy C Means Algorithm

Concerning to segment the Images, the first step is to identify the number of groups or identify the number of clusters, and then consider the Histogram of the Images and the peaks to define the clusters. Once the clusters are identified, the next criterion is to cluster the pixels into each of these groups basing on the relevance of attributes or features. Among the various clustering algorithms, Means algorithm is mostly focused, because of the fact that it clusters the medical images faster. However, the Fuzzy C-means algorithm's advantage is that it foresees the tumor cells which can not be predicted by K-means algorithm. The Fuzzy algorithm has the ability to cluster the pixels more accurately but considered pixels are partly damaged pixels, fully damaged and undamaged pixels. Hence, Fuzzy C-Means algorithm (FCM) is considered in this paper [16]. The Fuzzy C-means algorithm is as follows:

Step1: (U) using as randomly initialize the membership matrix.

$$u_{ij} = \frac{1}{\sum_{k=1}^{c}\left(\frac{d_{ij}}{d_{kj}}\right)^{2/(m-1)}}$$

Step2: Determine centroids (c_i) by using

$$c_i = \frac{\sum_{j=1}^{n} u_{ij}{}^{m} x_j}{\sum_{j=1}^{n} u_{ij}{}^{m}}$$

Step3: Calculate dissimilarity between data points and centroids using

$$J(U, c_1, c_2, ..., c_c) = \sum_{i=1}^{c} J_i = \sum_{i=1}^{c}\sum_{j=1}^{n} u_{ij}{}^{m} d_{ij}{}^{2}$$

Step4: Evaluate a new U. Go to Step 3.

An iterative process is updated with membership grades and the cluster centers for each data point, the cluster centers are moved to the right location by applying the FCM iteratively within a dataset.

Optimal solution cannot be achieved with FCM because the cluster centers are randomly initialized using U. The performance mainly depends on the initial centroid. There are two ways to evaluate U which is described as

- Algorithm used to determine all of the centroids.
- Running FCM with different iterations each starting with unique initial centroids

V. Data Set Considered

To present the proposed work we considered the Data set from UCI Image repository which consists of the Medical Images like Tumor images for our implementation purpose.

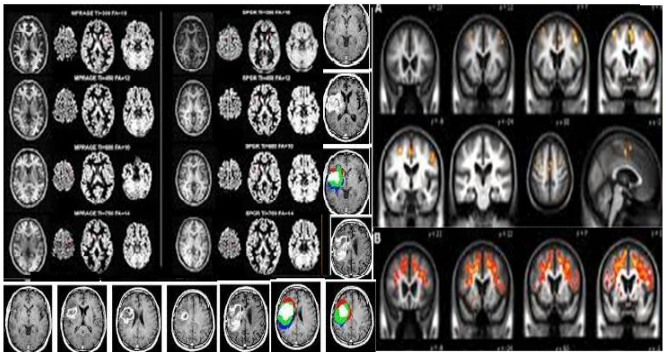


Figure 1: Brain Tumor Data Set

VI. FEATURE EXTRACTION FOR EFFECTIVE SEGMENTATION

For effective segmentation, we have considered two features namely, color and shape of the Tumor, for segmenting the Images, corresponding YIQ pattern are considered. Among these YIQ patterns, intensity play vital role in Medical Images and therefore in the intensity of the color is considered as a feature along with the shape of the deformities region.

VII. PERFORMANCE EVALUATION AND EXPERIMENTAL RESULTS

The Experimental results are carried out in MATLAB Environment. From the identification of the peaks from the histogram initial clusters are retrieved. Each cluster is considered and the parameters are estimated against and these parameters values along with the features are given as input to the Beta Mixture Model presented in section 3 of the paper. Then the pixels against this PDF's are considered and the image reconstruction is carried out using the maximum likely hood estimation. The generated images are to be compared with that of the original Images.

In order to estimate the deviations from the original Images and the reconstructive Image, Performance Evaluation Matrices (PEM) is considered. The different Matrices which were considered includes Means Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Image Fidelity (IF) and Average Difference (AD).

The proposed model is applied to 8 sub images of 2 T_1 weighted different brain medical images obtained from the brain web database of dimensions 150x174 and 163x199 respectively.

Table 1 shows the values of initial number of segments of the medical images obtained from histograms of the respective image.

Table 1 K Estimates

Image	B0	B1
Estimation for K	4	3

To estimate the initial model parameters and number of segments, fuzzy c-means clustering is applied for two medical images and are shown in table 2.

Table 2 Fuzzy C-Means Clustering Estimates

Image	B0	B1
Estimate of Fuzzy C-Means Clustering	3	4

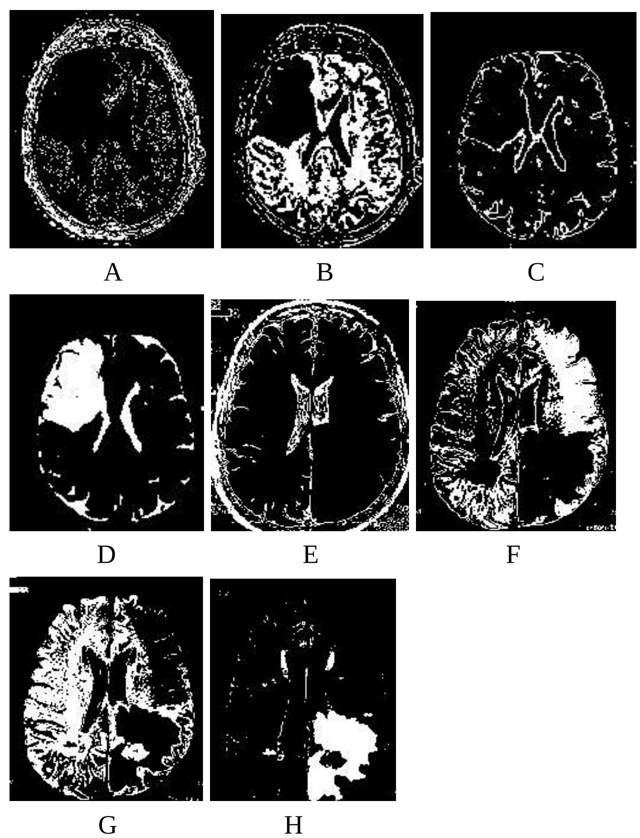


Figure 2 A, B, C and D represent reconstructed images of B0 and E, F, G and H represent reconstructed images of B1

The input images for the reconstructed images B0 and B1 are

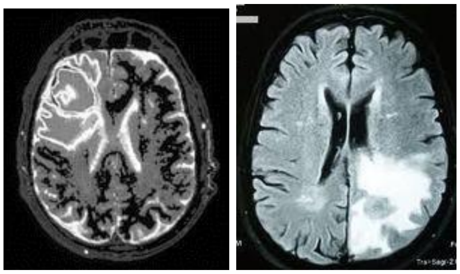


Figure 3 Input images of image B0 and B1

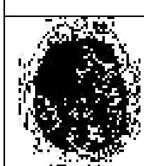
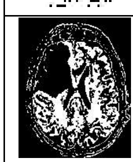
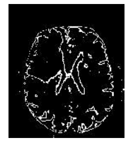
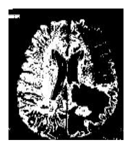
Image quality metrics are used to evaluate the performance of the reconstructed image, and the metrics utilized are presented below.

Table 3 Formulae for Evaluating Quality Metrics Used

Quality metric	**Formula to Evaluate**
Image Fidelity	$1-\left[\sum_{j=1}^{M}\sum_{k=1}^{N}\left[F(j,k)-\hat{F}(j,k)\right] \Big/ \sum_{j=1}^{M}\sum_{k=1}^{N}\left[F(j,k)\right]^2\right]$ where M, N are rows and columns of the image matrix
Mean Squared error	$\frac{1}{MN}\left[\sum_{j=1}^{M}\sum_{k=1}^{N}\left[O\{F(j,k)\}-O\{\hat{F}(j,k)\}\right]\right]^2 \Big/ \sum_{j=1}^{M}\sum_{k=1}^{N}\left[O\{F(j,k)\}\right]^2$ where M, N are rows and columns of the image matrix
Signal to noise ratio	$20\log_{10}\left(\frac{MAX_i}{\sqrt{MSE}}\right)$ MAX_i variable denotes the max; pixel value of an image. mean squared error is denoted with MSE

A comparison is done between GMM and BMM and results are shown in the table 4.

Table 4 Quality Measures

Image	**Quality Metric**	**GMM**	**BMM**
	IF MSE SNR	0.416 0.04 17.41	0.923 0.094 33.89
	IF MSE SNR	0.336 0 2404 14.45	0.859 0.2019 39.85
	IF MSE SNR	0.44 0.22 19.88	0.917 0.2123 39.71
	IF MSE SNR	0.212 0.24 21.42	0.892 0.1192 37.41
	IF MSE SNR	0.391 0.2514 3.241	0.876 0.1759 5.68
	IF MSE SNR	0.2134 0.06 13.43	0.791 0.594 20.39
	IF MSE SNR	0.233 0.01 11.11	0.923 0.119 29.86
	IF MSE SNR	0.293 0.18 21.214	0.791 0.213 99

With respect to quality metrics the results obtained by using fuzzy c-means clustering shows better results when compared with the existing model based on gaussian mixture model.

VIII. CONCLUSION

To develop and evaluate the clustering, segmentation techniques based on finite beta mixture model with fuzzy c-means is implemented. This algorithm has shown the outperformed results when compared with existing methods. This method helps in proper diagnosis and preventing disabilities such as hearing loss, acoustic neuroma diagnosis, Parkinson's diagnosis in medical pathology.

REFERENCES

[1] Adelino R. Ferreira da Silva: "Bayesian mixture models of variable dimension for image segmentation", *Computer methods and programs in biomedicine*, pp.1-14, 2009.

[2] Ahmet M. Eskicioglu and Paul S. Fisher*:* "Image Quality Measures and Their Performance", *IEEE Transactions on Communications*, Vol. 43, No.12, pp. 2959 – 2965, 1995.

[3] D. L. Pham, C. Y. Xu, and J. L. Prince: "A survey of current methods in medical image segmentation*", Annual Review of Biomedical Engineering*, vol. 2, pp.315–337, 2000.

[4] David W. Shattuck, GautamPrasada, MubeenaMirzaa, Katherine L. Narra and Arthur W. Togaa: "Online resource for validation of brain segmentation methods", *ELSEVIER, NeuroImage* Volume 45, Issue 2, 1, Pages 431-439, 2009.

[5] Dr.Samir Kumar Bandhyopadhyay, TuhinUtsab Paul: "Segmentation of Brain MRI Image – A Review", *International Journal of Advanced Research in Computer Science and Software Engineering*, Vol. 2, Issue 3, pp.409-413, 2012.

[6] G. Dugas-Phocion, M. Á. González Ballester, G. Malandain, C. Lebrunand N. Ayache*:* "Improved EM-based tissue segmentation andpartial volume effect quantification in multi-sequence brain MRI", *International Conference Medical Image Computing and Computer-Assisted Intervention*, Vol. 3216, pp. 26–33, 2004.

[7] GuangJianTian, Yong Xia, Yanning Zhang, Dagan Feng:"Hybrid Genetic and Variational Expectation-Maximization Algorithm for Gaussian-Mixture-Model-Based Brain MR Image Segmentation", *IEEE Transactions on Information Technology in Biomedicine*, Vol. 15, No. 3, 2011.

[8] Herng-Hua Chang, Daniel J. Valentino, Gary R. Duckwiler and Arthur W. Toga: "Segmentation of Brain MR Images Using a Charged Fluid Model", *IEEE Transactions on Biomedical Engineering*, Vol.54, No.10, pp. 1798-1813, 2007.

[9] J. Ashburner and K.J.Friston: "Multimodal image co registration and partitioning – A unified framework", *NeuroImage*, Vol.6, pp 209-217, 1997.

[10] J.A. Hartigan: Clustering Algorithms, New York: Wiley, 1975.

[11] Shubhangi D.C., Sabahat Fatima, "*Privacy-Preserving Outsourcing of Medical Image Data using SIFT Descriptor*", International Journal of Scientific Research in Network Security and Communication, Vol.5, Issue.3, pp.141-145, 2017.

[12] P. Umorya, R. Singh, "*A Comparative Based Review on Image Segmentation of Medical Image and its Technique*", International Journal of Scientific Research in Computer Science and Engineering, Vol.5, Issue.2, pp.71-76, 2017

[13] Nagesh Vadaparthi, "Unsupervised Medical Image Segmentation on Brain MRI images using Skew Gaussian Distribution", *IEEE – International Conference on Recent Trends in Information Technology*, pp.1293 – 1297, 2011.

[14] Sonam S. Gavhande, S.B.Jadhav, "Image Segmentation and Identification of Brain Tumor from MRI Image", *International Research Journal of Engineering and Technology (IRJET),* Volume: 02 Issue: 02 . PP.167-170, 2015.

[15] Vrushali Borase, Gayatri Naik, Vaishali Londhe, "Brain MR Image Segmentation for Tumor Detection using Artificial Neural", *International Journal Of Engineering And Computer Science,* Volume 6 Issue 1, pp. 20160-20163,2017.

[16] K Van Leemput, F. Maes, D. Vandeurmeulen, and P. Suetens: "Automated model-based tissue classification of MR images of the brain", *IEEE Transactions Medical Imaging*, Vol. 18, no. 10, pp. 897–908, 1999.

[17] Nookala Venu, B. Anuradha: "Medical Image Segmentation Using Kernal Based Fuzzy", *International Journal of Engineering Innovation & Research,* Vol. 4, Issue 1, pp-207-212, 2015.

[18] M. Prastawa, E. Bullitt, S. Ho, and G. Gerig: "Robust estimation forbrain tumor segmentation", in *International Conference Medical Image Computing and Computer-Assisted Intervention*, LNCS 2879, pp. 530–537, 2003.

[19] Yazid Cherfa, Assia Cherfa, Yacine Kabir, Sammyh Kassous, Assia Jaillard, Michel Dojat, and Catherine Garbay: "Segmentation of Magnetic Resonance Brain Images Using Edge and Region Cooperation Characterization of Stroke Lesions", *International Arab Journal of Information Technology*, Vol. 4, No 3. pp. 281-288, 2007.

[20] Ruchi," Study of Different Brain Tumor MRI Image Segmentation Techniques", *International Journal of Computer Science Engineering and Technology* (IJCSET), Vol 4, Issue 4, PP.133-136, 2014.

[21] Azzeddine Riahi, "Image Segmentation Techniques Based on Fuzzy C-Means and Otsu, Applied to the Brain MRI in Tumor Detection", *International Journal of Computer Sciences and Engineering* (IJCSE), Vol 3, Issue 12, PP. 89-101, 2015.

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