Review Paper on Brain Tumor Detection Using Pattern Recognition Techniques

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Abstract: Brain Tumor is an abnormal growth caused by cells reproducing themselves in a uncontrolled manner. Brain Tumor segmentation aims to separate the different tumor tissues such as active cells, necrotic core & edema from normal brain tissues of White Matter(WM), Gray Matter (GM), Cerebrospinal Fluid (CSF). Tumor segmentation from MRI data is an Important but time consuming manual task performed by medical experts. Accurate Detection of size & Location of Brain Tumor plays a vital role in the diagnosis of Tumor. Image Processing is an active Research area in which medical image processing is highly challenging field. In this paper various feature extraction and classification methods which are used for detection of brain tumor from MRI images are reviewed.

Keywords: Brain Tumor, MRI images, Image Processing, Segmentation.

I. INTRODUCTION

Abnormal growth of cells developed inside human body is called as Tumor. Brain Tumor is an intra-cranial solid neoplasm occurs within the brain or the central spinal canal. Brain tumor is implicitly serious and life-ominous disease because brain is very fragile part of human body to treat for. However, Brain tumors can be malignant that is cancerous or benign that is non-cancerous.[9] Treatment of brain tumor depends on proper diagnosis and depends on the different factor like the type of tumor, location, size and state of development. MRI is technique used to measuring density of photons in tissue; it is based on fundamental property of photon that spins and possesses magnetic movement. It is done to visualize the internal structure of human body, gives superior image quality. Fig 1 shows the normal MR brain image and image with tumor. Early and proper detection of tumor is the key for the proper treatment. Previously stage of tumor is used to be detected manually with the help of observation of image by doctors and sometimes it takes more time and sometimes results may inaccurate. There are many different types of brain tumor and only experienced and expert doctor can able to give the accurate result. So we require accurate diagnosis tool for proper treatment. Detection involves finding the presence of tumor; segmentation involves the detection of size and location of tumor and classification involves the detection of stage of tumor. Now a day's many computer added tool is used in medical field. These tools possess a property of quick and accurate result. The known MRI images are first processed through various image processing steps such as histogram equalization and sharpening filter etc. and then features are extracted using wavelet and quadtree transform in that the specific feature is Gray Level Co-occurrence Matrix.[15,20].

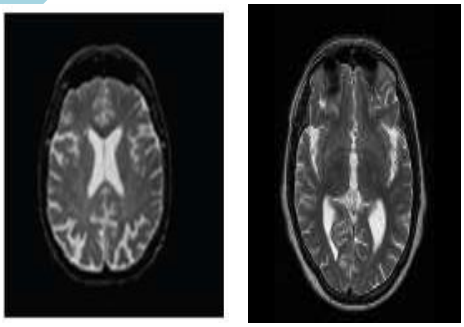


FIG 1: Normal Image and Tumor MRI Image

The features extracted are used in the Knowledge Base which helps in successful classification of unknown Images. These features are normalized in the range -1 to 1 and given as an input to support vector machine Classifier [4, 12].This paper proposes a genetic algorithm and SVM based classification of brain tumor. It is concluded that, Gabor filters are poor due to their lack of orthogonality that results in redundant features at different scales or channels. While Wavelet and quadtree Transform is capable of representing textures at the most

suitable scale[18], by varying the spatial resolution and there is also a wide range of choices for the wavelet and quadtree function.

II. RELATED WORK

Ahmed Kharrat et. al. [1] presented MRI Brain Tumor Classification using Support Vector Machines and Meta-Heuristic Method .They developed a new approach for automated diagnosis, based on classification of Magnetic Resonance (MR) human brain images. 2D Wavelet Transform and Spatial Gray Level Dependence Matrix (DWT-SGLDM) is used for feature extraction. For feature selection Simulated Annealing (SA) is applied to reduce features size. The next step in our approach is Stratified K-fold Cross Validation to avoid overfitting. To optimize support vector machine (SVM) parameters we use Genetic Algorithm and Support Vector Machine (GA-SVM) model. SVM is applied to construct the classifier. An intelligent classification rate of 95,6522 % could be achieved using the support vector machine. Amitava Halder et. al. [2] proposed Brain Tumor Detection using Segmentation based Object Labeling Algorithm. This method extracts the tumor by using K-means algorithm followed by Object labeling algorithm. Also, some preprocessing steps (median filtering and morphological operation) are used for tumor detection purpose. It is observed that the experimental results of the proposed method gives better result in comparison to other techniques. A.R. Kavitha et.al. [3] presented An Efficient Approach for Brain Tumour Detection Based on Modified Region Growing and Neural Network in MRI Images . The technique consists of pre-processing, modified region growing, feature extraction of the region and final classification. The MRI image dataset taken from the publicly avail-able sources contains 40 brain MRI images in which 20 brain images with tumor and the other 20 brain images without tumour. The performance of .

III. ARCHITECTURE

Good image contrast can give better effect of vision, it is especially important for medical image where the slight anatomic or physiological feature may lead to different diagnostic result. The image contrast can be estimated by the range of gray level values occupied by the pixels in the histogram. It is usually not easy to acquire a digital image with full-range gray level using commercial products currently available. The general approach to serve the purpose in digital image processing is the histogram-modification technique. However, such an approach usually results in image distortion.

3.1. Steps of Digital Image Processing

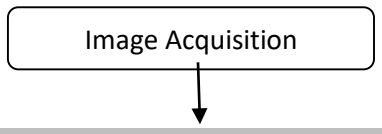
proposed technique is evaluated by considering the region growing algorithm and the modified region growing algorithm in terms of the quality rate. The tumour detection is evaluated through performance metrics namely, sensitivity, specificity and accuracy. Comparative analyses were made considering the normal and the modified region growing using both the Feed Forward Neural Network (FFNN) and Radial Basis Function (RBF) neural network. From the metrics obtained, it is seen that the proposed technique gives better results in terms of sensitivity, specificity and accuracy proving its effectiveness. D. Saraswathi et. al. [5] presented An Automated Diagnosis system using Wavelet based SFTA Texture Features. In this paper, Wavelet based SFTA Feature extraction technique (WSFTA) consists of two steps: (i) Initially the input image is decomposed into different frequency sub band images using 2-D Discrete Wavelet Transform, (ii) the texture features are extracted from the decomposed Low frequency image using SFTA (Segmentation based Fractal Texture Analysis). Two layered feed forward neural network is used for the classification of MRI brain images into normal or abnormal stages. Performance of this proposed technique is compared with GLCM and Haralick's texture feature in terms of MSE and classification accuracy. It also gives better accuracy and reduced MSE of 98.0% and 0.585 respectively. Thus, the resultant WSFTA technique performs more accurately than the previous works. J. Vijay et. al. [10] proposed An Efficient Brain Tumor Detection Methodology Using K-Means Clustering Algorithm. This paper describes an efficient method for automatic brain tumor segmentation for the extraction of tumor tissues from MR images. In this method segmentation is carried out using K-means clustering algorithm for better performance. This enhances the tumor boundaries more and is very fast when compared to many other clustering algorithms. The proposed technique produce appreciative results

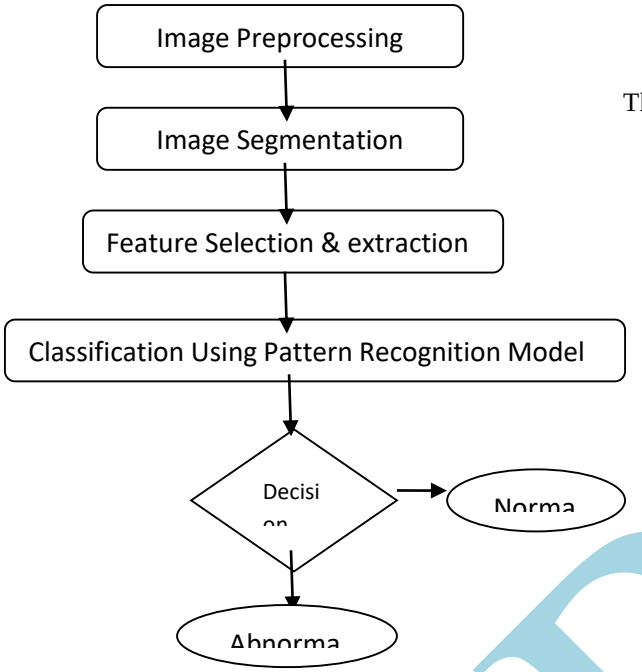
The basic steps of digital image processing

are as given as in this figure

a) Image Acquisition

First considered that the MRI scan images of a given patient are either color, Gray-scale or intensity images herein are displayed with a default size of 220×220. If it is color image, a Gray-scale converted image is defined by using a large matrix whose entries are numerical values between 0 and 255, where 0 corresponds to black and 255 white for instance. Then the brain tumor detection of a given patient consist of two main stages namely, image segmentation and edge detection.





b) Image Preprocessing

According to the need of the first level the preprocessing step convert the image. It performs filtering of noise in the image. RGB to grey conversion and reshaping also takes place here. It includes median filter for noise removal. The possibilities of arrival of noise in modern MRI scan are very less. It may arrived due to thermal Effect.

- Image Smoothing: It is the action of simplifying an image while preserving important information. The goal is to reduce noise or useless details without introducing too much distortion so as to simplify subsequent analysis.
- Image Registration: Image registration is the process of bringing two or more images into spatial correspondence (aligning them). In the context of medical imaging, image registration allows for the concurrent use of images taken with different modalities (e.g. MRI and CT), at different times or with different patient positions. In surgery, for example, images are acquired before (pre-operative), as well as during (intra-operative) surgery. Because of time constraints, the real-time intraoperative images have a lower resolution than the pre-operative images obtained before surgery. Moreover, deformations which occur naturally during surgery make it difficult to relate the high-resolution pre-operative image to the lower-resolution intra-operative anatomy of the patient. Image registration attempts to help the surgeon relate the two sets of images.
- Image Segmentation

The segmentation is the most important stage for analyzing image properly since it affects the accuracy of the subsequent steps. However, proper segmentation is difficult because of the great verities of the lesion shapes, sizes, and colors along with different skin types and textures. In addition, some lesions have irregular boundaries and in some cases there is smooth transition between the lesion and the skin. To address this problem, several algorithms have been proposed. They can be broadly classified as thresholding, edge-based or region-based, supervised and unsupervised classification techniques

- Threshold segmentation
- Water shed segmentation
- Gradient Vector Flow (GVF)
- K-mean Clustering
- Fuzzy C-means Clustering

c) Feature Extraction

Features, the characteristics of the objects of interest, if selected carefully are representative of the of the maximum relevant information that the image has to offer for a complete characterization of a lesion. Feature extraction methodologies analyze objects and images to extract the most prominent features that are representative of the various classes of objects. Features are used as inputs to classifiers that assign them to the class that they represent. The purpose of feature extraction is to reduce the original data by measuring certain properties, or features, that distinguish one input pattern from another pattern. The extracted feature should provide the characteristics of the input type to the classifier by considering the description of the relevant properties of the image into feature vectors. In this proposed method we extract the following features.

- Shape Features - circularity, irregularity, Area, Perimeter, Shape Index
- Intensity features – Mean, Variance, Standard Variance, Median Intensity, Skewness, and Kurtosis.
- Texture features –Contrast, Correlation, Entropy, Energy, Homogeneity, cluster shade, sum of square variance.

Accordingly, 3 kinds of features are extracted, which describe the structure information of intensity, shape, and texture. These features certainly have some redundancy, but the purpose of this step is to find the potential by

useful features. In the next step the feature selection will be performed to reduce the redundancy.
Feature selection is the technique of selecting a subset of relevant features for building robust learning models by removing most irrelevant and redundant features from the data, feature selection helps improve the performance of learning models by:

- Alleviating the effect of the curse of dimensionality.
- Enhancing generalization capability.
- Speeding up learning process.
- Improving model interpretability.

e) CLASSIFICATION TECHNIQUES
There are various classification techniques used for classifying brain as normal or abnormal . These classification techniques are described below :-

i) Artificial Neural Network :- In this technique, the image is mapped into a Neural Network. The neural network works in two phases- the training phase and the testing phase. Firstly the neural network was trained with training examples in the training phase. After training, the neural network is tested on the unknown instances. Neural network technique includes important step that is feature extraction. Feature extraction is very important as the features that are extracted forms the input part of the neural network.
Artificial Neural Network is divided into 2 categories:-
1. Feed-Forward Neural Network.
2. Recurrent Network or Feed-Backward Network.

In feed-forward neural network, the neurons are arranged in layers and they have unidirectional connections between them. They produce only one set of output values. They are called as static network because in this the output values are produced only based on current input. The output values does not depend on previous input values. They are also called as memory less network. In feedback network, the neurons have bidirectional connections between them. Feedback or Recurrent networks produce a set of values which depends on the previous input values. Feedback network is also known as dynamic network because the output values always depend on the previous input values. Back Propagation algorithm is used in feed-forward neural network. In this network, the neurons are arranged in layers and send the output in the forward direction. The errors generated are back propagated in the backward direction to the input layer. The network receives the input by neurons in the input layer of the neural network and the output of the network is given by the neurons on an output layer of the neural network. The neural network consists of one or more intermediate hidden layers. In back propagation algorithm, the supervised learning is used. The error between the input and the computed output is calculated and back propagated. The network is trained with random weights and then later the weights are adjusted by back propagation to get the minimal error. The network is perfect if the error is minimal. In back propagation, the weights are changed each time such that the error reduces gradually. This is repeated until there is no change in the error.
Advantages of artificial neural network :-

- The neural networks have high parallel ability and fast computing.
- Expert intervention is reduced during the whole process.

Disadvantages of artificial neural network :-

- Some of the information should be known beforehand.
- They should be first trained using learning process beforehand.
- Period of training neural networks may be very long.

ii) Fuzzy C-Means :- It is a method of clustering. In this method, one pixel may belong to two or more clusters which represents group. In this algorithm, the finite collection of pixels are partitioned into a group of "c" fuzzy clusters according to some given criterion. The objective function of this algorithm is defined as the sum of distances between cluster centers and patterns. Different types of similarity measures are used to identify classes depending on the data and the application in which it is to be used. Some examples which can be used as similarity measures are intensity distance and connectivity. **The algorithm contain following steps:-**

- Initialize the matrix M.
- Centers vectors are calculated.
- Perform K steps until the termination value is reached.

Advantages of fuzzy c-means :-

- It is very simple and fast algorithm.
- This algorithm is more robust to noise and provides better segmentation quality.

Disadvantages of fuzzy c-means :-

- It considers only image intensity values.

iii) Support Vector Machines(SVM) :-
SVM is a supervised classifier with associated learning algorithm. The SVM based on the training samples. It attempts to minimize the bound on the generalization error . The generalisation error is the error made by the learning machine on the test data not used during training phase. Thus, the SVM always performs well when applied to data which is outside the training set. SVM uses this advantage and focus on the training examples which are difficult to classify. These “borderline” training examples which are difficult to classify are called as support

vectors. SVM formulation is somewhat modified by adding least squares term in its cost function. It helps to circumvent the need to solve a more difficult quadratic programming problem and only requires the solution of a set of linear equations. This approach significantly reduces the complexity and computation in solving the problem of classification . It is based on the hyperplane and the hyperplane maximizes the separating margin among the two classes. Support Vector Machines (SVM) works in the two stages- the training stage and the testing stage. SVM trains itself by learning features which are given as input to its learning algorithm. During the training phase, SVM selects the suitable margins between its two classes. Artificial neural network has a number of issues like having local minima and selection of number of neurons for each problem. Thus, the SVM classifier has no local minima. SVM is a systematic and effective method for two class problems. The MRI brain images are classified into two separate classes such as normal class and abnormal class using SVM classifier. The SVM classifier method is better than rule based systems.

Advantages of support vector machines :-

- This algorithm has high generalization performance.
- It works well in case of high dimensional feature space.
- This algorithm works independent of the dimensionality of the feature space.
- The results given by support vector machines are very accurate.

Disadvantages of support vector machines :-

- The training time is very long.
- This algorithm is highly dependent on the size of data.

iv) K-Nearest Neighbour (KNN) :- The KNN algorithm is based on a distance function (Euclidean Distance) and a voting function is used for the k-Nearest Neighbours. The distance metric used is the Euclidean distance, It shows the higher accuracy and stability for MRI images than other classifiers. The KNN algorithm has a slow running time. The segmentation steps of KNN algorithm are as following :-

- Determine k value where k gives the number of nearest neighbors.
- Distance between query instance and all the training samples is calculated.
- On the basis of kth minimum distance , the distance is sorted.
- The majority class is assigned.
- The class is determined.
- The brain abnormalities are segmented.

Advantages of KNN algorithm :-

- KNN algorithm is fairly simple to implement.
- Real time image segmentation is done using KNN algorithm as it runs more quickly.

Disadvantages of KNN algorithm :-

- There is some possibility of yielding an erroneous decision if the obtained single neighbour is an outlier of some other class

Conclusion:

In this paper various automated brain tumor detection methods through MRI has been surveyed and compared. This

It is used to focus on the various combinations of techniques proposed by different people in medical image processing and their performances. This paper deals with the sequence of methods in image processing as i) Image Acquisition ii) Image Preprocessing iii) Segmentation iv) Feature Extraction and
Selection and v) Classification. Many algorithms have been proposed in the literature for each image processing stage. TheAdvantages & disadvantages of various classification techniques are discussed.

References

[1] A Kharrat, K. Gasmi, M. B. Messaoud, N. Benamrane and M. Abid, "Automated Classification of Magnetic Resonance Brain Images Using Wavelet Genetic Algorithm and Support Vector Machine", 9th IEEE Int. Conf. on Cognitive Informatics (ICCI'IO), pp. 369 - 374, 2010.

[2] Amitava Halder, Chandan Giri, Amiya Halder, Brain Tumor Detection using Segmentation based Object Labeling Algorithm, Electronics, International Conference on Communication and Instrumentation (ICECI), 2014 , IEEE Transaction, pp.1,4, 16-17 Jan. 2014

[3] A.R. Kavitha, Dr.C.Chellamuthu, Ms.Kavin Rupa, An Efficient Approach for Brain Tumour Detection Based on Modified Region Growing and Neural Network in MRI Images, International Conference on Computing, Electronics and Electrical Technologies [ICCEET], Pg No. 1087-1095, 2012

[4] Arati Kothari "*Detection and Classification of brain cancer using ANN in MRI images*" World journal of Science and Technology Vol.5, Pg.26-29, April 2013.

[5] D. Saraswathi, G. Sharmila, E. Srinivasan, An Automated Diagnosis system using Wavelet based SFTA Texture Features, IEEE conference on Information Communication and embedded systems (ICICES) , Pg. No. 1-5, 27-28 Feb 2014.

[6] Dr.M.Karnan, K.Selvanayaki, Improved Implementation of Brain MRI Image Segmentation

Using Meta Heuristic Algorithms, IEEE International Conference on Computional Intelligence and computing Research (ICCIC), pp: 1 -4, 2010.

[7] E. A. El-Dihshan, T, Hosney, A. B. M. Salem, Hybrid intelligence techniques for MRI Brain images classification, ELSEVIER, Digital Signal Processing, , Volume 20, pp.433-441, 2010

[8] Hari Babu Nandpuru, Dr. S. S. Salankar, Prof. V. R. Bora, MRI Brain Cancer Classifi-cation Using Support Vector Machine, IEEE Conference on Electrical, Electronics and Computer Science, Pg. No. 1-6, 1-2 March 2014

[9] Heena Hooda, Om Prakash Verma, Tripti Singhal , Brain Tumor Segmentation: A Performance Analysis using K-Means, Fuzzy C-Means and Region Growing Algorithm, IEEE International Conference on Advanced Commun-ication Control and Computing Techno-logies ICACCCT),pg.no. 1621-1626, 2014

[10] http://www.abta.org/secure/about-brain-tumors-a-primer.pdf

[11] J. Selvakumar, A. Lakshmi, and T. Arivoli, "Brain tumor segmentation and its area calculation in brain mr images using k-mean clustering and fuzzy c-mean algorithm," in Proceedings in IEEE-International Conference On Advances In Engineering, Science And Management, pp. 186-190, 2012.

[12] J. Vijay, J. Subhashini, An Efficient Brain Tumor Detection Methodology Using K-Means Clustering Algorithm, IEEE conference on Communication and Signal Processing, Pg. No. 653-657, April 3-5, 2013.

[13] Ishita Maiti, Dr. Monisha Chakraborty,'A new method for brain tumor segmentation based on watershed and edge detection algorithms in HSV colour model', IEEE National Conference on Computing and Communication Systems (NCCCS), pp. 1-5, Nov. 2012.

[14] K.B.Vaishnavee, K.Amshakala, An Automated MRI Brain Image Segmentation and Tumor Detection using SOM-Clustering and Proximal Support Vector Machine Classifier, IEEE International Conference on Engineering and Technology (ICETECH), 20th March 2015, Coimbatore, TN, India

[15] Madhusudhana Reddy, Dr. I Shanti Prabha. "*Novel Approach in Brain Tumor Classification using Artificial Neural Networks*", International Journal of Engineering Research and Applications, Vol. 3, Issue 4, August 2013.

[16] M. F. B. Othman, N. B. Abdullah, N. F. B. Kamal, "MRI brain classification using Support vector machine", IEEE, Centre for Artificial Intelligence & Robotics (CAIRO), 2011.

[17] Mohd Fauzi Othman and Mohd Ariffanan Mohd Basri , Probabilistic Neural Network For Brain Tumor Classification, IEEE Conference on Intelligent Systems, Modelling and Simulation, Pg. No. 136-138, 25-27 January 2011

[18] Mohamed Gouskir, Hicham Aissaoui , Benachir Elhadadi, Mohammed Boutalline and Belaid Bouikhalene, Automatic brain tumor detection and segmentation for MRI using covariance and geodesic distance, IEEE conference on Multimedia Computing and Systems (ICMCS), pg no. 490-494, 2014

[19] M. Murugesan and Dr. (Mrs.).R. Sukanesh "*Towards Detection of Brain Tumor in Electroencephalogram Signals Using Support Vector Machines*" International Journal of Computer Theory and Engineering, Vol. 1, No. 5,December, 2009

[20] M. U. Akram and A. Us man, "Computer aided system for brain tumor detection and segmentation," in Proceedings IEEE-International Conference on Computer Networks and Information Technology, vol. 1,2011, pp.299-302.

[21] Natarajan.P, Krishnan.N, "MRI Brain Image Edge Detection with Windowing and Morphological Erosion", IEEE International Conference on Computational Intelligence and computing Research, pp: 94-97, 2011.

[22] Natarajan P, Krishnan.N, Natasha Sandeep Kenkre, Shraiya Nancy, Bhuvanesh Pratap Singh, Tumor Detection using threshold operation in MRI Brain Images, IEEE International Conference on Computational Intelligence and Computing Research, Pg. No. 1-4, 18-20 Dec 2012.

[23] Parveen, Amritpal Singh, Detection of Brain Tumor in MRI Images, using Combination of Fuzzy C-Means and SVM, IEEE Conference on Signal Processing and Integrated Networks (SPIN), pg. no. 98-102, 2015

[24] Parveen, Anita Agarwal, Hybrid Approach for Brain Tumor Detection and Classification in Magnetic Resonance Images, IEEE Conference on Communication, Control and Intelligent Systems (CCIS), Pgno. 162-166, 2015

[25] R. Mishra, *MRI based Brain Tumor Detection using Wavelet Packet Feature and Artificial Neural Networks*, Department of computer science India Gandhi Institute of Technology Indraprastha University, Delhi, India, 2010.

[26] Said E. El-Khamy, Rowayda A. Sadek, Mohamed A. El-Khoreby, An Efficient Brain Mass Detection with Adaptive

Clustered based Fuzzy C-Mean and Thresholding, IEEE Conference on Signal and Image Processing Applications (ICSIPA), Pg. No. 429-433, 2015.

[27] Sridhar, D., Murali Krishna, I.V. "*Brain Tumor Classification Using Discrete Cosine Transform and Probabilistic Neural Network*" in "Signal Processing Image Processing & Pattern Recognition (ICSIPR), 2013

[28] S.U.Aswathy, Dr G.Glan Deva Dhas, Dr. S.S.Kumar, A Survey on Detection of Brain Tumor from MRI Brain Images, IEEE Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT), Pg. No. 871-877, 2014

[29] Sudipta Roy, Samir K. Bandyopadhyay ,'Detection and Quantification of Brain Tumor from MRI of Brain and it's Symmetric Analysis ', IEEE International Journal of Information and Communication Technology Research, vol. 2 No. 6, pp. 477-483, Jun. 2012.

[30] T.Logeswari, M.KARNAN, An Enhanced Implement-ation of Brain Tumor Detection Using Segmentation Based on Soft Computing, IEEE Conference on Signal Acquisition and Processing, Pg. No. 243-247, 2014

[31] T.Logheshwari, Dr. M. Karnan, 'Improved MRI image Segmentation using Ant Colony System', IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), pp.1-4, Dec.2010.

[32] Y. S. Raja, M. Shasidhar, and B. Y. Kumar, "Mri brain image segmentation using modified fuzzy c-means clustering algorithm," in Proceedings in IEEE-International Conference on Communication Systems and Network Technologies, pp. 473-478, 2011.

[33] Yehualashet Megersa, Getachew Alemu, Brain Tumor Detection and Segmentation Using Hybrid Intelligence, IEEE transactions in AFRCON, pg. no. 1-8, 16-17 sept 2015.

[34] W.Gonzalez, "Digital Image Processing", 2nd ed. Prentice Hall, Year of Publication 2008.

