

A Comparative Study of Segmentation Techniques used for Brain Tumor Detection from Pre-processed MR Images

Smita Zol¹, Dr. R. R. Deshmukh²

¹Department of Computer Science and Information Technology,
Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, MS-India

²Professor & Head, Department of Computer Science and Information Technology,
Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, MS-India

Abstract: *Image Segmentation is an important and challenging factor in the medical image segmentation. This paper presents comparative study of two techniques used for brain tumor detection from pre-processed MR Images. In one of the two methods, edge – based segmentation technique is used and in the other one brain tumor is detected by using segmentation based on soft computing with Hierarchical Self Organizing Map (HSOM).*

Keywords: Edge-based segmentation, color-based segmentation, HSOM, tumor detection.

1. Introduction

Brain cancer is among the diseases which are counted as the most deadly and intractable diseases. Tumors may be embedded in regions of the brain that are critical to orchestrating the body's vital functions, while they shed cells to invade other parts of the brain, forming more tumors too small to detect using conventional imaging techniques. Brain cancer's location and ability to spread quickly needs treatment with surgery or radiation.

Image processing techniques play a vital role in radiology. There are many computer-aided diagnosis systems which are used by doctors for disease monitoring, operation guiding, etc. Radiological evaluation becomes a very important factor for disease diagnosis and treatment. Without a correct segmentation method, accurate medical image analysis and classification for radiological evaluation or computer-aided diagnosis can not be provided. The quantification is based on accurate segmentation. To reach the goal that can assist and direct the doctor for diagnosis and treatment, a system should implement the algorithm of segmentation which could provide the most precise result as possible. At the same time, the system should adapt good interactive mechanism, such that segmentation could be under the user's control and give the feedback in the real time.

In this paper, we have studied methods for efficient detection of brain tumor from MR Images using edge detection technique and color based segmentation and using soft computing with HSOM.

Edge-based segmentation uses operators e.g. Sobel, Prewitt, Canny and Laplacian of Gaussian operators for implementation [1]. The color-based segmentation method uses Kmeans clustering algorithm. The color-based segmentation carefully selects the tumor from the pre-processed image as a clustering feature.

In the soft computing method by using HSOM, segmentation consists of two phases. In the first phase, the MRI brain image is acquired from patients database, In that film artifact and noise are removed. After that Hierarchical Self Organizing Map (HSOM) is applied for image segmentation. The HSOM is the extension of the conventional self organizing map used to classify the image row by row[2]. In this lowest level of weight vector, a higher value of tumor pixels, computation speed is achieved by the HSOM with vector quantization.

2. Brain Tumor

It is quite easy to remove a small tumor than a large one. About 60 percent of glioblastomas start out as a lower-grade tumor. But small tumors become big tumors. Low-grade gliomas become high-grade gliomas. Once symptoms appear, it is generally too late to treat the tumor. A brain cancer is a disease in which cells grow uncontrollably in the brain. Brain tumors are of two main types: 1) Benign tumors 2) Malignant tumors [3].

Benign tumors are incapable of spreading beyond the brain itself. Benign tumors in the brain usually do not need to be treated and their growth is self limited. In some cases, they cause problems because of their location and surgery or radiation can be helpful. Malignant tumors are typically called brain cancer. These tumors can spread outside of the brain.

Brain malignancies can be divided into two categories:

- Primary brain cancer originated in the brain.
- Secondary or metastatic brain cancer spreads to the brain from another site in the body.

Cancer occurs when cells in the body divide without control or order. Normally, cells divide in a regulated manner. If cells keep dividing uncontrollably when new cells are not needed, a mass of tissue forms, called a growth or tumor.

The term cancer usually refers to malignant tumors, which can spread to other parts of the body[3].

What is Image segmentation?

Segmentation subdivides an image into its constituent parts of objects, the level to which this subdivision is carried depends on the problem being solved. The segmentation should stop when the edge of the tumor is able to be detected. i.e. the main interest is to isolate the tumor from its background. The main problem in the diseases detection process is that the cancer cells near the surface of the MRI is very fatty, so appears very dark on the MRI, which is very confusing in the image processing. Image preprocessing is necessary before applying algorithms.

Why are ANN's Good for Segmentation?

MR images are large data sets with an important number of independent variables and complex relationships that usually show a nonlinear character that makes classical statistical methods particularly inappropriate for their analysis. This suggests that ANN is good candidates to analyze such MR data and classify different tissues in terms of texture, intensity or contrast.

Some studies like edge techniques and color segmentation show the potential and prove more convenient than traditional ANN approaches such as back-propagation ANN. Several research in brain MR image segmentation using neural networks has been suggested in literature. The use of Self Organizing Map (SOM) ANN based algorithms [2] in images shows excellent results in the classification of white matter, gray matter and cerebral spinal fluid (CSF). Algorithms using Texture features and neuro fuzzy classifier prove to be efficient for identification of diseases from medical images [3], particularly in the detection of abnormal issue with two or three channels data segmentation. In any case, it is of primary importance to establish methods to select the features used as input for these networks, which are usually obtained from the neighborhood of a certain number of pixels, which is especially critical in pixels located in boundaries of image segments [4].

3. Methods

3.1 Edge and Color Based Technique

This segmentation technique detects brain tumor from two-dimensional MR images. In this work, Sarbani Datta and Dr. Monisha Chakraborty [1] have applied preprocessing algorithm on MR images of brain to enhance the contrast. Subsequently, image segmentation methods e.g. edge-based method and pixel-based method are applied. The edge-based segmentation detects the tumor. The pixel-based segmentation technique detects the tumor from the pre-processed image as a clustering feature. Low computation aspect are maintained and resulted with a successful segmentation. Therefore, color-based K-means clustering segmentation on brain MR images for tumor detection has maintained efficiency.

3.1.1 Working

a) Pre-Processing

MR images are applied for evaluation of the proposed algorithm. The first step is histogram equalization. As perform the subtraction operation are to be performed, the original and the histogram equalized images are converted to double precision images. Subtraction image is obtained by subtracting the original image from the histogram equalized image. At the last, the subtracted image is complemented to get the preprocessed image. Histogram equalization takes advantage of the neglected pixel values and provides better definition and more information for the doctors.

b) Edge – Based Segmentation

Edge detection operators e.g. Sobel, Prewitt, Canny and Laplacian of Gaussian are used to perform on the complemented image. The developed algorithm automatically calculates the threshold for the images. Edge detection algorithms are able to detect the tumor region very well. The best algorithm among the Sobel, Prewitt, Canny and Laplacian of Gaussian is the Canny operator[1]. This algorithm detects the tumor well to help the doctors for treatment plan making. The operators are[1] -

Sobel Operator

The Sobel operator performs a 2-D spatial gradient measurement on an image. It gives the approximate absolute gradient magnitude at each point in an input grayscale image.

Prewitt Operator

Prewitt operator is similar to sobel operator. The Prewitt operator measures two components. The vertical edge and horizontal components are calculated with corresponding kernels.

Canny Operator

The Canny edge detection algorithm is known as an optimal edge detector based on a set of criteria which include finding the edges by minimizing the error rate, marking edges as closely as possible to the actual edges to maximize localization, and marking edges only once when a single edge exists for minimal response.

The first stage is smoothing the image by convolving with a Gaussian filter. This is followed by computing the gradient of the image by feeding the smoothed image through a convolution operation with the derivative of the Gaussian in both the vertical and horizontal directions[1].

Laplacian of Gaussian Operator

The Laplacian is a 2-D isotropic measure of the 2nd order derivative of an image. The Laplacian of an image highlights regions of rapid intensity change. This is the reason behind its often use for edge detection. First the image has to be smoothed with Gaussian filter and then The Laplacian is applied to image in order to reduce its sensitivity to noise. The operator takes a single gray level image as input and produces another graylevel image as output.

c) Color – Based Segmentation

In this method, initially, the pre-processed gray-level brain MR image is converted into RGB color image. The RGB

color image is then coarsely represented using 25 bins. The spatial information from a histogram based windowing process is used by Coarse representation. In this method, K-means clusters the coarse image data. The tumor region is identified significantly by segmentation.

d) Pixel-based Segmentation

K-means is partitions data into k clusters. It is used widely for clustering data. Clustering is the process for grouping data points with similar feature vectors into a single cluster and for grouping data points with dissimilar feature vectors into different clusters. The generalized algorithm initiates k cluster centroids by randomly selecting k feature vectors from X. Later, the feature vectors are grouped into k clusters using a selected distance measure such as Euclidean distance. The next step is to recompute the cluster centroids based on their group members and then regroup the feature vectors according to the new cluster centroids. The clustering procedure stops only when all cluster centroids tend to converge.

3.2 Detection of Tumor Using Soft Computing

Artificial Neural Networks (ANNs) are made up of a parallel interconnected system of nodes, called neurons. The parallel action is a difference between von Neumann computers and ANNs. Different ANN systems are made by combining ANN architectures with different learning schemes. The proper ANN is obtained by taking into consideration the requirements of the specific application, as each ANN topology does not yield satisfactory results in all practical cases. T.Logeswari and M.Karnan [2], have proposed a new unsupervised learning optimization algorithms such as SOM which are implemented to extract the suspicious region in the Segmentation of MRI Brain tumor. The textural features can be extracted from the suspicious region to classify them into benign or malign.

3.2.1 Working

a) Preprocessing

The MRI image consists of film artifact. Film artifact tracking algorithm is used to remove it. It starts from the first row and the first column with removing the intensity value, greater than that of the threshold value from MRI. The high intensity values of film artifact are removed from image. At the time of removal of film artifacts, the image consists of salt and pepper noise.

At the enhancement stage, high intensity component and the above noise are removed.

This part is enhances the smoothness towards piecewise-homogeneous region and reduces the edge blurring effects. This system describes the information of enhancement using weighted median filter for removing high frequency component.

b) Segmentation using HSOM

A self-organizing map consists of components called nodes or neurons. A weight vector of the same dimension as the input data vectors and a position in the map space are associated with each node. Nodes are arranged in a regular spacing in a hexagonal or rectangular grid. The self-

organizing map gives a mapping from a higher dimensional input space to a lower dimensional map space.

A vector from data place is placed onto the map by finding the node with the closest weight vector to the vector taken from data space. Euclidean distance to all weight vectors is computed. Among all of these, the neuron with weight vector most similar to the input is called the best matching unit (BMU). The weights of the BMU and neurons close to it in the SOM lattice are adjusted towards the input vector. The magnitude of the change decreases with time and with distance from the BMU.

This process is repeated for each input vector for a large number of cycles. The network winds up associating output nodes with groups or patterns in the input data set. If these patterns can be named, the names can be attached to the associated nodes in the trained net.

4. Conclusion

In this paper, two methods which are used for brain tumor detection are studied. First method is color-based segmentation and the other one is using soft computing with HSOM. Both the methods can detect the brain tumor and thereby help the doctors for analyzing tumor size and region.

Color-based segmentation uses K-means clustering for brain tumor detection. This method shows better result than Canny based edge detection. The method will help the doctors for diagnosis in a better way by reducing the subjectivity and miss rate in brain MR images and thereby will enhance the tumor detection accuracy in less time.

In HSOM, the algorithm works with weight vector, execution time and tumor pixels. The target area is segmented and this tool helps the doctors in diagnosis, the treatment plan making and state of the tumor monitoring. In future, the system should be improved by adapting more segmentation algorithm to suit the different medical image segmentation.

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Author Profile



Smita Zol received M.C.A.(Science) from University of Pune in 2008. Currently undergoing Ph.D. from Dr. Babasaheb Ambedkar Marathwada University, Aurangabad., MS-INDIA



Dr. R. R. Deshmukh has done M.E. (CSE), M.Sc. (CSE) Ph.D. FIETE, Presently working as Professor & Head, Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, MS-India. He was Member of Management Council of Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, MS-India. He is Chairman IETE Aurangabad Centre, Chairman of Ad-Hoc Board of Studies in Computer Science and IT and Bioinformatics, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, MS-India. He is Member of Ad-Hoc Board of Studies in Computer Engineering of Mumbai University, Mumbai. He is Member of Board of Study Computer Science, Solapur University, Solapur. He is a Fellow of IETE, Senior member of IEEE, Life member of ISCA, CSI, ISTE, ACEEE, IaENG, CSTA and IDES. He has edited of nine books and published more than 95 research papers in reputed Journals, National and international conferences. He is reviewer and editor of several journals at national & international level. He has organized several workshops and conferences. He is nominated as a subject expert on various academic & professional bodies at national level government bodies. He is Faculty member for Engineering, Science & Management Faculty & Member of various committees at university level. He has two research project projects from UGC and received grants more than 13 Lakhs. His areas of specialization are Human Computer Interaction (HCI), Data Mining, Data Warehousing, Image Processing, Pattern Recognition, Artificial Intelligence, Computational Auditory Scene Analysis (CASA), Neural Networks etc. He won First prize in Inter University State Level Research Festival "AVISHKAR - 2009" under H. L. F. A. category at Teacher level & for the Team Management.