A Research on Brain Tumor Detection using Fast Marching Method Algorithm

Chitralekha Magre[1]

[1]*Student, Department of Electronics and Telecommunication, Deogiri Institute of Engineering and Management Studies, Aurangabad, Maharashtra, India*

Abstract - *In the past seven decades the cases of brain tumor has increased exponentially. The growth of abnormal mass of cells into the brain is essentially classified as a tumor. There are various types of tumors. Some brain tumors are noncancerous known as benign while some other brain tumors are cancerous known as malignant. The growth rate, size and the location of a brain tumor is the determining factor in how it will affect the function of the nervous system. Brain tumor treatments solely depends on the type of brain tumor one has, as well as the specified size and location of it. In this paper, an effort has been made to present a new approach of brain tumor detection using the fast marching method algorithm for faster results with greater accuracy.*

Key Words: Fast Marching Method, Matlab, Brain Tumor Detection, MRI.

1. INTRODUCTION

This James Sethian invented the Fast Marching Method Algorithm, a mathematical technique utilized for tackling limit condition issues, boundary level problems and uneven intensity distribution, by making the use of Eikonal Equation. Essentially, this calculation manages the extension (development) of shut closed surfaces as an element of speed and time from boundary to the point x on a surface. In the FMM, the surface grows until a limit is reached by characterizing introductory conditions. A similar rule is applied in the division of the cerebrum tumor. In this step we take the images from the dataset of our reference and the image that we acquired from the test images dataset and we divide it into smaller areas known as tiles. Each tile is compared and upgraded to make the yield area match able. This takes out any misleading limits and further improve the visibility level of the foggy images. To detect tissue boundaries from local information that is provided, edge detection is a primary approach to take into consideration.

2. RELATED WORK

A lot of methods have been implemented till date for the purpose of brain tumor detection. Segmentation and thresholding approaches are the most common among them. These are as follows-

1) Approaches involving Thresholding

2) Approaches involving region growing algorithm

3) Approaches involving the genetic algorithm

4) Approaches involving clustering

5) Approaches involving the neural networks

After doing an initial intensity normalization of an MRI image, an affine alignment is performed, where the unsegmented image is meticulously being compared to that of a segmented standard brain used for reference. Probabilistic diffusion followed by the probability measures between grey matter, white matter and the cerebro spinal fluid, is the further performed in that order to suppress any influence of the extra-cerebral tissues present in the brain. To detect tissue boundaries from local information that is provided, edge detection is a primary approach to take into consideration. Although, since the contrast may vary substantially in an Magnetic resonance image of the brain, in general it will not be possible to find thresholds and scale levels that lead to the desired connected edges that separate different tissues into connected regions. A more defined approach was considered by (Zeng et al. 1999), who developed an edge detector aimed at detecting only edges that correspond to boundaries between pre-defined tissue types, for e.g. between cerebrospinal fluid and the white matter. To avoid this possible negative influence of spurious high values in the original MR image, an intensity normalization was performed prior to the affine normalization. As a result of this transformation, brain segmentation image is obtained without encountering any unnecessary changes or alterations in the physical qualities of the main brain MR image. This image processing entails image enhancement using histogram equalization, edge detection and segmentation process to take patterns of brain tumors, so the process of making computer aided diagnosis be easier. The downfall of it is false positive and false negative.

3. BRAIN TUMOR DETECTION USING FAST MARCHING METHOD

The detection of tumor is performed in two phases: Pre processing and Enhancement in the first phase and training and classification in the second phase.

3.1. IMAGE ACQUISITION

For the purpose of this research, MRI Images were acquired from the Government Medical Hospital and College, Aurangabad, Maharashtra, India. This dataset of MRI Images were then further divided into database images and the test images. Along with that multiple other reliable online sources were also used to collect more dataset to check the accuracy of the proposed system.

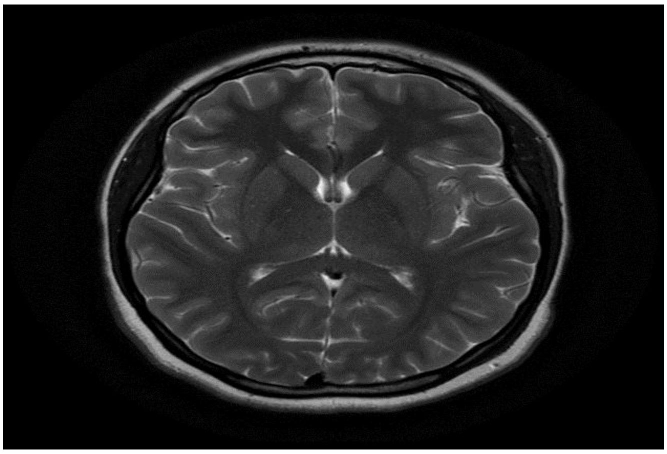

Fig-1: An acquired MRI Image of the human brain

The pictures are further ideally resized to 512x512 pixel. MR pictures contain commotion and the expulsion of clamor is an essential advance in division measure. PSNR and MSE of the pictures are improved utilizing separating measures. The difference of the MRI pictures are upgraded utilizing Contrast restricted versatile histogram Equalization (CLAHE).

3.2. PRE-PROCESSING AND ENHANCEMENT

The MR Images need to be resized, grayscale converted and further go through the removal of internal and external noise. For the purpose of noise removal wiener filter and Gaussian filter have been used. Magnetic resonance imaging images makes use of the radiofrequency and the magnetic field to determine a tumor image in the human body without any ionized radiations. This is also considered as the very first step for understanding the brain image. It also involves an entropy partition on a two-dimensional histogram where a 2-D entropy is first defined, and the fast marching algorithm is further executed to find the optimal result. The below criteria should be considered:

- Aligning individual brains to a standard anatomical format.
- delimiting the extra volume in the brain where statistical measurements of brain activation are to be performed

3.3. LOADING THE DATABASE

In this step we are taking the entire dataset and performing the same resizing operation, noise removal operation and grayscale conversion operation onto it. This is to ensure that both the database images and the test image are denoised and well aligned in order to be compared with their respective thresholds. The below figure shows it's implementation in the Probabilistic neural network of the Matlab Software.

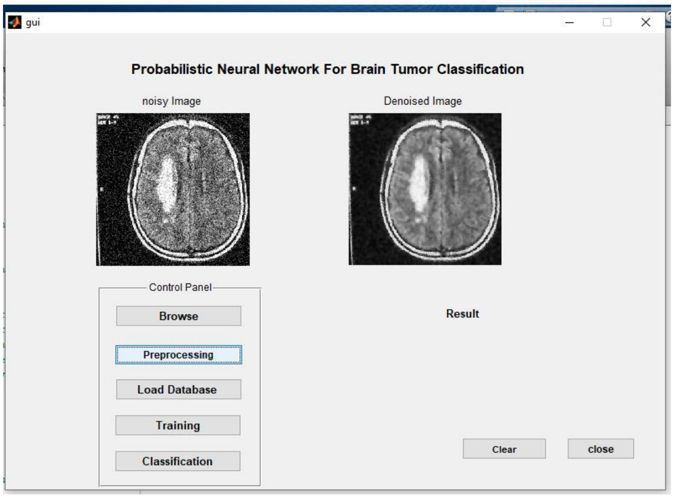

Fig-2: Enhancement of the test image and dataset images

We can say that the Gaussian channel performs better in evacuation of noise for the pictures considered in this paper. It can likewise be derived that the PSNR esteem for the Gaussian channel is better contrasted with different channels and MSE is additionally diminished in the pictures sifted with Gaussian channel.

3.4 FAST MARCHING ALGORITHM

It uses the eikonal equation, which is essentially a non linear differential equation that provides a link between the physical optics that is the wave and the geometric optics respectively.

$$|\nabla u(x)| = \frac{1}{f(x)}, x\varepsilon\Omega$$

In the above equation, the terms are explained as under:

Ω: It is an open set with a well behaved boundary.

f(x); Function with positive values. It is also considered as the input.

∇: It denotes gradient.

U(x): Shortest time needed to travel from the boundary to the point 'x'

We basically take the image of the brain, then we divide it into nodes and assign every node a value. The value of u(x)=0, for the boundary set nodes. In simple terms it is the expansion of a closed surface as a function of speed and time. The surface expands until a boundary is reached. This way the system considers the gradient weight of each pixel value. The MRI pictures with the Brain tumor for the examination reason for existing were taken from Government Medical Hospital in Aurangabad, 431002. The data base consists of numerous modalities of MRI, such a T1-differentiation, T1 and T2 - weighted.

3.5. CLASSIFICATION OF TUMOR

After performing the above steps on the acquired image and doing the required morphological operations onto it, we can finally have a final classification on the type of tumor the acquired image has. Now, there are three possible cases. The tumor in the brain can either be benign or malignant. If both of them aren't the case, then the MR image that we acquired is the image of the normal human brain. From the given image we can see that the MR image that we acquired from our test image dataset is that of a benign tumor.

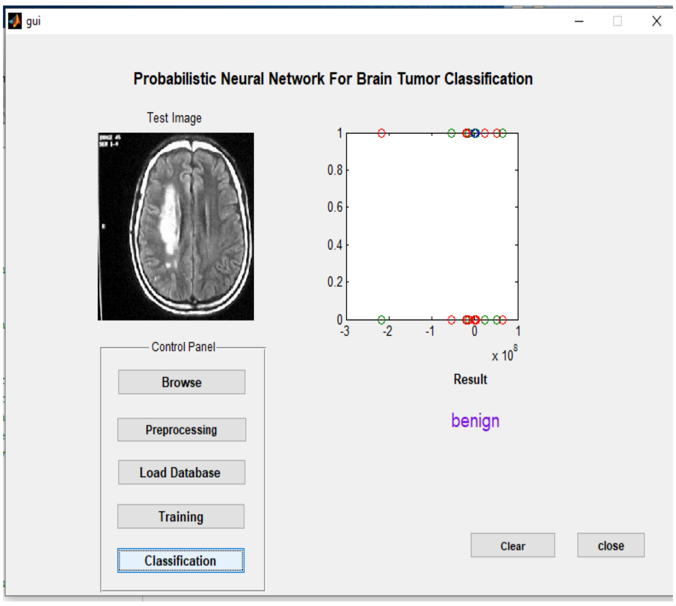

Fig-3: Classification of Tumor

Due to the alignment of the input image to a standard anatomical brain, we can use a manual pre-segmentation of the standard brain into different tissue types (white matter, grey matter, cerebrospinal fluid and bone) as an initial estimate of the segmentation that is to be computed. In particular, since the volume of the transformed brain ideally will be equal to the volume of the standard brain, we can initially assume that the volume of white matter, grey matter and cerebrospinal fluid is equal in these two brains. This proves to us the system has performed all the required steps and followed the fast marching algorithm method to arrive at this conclusion.

4. CONCLUSIONS

In this paper, classification and detection of the human brain tumor from MRI images is accomplished by utilizing Fast walking technique (FMM) by determining the slopes dependent on loads of every pixel in a picture. The pictures were separated utilizing a Gaussian channel to eliminate the Speckle commotion. CLAHE was applied to improve the difference of the pictures. Nature of the pictures was assessed utilizing various measurements like SSIM, PSNR, and MSE. Early conclusion and treatment of cerebrum tumor is the primary factor in the field of Healthcare. X-ray is utilized for imaging various pieces of the body. With the ongoing advancements in the field of picture preparing, PC helped examination of the pictures is an extremely key viewpoint in the identification of the mind tumor. A general exactness of 98.83 % was accomplished utilizing this calculation. Dice coefficient was utilized to gauge the likeness between the ground truth picture and portioned picture. Henceforth this calculation can be utilized for division of Brain Tumor. This system can be used in variety of detection techniques. Some of it's advantages are listed below:

1. Accurate Detection of brain tumor.
2. Exact analysis of the size of the tumor.
3. Better computational speed of segmentation.
4. Prevents false detection.
5. Faster Operations.

The high accuracy is desirable as human life is involved. Automated defect detection in medical imaging has become the emergent field in several medical diagnostic applications. Automated detection of tumor in Magnetic Resonance Imaging (MRI) is very crucial as it provides information about abnormal tissues which is necessary for planning treatment. As compared to the earlier techniques of brain tumor detection, we can confidently say that the fast marching algorithm is the most accurate and fast acting technique that can be implemented in the detection and classification of the brain tumor.

REFERENCES

[1] 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, 2012.

[2] Dipali M. Joshi, N. K. Rana, V. M. Misra, "Classification of Brain Cancer Using Artificial Neural Network", IEEE International Conference on

Electronic Computer Technology ,ICECT ,2010.

[3] Deepthi Murthy T.S. and G.Sadashivappa, "Brain Tumor Segmentation Using Thresholding, Morphological Operations And Extraction Of Features Of Tumor," International Conference on Advances in Electronics, Computers and Communications (ICAECC), pp. 1-6, Oct. 2014

[4] Aastha Sehgal, Shashwat Goel , Parthasarathi Mangipudi, Anu Mehra , Devyani Tyagi "Automatic Brain Tumor Segmentation And Extraction In MR Images "2016 Conference on Advances in Signal Processing (CASP) Cummins College of Engineering for Women, Pune. Jun 9-11, 2016. ISBN-978-1-5090-0849-0/16.

[5] Kai xiao,A.Lei Liang, Hai Bing Guan, Aboul Ella Hassanien,"Ext ract ion and Application of Deformat ion Based Feature in Medical Images", ELSEVIER Neuro comput ing 2013

[6] Sumitra, Saxena "Brain Tumor Classification Using the Back Propagation Neural Networks" ,I.J.Image, Graphics and Signals pre and post Processing, 2013,2,45-50

[7] Mehdi Jafari & Reza Shafaghi,"A Hybrid Approach for Automatic Tumor Detection of Brain MRI Using Support Vector Machine And Genet ic Algorithm" Global Journal of Science, Engineering and Technology(ISSN:2332-2441) ,2012

[8] A. Ruby Catharin, A. Sadeesh Kumar, M. Rakshiga, Sahana Kumaresan*, N.Sri Madhava Raja"Examination of Glioblastoma Images by Thresholding using Heuristic Approach"IEEE sponsored 4th International Conference on Biosignals, Images and Instrumentation, SSNCE, Chennai.ISBN 978-1-5386-4473-7

[9] Ashima Anand" Brain Tumor Segmentation using Watershed Technique and Self Organizing Maps"Indian Journal of Science and Technology, Vol 10(44), DOI: 10.17485/ijst/2017/v10i44/120574, November 2017 ISSN (Print) : 0974-6846 ISSN (Online) : 0974-5645

[10] Radiopaedia:https//radiopaedia.org/articles/ brain-tumours

[11] J Y. Zhang, Z. Dong, L. Wu, and S. Wang, "A hybrid method for MRI brain image classification," Expert Systems with Applications, vol. 38,no. 8, pp. 10 049 10 053, 2011.

[12] M.H Fazel Zarandi , M.Zarinbal,M.Izadi ,"Syst ematic Image processing for diagnosis Brain Tumor :A type II expert system approach",ELSEVIER applied soft compu ing 11(2011) 285 -294

[13] Yudong Zhang, Zhengchao Dong, Lenan Wu " A Hybrid Met hod for MRI Brain Image Classificat ion", ELSEVIER Expert Syst em with Applicat ion 38 (2011) 10049-100

[14] Pantelis georgiadis, Dioisis cavouras,Menelaos Malamas," Improving Brain Tumor Characterizat ion On MRI By Probabilist ic Neural Network and Non Linear Transform of Texture Feature", ELSEVIER :computer methods and program in Biomedicine 2008

[15] C. Ramalakshmi,A.Jaya Chandran,"Aut omat ic Brain Tumor Detect ion in MR Images Using Neural Network Based Classificat ion",int Journal of science research and management (IJSRM)volume Issue 2IIpages 109-113II2013