ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Vol 11, Issue 8, August 2024

Comparative Analysis on Contour Detection of Cancerous Region from Brain Cancer MRI

[1] Dr.Akshita S. Chanchlani, [2] Dr.Vijay M Wadhai, [3] Dr.Vilas M.Thakare

[1] Department of Computer Science and Engineering,
Dr. Vishwanath Karad MIT World Peace University (MIT-WPU), Pune, India
[2] President, Cyber Security Pune Corporation
[3] Departments of CSE, Ex. Head of Department, SGBA University, Amravati, India
Corresponding Author Email: [1] akshita.chanchlani@mitwpu.edu.in, [2] drwadhai.vijay@gmail.com,
[3] vilthakare@yahoo.co.in

Abstract*— Image extraction or countering is the process of identifying structural outlines of objects in image that can help to detect the object shape. Image segmentation is process that plays important role to interpret a picture very well. Segmentation process is simplifying the image as a group of segments that collectively covers the complete image or a group of contours extracted from the image. It also separates the image into multiple segments (set of pixels) and each segment possesses different features like texture, color, intensity and many statistical properties. For any image to be processed, segmentation is a prime task to visualize the ROI (Region of Interest). Accurate segmentation is required in crucial areas as medical image retrieval where it may contribute to save and protect human life. This paper focusses on implementation of algorithms for identifying brain tumor in MR images, furthermore it involves applying noise removal techniques followed by enhancing the images using image segmentation. This paper is focused on applying segmentation techniques for finding suspicious region in Brain Cancer Magnetic Reasoning Image (MRI). Further the contours are highlighted from the brain cancer MRI using edge-based segmentation. To do this, first detection of the edges of features is performed using Canny edge-detector further region-based method is applied using watershed transform. Finally, the comparative analysis is depicted between various segmentation technique regarding the contour detection.

Keywords: Machine Learning, Brain Cancer MRI, Image Contouring, Pre-Processing, Image Segmentation.

I. INTRODUCTION

A brain tumor is a collection of abnormal cells in the brain. A tumor may lead to cancer, which is a major leading cause of death and responsible for around 11% of all deaths worldwide. Magnetic Resonance Imaging (MRI) is a medical imaging technique in radiology to form images of the anatomy and the physiological processes of the body as it offers better visualization. To enhance the image and to extract meaningful insight from an image various image processing technique can be performed. Machine learning (ML) is a subfield of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

The main goal of image segmentation is to partition the image into a group of disjoint regions that are visually different, homogeneous and meaningful with respect to some characteristics for example grey level, texture or color to enable image analysis (object identification, classification and processing) easily. Image Segmentation consist of various methods that vary according to various applications as a single segmentation method cannot produce the desired result. It is because the images have different property and many other factors also like noise, brightness etc. these factors put impact on the images, and it is not possible to apply a single segmentation method and also a single evaluation technique for all types of imagery. Image contouring is to find structural outlines of objects in an image that can help to identify shape of the object. Contours can be defined as a curve joining all the continuous points (along the boundary), having same color or intensity. The contours can act as a useful tool for shape analysis, object detection and recognition.

This paper focuses on implementation of edge based and region-based segmentation using canny edge detection and watershed algorithm respectively on brain cancer MRI to detect the contour and region. Further this paper also analyzes the results of various segmentation algorithms, using the subjective evaluation, on the Brain Cancer MRI images and particularly on gray level images. Paper is organized as in different sections. Initially the survey on various segmentation techniques is performed. Further a short survey on Various Image modalities, Preprocessing Techniques on images and Machine Learning are mentioned. Next section presents the implementation details about proposed methodology on brain cancer MRI using python. Finally before the conclusion remark the result of Image Segmentation (Region based and Edge based Segmentation) is depicted in the diagrams along with comparative analysis.

II. SURVEY ON SEGMENTATION TECHNIQUES ON BRAIN MRI

In past, various machine learning based segmentation approaches were proposed based on the criteria of either

ISSN (Online) 2456 -1304
International Journal of Science, Engineering and Management (IJSEM)
Vol 11, Issue 8, August 2024

similarity measurement or dissimilarity analysis. [1] Adaptive K-Means Clustering is implemented with 98% of accuracy, the authors have performed MRI image enhancement and Tumor Segmentation for brain on one single MRI sequence. Also FCM, K-means has been developed as unsupervised learning machine learning algorithm with 76% accuracy. [1] Brain Tumor Segmentation using Wavelet Multi-resolution Expectation Maximization Algorithm has given 95% of accuracy and finally 90% , 80% and 73% accuracy is predicted in Concatenated and Connected Random Forest with Multiscale Patch-driven Active Contour Model.

III. PREPROCESSING TECHNIQUES ON IMAGE

Various Image Modalities

There are different image modalities for detecting image such as Digitized X-ray, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Ultrasound (US), Positron Emission Tomography (PET), Nuclear Medicine (NM), Radiation Therapy. An X-ray is beam that circulates around specific part of the body and a series of images captured from various angles. CT scans uses X-rays that emits ionizing radiation and have the potential to affect living tissues, thereby increasing the risk of cancer. MRI is a radiation free and it is a safer imaging technique than CT. MRI provides finer details of the brain, spinal cord and vascular anatomy due to its good contrast. MRI is able to visualize the anatomical structure of the brain. Biopsies are the gold standard for all cancer diagnosis and grade estimation. In a biopsy, the color, shape, and size of the cell nuclei of tumor sample are observed. Biopsy is the primary test for diagnosis & stage confirmation.

Computed Tomography Imaging (CT)

An X-ray beam circulates around specific part of the body and a series of images captured from various angles. CT scans use X-rays which emit ionizing radiation and have the potential to affect living tissues, thereby increasing the risk of cancer.

Positron emission tomography (PET)

It is a variant of CT where a contrast agent is injected into the body in order to highlight abnormal regions.

Magnetic Resonance Imaging

MRI is a radiation free and therefore a safer imaging technique than CT and provides finer details of the brain, spinal cord and vascular anatomy due to its good contrast. MRI is able to visualize the anatomical structure of the brain.

Biopsy

Biopsies are the gold standard for all cancer diagnosis and grade estimation. In a biopsy, the color, shape, and size of the cell nuclei of tumor sample are observed. Biopsy is the primary test for diagnosis & stage confirmation.

Image Preprocessing Techniques

Image processing is a to perform various operations on an image. Image processing helps for enhancing an image or for extracting some useful information from it. It is process that takes input as an image and generates the output that can be image or characteristics/features associated with that image. [3]

Image processing basically follows three steps:-

1. Importing the image from image dataset through image acquisition tools.
2. Analyzing and manipulating the image as per processing need.
3. Output in which result can be altered image or an image analysis.

Table 1 presents various preprocessing methods with its advantages and disadvantages.

Table 1. Image Preprocessing Methods

Preprocessing Method	Advantages	Disadvantages
Adaptive Histogram Equalization (AHE)	1. Suitable for enhancing the edges in each region of an image. 2. Removes associated dark black edge pixels and labels.	1. Over-amplifies noise in relatively homogeneous regions of an image. 2. Unable to retain the brightness with respect to the input image.
Median Filter	1. It maintains the sharpness of the picture boundaries. 2. Effective in non-linear smoothing.	1. It can't distinguish fine details from the noise
Adaptive Median Filter	1. It can handle impulse noises with larger probabilities. 2. It preserves the details, and smoothen the non-impulse noises. 3. It reduces distortion, like excessive thinning or thickening of object boundaries.	1. It distinguishes fine details from the existing noise in the images to a limited extent.

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Vol 11, Issue 8, August 2024

Preprocessing Method	Advantages	Disadvantages
Weiner Filter	1. It de-blurs and removes the additive noise from the image simultaneously. 2. It is used to measure the contrast between original image and low-pass filter image. 3. It minimizes the Mean Squared Estimation (MSE) error.	1. This filter assumes that the process dynamics are linear. 2. It can handle additive and unimodal noise only.
Gaussian Filter	1. Fast processing, 2. More effective while smoothening is applied on the images.	1. It might not preserve image brightness. 2. Not particularly effective at removing salt and pepper noise.

Machine Learning

Machine Learning is used in different domains. The general idea behind most machine learning is that a computer learns to perform a task by studying a training set of examples. Two of the most widely adopted machine learning methods are supervised learning and unsupervised learning. Supervised learning algorithms are trained using labeled examples, such as an input where the desired output is known. Unsupervised learning is used against data that has no historical labels. The system is not told the "right answer." The algorithm must figure out what is being shown. The goal is to explore the data and find some structure within. Research in this area attempts to make better representations and create models to learn these representations from large-scale unlabeled data. Various deep learning architectures such as deep neural networks, convolutional deep neural networks, deep belief networks and recurrent neural networks have been applied to fields like computer vision, automatic speech recognition, natural language processing, audio recognition and bioinformatics where they have been shown to produce state of-the-art results on various tasks.[5] [6]

Digital image processing is a rising field for the investigation of complicated diseases such as brain tumor, breast cancer, kidney stones, lung cancer, ovarian cancer, and cervix cancer and so on. The recognition of the brain tumor is considered to be a very critical task. Machine Learning and Deep Learning algorithms are mainly used for analyzing the medical images which can identify, localize and classify the brain tumor into sub categories, according to which the diagnosis would be done by the professionals. [7]

IV. PROPOSED METHODOLOGY

Proposed Paper represents implementation of two image segmentation techniques one is region based and second edge-based segmentation on brain cancer MRI image for detection of region of interest. A brain tumor is a collection, or mass, of abnormal cells in your brain. Symptoms of brain tumors depend on the location and size of the tumor. Detection of tumor at early stage is very crucial. MRI is for detection of brain cancer. Further MRI images can be analyzed, But the analysis process of MRI is very time consuming for vast number of cases[9][10]. For this paper the dataset that is acquired is from various online resources.[11][12] Kaggle brain cancer MRI dataset is used where grayscale brain MRI as an input and results with a tumor outlined output.

Figure 1 represents the proposed methodology for comparative analysis on brain cancer MRI. These algorithms are implemented using python programming language.

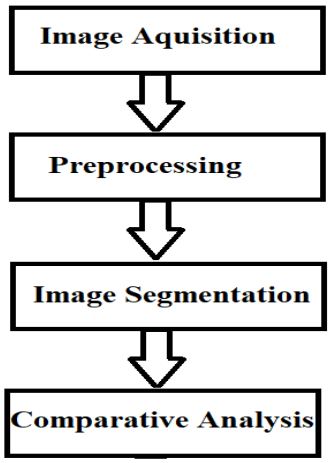


Figure 1: Proposed Methodology

Image Acquisition

Image Dataset (gathered images) that are made generic to the system because images acquired through MRI are of different color, grayscale or intensity and with different image sizes, to process these images using machine learning algorithms the image dataset has to be uniform. So for this purpose the image dataset is converted to 256 X 256 grayscale images using python opencv package.

Preprocessing

As MRI image dataset is captured from various sources and various systems so Image preprocessing is the prime task that is to be performed. Once the image dataset is ready then its next step is to preprocess the image. At this stage acquired and resized grayscale images acts as input for preprocessing using various techniques. The purpose of this method is to

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Vol 11, Issue 8, August 2024

improve the quality of the MRI and transform respectively for further processing. Preprocessing also helps to improve certain parameters of MR images such as improving the signal-to-noise ratio, enhancing the visual appearance of MR image, removing the irrelevant noise and undesired parts in the background while preserving the edges.

Image Segmentation

Image segmentation is a set of regions that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Image segmentation techniques are characterized into two categories: edge based also called as discontinuity approach and region based also called as similarity approach . Edge Based Segmentation technique is based on the discontinuity property of pixel, separate the image based on the sudden changes in intensity and it also includes boundary or edge-based techniques. Region based segmentation method is based on similarity and homogeneity that partitions the image by constructing the groups which are very analogous to each other. For this technique various algorithms like Thresholding, merging, region splitting and region growing are used.

a). Edge Based Segmentation

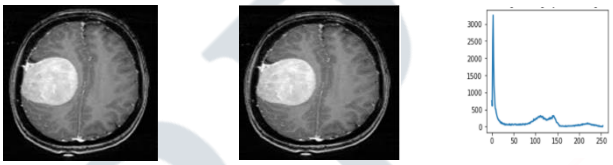
The first Technique of image segmentation is Edge detection. This technique is mainly used for object detection. Edge detection technique is built on the discontinuities in image values between different regions and highlights intensity changes. The major types of discontinuities that can occur in gray scale images are Point, line and edges. Edges generally composed with the pixels in the image where the gray value changes drastically from one pixel to another. Using edge detection operators, edge information can be fetched from the image and transform original image into edge images. Generally filtering, enhancement and detection of edge points are the three main steps to carry out edge detection process. In Edge based segmentation, canny edge detection algorithm is implemented for delineating the contours of the image. However, edge based segmentation is not so robust. So region based segmentation has been implemented further.

b). Region Based Segmentation

The another technique, Region based technique is also known as “similarity based segmentation” that is for finding out the region directly. It partitions an image into uniform sub-regions based on properties like texture, color, intensity etc. Pixels belong to same intensity characteristics and closed to each other can be group together and assumed to be in same object. Region comprises more information because it covers more pixels than edges. In noisy images where edges are difficult to fetch, region growing technique is can be applied. Watershed algorithm, region split and merge algorithm and region growing algorithm are the some commonly used methods of region based technique. This paper focuses on implementation of watershed algorithm, that is one of the technique of region-based method. This method works better than edge detection.

V. RESULTS

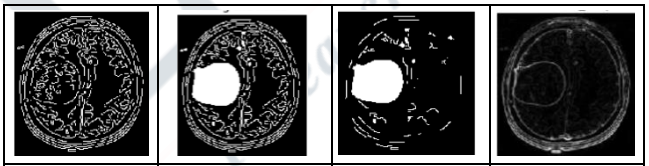
Figure2 represents the original brain cancer MRI, preprocessed image gray scaled image and represents histogram of gray scale image.



Original Brain Cancer MRI Image | Gray Scaled Image (Preprocessing) | Histogram of Gray Scale Image

Figure2 Image Acquisition and Pre-Processing

Figure3 represents canny edge detection and watershed transformation. Then the contours are filled using some morphological operation.



Canny Edge Detection	Morphological Operations Applied for Filling the holes	Removing the small object (Edge Detected)	Region Based using Watershed algorithm

Figure 3 Canny Edge Detection and Watershed Algorithm

VI. COMPARATIVE ANALYSIS OF SEGMENTATION TECHNIQUES

Performance Parameters	Edge Based Segmentation	Region Based Segmentation
Measurement of Quality of Image	Built on Intensity variation	Built on Similar Pixel Region
Effect of Segmentation	Average	Normal
Level of Segmentation	Discontinuity in homogeneity	Homogeneity
Image color space	Gray levels and RGB levels	RGB and grayscale image, intensity and saturation.

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Vol 11, Issue 8, August 2024

VII. CONCLUSION

There is a need of image segmentation as the quality of MRI images is directly affected by the temperature, noise and pressure. A good image segmentation technique on brain cancer MRI can help for further correct analysis. There are many image segmentation methods and algorithms but still it is very difficult to measure and compare the performance of these segmentation techniques. A very basic and simple technique to segment is to select a threshold based on the histogram of grey values. Unfortunately, thresholding image generates a binary image that misses significant parts of the image or merges parts of the background with the image. So, to overcome the thresholding technique this paper focused on implementation of edge based and region-based segmentation. After implementation however edge-based method is not so robust because sometimes contours are not perfectly identified. Further a region-based algorithm by using watershed technique has been implemented. This method works better and the region can be segmented and can be labeled easily for further analysis. All segmentation algorithms do not guarantee same kind of result for all type of images so one can choose segmentation techniques according to the type of images and research area. In this proposed work two segmentation techniques edge based and region based are implemented using python. Also section6 mentioned about the comparative analysis of both the techniques using different performance parameters.

REFERENCES

[1] S. R. Telrandhe, A. Pimpalkar, and A. Kendhe, "Detection of brain tumor from MRI images by using segmentation & SVM," IEEE WCTFTR 2016 - Proc. 2016 World Conf. Futur. Trends Res. Innov. Soc. Welf., 2016, doi: 10.1109/ STARTUP.2016.7583949.

[2] G. S. Tandel *et al.*, "A review on a deep learning perspective in brain cancer classification," *Cancers (Basel).*, vol. 11, no. 1, 2019, doi: 10.3390/cancers11010111.

[3] D. S. S. K. Vipin Y. Borole, Sunil S. Nimbhore, "Image Processing Techniques for Brain Tumor Detection: A Review," *Int. J. Emerg. Trends Technol. Comput. Sci. Web*, vol. 4, no. 5, pp. 28–32, 2015, [Online]. Available: http://www.ijettcs.org/Volume4Issue5(2)/IJETTCS-2015-10-01-7.pdf

[4] P. Louridas and C. Ebert, "Machine Learning," *IEEE Softw.*, vol. 33, no. 5, pp. 110–115, 2016, doi: 10.1109/MS.2016.114.

[5] P. Ongsulee, "Artificial intelligence, machine learning and deep learning," *Int. Conf. ICT Knowl. Eng.*, pp. 1–6, 2018, doi: 10.1109/ICTKE.2017.8259629.

[6] R. Kaur and A. Doegar, "Localization and classification of brain tumor using machine learning & deep learning techniques," *Int. J. Innov. Technol. Explor. Eng.*, vol. 8, no. 9, pp. 59–66, 2019, doi: 10.35940/ijitee.I1010.0789S19.

[7] I. Despotović, B. Goossens, and W. Philips, "MRI segmentation of the human brain: Challenges, methods, and applications," *Comput. Math. Methods Med.*, vol. 2015, 2015, doi: 10.1155/2015/450341.

[8] A. Sawant, M. Bhandari, R. Yadav, R. Yele, and S. Bendale, "Brain Cancer Detection From Mri: a Machine Learning Approach (Tensorflow)," *Int. Res. J. Eng. Technol.*, vol. 9001, p. 2089, 2008, [Online]. Available: www.irjet.net.

[9] A. Işin, C. Direkoğlu, and M. Şah, "Review of MRI-based Brain Tumor Image Segmentation Using Deep Learning Methods," *Procedia Comput. Sci.*, vol. 102, no. August, pp. 317–324, 2016, doi: 10.1016/j.procs.2016.09.407.