A Survey on MRI Brain Image Segmentation Technique

Nisha Pal[1], Akhilesh Pandey[2], Dr Dinesh Goyal[3]

[1]Research Scholar, Suresh Gyan Vihar University, Jaipur, India
[2]Assistant Professor, Computer Science and Engineering, Suresh Gyan Vihar University, Jaipur, India
[3]Professor, Computer Science and Engineering, Suresh Gyan Vihar University, Jaipur, India

Abstract— *One of the most dangerous disease occurring these days i.e. brain tumor can be detected by MRI images. Biomedical imaging and medical image processing that plays a vital role for MRI images has now become the most challenging field in engineering and technology. A detailed information about the anatomy can be showed through MRI images, that helps in monitoring the disease and is beneficial for the diagnosis as it consists of a high tissue contrast and have fewer artifacts. For tracking the disease and to proceed its treatment, MRI images plays a key role. It is having several advantages over other imaging techniques and is an important step for post-processing of medical images. However, having a large amount of data for manual analysis can sometimes proved to be an obstacle in the way of its effective use. In this paper, the introduction of image processing and the details of image segmentation techniques such as image preprocessing, feature extraction, image enhancement and classification of tumor processes, and how image segmentation can be applied to all Other available imaging modalities that are different from one another. This paper provides the survey on various methods used for image segmentation that have been applied for MRI images, that detects the tumor by segmenting the brain images into constituent parts. Also the advantages and disadvantages of Image segmentation is discussed using the various approaches of image segmentation of MRI brain images.*

Keywords—MRI Brain Images, Segmentation methods, brain, tumor, Brain Image Segmentation.

I. INTRODUCTION

Imaging technology in medicine has made the doctors to see the interior portions of the body for easy diagnosis. It has also helped doctors to make keyhole surgeries for reaching the interior parts without really opening too much of the body. CT scanner, Ultrasound and Magnetic Resonance Imaging took over X-ray imaging by making the doctors to look at the body's elusive third dimension. With the CT scanner, body's interior can be bared with ease and the diseased areas can be identified without causing either discomfort or pain to the patient. MRI picks up signals from the body's magnetic particles spinning to its magnetic tune and with the help of its powerful computer, converts scanner data into revealing pictures of internal organs. Image processing techniques developed for analyzing remote sensing data may be modified to analyze the outputs of medical imaging systems to get best advantage to analyze symptoms of the patients with ease. In medical imaging there is a massive amount of information, but it is not possible to access or make use of this information if it is efficiently organized to extract the semantics. To recover semantic image, is a hard problem. In image retrieval and pattern recognition community, each image is mapped into a set of numerical or symbolic attributes called features, and then to find a mapping from feature space to image classes. Image classification and image retrieval share fundamentally the same goal if there is given a semantically well-defined image set. Dividing the images which is based on their semantic classes and finding semantically similar images also share the same similarity measurement and performance evaluation standards. [1]

In modern medicine, medical imaging has undergone major advancements. Today, this ability to achieve information about the human body has many useful clinical applications. Over the years, different sorts of medical imaging have been developed, each with their own advantages and disadvantages.

X-ray based methods of medical imaging include conventional X-ray, computed tomography (CT) and mammography. To enhance the X-ray image, contrast agents can be used for example for angiography examinations.

Other types of medical imaging are magnetic resonance imaging (MRI) and ultrasound imaging. Unlike conventional X-ray, CT and Molecular Imaging, MRI and ultrasound operate without ionizing radiation. MRI uses strong magnetic fields, which produce no known irreversible biological effects in humans.

Diagnostic ultrasound systems use high-frequency sound waves to produce images of soft tissue and internal body organs. [2]

Tumour is characterized as the unusual development of the tissues. Cerebrum tumour is an unusual mass of tissue in which cells develop and duplicate wildly, apparently unchecked by the systems that control typical cells. Neurons typically create electrochemical driving forces that follow up on different neurons, organs, and muscles to deliver human musings, sentiments, and activities. In epilepsy, the ordinary example of neuronal movement gets to be bothered, bringing on weird sensations, feelings, and conduct or now and then writhing, muscle fits, and loss of awareness.

Magnetic Resonance Imaging (MRI) is a propelled medicinal imaging procedure used to deliver superb pictures of the parts contained in the human body MRI imaging is frequently utilized when treating cerebrum tumours, lower leg, and foot.

These days there are a few procedures for grouping MR pictures, which are fluffy strategies, neural systems, map book techniques, learning based strategies, shape techniques, variety division. X-ray comprises of T1 weighted, T2 weighted and PD (proton thickness) weighted pictures and are handled by a framework which coordinates fluffy based procedure with multispectral examination.

Pre-preparing of MRI pictures is the essential stride in picture investigation which performs picture improvement and noise reduction decrease systems which are utilized to upgrade the picture quality, then some morphological operations are connected to recognize the tumor in the picture. The morphological operations are fundamentally connected on a few presumptions about the size and state of the tumor and at last the tumor is mapped onto the first dark scale picture with 255 force to make unmistakable the tumor in the picture. [3]

1.1 TYPES OF TUMOUR

The word tumor is a synonym for a word neoplasm which is formed by an abnormal growth of cells Tumor is something totally different from cancer.

There are three common types of tumor:-

a) Benign

b) Pre-Malignant

c) Malignant (cancer can only be malignant)

a) Benign Tumor: A benign tumor is a tumor is the one that does not expand in an abrupt way; it doesn't affect its neighboring healthy tissues and also does not expand to non-adjacent tissues. Moles are the common example of benign tumors.

Benign tumors are non-cancerous. They rarely cause serious problems or threaten life unless they occur in a vital organ or grow very large and press on nearby tissues. Benign tumors tend to grow slowly and stay in one place, not spreading into other parts of the body.

Once removed by surgery, benign tumors don't usually come back (recur). Benign tumors usually stay non-cancerous, except in very rare cases.

b) Pre-Malignant Tumor: Premalignant Tumor is a precancerous stage, considered as a disease, if not properly treated it may lead to cancer.

Precancerous (premalignant) cells are abnormal cells that may develop into cancer if they aren't treated. Some cells develop mild changes that may disappear without any treatment.

Precancerous (or premalignant) changes can vary in their degree of abnormality.

- hyperplasia – an abnormal increase in the number of cells
    - Some hyperplasia's are precancerous, but most are not.
- atypical (atypical) – cells look slightly abnormal under a microscope
    - Sometimes atypical refers to changes caused by healing and inflammation, rather than a precancerous change, and the cells go back to normal once inflammation goes away or the body heals.
- metaphase – cells look normal under a microscope, but are not the type normally found in the that tissue or area
    - Metaplasias are usually not precancerous.
- dysplasia – cells develop abnormally, have an abnormal appearance and are not organized like normal cells
    - Dysplasia almost always refers to a precancerous condition.

c) Malignant Tumor or cancerous tumors: Malignancy (mal- = "bad" and -gins = "fire") is the type of tumor, that grows worse with the passage of time and ultimately results in the death of a person. Malignant is basically a medical term that describes a severe progressing disease. Malignant tumor is a term which is typically used for the description of cancer.

Malignant tumors are cancerous. Cancer can start in any one of the millions of cells in our bodies. Cancer cells have a larger nucleus nucleus. The part of the cell that holds the chromosomes, which contain DNA(Genetic Information that looks different from a normal cell's nucleus, and

cancer cells behave, grow and function quite differently from normal cells.

Brain, heart and lung etc. are the most important parts of the human body. And then, all parts of the body are controlled by the brain cells. Therefore, brain is a vital organ of the body. Nowadays, brain tumor is a very serious disease among children and adults. The most deadly and intractable diseases are brain tumor. Brain tumor's location and quickly spreading make a critical problem in treatment of tumor. Imaging of the brain tumor can be done by computer tomography (CT) scan, magnetic resonance image (MRI) scan, Ultrasound, etc.

The widely used diagnosis technique is MRI. The classification and detection of the tumor is very expensive. MRI is an advance technique to detect the tissues and the disease of brain cancer. MRI provides the different information about different structures in the body which are achieved with the help of an X-ray, computed tomography (CT) scan, Ultrasound but MRI is the best technique for higher quality of its images. MRI technology has a magnetic field and train pulses of radio wave energy that makes pictures of structures and organs within a body.

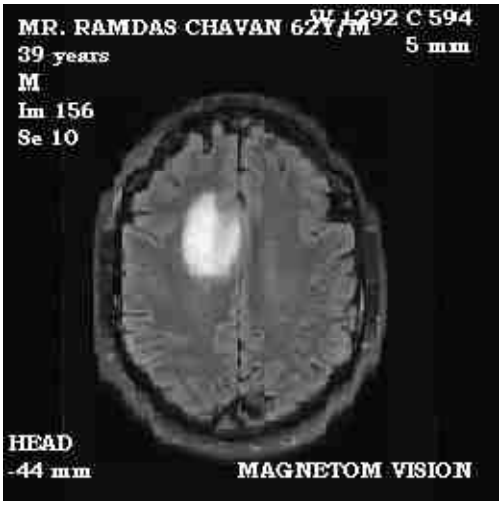

Fig.1: MRI image of tumor affected brain

Human cell is having cancer as a major disease. The human body is a group of cells united together to form organs and tissues such as bones and muscles, liver and the lungs. In each cell order, Genes inside each the cell work, reproduce, grow, and die. Tumors can be either malignant (cancerous) or benign (noncancerous). The tumor cells which stay in one place in the body are called benign and are not generally life-threatening. The tumor cells are able to invade nearby tissues called malignant and scattered and spared to another parts of the body. The cancer cells, which are spreading over other parts of the body, are called metastases. Brain is affected by the brain cancer starts in the human brain cells. The brain is a soft collective mass of neurons (nerves) and gill cells or supportive tissue, covered by membranes and protected by the skull. The brain is covering 3 main parts as shown in fig.

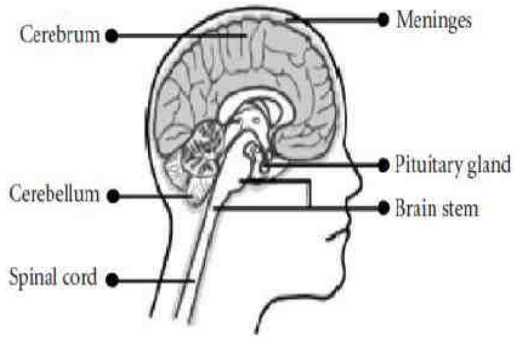

Fig. 2: Human Brain

(I) the cerebrum is the biggest part of the brain and consists of the left and right cerebral hemispheres. It permits human body to move, see, think, feel, and speak. The left side of our brain controls the right side of our body and vice versa.

(ii) The position of the cerebellum is exactly in the back of the brain and controls coordination and balance.

(iii) Vital bodily functions in human body, like breathing, heartbeat, and reflexes are controlled by the brain stem. Brain is connected to the spinal cord with the help of brain stem. The skull is tough and hard and cannot explore. Moreover, tumor increases the pressure and can damage brain cells or destroy cells. Brain cancer mostly involves either the gill cells or the neurons. Cancer is started in the gill cells as an adult state and called astrocytomas or gliomas. Neurological specialists perform different diagnostic tests for brain tumors. The names of the tests are Electroencephalogram (EEG), Lumbar puncture (spinal tap), RN (radionuclide), computerized axial topographer (CT or CAT), MRI, PET scan and Biopsy.

Brain tumor detection and extraction in MR image is an important digital image processing technique applied in radiology reconstruction of 2D and for 3D view. In real contours are rich indexes for any subsequent interpretation of the image. Contours in image are due to discontinuities of the reflectance function, and Discontinuities of the boundaries of the object or the depth. Intensity function is the characteristics counted by the contours are characterized by the discontinuities. That's what, the principle of contours detection is related to the study of the derivatives of the intensity function presented in the image. The contours are characterizing by the different boundaries of the objects, and separately defined as a transition mechanism between two regions of different characteristics available in parallel or simultaneously to within a single digital image. [4]

II. OVERVIEW OF THE DIFFERENT TECHNOLOGY

Dina A. Dahab et al. have used a modified image segmentation algorithm and have also proposed a probabilistic neural network algorithm which has given a very fast classification and the accuracy rate of classification was also found to be higher than the conventional neural network system. [5] M. Sinha and K. Mathur have proposed a system to improve the detection rate and they also have integrated it with ontology-based technique dealing with classes and subclasses. [6]

A variation of the fuzzy clustering technique was also used with a gradient vector flow snake model in order to segment the brain image. N. Noreen et al. have integrated image segmented by fuzzy c-means and the image transformed by Wavelet and have later enhanced the edges using Kirch's mask.

S. Mohsin et al. have focused on efficient and faster technique of skull stripping as a major portion of the pre-processing phase; they have combined erosion step along with selection of area of interest. Along with thresholding operation, watershed segmentation was also used to mark the region of the threshold tumour. [7]

P. Vasuda and S. Satheesh have proposed a fuzzy-based clustering in order to detect tumours and also have compared the conventional and modified clustering algorithm.[8]

A. Dasgupta has given a technique that has overcome the drawback of fuzzy clustering with noisy images.[9] M. Rakesh and T. Ravi have used an integration of color-based segmentation along with K-means clustering and histogram-clustering to separate timorous object from other components.[10]

I. Soesanti et al. have integrated spatial information into the membership function of the fuzzy c-means clustering algorithm which is based on fuzzy logic and have also used a neighbouring effect to obtain the statistics of cluster distribution.

P. Rajendran and M. Madheswaran in proposed association rule mining technique to classify the CT scan brain images. For this study three categories have been taken namely normal, benign and malign. Low level feature extracted from images and high level knowledge from specialists is combined into system. [11]

hasan aydin, nilay aydin oktay, serdar spaholu, elif altin and baki hekmolu in evaluated proton MR spectroscopy for brain tumour categorization. Brain tumours are classified into low-high grade glial neoplasms, menengiomas and metastasis. Brain tumours are categorized on the basis of Cho/NAA, Cho/Cr and Cho/MI metabolite ratios. [12]

T. Logeswari and M. Karnan in [13] proposed segmentation based brain tumour detection. Proposed segmentation method has two phases. In the first phase, film artifact and noise are removed. In second phase, Hierarchical Self Organizing Map (HSOM) is applied.

G Vijay Kumar and Dr GV Raju in [14] proposed early prediction of brain cancer based on texture features and neuro classification logic. Nine distinct features along with minimum distance are used for brain tumour detection in given MRI image. Extracted region is recognized using neuro fuzzy approach.

Andac Hamamci, Nadir Kucuk, Kutlay Karaman, Kayihan Engin, and Gozde Unal in [15] presents fast and robust tool for segmentation of solid brain tumors. Tool assists clinicians and researchers in radio surgery planning with minimal user interaction.

Dina Aboul Dahab, Samy S. A. Ghoniemy and Gamal M. Selim in applied modified segmentation techniques on MRI scan images to detect brain tumor. Modified Probabilistic Neural Network based on Learning Vector Quantization with image and data analysis to classify brain tumour using MRI scans.

Sudipta Roy and Samir K. Bandyopadhyay in [16] proposes fully automatic algorithm for brain tumour detection using symmetry analysis. Disease progression is indicated by quantitative analysis.

III. CONCLUSION

The Survey tells us that there are ample of methods that are used to trace or to detect the tumor. We have listed and explained the most efficient techniques that are based on high resolution images. In such kind of techniques the brain tumor can be detected or its treatment can be processed easily and effectively. MRI imaging technique is the most efficient technique through which the level of tumor or any detail of brain tumor can be traced easily. Through this technique each and every detail related to tumor can be easily visualized.

REFERENCES

[1] A. R.Kavitha, Dr.C.Chellamuthu, Ms.KavinRupa "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] IEEE Xplorer 2011, pp (1087 – 1096)

[2] **"**Brain MRI Image Segmentation for Tumour Detection using Artificial Neural Networks" "ISSN Journal", Vol. no: 5, 2 Apr-May 2013.

[3] Mohamed Lamine Toure, "Advanced Algorithm for Brain Segmentation using Fuzzy to Localize Cancer and Epilepsy Region", International Conference on Electronics and Information Engineering (ICEIE 2010), Vol. no 2.

[4] "Detection and Extraction of Brain Tumor from MRI Images Using K-Means Clustering and Watershed Algorithms", International Journal of Computer Science Trends and Technology (IJCST) – Volume 3 Issue 2, Mar-Apr 2015.

[5] Dahab, D.A., Ghoniemy, S.A., Selim, G.M., 2012. Automated Brain Tumor Detection and Identification using Image Processing and Probabilistic Neural Network Techniques. International Journal of Image Processing and Visual Communication, 1-8.

[6] Sinha, M., Mathur, K., 2012. Improved Brain Tumour Detection with Ontology. International Journal of Computational Engineering Research. 584-588

[7] Sajjad Mohsin, S., Sajjad, S., Malik, Z., Abdullah,A.H., 2012. Efficient Way of Skull Stripping in MRI to Detect Brain Tumour by Applying Morphological Operations, after Detection of False Background. International Journal of Information and Education Technology. 335- 337

[8] Vasuda, P., Satheesh S., 2010. Improved Fuzzy C Means algorithm for MR brain image segmentation. International Journal on Computer Science and Engineering, 1713-1715

[9] Dasgupta, A., 2012. Demarcation of Brain Tumour using Modified Fuzzy C-Means. International Journal of Engineering Research and Applications. 529-533,

[10] Rakesh, M., Ravi, T., 2012. Image Segmentation and Detection of Tumour Objects in MR Brain Images Using Fuzzy C-Means(FCM) Algorithm. International Journal of Engineering Research and Applications. 2088-2094.

[11] P.Rajendran and M.Madheswaran, "An Improved Image Mining Technique For Brain Tumour Classification Using Efficient classifier", International Journal of Computer Science and Information Security, Vol. 6, No. 3, pp. 107-116, 2009.

[12] Hasan aydin, nilay aydin oktay, serdar spaholu, elif altin and baki hekmolu, "The Efficacy and Value of Proton MR Spectroscopy In Evaluating the Brain Tumours", The New Journal of Medicine 2010, pp. 37-42, 2010.

[13] T. Logeswari and M. Karnan, "An improved implementation of brain tumour detection using segmentation based on soft computing", Journal of Cancer Research and Experimental Oncology, Vol. 2, No. 1 pp. 006-014, March, 2010.

[14] G Vijay Kumar and Dr GV Raju, "Biological Early Brain Cancer Detection Using Artificial Neural Network", International Journal on Computer Science and Engineering, Vol. 02, No. 08, pp. 2721- 2725, 2010.

[15] Andac Hamamci, Nadir Kucuk, Kutlay Karaman, Kayihan Engin, and Gozde Unal, "Tumour-Cut: Segmentation of Brain Tumours on Contrast Enhanced MR Images for Radiosurgery Applications", IEEE TRANSACTIONS ON MEDICAL IMAGING, Vol. 31, No. 3, pp. 790-804, March 2012.

[16] Sudipta Roy and Samir K. Bandyopadhyay, "Detection and Quantification of Brain Tumour from MRI of Brain and it's Symmetric Analysis", International Journal of Information and Communication Technology Research, Volume 2 No. 6, pp. 477-483, June 2012.