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A REVIEW ON SEGMENTATION TECHNIQUES USED TO DETECT BRAIN TUMOUR FROM MRI IMAGES

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Abstract: Tumour is the uncontrolled growth of abnormal tissues in the body. Tumours are detected by using the Magnetic Resonance Imaging (MRI) for which the patient is sent into the dome shaped machine, which releases the magnetic wave signals. These waves locate the tumour or any other kind of cellular changes in the body. The images obtained from MRI are of the DICOM (Digital imaging and communications in medicine) format. In the output image of the MRI, the tumour is represented by brighter pixels. The most complicated part of the body is brain. MRI image processing and especially the image segmentation is very helpful in the detection of brain tumour. The whole process of determining the presence of tumour in brain can be divided into three parts Pre-Processing, Segmentation and the Feature Extraction. In this review different segmentation techniques are discussed such as the Histogram based, Region Growing Method, K-means and the Threshold segmentation. Present study concludes that the best segmentation technique is the Seed Region Growing Method followed by Threshold Segmentation Technique and it can also be used effectively in segmenting the image.

Index Terms: **Image Segmentation, Image Processing, Brain Tumour, Feature Extraction, Seeded Region**

I. Introduction

Cancer is a disease in which some of the body's cells grow uncontrollably and spread to other parts of the body. Cancer can start almost anywhere in the human body, which is made up of trillions of cells. Cancers can broadly be divided into two main categories viz. Hematologic (cancers of the blood cells, including leukemia, lymphoma, and multiple myeloma) and Solid tumour (cancers of any of the body organs or tissues. The most common solid tumours are brain, breast, prostate, lung, and colorectal cancers). It is estimated that 12.5% men and 9.09% women die from the cancer (International Agency for Research on Cancer 2020). Cancer is the leading death causing disease, which alone contributed nearly 10 million in 2020 (WHO, 2021).

Tumours can be detected by already existing technologies such as the MRI, Computerized Tomography (CT) Scan, Positron Emission Tomography (PET) Scan. CT scan is the widely used computerized X ray imaging procedure in which a narrow beam of X rays is aimed at a patient and quickly rotated around the body, producing signals that are processed by the machine's computer to generate cross-sectional images or "slices" of the body.

PET scan is an imaging test for cancer detection in the body. In PET scan, a radioactive dye known as tracer is injected into the body for the detection of disease or injury in the brain. PET scan provides quantitative functional information on diseases. PET/CT (Brent et al., 2014) combined scan help pinpoint abnormal metabolic activity and may provide more accurate diagnoses than the two scans performed separately. Moreover, some imaging labs also provides PET-MRI scans, which is the combined scan of PET and MRI. PET-MRI is more appropriate than the PET-CT as the PET-MRI provides the more clinical value in terms of changes to more appropriate management in 8% of cancer patients who undergo PET-CT in routine clinical practices (Mayerhoefer, M.E. et al., 2020).

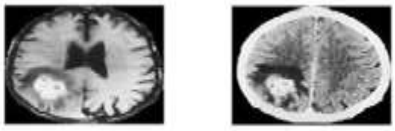

Figure 1: (a) Brain CT scan Image (b) Brain MR Image (Roopali and.Ladhake, 2014).

Images obtained from the MRI and CT scans are fused Fig. 1. CT images which are used to ascertain the difference in tissue density and MRI provide an excellent contrast between various tissues of the body (Roopali and.Ladhake, 2014). It is a very tedious task to find out the

problems inside the Brain. Brain can have many problems such as the tumours, parasitic infections, bacterial infections and much more. Tumour is the mass of cells that have grown and uncontrollably multiplied. There are two main types of tumours: malignant or cancerous tumours and benign tumours (Murthy and G. Sadashivappa, 2014).

MRI is an advanced medical imaging technique used to produce high quality images of the parts contained in the human body (Black PM. Et al., 1997). MRI is predicated on the principle of Nuclear Magnetic Resonance (NMR). In order to get an image in MRI, instead of using the uniform field, a varying magnetic field is applied across the body part. The protons in different regions come to resonance at different frequencies and the intensity of the signals will be proportional to the number of protons at each magnetic field. Doctors or medical experts use the data/images obtained from the MRI to detect the Tumours. MRI results are divided into different segments by the process called Segmentation. Brain tumour segmentation is a significant process to extract information from complex images of the brain MRI (Priyanka Bedekar, et al., 2017). Images obtained from the MRI are not simple to read and understand because sometimes, it contains noise. Noise in simple words is the unwanted extra data present in the Image. Image Processing is the process by which an individual analyses and manipulate the digitalized image.

II. Methods Used for the detection of tumour from MRI.

In this paper, different stages of image processing used in detecting the tumour from the images of brain MRI are discussed. Segmentation is the main process in the detection of brain tumour using image processing. There are several types of Segmentation techniques used by various researchers based on the need.

Following steps are being followed by different researchers to detect the tumour efficiently Fig. 2.

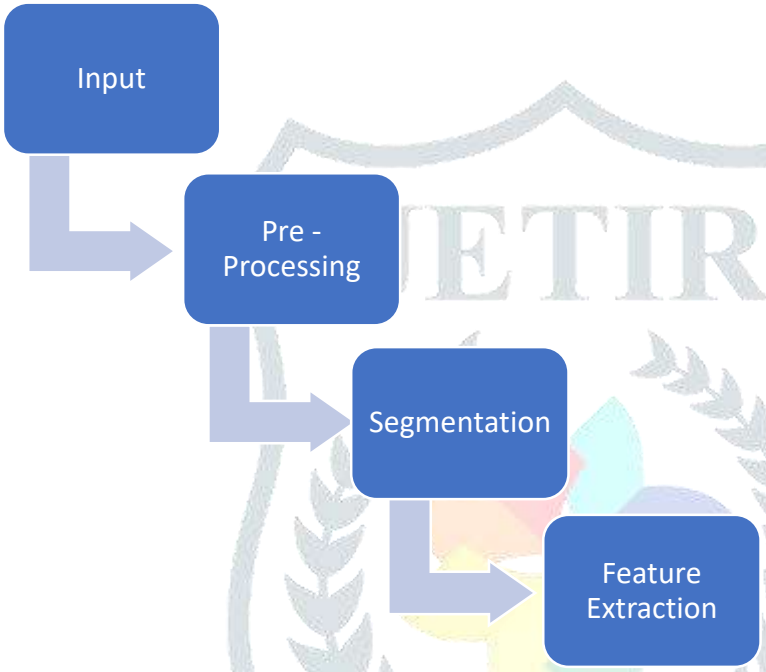

Figure 2: Flowchart of The Steps to be Followed for Brain Tumour Detection from MRI Images

2.1. Input

This is the first step, where the image data set of the MRI, in which the brain tumour is to be located is provided. The images we got from MRI are of three types: Axial Images, Saggital Images, Coronal Images. The number of images depends on the resolution of the movement of the MRI magnets (Yao Yao, 2004). After loading, the data set will be processed, following which the total number of images under consideration will reduce to 3 from 384 (T. Logeswari and M.Karnan, 2010).

2.2. Pre – Processing

The images of MRI, already contains the unwanted data known as noise. It is very important to remove the noise from the image to process and find the Tumour in the image. In the image pre – processing, all the unwanted information is removed so that the image can be processed successfully. During this stage only, the image is converted into the Grayscale and also sometimes the image reconstruction takes place. Removal of noise is done by using the different filters such as the Mean Filter, Median Filter, Hybrid Filter etc.

Filters are the techniques, using which the size, colors, shading altered. Filters also help to suppress the high frequencies in the image.

Mean Filter: In the Mean filter, each pixel is replaced by the average of its neighbouring pixels to remove the noise from the image. Mostly, it acts as the lowpass frequency filter.

Median Filter: In the Median filter, each pixel is replaced by the median of its neighbouring pixels to remove the noise from the image. In Median filter, the changed value of pixel is the value of one of its surrounding pixels.

Median filter is generally better than the mean Mean filter as the Median filter does not create any new fictional pixel value, when the filter reaches the edge.

2.3. Segmentation

Image Segmentation is the process, by which the image gets spilitted into several small parts. This splitting of image creates several sets of pixels within the same image. Assigns a tag to every pixel in an image is assigned a tag and the pixels with the similar tags share particular features (Praveen Gamage, 2017). There are different types of Segmenting Techniques available such as the Histogram Based, Region Growing Method, Threshold Segmentation, Morphological Based, Clustering Based Segmentation, SVM based Segmentation, MRF based Segmentation, Watershed Segmentation and the K- Means Algorithm. Threshold Segmentation is the best and easiest Segmentation technique among the image segmentation techniques (Praveen Gamage, 2017). In this paper, we will be discussing about the Histogram Based Segmentation, Region Growing Method and the Threshold Segmentation Method of the Image Segmentation Technique. The main drawback of K - Mean clustering sometimes it becomes difficult to predict the value of K and this technique does not produce good results for clusters of different density and different sizes (Madhvi and Reecha, 2016).

2.3.1 Histogram Based Segmentation

This is the type of segmentation Technique, in which all the pixels of the image are used to create a histogram. The histogram of an image represents the relative frequency of occurrence of the various colours (gray levels) in the image (Simona and Vasile, 2014). There are different peaks and valleys in the histogram, which represent different things, such as the first largest peak represents the background of the image and the second largest peak represents the object. Thresholding sets that pixel to one whose value is on the object side and all other values are set to zero (Julie Delon, et al., 2007). Generally, it is difficult to identify the peaks and valleys. For the easy identification, two steps are involved, these are the Histogram Equalizer and the Histogram Smoothing. Histogram Based Segmentation shows the accuracy of 81% (Praveen Gamage, 2017). Hence, it is the least accurate Segmentation Method used.

2.3.2 Region Growing Method

Region Growing Method majorly rely on the assumption that the neighbouring or the surrounding pixels within the same region have same values. Region Growing Method comprises of Seeded Region Growing Method, Unseeded Region Growing Method and the λ – Region Growing Method. Region Based Growing Methods can correctly separate regions based on the properties of similar pixels. Region Growing method can separate the regions that have same properties correctly.

2.3.2.1 Seeded Region Growing

Seeded Region Growing Segmentation Method is one of the simplest Region Growing Method. It is very attractive for semantic image segmentation. In order to check whether pixel belongs to particular region or not the difference between pixel intensity value and region mean is used (Madhvi and Reecha, 2016). In Seeded Region Growing method, the feature of interest is to be embedded. Feature of Interest is embedded in the choice of seeds (Adams, R. and Bischof, L 1994). Generally, it is the most preferred type of Segmentation Technique as it is fast, robust and free of tuning parameters (Octavio G´omez, 2007). Seeded Region Growing Method shows the highest accuracy rate of 92% (Praveen Gamage, 2017).

2.3.2.2 Unseeded Region Growing

Unseeded Region Growing Method is the updated version of the Seeded Region Growing Method. In Unseeded Region Growing Method, the explicit seeds are not required.

2.3.2.3 λ – Region Growing Method

λ – Region Growing Method is based on the Linking Paths and the intensity of the pixels of the image to be considered. In this method, the λ represents the degree connectivity.

2.3.3 K - means Segmentation

K – means segmentation treats the raw image, i.e., the image which is not pre – processed as a point having a location in the space. K – means Segmentation method works well with the images having poor color contrast. K- means segmentation is susceptible to sample selection and establishing fuzzy sets may be difficult (Luxit and Sanjeeev, 2017). K- means Segmentation Method shows an accuracy rate of 85% (Praveen Gamage, 2017). which is comparatively less than the accuracy level of other techniques used.

2.3.4 Threshold Segmentation

In the Threshold Segmentation, the gray scaled image is converted into the binary form. It is a very popular Segmentation Technique, used for differentiating the background and the object. In this method, the intensity of all the pixels are compared with threshold intensity or the pre - defined intensity. Threshold Method of segmentation is used in the gradient magnitude to find the potential edge pixels (Vipin Y, et al., 2015). Thresholding techniques are based on the postulate that all pixel whose value lie within certain range belongs to one class (E K. Sahoo et al., 1988). The Threshold Segmentation Method shows an accuracy of 91% and 89.90% (Praveen Gamage, 2017 and Astina and Chanddrakant, 2017).

2.3.5 Watershed Segmentation

Watershed segmentation can classify the intensities with very small difference also, which is not possible with snake and level set method (Roopali and.Ladhake, 2014). In watershed segmentation magnitude of an image which is gradient is considered as a topographic surface (Madhvi and Reecha, 2016). Watershed Segmentation works only on the gray scaled images. If the images are not pre – processed, then using the Watershed segmentation will lead to over – segmentation of the image. Watershed Segmentation Method shows an accuracy of 88.5% (Praveen Gamage, 2017).

2.4 Feature Extraction

Extraction of Tumour from the images of MRI is a tedious and time - consuming task. It is due to the complex structure of Human Brain. The features such as the standard deviation, kutosis, variance, correlation are extracted from the images. On the basis of these features, the tumour region is indicated.

III. Conclusion

Detection of the Brain tumour is one of the most difficult tasks in the world. To perform such a difficult task, we can use the algorithms for better results as compared to the humans as while reading the scan of the MRI, a human can unintentionally make some errors, which is very common. For the detection of Tumour, we will be using the image processing algorithms. The first step is the input of data set of the images, then the pre – processing step takes place followed by the Segmentation and the Feature Extraction. In the image processing also, the main step is the Image Segmentation. Region Growing Method of Segmentation is sensitive to noise i.e., the image needs to be properly pre - processed and without the noise for the proper implementation of the Region Growing Method.

According to the results of the researchers, the best segmentation technique is the Seed Region Growing Method. Threshold Segmentation Technique also shows good results in the study. Hence, the Threshold Segmentation Technique can also be preferred for the detection of Brain Tumour. Watershed Segmentation can also be used but, the only criterion to use is that the image must be pre – processed and without the noise, because noise in the image will lead to over segmentation of the image.

References

1. Adams, R. and Bischof, L. 1994. Seeded Region Growing. IEEE Transactions on Pattern Analysis and Machine Intelligence. 16: 641–647.
2. Astina Minz, and Chanddrakant Mahobiya 2017. “MR Image classification using Adaboost for brain tumor type”. IEEE 7th International Advance Computing Conference. 701-705.
3. Black PM, Moriarty T and Alexander E 1997. Development and implementation of intraoperative magnetic resonance imaging and its neurosurgical applications. Neurosurgery. 41(4): 831-845.
4. Brent Foster, Ulas Bagci, Awais Mansoor, Ziyue Xu and Daniel J. Mollura 2014. A Review on Segmentation of Positron EmissionTomography Images. Comput Biol Med. 76-96.

5. E K. Sahoo, S. Soltani, and A. K. C. Wong 1988. A survey of thresholding techniques. Comput. Vision Graphics Image Process. 41:230-260.
6. International Agency for Research on Cancer (IARC) accessed in August 2021. Available at https://www.uicc.org/news/globocan-2020-new-global-cancer-data#:~:text=IARC%20released%20on%2014th%20December,million%20cancer%20deaths%20in%202020,
7. Julie Delon, Agnes Desolneux, Jose-Luis Lisani and Ana-Belen Petro 2007. A non-parametric approach for histogram segmentation. IEEE Transactions on Image Processing. 16(1): 253-261.
8. Luxit Kapoor and Sanjeeev Thakur 2017. A Survey on Brain Tumour Detection Using Image Processing Techniques. 7th International Conference on Cloud Computing, Data Science & Engineering – Confluence. 582-585.
9. Madhvi Arya and Reecha Sharma 2016. Brain Tumour Detection through MR Images: A Review of Segmentation Techniques. International Journal of Computer Applications. 153(7): 33-37.
10. Mayerhoefer, M.E., Prosch, H., Beer, L. et al 2020. PET/MRI versus PET/CT in oncology: a prospective single-center study of 330 examinations focusing on implications for patient management and cost considerations. Eur J Nucl Med Mol Imaging. European Journal of Nuclear Medicine and Molecular Imaging. 47: 51–60.
11. Murthy, TS Deepthi, and G. Sadashivappa 2014. Brain tumour segmentation using thresholding, morphological operations and extraction of features of tumour. International Conference on Advances in Electronics, Computers and Communications (ICAECC). 1-6.
12. Octavio G´omez, Jes´us A. Gonz´alez, and Eduardo F. Morales 2007. Image Segmentation Using Automatic Seeded Region Growing and Instance-Based Learning. Progress in Pattern Recognition, Image Analysis and Applications. 4756: 192-201.
13. Praveen Gamage 2017. Identification of Brain Tumour using Image Processing Techniques. An independent study final report submitted to Faculty of Information Technology University of Moratuwa. https://www.researchgate.net/publication/319623148_Identification_of_Brain_Tumour_using_Image_Processing_Techniques.
14. Priyanka Bedekar, Niharika Prasad, Revati Hagir and Neha Singh 2017. Automated Brain TumourDetection using Image Processing. International Journal of Engineering Research & Technology. Special Issue Vol. 5(1): 1-3.
15. Roopali R.Laddha and S.A.Ladhake 2014. A Review on Brain Tumour Detection Using Segmentation And Threshold Operations. International Journal of Computer Science and Information Technologies. 5(1): 607-611.
16. Simona Caraiman and Vasile I. Manta 2014. Histogram-based segmentation of quantum images. Theoretical Computer Science. 529: 46-60.
17. T. Logeswari and M.Karnan 2010. An improved implementation of brain tumour detection using segmentation based on soft computing. Journal of Cancer Research and Experimental Oncology. 2(1): 006-014.
18. Vipin Y. Borole, Sunil S. Nimbhore and Seema S. Kawthekar 2015. Image Processing Techniques for Brain Tumour Detection: A Review. in International Journal of Emerging Trends & Technology in Computer Science. 4, 5(2): 028-032.
19. World Health Organization (WHO), accessed in August 2021. Available at https://www.who.int/news-room/fact-sheets/detail/cancer
20. Yao Yao 2014. Segmentation of breast cancer mass in mammograms and detection using Magnetic Resonance Imaging. IEEE Image Processing Soc. J.. 561-567.