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Survey on Different Tumour Detection Methods from MR Images

Kshipra Singh[1], Prof. Umesh Kumar Lilhore[2], Prof. Nitin Agrawal[3]
M. Tech. Research Scholar[1], Head PG[2], Associate Professor[3]
NRI Institute of Information Science & Technology Bhopal, Madhya Pradesh, India, India

ABSTRACT

Image mining is a vital technique which is used to mine knowledge straightforwardly from the image. Image processing and segmentation are the primary phases in image mining. Image mining is simply an expansion of data mining in the field of image processing. Image mining handles with the hidden knowledge extraction, image data association and additional patterns which are not clearly accumulated in the images. Image processing and Image segmentation methods are widely used to separate objects from the background, and thus it has proved to be a powerful tool in biomedical imaging. In the field of medical science, MRI images are widely used in brain tumor detection, breast cancer detection. Brain tumor detection and its evaluation are tough duties in scientific images processing due to the fact brain images and its shape is complex that may be analyzed handiest with the aid of professional radiologists. MRI has ended up a particularly beneficial scientific diagnostic device for prognosis of the brain and other scientific images. This paper presents a comparative study and analysis of various brain tumour detection methods for MRI images by using image processing.

Keywords : Image processing, Image Mining, Image Segmentation, Brain Tumour, MR Images

I. INTRODUCTION

Early detection and classification of brain tumors are very important in clinical practice. Many researchers have proposed different techniques for the classification of brain tumors based on different sources of information. In this paper we propose a process for brain tumor classification, focusing on the analysis of Magnetic Resonance (MR) images and Magnetic Resonance Spectroscopy (MRS) data collected for patients with benign and malignant tumors. Various methods [2] which are available in diagnosis, are an expert opinion, human inspection, biopsy, and etc. These methods [5] have some drawbacks like time consumption, incorrect inspection etc. So image processing techniques can be helpful to detect brain tumor. There are various medical imaging techniques like x-ray, computed tomography (CT), positron emission tomography (PET), magnetic resonance imaging (MRI), are available for tumor detection [6]. The MRI is the most commonly used modality for brain tumor growth imaging and location detection due to its higher resolution. Magnetic Resonance Imaging (MRI) is an imaging technique which non-invasively provides high contrast images of different anatomical structures. It provides better a differentiation of tissues than other medical imaging techniques. Evaluation and analysis of An MRI image by radiologists is error-prone and time-consuming. Hence radiologists can use an algorithmic image processing in brain tumor diagnosis in MR images, especially due to large alterations in shape and size of structures needs to be considered for brain tumor detection and segmentation [11].

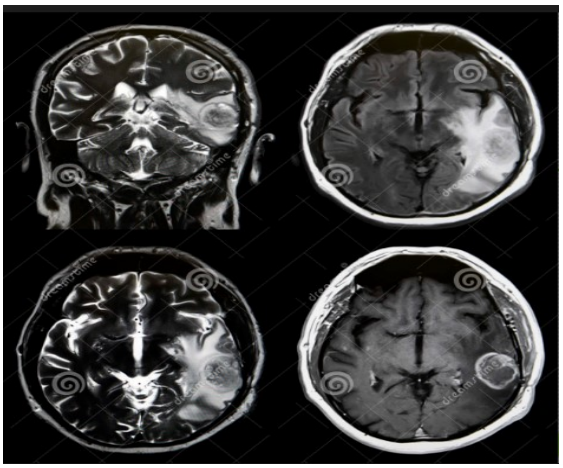

Figure 1. MRI Images for Brain Tumour [12]

The paper is organized in the various chapter which covers, Image processing, related work in the field of brain tumor detection using image processing, Challenges, and finally conclusion and future work.

II. IMAGE MINING

Image mining is a complicated task. Image mining is a vital technique which is used to mine knowledge straightforwardly from the image. Before any image can be processed, it is important to remove any unwanted artifacts it may hold [13]. Only then can the image be processed successfully. Processing a medical image involves two main steps. The first is the pre-processing of the image. This involves performing operations like noise reduction and filtering so that the image is suitable for the next step. The second step is to perform segmentation and morphological operations. These determine the size and the location of the Tumor Detection.

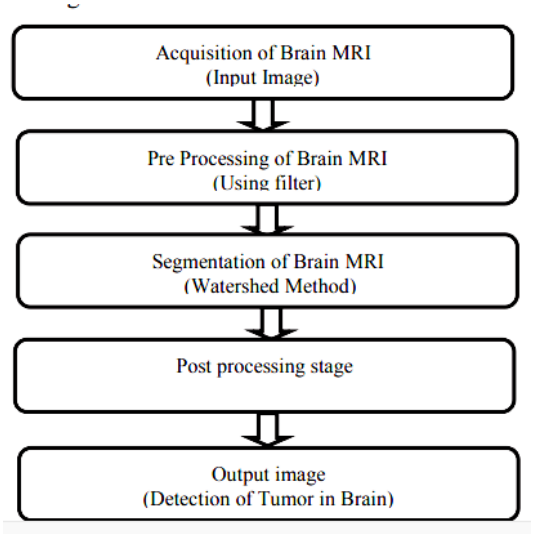

Figure 2. Image Processing Steps in Brain Tumor[7]

2.1 Image Processing- In imaging science, image processing is processing of images using mathematical operations by using any form of signal processing for which the input is an image, a series of images, or a video, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image [2].Most of the image-processing techniques involve isolating the individual color planes of an image and treating them as two-dimensional signal and applying standard signal-processing techniques to them. Images are also processed as
Three-dimensional signals with the third dimension being time or the z-axis. Image processing usually refers to digital image processing, but optical and analog image processing also are possible [11].

The purpose of image processing-The main purpose of image processing is

- **Visualization-** Observe the objects that are not visible.
- **Image sharpening and restoration-**To create a better image.
- **Image retrieval-**Seek for the image of interest.
- **Measurement of pattern-**Measures various objects in an image.
- **Image Recognition-** Distinguish the objects in an image.

2.2 Image Filtering: Median Filter is one of the most common noise removal techniques in use today. The reason behind its widespread use is that it preserves the edges of the image. As the name suggests, in this each entry is replaced with the median of its adjacent entries [11]. This filter is very effective for removing salt and pepper noise and poisson noise. This filter works by sweeping the entire signal in a pattern. The intensity of the median of the pixels in the pattern becomes the output intensity.

2.3 Image Segmentation: The process of splitting an image into multiple parts is known as segmentation. It creates various sets of pixels within the same image. Segmenting an image makes it easier for us to further analyze and extract meaningful information from it. It is also described as "The process of labeling each pixel in an image such that they share the same characteristics".[8] The process results in pixels sharing a common property.

2.4 Post-Processing: Successful Segmentation of the image is followed by the post-processing of the image. Post-processing of the image involves steps to judge the size of the tumor and its type. Post-processing may also involve various optimization techniques to further improve the result.

III. RELATED WORK IN MRI IMAGE MINING

Following existing techniques are suggested by various researchers, for brain tumour detection from MRI images.

Fuzzy C-Means Method : This paper [2] deals with the implementation of Simple Algorithm for detection of range and shape of the tumor in brain MRI. The tumor is the uncontrolled growth of tissues in any part of the body. Tumors are of different types and they have different Characteristics and different treatment. The advantage is that in the existing method is based on the Thresholding [7, 9]. The Thresholding technique was ignored the spatial characteristics. These techniques consist of segmentation, pre-processing, Feature extraction, and approximate reasoning. This project uses computer-aided method for segmentation and detection of brain tumor based on the combination of two algorithms. This method mostly uses the segmentation of tumor tissue with high accuracy and reproducibility comparable to manual segmentation.

Knowledge-based Method : In this paper [8] a system that can automatically segment and uses the labels glioblastoma multiforme tumors in magnetic resonance images (MRI's) of the human brain is presented. Along with cluster, the segmented images find outs the centers for each class that is provided to a rule-based expert system which extracts the region of intracranial. It uses the technique of Multispectral histogram analysis separates suspected tumor from the rest of the region of intracranial, with region analysis used in performing the final tumor labeling [12, 18]. There are lots of efforts have exploited MRI's multidimensional data capability through multispectral analysis.

Component Labeling Method : In this paper image segmentation scheme to segment 3-D brain tumor from MRI images through the clustering process [11]. The clustering is achieved using K-mean algorithm in conjunction with the connected component labeling algorithm to link the similar clustered objects in all 2-D slices and then obtain 3-D segmented tissue using the patch object rendering process. It is allowing a diagnostics automation and assists the expert in the qualitative and quantitative analysis. It is very important for the surgical planning and quantitative analysis such as volume measurements. In the existing system, it uses K-mean 2-D Slice Clustering. It consists in applying to each slice the k-mean clustering algorithm in 2-D and to propagate the result by labeling or relabeling the clustered contours of the preceding slice.

Content-based Retrieval Method : In this paper the Content-based medical image retrieval allows exploring same images appear with a different kind of diagnosis. It also allows the searching through large collections of disease-related illustrations using the visual attributes. It provides a convenient environment for the retrieved images [7]. Approaches that are based on one-to-one regions of image matching for shifting and scaling are highly useful. The existing system uses the MR images using discrete wavelet transformation (DWT).Following that, principles component analysis (PCA) that were used to reduce the features of MR image.

PNN Techniques : In this paper [5] they modified image segmentation techniques were applied on MRI scan images in order to detect brain tumors. In this paper, they Modified Probabilistic Neural Network (PNN) model that is based on learning vector quantization (LVQ) with image and data analysis and manipulation techniques are proposed to carry out an automated brain tumor classification using MRI-scans [9]. The simulation results showed that the modified PNN gives rapid and accurate classification compared with the image processing and published conventional PNN techniques.

Computer Aided System : In this paper [10] they propose a method for automatic brain tumor diagnostic system from MRI images. The system consists of three steps to detect and segment a brain tumor. In the first stage, MR image of the brain is acquired and pre-processing is done to remove the noise and too sharp the image. In the second step, global threshold segmentation is done on the sharpened image to segment the brain tumor [13]. In the third step, the segmented image is post-processed by morphological operations and tumor masking in order to remove the false segmented pixels. Results show that our proposed technique accurately identifies and segments the brain tumor in MR images.

Image Segmentation Methods : In paper [6] author presented image segmentation. Image segmentation is the primary step and the most critical tasks of image analysis. Its purpose is that of extracting from an image by means of image segmentation. The mechanization of medical image segmentation has established wide application in diverse areas such as verdict for patients, treatment management planning, and computer-

integrated surgery. There are three broad approaches to segmentation, termed, Boundary approach (Thresholding), Edge-based approach, Region-based Approach.

The K-Means Algorithm : In paper [4, 7] author presented K-Mean clustering. K-means algorithm is the most well-known and widely-used unsupervised clustering technique in partitioned clustering algorithms. The purpose of this algorithm is to minimize the distances of all the elements to their cluster centers. Most of the algorithms in this field are developed by inspiring or improving k-means. The algorithm upgrades the clusters iteratively and runs in a loop until it reaches to the optimal solution. The performance of K-means algorithm depends on initial values of cluster centers. Therefore the algorithm should be tested for different outcomes with different initial cluster centers by multi-running[15].

PSO-Based Clustering Algorithm : The algorithm based on swarm intelligence has been developed by adapting the collective behavior which is shown for searching food sources. Each solution in PSO algorithm is a bird in the search space and it is called as a "particle". All particles have a fitness value evaluated by a fitness function and a velocity data that orients their fights. In the problem space, the particles move by following the existing most favorable solutions. PSO algorithm starts with a group of randomly generated solutions (particles) and the optimal solution is investigated iteratively. In each of the iteration, all particles are updated according to two best values. The first of these best values is that a particle found so far and is called "gbest". The other one is the best value found so far by any particles in the population. This value is the global best value for the population and called as "gbest". PSO is a numeric optimization algorithm in nature [15]. However, Omran proposed a PSO-based clustering algorithm in 2004 and he applied this method for image segmentation. In this approach, optimal cluster centers are determined by PSO which is a population-based search technique. Thus the effects of initial conditions are reduced, compared with classic methods (K-MEANS, FCM).

Comparison of Existing Tumour detection methods

Table 1. Comparison of Existing Tumour detection methods

Paper Reference	Method Used	Usage	Susceptible To
[2]	Enhanced Darwinian Particle Swarm Optimization(EDPSO)	Should be used when the contrast intensity is high, Less susceptible to noise than other images so can be used in conditions where no pre-filtering is done When quick analysis of the image is to be done rather than exhaustive analysis	Not able to extract much information from the input MRI image and hence the analysis may or not prove helpful Cannot be used for images with poor contrast or images with a lot of background and foreground artifacts
[4]	Fuzzy C Means, K Means and Level Set Techniques	Unsupervised techniques and require least human interaction Useful for large images with poor contrast Level set techniques can be used for computer-aided vision	Noise has severe affects on the final product Sample selection and establishing fuzzy sets may be tedious
[3]	Region-Based	Watershed segmentation and region seed growing with well-selected seed regions can be used to accurately extract object of interests like tumors form input MRI's	Noise may lead to undesired artifacts in final result Susceptible to human error as seed region is manually selected
[5]	Combination of k-means and fuzzy c-means	Better precision and reproducibility	Detection time and tumour area
[9]	FKSRG	Lower over and Under segmentation	Noise
[11]	Multi-region and multi-reference framework	Higher tissue overlap rates and lower standard deviations	Detection time, noise and area
[10]	Generative probabilistic model and spatial regularization	Enhancement above the conventional multivariate tumor segmentation (25 gloom)	Noise may lead to undesired artifacts in final result and Time

[15]	Probabilistic model and localization	Latest strong valuable to observe disease progression	Noise and tumour detection time
[13]	Non-rigid registration, atlas and MRF	Multivariate tumor segmentation	Poor segmentation
[1]	SVM and BWT	10 multispectral patient datasets further feature segmentation low computation times	Noise and tumour detection time
[8]	Decision Forests and tissue-specific Gaussian mixture models	Segmenting the individual tissue types simultaneously such as AC, NC, E, etc.	Accuracy
[6]	SVM and Kernel feature selection	Good results tested in T1w, T2w and T1c and low computation time	Noise and time

IV. CONCLUSION

This paper surveys the various techniques that are part of Medical Image Processing and are prominently used in discovering brain tumors from MRI Images. At first, the various methods, which are being currently used in medical image processing were extensively studied. This involved studying the available research. Based on that research this paper was written listing the various techniques in use. A brief description of each technique is also provided. Also of all the various steps involved in the process of detecting tumors, Segmentation is the most significant and propitious. In future work we will proposed and developed an efficient brain tumor detection for MRI images. Also performed a comparative study with various existing methods.

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