A REVIEW ON SOFT COMPUTING TECHNIQUES IN MRI BASED BRAIN TUMOR DETECTION SYSTEM

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ABSTRACT: Brain tumor identifications are the most common issues for recent scenario of health care community. Image processing is a dynamic research zone in medical imaging methods utilized to image the internal segments of the human body for restorative diagnosis. A brain Magnetic Resonance Imaging (MRI) scan of a single individual consists of several slices across the 3D anatomical view. Therefore, manual segmentation of brain tumors from magnetic resonance (MR) images is a challenging and time-consuming task. Automatic brain tumor diagnosis with MRI is one of the precise medical image analyses which performance can be measured only through soft computing techniques. Now a day's many soft computing techniques are available for this desirable performance measures. Therefore a review on soft computing techniques in MRI based Brain tumor detection system is presented in this paper. In this paper, a wide spread relative study is focused on Soft computing techniques to analyze the geometric characteristics of brain tumor images for tumor detection. The main goal of this work is to emphasize the variety of automated methods which can ultimately serve to developing novel ideas for solving the health care issues of the current society.

KEYWORDS: Brain Tumor, Image processing, Magnetic Resonance Imaging (MRI), Soft Computing techniques.

I. INTRODUCTION

The detection of brain tumor is a very challenging task, in which special care is taken using medical image processing techniques.

Various scanning applications for medical image analysis and techniques are available such as MRI, CT (Computed Tomography) scan, X-rays. Brain tumor is a big cause of death worldwide and related abnormalities constitute for major changes in life [1]. The brain image analysis measures the abnormalities of the human brains through the scan images. The automatic detection involves several stages, like Pre-processing, feature extractions, Image classification and segmentation [2]. The pre-processing performs the smoothening of image. A feature extraction involved to measure the feature may be pixel based or block based or region based or textual based. The image classification approach is categorizing the abnormal input images into various tumor groups based on a number of similarity measures. The accuracy of the abnormality

measure must be significantly better so the treatment technique is based on this identification. The image segmentation is used to extract the abnormal tumor part which is necessary for volumetric measure. These volumetric measures find the effect of the treatment on the patient which can be identified the extracted size and shape of the abnormal portion of the image.

A tremendous research has been done in the last decade for brain tumor in the region of cerebral cancer diagnosis [7]. Varieties of image processing techniques are available to be applied on various imaging modalities for tumor detection that will detect certain features of the tumors such as the shape, border, calcification and texture [8]. These features will make the detection processes more accurate and easier as there are some standard characteristics of each feature for a specific tumor. Brain tumor segmentation requires the efficient knowledge of pathology and understanding the intensity and shape of MRI image [9]. The main problem in tumor segmentation arises due each tumor being of different shape, size, location and intensity. Soft computing is likely to play an increasingly important role in many application areas, including software engineering. The role model for soft computing is the human mind. Soft Computing is the fusion of methodologies that designed to model and enable solutions to real world problems, which are not modeled or too difficult to model, mathematically. Soft computing optimization technique finds solution of problems, which are very hard to answer. Soft computing not precisely defined. It consists of distinct concepts and techniques that aim to overcome the difficulties encountered in real world problems. Detection of brain tumor can be done through soft computing techniques [10]. The Computational analysis is very important role for the modern world. Particularly, the usage of the computer systems for biomedical applications has been explored to a higher extent. Several research articles with different techniques for brain tumor segmentation using soft computing techniques are reported in this paper.

II. SOFT COMPUTING IN IMAGE SEGMENTATION

Image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label are connected and meaningful, and share certain visual characteristics [11]. Pixels in a region are similar with respect to some features or property, such as color, intensity, or texture. The Image segmentation covers this objective by extracting the abnormal portion from the image which is useful for analyzing the size and shape of the abnormal region [12]. The taxonomy of image segmentation methods collectively can be divided among two categories Traditional methods and Soft Computing (SC) methods. Unlike Traditional methods, SC methods have the ability to simulate human thinking and are flexible to work with their ownership function, have been predominantly applied to the task of image segmentation [13].

Soft computing has been introduced into medical image processing because it is an effective approach to handle uncertainties inherent in acquired image data. Some examples in the past years are fuzzy connectedness approaches to image segmentation, fuzzy clustering methods particularly for human brain MR image

segmentation, and statistical atlases and fuzzy models for object recognition and delineation [14]. Soft computing approaches include fuzzy logic, neural networks, support vector machines, evolutional computation, probabilistic approaches, and chaos theory. This special issue aims to showcase recent advances in soft computing approaches in medical image processing. SC techniques are tolerant of partial truth, imprecision, uncertainty, and approximations. SC approaches also have advantages of providing cost-effective, high performance and steadfast solutions. In this survey paper, our emphasis is on core SC approaches like Fuzzy logic, Artificial Neural Network, and Genetic Algorithm used for image segmentation [15].

III. REVIEW ON SC TECHNIQUES IN MRI BASED BRAIN TUMOR DETECTION

3.1 Hybrid Approach Using Artificial Bee Colony Optimization with FCM

In this paper [3], an approach is taken as a blend of Fuzzy-C-Means (FCM) bunching alongside Artificial Bee Colony Optimization for the productive order and division of cerebrum tumors. This method shows a change over the administered order approaches. It beats the issues like manual division which causes wrong outcomes, joint division issue and furthermore producing false positives. Brain tumor Segmentation is the wide research area in the restorative field. Tumors are the brain boggling anatomical structures which are hard to segment in light of the manual cooperation. For that the Magnetic Resonance Images (MRI) with manual marking is utilized as the underlying point to choose the tumor district.

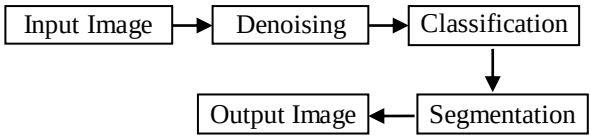

Fig. 1: Steps in Image Segmentation

For the brain tumor segmentation here, the fuzzy clustering for the efficient grouping of the pixels in the tumor region is used. By the use of Ant Colony Optimization (ACO) the features are extracted and efficiently classified. This technique reduces the manual segmentation and improves the classification. The feature values are analyzed and the pixels with same features are grouped together to form a cluster of the tumor region. The Fuzzy-C-Means (FCM) clustering is used to form the clustered region since it produces 'c' clusters for the grouping of the tumor region that satisfy the criteria to form the anatomical structure. The brain tumor segmentation is done with the help of optimization technique known as the Ant Colony Optimization, in which the number of iterations is done with the help of mutation process to achieve suboptimal solution. For the brain tumor segmentation here, the fuzzy clustering for the efficient grouping of the pixels in the tumor region is used. By the use of Ant Colony Optimization the features are extracted and efficiently classified. This technique reduces the manual segmentation and improves the classification.

3.2 Soft-Computing Assisted Tool for Brain Tumor to Extract from MR Images

In this work [4], heuristic approach supported automated tool is presented to extract and analyze the tumor part from the Magnetic Resonance Images (MRI) of brain. This tool consist of Skull stripping, Social Group Optimization assisted Kapur's multi-thresholding (SGO-KT), Watershed segmentation, and Evaluation of the extracted tumor stages. The tool is experimentally investigated using various bench mark brain MRI dataset.

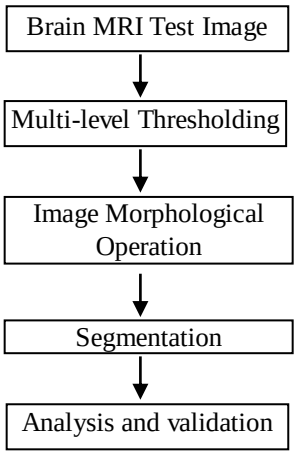

Fig. 2: Block diagram of brain MRI examination methodology

Fig.2 depicts the block diagram of the brain MRI examination task. Initially, the skull stripped brain MRI test image is preprocessed using the multi-level thresholding. This procedure will enhance the abnormal region of the test image. Later, the image morphological operation is considered to group the similar image pixels in order to get a smooth image. The post processed image is then treated using the Watershed Algorithm (WA), which extracts the tumor section from the brain MRI. Finally, the extracted tumor is analyzed to confirm the superiority of the proposed brain MRI image processing procedure. In this paper, freshly developed heuristic procedure known as the Social Group Optimization (SGO) assisted work is employed to enhance the tumor of brain MRI and the brain morphological procedure is then applied to group the similar pixels of the threshold image. Finally, the watershed based segmentation is implemented to extract the suspicious/enhanced region of brain MRI. To exhibit the superiority of their procedure, Flair modality registered various 2D slices of the brain MRI are considered. The experimental result demonstrated that, this approach is very efficient in extracting the tumor section from the chosen MRI slices. This approach was also efficient in providing better values of the gray-level co-occurrence matrix (**GLCM**), image similarity and statistical measures.

3.3 Self-Adaptive K-Means Clustering for Brain Tumor Detection

In the paper [5], Brain tumor detection using self-adaptive K-means clustering algorithm has been presented. This paper presented a self-adaptive K-means clustering algorithm to detect brain tumor accurately and in minimal execution time to overcome the limitation of original K-means algorithm in which the no. of clusters are define by the user i.e. user input is required. The MRI images for brain tumor analysis are extracted from the BRATS database available online. MRI as obtained from the MRI data is a collection of image sequences (frames) played over a period of time. The MRI data is loaded into MATLAB framework using the command load MRI. The MRI images are read in MATLAB environment in steps of frames played over a period of time. Before the detection algorithm, some image preprocessing steps are required in order to extract the same to remove the noise from MR image and enhance the image quality. Median filter is employed to remove the noise. Image background does not contain any valuable information but it increases the processing time. Skull info is in most abundant state in MRI image and therefore it is removed from noise free MR image using brain surface extraction algorithm. The output of this stage is noise free MR image which contains only human brain.

The de-noised image is clustered using the self-adaptive k-means clustering. Self-computation value of 'k' i.e. number of clusters is computed by histogram analysis

of the image under test. The number of neighbors, falling within prescribed percent range of peak, is taken as the value of 'k' in the presented algorithm known as self-adaptive k-means clustering. Self-computation value of 'k' i.e. number of clusters is computed by histogram analysis of the image under test. The number of neighbors, falling within prescribed percent range of peak, is taken as the value of 'k' in the presented algorithm known as self-adaptive k-means clustering. Therefore, based on nature of image in terms of its histogram, the number of clusters may be computed. Further, the sobel edge detector confines the growth in a boundary from where; size estimation can be done using the area and perimeter metrics. Sobel edge detection is implemented on the clustered MR image. The proposed technique decreases the thickness of boundary lines of regions and enhances the accuracy of the obtained image. Then the final tumor is obtained which filtered again with median filter to remove any unwanted noise. The graphical profile of area and perimeter go in same trend and are consistent in each slice. It can be observed that in each slice the area and perimeter are falling in an approximate same range.

3.4 Template based K-means and Fuzzy C-means Clustering Algorithm

The paper [6] presented a robust segmentation method which is the integration of Template based K-means and modified Fuzzy C-means (TK FCM) clustering algorithm that, reduces operators and equipment error. In this method, the template is selected based on convolution between gray level intensity in small portion of brain image, and brain tumor image. K-means algorithm is to emphasized initial segmentation through the proper selection of template. Updated membership is obtained through distances from cluster centroid to cluster data points, until it reaches to its best. This Euclidian distance depends upon the different features i.e. intensity, entropy, contrast, dissimilarity and homogeneity of coarse image, which was depended only on similarity in conventional FCM. Then, on the basis of updated membership and automatic cluster selection, a sharp segmented image is obtained with red marked tumor from modified FCM technique. The small deviation of gray level intensity of normal and abnormal tissue is detected through TK FCM. The performances of TK FCM method is analyzed through neural network provide a better regression and least error. The performance parameters show relevant results which are effective in detecting tumor in multiple intensity based brain MRI image. The whole method that has been proposed for the detection of tumor in brain MRI image using template based K-means and modified fuzzy C-means is described by the following flow chart in Fig. 3. In this flow chart firstly there is manipulated acquisition of brain MRI image, and then it is processed and given at the input of template based k-means segmentation method.

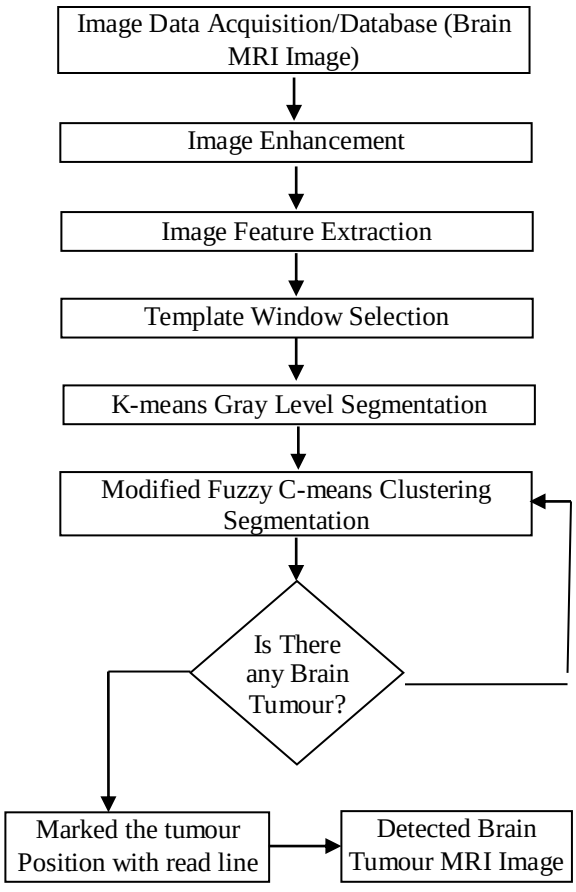

Fig. 3: Flowchart of TKFCM algorithm

Finally from the modified fuzzy C-means with updated membership the detected tumor with red line marked is obtained. This is done through the clustered image which is automatically selected from the image features. The performance is analyzed through neural network, which shows better accuracy and least error. The accuracy, sensitivity, and specificity show that it is better than other previous conventional methods. Though it is less noise sensitive, but for some images where the gray level intensity difference is very small causes trouble to select perfect template.

IV. CONCLUSION

Magnetic Resonance Imaging (MRI) is an important examination and diagnosis method for brain tumors in medical imaging. With a resonance mechanism and clear imaging of soft tissues, the doctor on the patient's diagnosis can be scientific and rational to extract the exact progression of the disease state that would set out the appropriate treatment to a series of disease control measures. Development of automated algorithms is helpful in fast processing of MRI. A review on various soft computing techniques in brain tumor detection was presented in this paper. The contribution lies in the fact to present this paper to the researchers is that explore state-of-the-art elaboration of almost all dimensions associated with the image segmentation. The idea is to encapsulate various aspects like emerging topics, methods, evaluation parameters, the problem associated with different type of images, databases, segmentation applications, and other resources so that, it could be advantageous for researchers to make effort in developing new methods for segmentation. The paper accomplishes with findings and concluding remarks.

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