Image Processing Application in The Detection Of White Matter Lesions

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Abstract--- Image processing is an important aspect when medical field is taken into account. Image processing is one of most growing research area these days and now it is very much integrated with the medical and biotechnology field widely. Image Processing can also be used to analyze different medical and MRI images to get the abnormality in the image. It is used to identify or diagnose the disease present in Brain as for example detection of Brain tumor. MRI image is processed with thresholding and morphological operations with MATLAB software such that the degenerative diseases like Multiple Sclerosis, Alzheimer etc. present in the white matter is detected and so it's useful for the early diagnosing of patient.

Keywords: White matter, Grey matter, Morphological operations, Image segmentation

I. INTRODUCTION

It is tough for medical examiners to accurately quantify the WMLs attributable to belittled distinction contrast between White Matter (WM) and Grey Matter (GM). White Matter Lesions (WMLs) are tiny areas of dead cells found in parts of the brain. Clustering methods are used for automatic detection of WMLs in brains of elderly people. The aim of this paper is to automatically detect the White Matter Lesions which is present in the brains of elderly people. Medical imaging is the technique used to create images of the human body for clinical or medical science that produce images of the internal aspect of the body. Magnetic Resonance Imaging (MRI) is one of the medical imaging techniques used for diagnosing. MRI of the human brain is extremely sensitive for detecting all forms of White Matter abnormalities. [4] Non-specifically variations in the White Matter appear frequently on MRI in elderly patients presenting with either stroke or psychological feature impairment. In general, human brain consists of main components namely, White Matter (WM), Grey Matter (GM). Neuronal tissue containing mainly long and myelinated axons are better known as White Matter. While the Closely packed neuron cell bodies form the Grey Matter. Grey Matter is in grey color because of the grey nuclei that comprises the cells. Myelin i.e. the white fatty substance is responsible for the white appearance of White Matter. White Matter Lesions (WMLs) are commonly found in patients with Multiple Sclerosis (MS). Grey matter is made up of nerve cell bodies, and white matter is made up of fibers. Grey matter occupies 40 percent of the brain, while white matter occupies of about 60 percent of the brain. Processing is concluded in the grey matter, where as white matter permits communication to and fro from the grey matter regions, and between the grey matter and the another parts of the human body.[1]

II. METHODS OF IMAGE SEGMENTATION

Image segmentation is partition of an image into its substituent until it is able to be recognized. Mainly there are three approaches for image segmentation edge based, region based and pixel based. The goal of segmentation in general is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Some of the general-purpose segmentation methods are region growing, histogram evaluation, graph cut and clustering. Region growing starts with a single pixel (current region) and progresses by recursively examining the adjacent pixels. If they are sufficiently similar, they are added to the current region, otherwise a new region is formed. Histogram evaluation takes place by computation of a color or intensity based histogram from all of the pixels in the image. The peaks and valleys in the histogram are then used to locate different regions in the image. Graph cut models the image into a weighted undirected graph. Each pixel would be a node in the graph, and an edge is directly formed between every pair of pixels in an image. The weight of an edge is the measure of similarity or say likeness between the pixels. The image is sub-divided into disjoint sets or segments by removing the edges connecting the segments. Clustering refers to the process of grouping pixels of a picture such that pixels which are in the same group (cluster) are similar and are dissimilar to the pixels which belong to the other groups (clusters).[2][6]

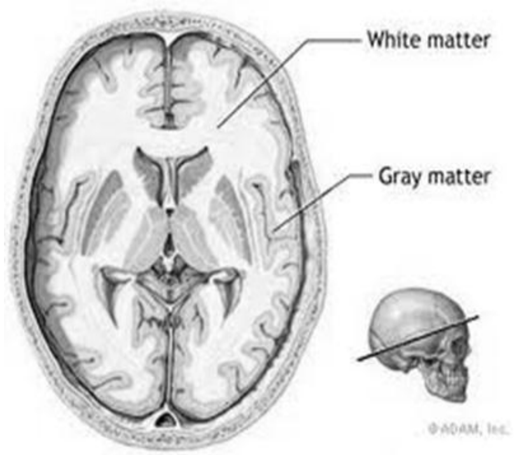

Fig. 1: Brain Image of WM and GM [7]

In medical imaging for analyzing anatomical structures like bones, muscles blood vessels, tissue sorts, pathological regions like cancer, disseminated multiple sclerosis lesions and for dividing a complete image into sub regions like the white matter (WM), grey matter (GM) and cerebrospinal fluid (CSF) areas of the brain automatic delineation or say depiction of various image parts are used. Within the field of medical image process segmentation of MRI it's notably appropriate for brain studies due to its glorious contrast of soft issues, non-invasive attributes and a very high spatial resolution. Below is the figure showing WM and GM in human brain/

III. MORPHOLOGY

The proposed approach utilizes mathematical morphology operations for the segmentation. The morphological operations are applied on the gray scale images to segment the abnormal regions. Morphological operators i.e. Erosion and dilation are the two elementary operations in Mathematical Morphology. A combination of these two represents the rest of the operations. The symbols, e, 0, and, respectively denote the four fundamental binary morphological operations:
Dilation, erosion, opening and closing. A function f(x, y) denotes the main image, where (x, y) R2 or Z2, or simply f and the function h(x, y) will form the structuring element or say mask for the image. The four operations are dilation, erosion, opening and closing. It extracts the biological contents of an image and its attributes.

IV. RELATED WORKS

A new rating scale for age-related white matter changes applicable to MRI and CT. In this approach the MRI is more sensitive than CT for detection of age-related white matter changes (ARWMC). Most rating scales estimate the degree and distribution of ARWMC on CT or on MRI as they differ in many aspects. That makes it very difficult job to compare CT and MRI studies and also to be able to study the evolution and possible effect of drug treatment on ARWMC in enormous amount of patient samples.[4]
MRI was highly superior in detection of small ARWMC, whereas larger amount of lesions were detected equally well with both CT as well as MRI. In the parieto-occipital and infratentorial areas, MRI detected significantly and accurately more ARWMC than CT while in the frontal area and basal ganglia, not many differences between different modalities were found. No single difference was found basal ganglia and infratentorial areas.
The other approach is Automatic Segmentation of Different-Sized White Matter Lesions by Voxel Probability Estimation. A new method for fully automated segmentation of white matter lesions (WMLs) on cranial MR imaging is presented. The algorithm for automated segmentation uses five types of regular MRI-scans. It is based on a K-Nearest Neighbor (KNN) classification method, which builds up a feature space from voxel intensity features and spatial information. [8] Automatic segmentation of white matter hyper intensities in the elderly using FLAIR images is done. It is to determine the precision and accuracy of an automated method for segmenting white matter hyper intensities (WMH) on fast fluid-attenuated inversion-recovery (FLAIR) images in elderly brains.
Computer-assisted segmentation of white matter lesions in 3D MR images using support vector machine. Brain lesions, especially white matter lesions (WMLs), are associated with cardiac and vascular disease, but also with normal aging process. Quantitative analysis of WML in large clinical trials is becoming more and more important. [9]

V. PROPOSED SYSTEM

A. K-means based segmentation:

The algorithm used to cluster the similar and dissimilar contents in an image with varying intensities and abnormalities the volumetric changes in the white matter increases with the aging process and the disease present in the lesion is diagnosed for the early detection so that the patient can have early recovery. MRI is used instead of CT (Computed Tomography) as it does not work on the radiations which are harmful for the human body. Moreover MRI is used for examining the soft tissues of body like ligaments, spinal cord injury, and detection of tumors in brain while CT is used for bone injury, chest and lung imaging. [4]
The amounts of data stored in databases (online and offline) are so huge that create a crucial need for effective and speedy data analysis methods. Cluster analysis is one of the primary data analysis tasks that helps in interpretation and understanding of natural grouping or structure in a dataset. K means clustering is the most widely used and studied method among clustering formulations that are based on minimizing a formal objective function.[7] Modifications to Means clustering method that makes it faster and more efficient are proposed. The main argument of the proposed modifications is on the reduction of intensive distance computation that takes place.
At each run (iteration) of K-means algorithm between each data point and all cluster centers. To reduce the intensive distance computation, a simple mechanism by which, At each iteration, the distance between each data point and the cluster nearest to it is computed and recorded in a data structure is suggested. Thus, on the following iteration(s) the distance between each data point and its previous nearest cluster is recomputed. The proposed method for this paper that is the automated detection of the white matter lesion present in a brain image is given below in the form of flowchart step by step shown in Fig 2.

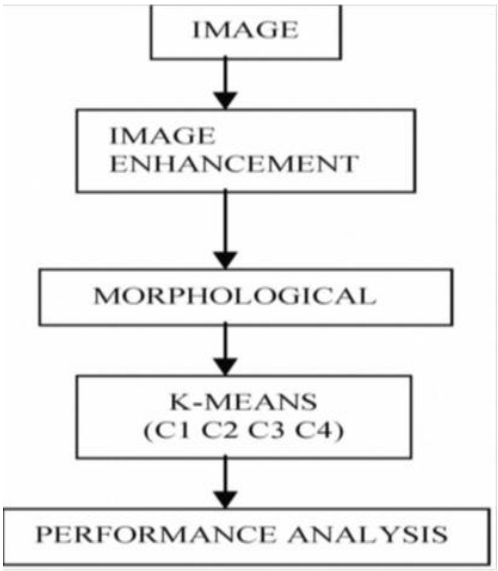

Fig. 2: Flowchart for K-means algorithm

B. Results

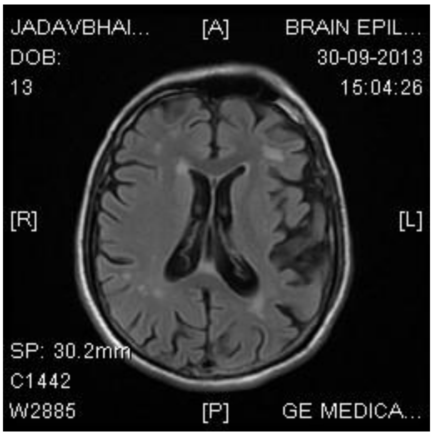

Fig. 3: Original Image- Real data

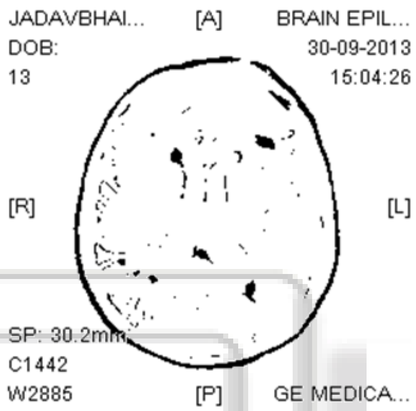

Fig. 4: Adaptive or Dynamic Thresholding

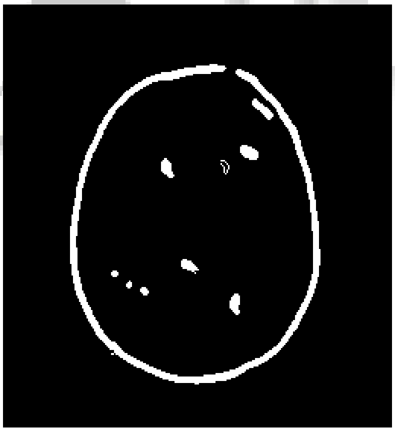

Fig. 5: Edge detection with Canny Operator

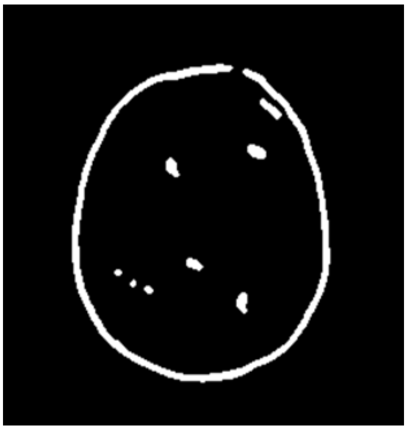

Fig. 6: Morphological operations of Hole filling

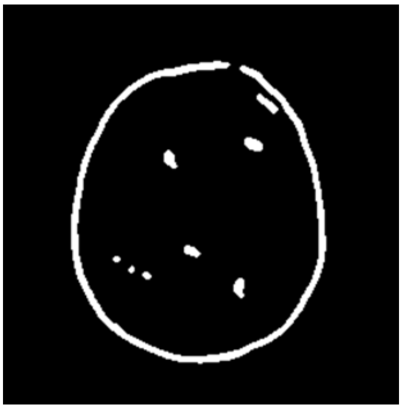

Fig. 7: Final output of Morphological Operation

VI. CONCLUSION AND FUTURE WORK

This work incurred segmentation involving thresholding technique and other morphological operations for the MRI. It has its limitations that the detection of white matter changes is shown in the final output image obtained along with the CSF (Cerebrospinal fluid). CSF is just like White matter and Gray matter present inside the human brain. Hence to overcome this drawback a new algorithm is developed comprising of the K-means clustering algorithm where the centre points are defined as desired and so only the part desired is detected. This does not make any confusion for the doctors to diagnose the disease from MRI.

Future work also includes the multiple data sets of patients having white matter changes in the elder people. So whenever only the images are taken as input than direct the output of the images are obtained.

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