

Diagnosis of Alzheimer's Disease Using Watershed Technique in MATLAB

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ABSTRACT

In this research paper, we are proposing an easy and accurate method for effective diagnosis of Alzheimer's disease by using Watershed's marker technique in MATLAB. Ultimately, Watershed method leads us to image processing methodology.

As per facts and readings, on average, the diagnosis takes at least 7 years and sometimes, it may also take 14 years. Moreover, much research shows that during diagnosis of Alzheimer disease, 97 percent patients die and only 3 percent patients survive after 14 years of diagnosis. This is mostly because of the late diagnosis and expensive methodology like single photon emission computed tomography used for detection of Alzheimer's disease. Hence, it is well known that Alzheimer disease is classified as a neurodegenerative disorder. This is the cause and progression of the disease and it is still not well understood; however, it is associated with plaques and tangles caused in the brain.

This research that we are proposing is focused on the method for the diagnosis of Alzheimer's disease, which is entirely based on image processing using MATLAB and it enables us to acquire fast and robust results. Not only this, it is much cheaper so that the poor can also be able to afford it and it is way better than the old methods which were being implemented. It only needs an MRI image to process and analyzes the Alzheimer's symptoms based on the color range difference than normal brain image. Selected color schemes can be observed on MATLAB software and functions like; gradient magnitude, grayscale, foreground objects, watershed transform and background markers would be used.

Our research work is based on experimental methodology. The results that we have gathered after our research illustrate much better detection of Alzheimer's disease and is also able to analyze other diseases like brain tumor and much more.

Keywords: Alzheimer disease, image processing, watershed technique, MRI image, gradient magnitude, MATLAB

1 Introduction

Dementia is a growing problem in aging populations. Its impact on health services and society is of increasing concern to health policy makers and service providers as life expectancy increases and, more particularly, as the baby boom generation ages[11]. Considering the broader field of neuroscience [9], of the estimated 135,000 actively publishing scientists worldwide, roughly 18% (or 25,000),

Have published one or more papers on AD. This Ratio of AD scientists to all neuroscientists Remains constant at 19% when assessing the 100 most-cited neuroscientists during the Period 1997–2007 [7].

Alzheimer's disease leads to nerve cell death and tissue loss throughout the brain. Overtime the brain shrinks dramatically, affecting nearly all its functions [1]. MRI may show a decrease or shrinkage in the size of different areas of the brain which is called atrophy. Brain atrophy is the wasting away of vital brain tissue, either in response to a disease process or stress. More specifically, disease or stress destroys the white matter of the brain, thereby atrophying the tissue [16, 17,18]. But as we know, it requires sharp eyes only to detect AD. Watershed transformation is an efficient morphological based tool for image segmentation. [18, 10]. An efficient watershed algorithm is proposed by using a marker image [13, 15]. And the motive of this study is to explore watershed transformation for the detection of AD.

2 Background

Alzheimer's is the most common form of dementia, a general term for memory loss and other intellectual abilities serious enough to interfere with daily life. Alzheimer's disease accounts for 60 to 80 percent of dementia cases[4].

Alzheimer's is a type of dementia that causes problems with memory, thinking and behavior. Symptoms usually develop slowly and get worse over time, becoming severe enough to interfere with daily tasks.

Alzheimer's disease is an irreversible, progressive brain disease that slowly destroys memory and thinking skills and, eventually even the ability to carry out the simplest tasks of daily living. In most people with Alzheimer's, symptoms first appear after age 60 and 65% of AD diagnose in old peoples. Dementia is a brain disorder that seriously affects a person's ability to carry out daily activities. Risk factor of Dementia like: Age, Family History and Head injury.

AD begins slowly. It first involves the parts of the brain that control thought, memory and language. People with AD may have trouble remembering things that happened recently or names of people they know. A related problem, mild cognitive impairment (MCI), causes more memory problems than normal for people of the same age. Many, but not all, people with MCI will develop AD.

Alzheimer's is a progressive disease, where dementia symptoms gradually worsen over a number of years. In its early stages, memory loss is mild, but with late-stage Alzheimer's, individuals lose the ability to carry on a conversation and respond to their environment. Alzheimer's is the sixth leading cause of deaths[19]. Alzheimer disease has 7 levels according to condition of patient[2].

Level 1: No impairment

Level 2: Very mild decline

Level 3: Mild decline

Level 4: Moderate decline

Level 5: Moderately severe decline

Level 6: Severe decline

Level 7: Very severe decline

There are different basic imaging techniques are used to diagnostic purpose for Alzheimer's disease. Different imaging techniques are mentioned below[3].

- (1) MRI
- (2) CT Scan
- (3) PET
- (4) SPECT

Basically we are using MRI because MRI image can be digital enhanced. Using MRI imaging Techniques after using MATLAB and image processing with marker controlled watershed technique.

3 Methodology

The methodology of this detection of Alzheimer's disease consists of 2 processes namely K means clustering marker controller watershed technique combined in one. Primary segmentation is conducted by K means clustering which is later refined and further segmented by mark controlled watershed detection technique.

3.1 Watershed Transformation

The watershed segmentation has proven to be a powerful and fast technique for both contour detection and region-based segmentation. In principal, water- shed

Segmentation depends on ridges to perform a proper segmentation, a property which is often fulfilled in contour detection where the boundaries of the objects are expressed as ridges. For region-based segmentation it is possible to convert the edges of the objects into ridges by calculating an edge map of the image. Watershed is normally implemented by region growing based on a set of markers to avoid severe over-segmentation [5][6][23][24].

3.2 Marker-Controlled Watershed Transform

The marker-controlled watershed represents an enhancement over the original watershed transform. The principle of the marker-controlled segmentation is to transform the input image so that the watersheds of the transformed image correspond to the object boundaries [16, 17]. The goal of the marker controlled segmentation is to detect the presence of the homogenous regions from the image by a set of morphological operations. Markers are connected components belonging to an image [21][22].

Proposed Algorithm

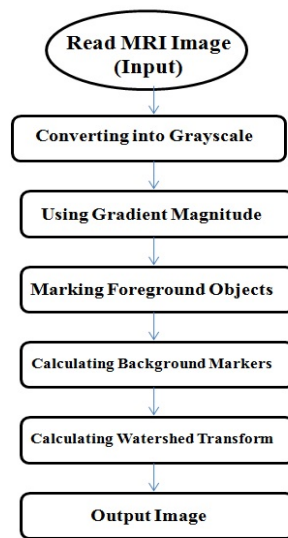


Figure Purposed Algorithm

We have used different morphological operations to remove noise from structured elements in the images such as dilation, erosion, opening, and closing. To get the better filtered image we used erosion and dilation functions. For getting more refined result we used opening and closing operations with different structuring elements.

In this proposed algorithm, we first converted the image into gray-scale and then performed gradient magnitude as the segmentation function. The developed segmentation function results into a resultant image, whose foreground and background markers are the objects we are interested to segment. The whole proposed algorithm is discussed in detail in below images. The fig 1(a) shows a grayscale converted MRI image, which contains tumour in the brain. Fig 1(b) shows the gradient magnitude of grayscale image as a segmentation function, sobel edge masks, imfilter, and some simple arithmetic operations are performed to compute the gradient magnitude. Fig 1(c) shows the watershed transform directly on gradient magnitude.

Now, the foreground marker, background marker and object boundaries are found by using some morphological techniques such as opening-by-reconstruction, closing-by-reconstruction, erosion, dilation, reconstruction and thresholding operations, the results of these operations can be seen in images fig1(d),1(m). Finally fig. 1(o) is the final marker control watershed segmented output of the original image, where Alzheimer of the brain is extracted out from the original MRI image.

3.3 K means clustering:

We use clustering algorithm called as K means to assign the segments to different classes. It basically assigns N data points to K disjoint subsets.

$$J = \sum_{j=1}^k \sum_{i=1}^n \|x_i^{(j)} - c_j\|^2$$

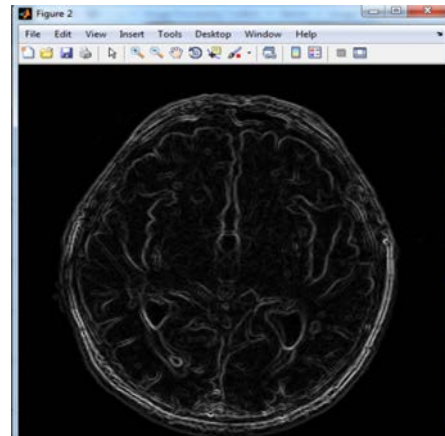
Where $\|x_i^{(j)} - c_j\|^2$ is a chosen distance measure between a data point $x_i^{(j)}$ and the cluster centre c_j , is an indicator of the distance of the n data points from their respective cluster centres.

The algorithm is composed of the K points should be placed into the space denoted by the objects that are being clustered. These points denotes the initial group centroids. Nearest centroid should be assigned each object of the group and after it recalculate the positions of the K centroids. Repeat similarly until the centroids no longer move. This produces a separation of the objects into groups from which the metric to be minimized can be calculated.

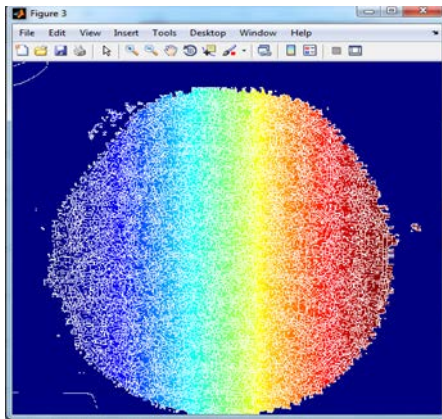
Watershed Transformation Images



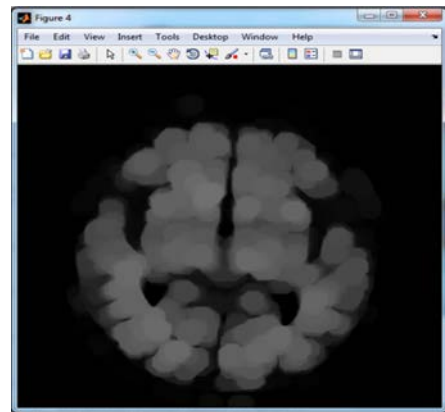
1(a) Grayscale



1(b) gradient magnitudes

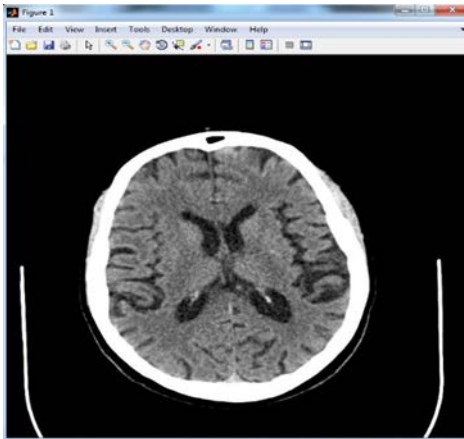


1(c) watershed transform

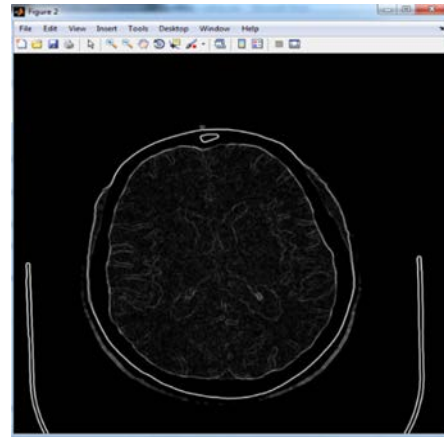


1(e) Closing-by-reconstruction

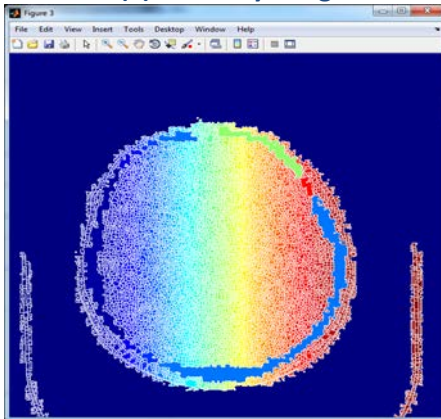
K Means Clustering Marker Controlled Watershed Technique Images



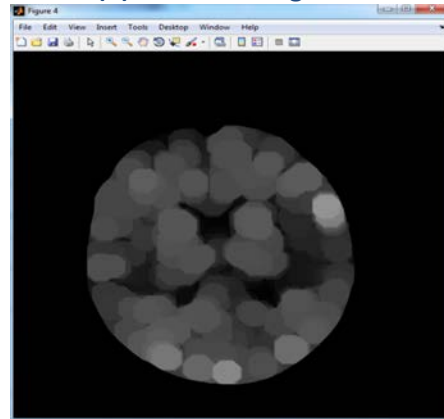
2(a) Intensity Image



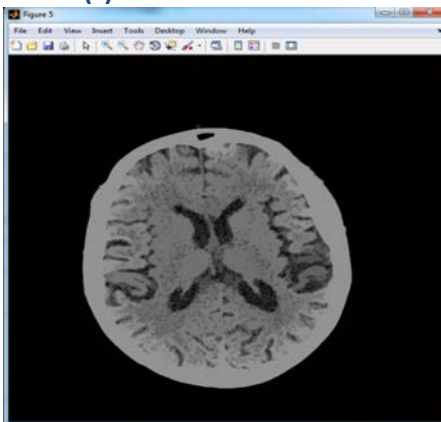
2(b) Gradient magnitude



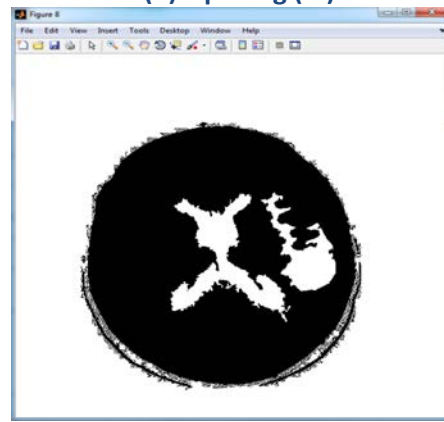
2(c) Watershed transform



2(d) Opening (Io)



2(e) Opening-by-reconstruction

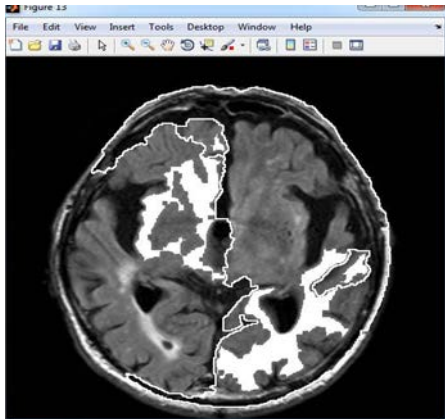


2(h) Regional maxima of opening-closing by reconstruction

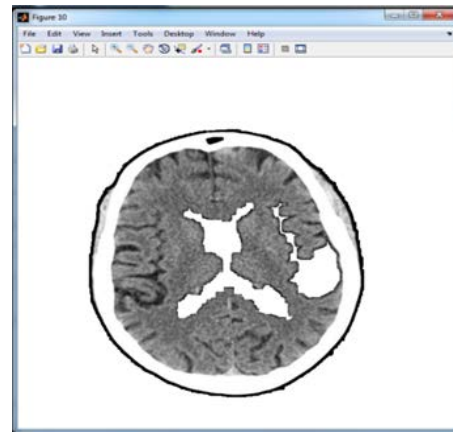
4 Results

This visualization illustrates how the locations of the foreground and background markers affect the result. In a couple of locations, partially occluded darker objects were merged with their brighter neighbor objects because the occluded objects did not have foreground markers. Another useful visualization technique is to display the label matrix as a color image. Label matrices, such as those produced by watershed and bwlable, can be converted to true color images for visualization purposes by Using

label2rgb. You can use transparency to superimpose this pseudo-color Label matrix on top of the original intensity image.



1(o) Final marker control watershed segmented output



2(j) Modified regional maxima superimposed on original image

5 Future work and Conclusion

In this study, we have proposed the watershed transform, gradient method along with the marker controlled technique. The results have been computed with the help of MATLAB 2013a software tool. Without additional preprocessing such as the marker computations below, using the watershed transform directly often results in "over segmentation". Here, we have used the gradient magnitude then the classical watershed technique and finally the marker controlled watershed transform. In the future, we are going to use the level set methods as post-segmentation filters on the marker controlled watershed transform in order to refine the resultant factors. We will use this methodology, in the DICOM understanding model in our future prospects, which could be used in the common sense reasoning of intelligent systems, or other applications in our proposed software.

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