STUDY OF APPLICATIONS AND ALGORITHMS OF IMAGE SEGMENTATION IN THE FIELD OF MEDICINE

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Abstract: Image segmentation is a technique to divide an image into small segments which is easier to examine. It plays an essential role in medicine field to improve the quality of medical diagnosis by automating the extraction of region of interest (ROI) from an image. The purpose of this paper is to provide a review of the different applications of image segmentation in the field of medicine and the various segmentation algorithms used. The different applications include detection of lung nodules, skin legion segmentation, brain tumor detection etc. The various segmentation algorithms include threshold method, K-Means algorithm, watershed algorithm etc.

Index Terms **-** Image segmentation, medical diagnosis, region of interest, applications, segmentation algorithms.

I. INTRODUCTION

Image segmentation plays a crucial role in the field of medicine. A major difficulty today is the high variations in medical images. Hence it is important to automate the process of segmentation using various algorithms which helps to focus on the desired region of interest (ROI).

In this paper many current applications of image segmentation in medicine field are described along with the algorithms used. Applications and the algorithms used are as follows: Detection of lung nodules using Otsu's thresholding method, distinguishing different parts of a tissue using K-Means and K-Nearest Neighbor(KNN) algorithm, skin lesion segmentation using GrabCut and K-Means algorithm, left ventricle segmentation in cardiac scintigraphic images using region based segmentation and edge detection method, white matter hyper intensity(WMH's) segmentation in brain images using W2MHS toolbox and detection of brain tumor using watershed algorithm and bilateral symmetry method. This paper is organized as follows: Introduction has been presented in Section I, followed by various applications and algorithms of image segmentation in Section II and Section III covers the conclusion

II. APPLICATIONS AND ALGORITHMS OF MEDICAL IMAGE SEGMENTATION

1. Detection of lung nodules in Computed Tomography (CT) image

Small masses of tissue in the lungs are known as lung nodules. They are round white shadows on CT scan or chest X-ray. Lung nodules maybe of two types i.e. Malignant or benign. Malignant nodules are cancerous whereas benign maybe non-cancerous. Segmentation of lung nodules from images using image segmentation algorithms helps in better medical diagnosis. Before segmentation the image is preprocessed to remove noise and for contrast adjustment. The algorithm used for segmentation of lung nodules is Otsu's thresholding [1].The algorithm is described as follows.

1.1. Otsu's thresholding

It is considered that image contains two classes of pixels.i.e. Background and foreground pixels. The optimum threshold separating the classes is calculated so that the spread which is known as intra class variance is minimal and inter class variance is maximal. It operates directly on the gray level histogram and hence it is fast.

2. Distinguish different parts of a tissue in pathology

In pathology, image segmentation is performed on the slides of tissues affected with tumors [2].Consider a slide of a tissue affected by syringocystadenoma papilliferum which is a sweat gland tumor. The tissue is stained with hematoxylin and eosin. Eosin is used to color eosinophilic structures in different shades of red or pink and hematoxylin colors nuclei of cells to blue color. A color based segmentation algorithm is used which allows the pathologist to focus on the desired region of interest based on color and differentiate between different types of tissues. K-Means [3] and K-Nearest Neighbor (KNN) algorithms are used for segmentation which are described below.

2.1. K-Means algorithm

Steps of the algorithm are as follows:

Step 1)'K' cluster centers are chosen based on some predefined criteria or randomly.
Step 2) Each of the pixel is assigned to the cluster so that there is minimum distance between pixel and cluster center.
Step 3) Average of all pixels in the cluster is calculated to recompute cluster centers.

Step 4) If previous cluster center and new cluster center is the same then the algorithm stops. If not same repeat step 2 and step 3.

2.2. K-Nearest Neighbor (KNN) algorithm

K-Nearest Neighbor is a technique that provides good classification accuracy. Considering 'K' points as nearest neighbor of a pixel 'x' using a certain distance metric, then classification of 'x' is the class label that is found in majority of the 'K' neighbors.

3. Skin lesion segmentation

Skin cancer is caused due to abnormal cell development. These cancer cells may spread out to other parts and organs if left unchecked [4].Most common types of skin cancers are basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and malignant melanoma. Visual screening by dermatologists does not provide accurate results and sometimes it may lead to potential harm which includes unnecessary procedure's such as skin biopsy for lesions which are non-cancerous. Before applying the segmentation algorithm the image is preprocessed to remove the noise present in the image. The filtered image is then used for segmenting the skin lesion. Algorithms used for segmentation are GrabCut and K-Means algorithm which are described below.

3.1. GrabCut Segmentation algorithm

GrabCut algorithm [5] is used to segment the foreground from the image. Steps of the algorithm are as follows:

Step 1)Input foreground, background and the unknown part of the image, which is done by drawing a rectangle around the object of interest and marking the region inside that rectangle as unknown. Pixel values which are outside the rectangle are then marked as known background.
Step 2)Initially foreground class will contain the unknown pixels and all known background pixels are classified as background.
Step 3)Build foreground and background as Gaussian mixture models (GMMs).
Step 4)Assign every pixel in the foreground the most probable Gaussian component in foreground GMMs and assign every pixel in background the most probable Gaussian component in background GMMs.
Step 5)Learn new GMMs from the pixel sets that were created in the previous step.
Step 6)Built a graph and graph cut is used to find a new classification of foreground and background pixels.
Step 7) Repeat step 4-6 until convergence is attained.

The foreground image which is segmented using GrabCut algorithm is further processed using K-Means algorithm as discussed in section 2.1.For skin lesion segmentation using K-Means the input pixels are grouped into interior skin lesion, lesion boundary, lesion background and background image [4].From the obtained clusters , the cluster with pixel color similar to skin lesion is retained.

4. Left ventricle segmentation in cardiac scintigraphic images

In radionuclide ventriculography image left ventricle is the most important part to calculate ejection fraction (VEF) and to give information about heart muscle walls. Algorithms used for segmentation are region based segmentation and edge based segmentation as described below.

4.1 Region based segmentation

It is used to segment images into regions that have common properties according to a set of predefined criteria.

4.1.1. Active contour model

Active contour is based on the evolution of a curve. It is initialized by the user near the frontier of the detectable object. Then in an iterative process the curve is moved and deformed in order to minimize the energy function [6].

4.1.2. Gray level thresholding

In gray level thresholding two cases are possible. First is bi-level thresholding in which if the pixel has a gray level value greater (or less depending on user's choice) than the threshold, it is coded to one otherwise zero. Second is multithresholding in which different thresholds are used and pixels are sorted into many groups of gray levels.

4.2 Edge based segmentation

In gradient based method, the commonly used first order edge detectors are prewitt, sobel and canny operators as discussed below.

4.2.1. Prewitt operator

Prewitt operator is used to detect horizontal and vertical edges. Difference between corresponding intensities is used to calculate the edges. Masks are also known as derivative masks and it uses two masks to detect edges in horizontal and vertical direction.

4.2.2. Sobel operator

Sobel operator is used to detect horizontal and vertical edges. In Sobel operator the coefficients of masks can be adjusted and is not fixed unlike prewitt operator. Sobel operator uses a 3x3 mask.

4.2.3. Canny operator

First a Gaussian mask is used to smoothen the image. Then gradient operators (sobel, prewitt etc.) are used to compute the gradient. Then pixel values are chosen based on angle of magnitude of that pixel and neighboring pixels.

5. White Matter Hyperintensity (WMHs) segmentation in brain images

White matter hyperintensity (WHMs) also known as leukoaraiosis are lesions in the brain that are mostly found in MRI or CT of older patients. Early detection is used to prevent fast growth of neurology illness and segmentation of WHMs is very useful for the diagnosis of abnormalities in an image and Alzheimer's disease [7].

5.1. Wisconsin white matter hyperintensities segmentation toolbox (W2MHs)

Segmentation of WHMs is done using Wisconsin white matter hyperintensities segmentation (W2MHs) toolbox.W2MHs toolbox [8] is designed in MATLAB and its several modules include the following.

a. Pre-processing module: It includes construction of white matter (WM) region of interest

b. Segmentation module: It is the main part of W2HMs which uses random forest based regression method to detect WMHs.

c. Quantification module: It summarizes WHM segmentation

6. Brain tumor detection

Brain tumor detection is one of the upcoming field in medicine. In order to increase survival rate of the patients, segmentation of brain tumor is very important. There are different methods for brain tumor segmentation. The two methods described are watershed algorithm and bilateral symmetry.

6.1. Watershed transformation

It is used on a grayscale image. Watershed segmentation is essential to differentiate between the overlap in the margin of each organs. Then the gradient is found from the grayscale image [9].

6.2. Bilateral symmetry

In this technique first edge detection is used and mid pixel position of row is determined. Also the intensity of mid pixel of row is read. It then shows the curve in tumor affected area. Tumor area is calculated using automatic brain tumor detection [9].

III. CONCLUSION

This paper is concerned with the survey of different applications of image segmentation in the field of medicine and the algorithms used for segmentation. Applications and algorithms include detection of lung nodules using Otsu's thresholding method, distinguishing different parts of a tissue using K-Means and K-Nearest Neighbor(KNN) algorithm, skin lesion segmentation using GrabCut and K-Means algorithm, left ventricle segmentation in cardiac scintigraphic images using region based segmentation and edge detection method, white matter hyper intensity(WMH's) segmentation in brain images using W2MHS toolbox and detection of brain tumor using watershed algorithm and bilateral symmetry method.

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REFERENCES

[1] AS Chithra ; Renjen Roy R U, "Otsu's adaptive thresholding based segmentation for detection of lung nodules in CT image"2018 2nd International Conference on Trends in Electronics and Informatics (ICOEI), IEEE Conferences.

[2] Prachi Surlakar ; Sufola Araujo ; K. Meenakshi Sundaram," Comparative Analysis of K-Means and K-Nearest Neighbor Image Segmentation Techniques ",2016 IEEE 6th International Conference on Advanced Computing (IACC).

[3] Prachi Surlakar ; Sufola Araujo ,Okstynn Rodrigues," Analysis Of Computational Techniques For Image Segmentation" International Journal of Advances in Electronics and Computer Science, Volume-2, Issue-10, Oct.-2015

[4]Seetharani Murugaiyan Jaisakthi; Palaniappan Mirunalini ; Chandrabose Aravindan," Automated skin lesion segmentation of dermoscopic images using GrabCut and k-means algorithms", Published in IET Computer Vision

[5]Tomas Malmer ,"Image segmentation using GrabCut",May 2010

[6]Y. Ben Fadhel ; S. Ktata ; T. Kraiem," Cardiac Scintigraphic Images Segmentation Techniques"2nd International Conference on Advanced Technologies for Signal and image Processing (ATSIP),IEEE Conferences.

[7]S. S. Soh, T. S. Tan and T. A. I. Tengku Alang, E. Supriyanto," White Matter Hyperintensity Segmentation on T2 FLAIR Brain Images using Supervised Segmentation Method", IEEE Conferences

[8]Wisconsin Alzheimer's Disease Research Center, "Wisconsin White Matter Hyperintensities Segmentation Toolbox",UW Madison - v1.3,November 4, 2013

[9]Aby Elsa Babu, Anandu Subhash, Deepa Rajan S, Femi Jacob, Parvathy A Kumar," A Survey on Methods for Brain Tumor Detection", IEEE Conference on Emerging Devices and Smart Systems (ICEDSS 2018),2-3 March 2018.