State of Art of Medical Image Segmentation Techniques

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ABSTRACT
Segmentation is used as the first step in treatment and recognizing a disease by distinguishing the tissue borders. Thus, it is important to correctly perform segmentation so that the illness can be cured successfully. It even works when the brightness of the image becomes too low. In this paper, we will discuss different techniques to perform image segmentation.

General Terms
Digital image processing, Medical Image Segmentation, Genetic Algorithm

Keywords
Medical Image segmentation, Genetic Algorithm

1. INTRODUCTION
An image is an artifact that depicts or records visual perception [1]. It is basically a two dimensional function of spatial coordinates f(x, y), and amplitude of this function at a given coordinate gives the intensity value of the image. It can also be expressed as the product of functions of illumination and reflection.

$f(x,y) = i(x,y) \cdot r(x,y)$

Where i(x,y) is the function of intensity and r(x,y) is the function of reflectivity.[2]

There are three types of images [9]:

- Gray scale [10]
- Hyper spectral
- Medical images

In our paper we focus only on medical images.

An image also plays a very important role in providing information related to medical field. The information is provided in the form of volume, shape, motion of organs, to detect any difference from the normal working organs.

Digital Image Processing is an important term which includes the application of various algorithms on the image to remove any unwanted noise that can be present in the image in the form of unwanted pixels. Thus, improving the quality of the image. This way more information can be obtained from the image. Among the various techniques used in digital Image Processing for improving the quality of the image, Image Segmentation is also a very important technique used and its results are used in many image processing applications.

1.1 More about Image Segmentation
It is a procedure used for clustering or classifying a digital image into several parts which are disjoint in nature based on the process of grouping the pixels into regions which are alike. This likeness is compared on the basis of pixel characteristics such as gray level, color, texture, intensity and other features. The main purpose of the segmentation process is to get more information in the region of interest in an image which helps in annotation of the object scene [5]. It aims at partitioning (that is domain-independent) of image into a set of regions that are visually distinct and alike with respect to certain properties [6]. In other words segmentation can be best understood as portioning an image from its background.

Based on the various techniques used, image segmentation approaches are divided into following two categories:

(A) Detecting Discontinuities
The boundaries can be detected by detecting discontinuities in the region which includes image segmentation algorithm. As the intensity value changes, partitioning is done easily. In this, segmentation by finding the pixels on the boundary region is done. Thus, leading to edge (partition between two different regions of an image) detection.

(B) Detecting Similarities
It defines partitioning an image into regions that are similar according to predefined criteria or set [8]. This can be achieved by using various segmentation algorithms that includes thresholding, region growing, region splitting and merging [9].

1.2 Image Segmentation Techniques
1.2.1 Edge Detection Technique
It is a discontinuity detection technique which aims at determining and outlining an edge in an image [14]. An edge is defined as a boundary or an outline made up of pixels that connect two regions with varying image amplitude attributes. Various attributes used can be such as different constant luminance and tristimulus values present in an image [14][15][16].

Detection operation starts with detecting discontinuity at local level of pixel element in an image. The various elements of interests such as amplitude, orientation and location of a particular subarea in an image are looked after as they are essentially to be the possible edges. Based on the various elements, it is decided whether each of the pixels that has been examined is an edge or not.

1.2.2 Thresholding Technique
It is considered as one of the easiest image segmentation technique. Through this technique a threshold is selected based on which the recognition of the various regions is done.

It can be used to convert gray scale images to binary images as the region having intensity value above the threshold value is given 1 whereas other regions are given 0 value.There are two types of thresholding [17]:

Segmented image g(x,y) is given by:

G(x,y)=1 ,if f(x,y)> threshold value,

Otherwise G(x,y)=0

1) GLOBAL THRESHOLDING:

When the threshold value is same or constant over the entire image, the process given in the above image is known as global thresholding.

2) VARIABLE/LOCAL/REGIONAL THRESHOLHING:

When the threshold value changes over an image, the process given in the above image is known as variable or local or regional thresholding.

1.2.3 Clustering Technique

Clustering technique is an unsupervised learning technique, easy for implementation. In this firstly a finite set of classes is identified. These set of classes is known as clusters. The data train themselves using data that is accessible i.e. without making use of any training stages.

- Assumption: Each region that is present in an image forms a separate cluster in the feature space [11].
- Firstly the points in the feature space are categorized into clusters [11].
- The grouping of the pixels into clusters is based on the principle i.e. maximizing the intra class similarity and minimizing the inter class similarity.
- Then, these clusters are mapped back to the spatial domains that form the separate regions [11].

Clustering algorithms are classified as:

- Hard clustering
- K-means clustering
- Fuzzy clustering, etc

So, the above techniques are used for image segmentation. As concerned with medical section the images used i.e. medical images are sometimes too bright. This way it becomes difficult to recognize the tissue borders. In order to overcome this problem segmentation is used. Therefore, it is very much obvious that segmentation is often used as the first and most important phase in the recognition and treatment of a disease in analyzing medical images [11].

For the above mentioned problem Genetic Algorithms are one of the most powerful techniques used. This is most helpful in case of computation time [11].

1.3 Genetic Algorithm

Genetic algorithms are an optimization technique most commonly used in image segmentation. It imitates the natural selection thus, permitting an algorithm to adapt. Solutions are most often represented as binary strings (population of individual chromosomes). The process follows in the following manner [12]:

1. We start with randomly generating a population of some chromosomes.
2. Calculate the fitness i.e. fitness value of each chromosome so produced in the population.
3. Repeat until N number of offspring's are produced:

i) Follow a selection process in which probabilistically select a pair of chromosomes from current population being produced using the value of the fitness function that was used.

ii) Produce an offspring xi using crossover and then mutation operators

4. Replace the population produced currently with the one created newly.
5. Go back to step 2.

Table 1.Comparison of Image Segmentation Techniques

AUTHORS	YEAR	PAPER	TECHNIQUE	RESULT
A. M. Khan, Ravi. S	2013	[2]	Threshold Based Segmentation, Edge Based Segmentation, Region Based Segmentation	Every technique has its own advantages and disadvantages. It is difficult to find out a single solution for segmentation as approach varies from individual users perspective.
Keri Woods	2007	[3]	Genetic algorithm	The major decisions in GA is 1) Choosing a method of segmentation to which GA will be applied. 2) Finding a fitness function.
P. Kanungo, P.K. Nanda, U.C. Samal	2013	[6]	GA based crowding algorithm	Histogram with bimodal feature.
Tianzi Jiang, Faguo Yang, Yong fan, David J. Evans	2010	[7]	Parallel Genetic Algorithm	The proposed method is able to segment images of elliptically shaped cells successfully.
G.M.N.R. Gajanayake, R. D. Yapa and B. Hewawithana	2009	[18]	Using standard image segmentation techniques in order to isolate a brain tumor	Otsu's thresholding method is the most suitable image segmentation that can be used for separating brain tumor from a Magnetic

			from the other regions of the brain	Resonance Image.
M. P. Gupta and M. M. Shringirishi.	2013	[19]	Combination of k-means and fuzzy c-means	This proposed method is able to improve the reproducability and accuracy.
N. Zhang, S. Ruan, S. Lebonvallet, Q. Liao, and Y. Zhu.	2011	[20]	Combination of SVM and Kernel feature selection	Good results in low computation time.
R. Meenakshi and P. Anandhakumar	2012	[21]	Combination of K-means clustering, PN classifier	It combines clustering and classification algorithm, but the accuracy can be improved in less time.
G.-C. Lin, W.-J. Wang, C.-C. Kang, and C.-M. Wang.	2012	[22]	Multispectral mr images segmentation based on fuzzy knowledge and modified seeded region growing	This method results in lower over and under segmentation.
M.Kumar and K.K. Mehta	2011	[23]	Texture based Tumor detection and automatic segmentation	This paper describes region growing segmentation method for segmentation of brain tumor in MRI, in which it is possible to determine abnormality is present in the image or not.

2. CONCLUSION

In this paper, we have discussed about various techniques of image segmentation such as edge detection technique, thresholding technique and clustering technique. Every technique has its own advantages and disadvantages. Further, we have discussed about Genetic Algorithm and its process. In this paper, we conclude that high quality image segmentation can be achieved using colored images rather than using grey-scale images because colored images contains more information as compared to grey-scale images.

3. REFERENCES

[1] http:/www.google.com/Wikipedia

[2] A. M. Khan, Ravi. S "Image Segmentation Methods: A Comparative Study", International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-3, Issue-4, September 2013

[3] Keri Woods, "Genetic Algorithms: Colour Image Segmentation Literature Review", July 24, 2007.

[4] W. Skarbek and A. Koschan. Colour image segmentation - a survey, 1994.

[5] Dr. (Mrs.) G.Padmavathi, Dr.(Mrs.) P.Subashini and Mrs.A.Sumi "Empirical Evaluation of Suitable Segmentation Algorithms for IR Images", IJCSI International Journal of Computer Science Issues, Vol. 7, Issue 4, No 2, July 2010.

[6] X. Munoz, J. Freixenet, X. Cuf_ı, J. Mart, "Strategies for image segmentation combining region and boundary information", Pattern Recognition Letters 24, page no 375–392, 2003.

[7] Tianzi Jiang, Faguo Yang, Yong fan, David J. Evans,"Brain Tumor Image Segmentation using Parallel Genetic Algorithm" International Journal of Science and Modern Engineering (IJISME),2010

[8] Wahba Marian, "An Automated Modified Region Growing Technique for Prostate Segmentation in Trans-Rectal Ultrasound Images", Master's Thesis, Department of Electrical and Computer Engineering, University of Waterloo, Waterloo, Ontario, Canada, 2008.

[9] H.P. Narkhede, "Review of Image Segmentation Techniques", International Journal of Science and Modern Engineering (IJISME) ISSN: 2319-6386, Volume-1, Issue-8, July 2013

[10] Zhang, Y. J, "An Overview of Image and Video Segmentation in the last 40 years", Proceedings of the 6th International Symposium on Signal Processing and Its Applications, pp. 144-151, 2001

[11] Divya Kaushik, Utkarsha Singh e.t.al, "Medical Image Segmentation using Genetic Algorithm", International Journal of Computer Applications (0975 – 8887) Volume 81 – No 18, November 2013.

[12] Keri Woods, "Genetic Algorithms: Colour Image Segmentation Literature Review", July 24, 2007

[13] Falkenauer, E., "Genetic Algorithms and Grouping Problems", John Wiley & Sons, Boston, 1998.

[14] W. Frei, C. Chen, "Fast Boundary Detection: A Generalization and New Algorithm," IEEE Trans. Computers, vol. C-26, no. 10, pp. 988-998, Oct. 1977.

[15] R. C. Gonzalez and R. E. Woods, "Digital Image Processing. Upper Saddle River, NJ: Prentice-Hall", 2001, pp. 572-585.

[16] W. K. Pratt, "Digital Image Processing". New York, NY: Wiley-Interscience, 1991, pp. 491-556.

[17] Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", third edition, Pearson publication.

[18] G. M. N. R. Gajanayake, R. D. Yapa and B. Hewawithana "Comparison of Standard Image Segmentation Methods for Segmentation of Brain Tumors from 2D MR Images".

[19] M. P. Gupta and M. M. Shringirishi, "Implementation of Brain tumor Segmentation in Brain MRI using K-means Clustering and fuzzy c-means algorithm", International Journal of Computers & Technology, vol. 5, no. 1,pp. 54-59,2013.

[20] N. Zhang, S. Ruan, S. Lebonvallet, Q. Liao, and Y. Zhu,"Kernal Feature Selection to fuse multi-spectral MRI imags for brain tumor segmentation,Computer Vision and Image Understanding,vol. 115,no. 2,pp.256-269,2011.

[21] R. Meenakshi and P. Anandhakumar, "Brain Tumor Identification in MRI with BPN Classifier and Orthonormal Operators",European Journal of Scientific Research,September 2012.

[22] G.-C. Lin, W.-J. Wang, C.-C. Kang, and C.-M. Wang," Multispectral mr images segmentation based on fuzzy knowledge and modified seeded region growing",Magnetic Resonance Imaging,vol. 30,no. 2,pp. 230-246,2012

[23] M.Kumar and K.K. Mehta," Texture based Tumor detection and automatic Segmentation using Seeded Region Growing Method",International Journal of Computer Technology and Applications,August 2011.