MATLAB implementation of image segmentation algorithms

Conference Paper · August 2010

DOI: 10.1109/ICCSIT.2010.5564131 · Source: IEEE Xplore

3 authors, including:

Shyamkant Limaye
St Vincent Pallotti College of Engineering & Technology
28 PUBLICATIONS **47** CITATIONS

SEE PROFILE

MATLAB Implementation of Image Segmentation Algorithms

Pankaj Agrawal
Dept. of Electronics Engg.
S. R.K.N.E.C.
Nagpur, India
pankaj_rknec@rediffmail.com

Dr. S. K. Shriwastava
Dept. of Electronics Engg.
N.I.E.T.M.
Nagpur, India
sansri_99@yahoo.com

Dr. S. S. Limaye
Dept. of Electronics Engg.
J.I.T.
Nagpur, India
shyam_limaye@hotmail.com

Abstract - **Image segmentation is a relevant research area in Computer Vision, and several methods of segmentation have been proposed in the last 40 years. This paper presents the implementation using the GUI feature of the MATLAB and one best result can be selected for any algorithm using the subjective evaluation. This process can help to find out the best suitable value of parameters for the segmentation of different types of imagery. In this paper, one best algorithm has considered for each method of image segmentation. The interactive based method provides the facility to select the desired area as an object and produces better result. The proposed process also displays the duration of segmentation of each algorithm.**

Keywords – Image Segmentation, MATLAB, GUI, Segmentation Parameters.

I. INTRODUCTION

One of the most important operations in Computer Vision is segmentation [1]. Segmentation is the task of recognizing objects in an image. The rest of the image is background. The aim of image segmentation is the domain - independent partition of the image into a set of regions which are visually distinct and uniform with respect to low level information, such as gray level, texture or colour. The output of this is used as input in high level processing such as object recognition, scene analysis etc. Generally segmentation methods are based on two basic properties of the pixels in relation to their local neighborhood: discontinuity and similarity. Methods based on some discontinuity property of the pixels are called boundary-based methods, whereas methods based on some similarity property are called region-based methods. Unfortunately, both techniques often fail to produce accurate segmentation results [2].

Image segmentation is used in various applications. For all the applications, a single method can not produce the desired result. It is all due to that the images have different property and some other factors also like noise, brightness etc. put impact on the images, and it is not possible to apply a single segmentation method and also a single evaluation technique for all types of imagery.

This paper analyzes the results of various segmentation algorithms, using the subjective evaluation, on the different types of images and particularly on gray level images. Every segmentation algorithm has some parameters such as threshold in edge based methods, blocksize in split and merge method etc., and a good segmented result of an algorithm is having different value of the parameters for different images. In this paper, the effect of change of parameter's value has been studied and one best value can be selected using subjective evaluation.

II. IMAGE SEGMENTATION AND ITS EVALUATION

Image segmentation simplifies and changes the representation of an image, i.e., the image is transferred into something that is more meaningful and easier to analyze.

Image segmentation is broadly classified into five classes –

- Edge detection methods
- Thresholding based methods
- Region based methods
- Cluster based methods
- Graph based methods

It is difficult to assess whether one algorithm produces more accurate segmentations than another, whether it be for a particular image or set of images, or more generally, for a whole class of images. To this end, a variety of attempts have already been made by many researchers.

The iteration of algorithm selection, image segmentation and segmentation evaluation will not stop until a satisfied result is achieved. However, up to now, there is still no universally accepted method of evaluation of segmentation result, which makes evaluation-based algorithm selection hard to apply to real applications.

As a matter of fact, selecting different algorithms to segment different images seems to be the most straightforward and effective solution. For one segmentation algorithm, two types of evaluation can often be distinguished. One is carried out with the same parameter setting of the algorithm for segmenting multiple images. That is, the ability and consistency of the algorithm in treating images with different contents and/or acquired under various conditions are evaluated. Another one is carried out by giving different values to the algorithm's parameters for segmenting some comparable images and then evaluating the influence of multiple settings of the algorithm over its performance. That is, the adaptability and the best performance of the algorithm for given images are evaluated.

978-1-4244-5539-3/10/$26.00 ©2010 IEEE

Zhang [3] proposes a classification of evaluation methods as “analytical”, “empirical goodness”, or “empirical discrepancy”.

In another way, segmentation evaluation method can be divided in to subjective and objective one. In subjective evaluation, a human visually compares the image segmentation results, which is a tedious process and inherently limits the depth of evaluation to a relatively small number of segmentation comparisons over a predetermined set of images.

III. MATLAB IMPLEMENTATION

MATLAB is a high-performance language for technical computing and interactive environment for algorithm development [4]. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

One of the advantages of working in MATLAB is that functions operate on entire arrays of data, not just on single scalar values.

MATLAB stores most images as two-dimensional arrays, i.e., matrices, in which each element of the matrix corresponds to a single *pixel* in the displayed image. Pixel is usually denotes a single dot on a computer display. MATLAB can store images as *uint8*, *uint16*, or *double* arrays.

In this paper, a program has been developed using MATLAB GUI to load the images, which contained link for all algorithms using pushbutton, drop down menu and sliders to change the values of the parameters related to the concerned method such as threshold in edge based methods, value of K in k-means method. This GUI also contains the option to display the time taken by each method so that the duration of each method also can be compared. The developed GUI is shown in Fig. 1.

A. Process

- Initially an image is selected and then converted into Gray level image of size 256x256.
- The original and resized image is displayed.
- The value of the concerned parameters, if any, is selected.
- The result of each algorithm is displayed in the separate figure window.
- The segmented image is displayed at a particular position according to the range of the selected value of the parameter.
- Every output image in that figure window contains the value of parameters and the duration of process.

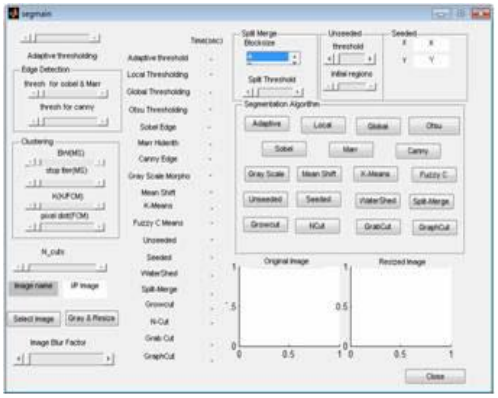

Figure 1. Developed MATLAB GUI for Image Segmentation

Above step is repeated with various values of parameters for the same algorithm and the results are obtained in the same figure window.

With the help of those results in a figure window, a best segmented image can be selected on the basis of visual inspection and the value of the parameters for that segmented image can be chosen as a result.

Similarly, all the algorithms are applied on an image and for every segmentation algorithm; the result is displayed on separate figure window.

The proposed MATLAB GUI framework also had an option of image blurring. So this paper also included the evaluation of effect of blurring on the segmented results of various algorithms.

III. SEGMENTATION RESULT

This paper displays the segmentation result of one algorithm from each segmentation class. Along with each segmented image, the value of parameter and time taken by that is also shown.

If any algorithm has two parameters, in that case the value of one parameter is varied and the value of second parameter remains fixed. For every value of second parameter, the segmentation is applied using various values of first parameter. For example, in Split and Merge method, there are two parameters Blocksize and Split Threshold. First the value of Split threshold is set and then the value of Blocksize is varied. It is repeated for different values of Split Threshold.

The result of Canny algorithm [5], a edge based method, on an Football Image is shown in Fig. 2. The segmented images are showing the threshold value (T) and the duration.

The result of Thresholding methods [6, 7] on a Lotus image are shown in Fig. 3. In all the methods, the parameter is T and its value is selected in the program itself.

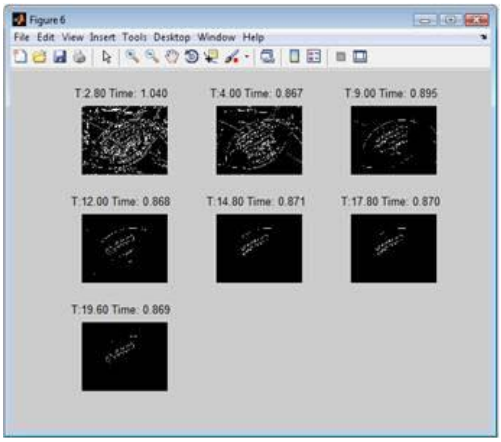

Figure 2. Segmented Images of Football.bmp using Canny Algorithm

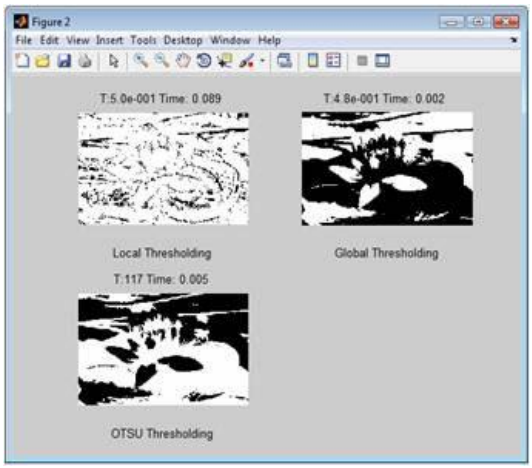

Figure 3. Segmented Images of Lotus.bmp using Local, Global and Otsu Thresholding Algorithm

The result of Split and Merge algorithm, a region based method [8], on a Football image is shown in Fig. 4. The segmented parameters are Blocksize (BS) and Split Threshold. The figure shows the result for various values of BS when value of split threshold is 1.0.

In Cluster based methods, the result of Fuzzy C-Means (FCM) clustering [9] and Mean Shift method [10] on a Football Image is shown in Fig. 5 and Fig. 6 respectively. In FCM, the segmentation parameters are number of clusters (K) and Pixel Distance (m).

In Graph based method, the normalized cut (N-cut) [11] is a non-interactive method while the Graph cut, Grab cut and Grow cut are interactive methods [12]. The result of N-

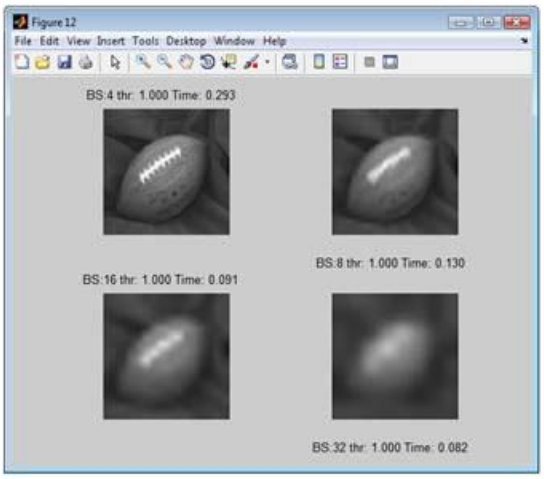

Figure 4. Segmented Images of Football.bmp using Split and Merge Method with split threshold equal to 1.0

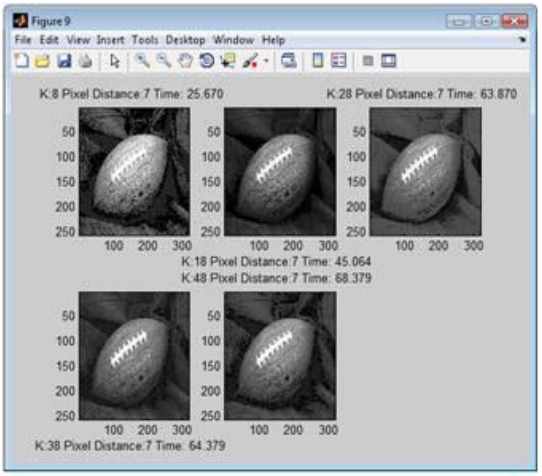

Figure 5. Segmented Images of Football.bmp using Fuzzy C-Means Clustering Method with pixel distance equal to 7

cut method with various values of number of N-cuts is shown in Fig. 7. In Graph Cut method [13], the foreground and background is selected by a user and the segmented image shows the foreground area while the background area becomes black. The Fig. 8 shows the selected area for foreground (red color) and background (blue color) in a ls.bmp image for Graph Cut method. The result of Graph Cut segmentation is shown in figure 9.

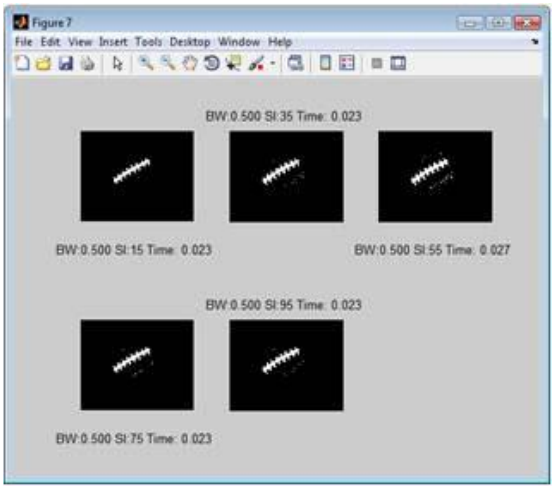

Figure 6. Segmented Images using Mean Shift Method for Bandwidth equal to 0.50

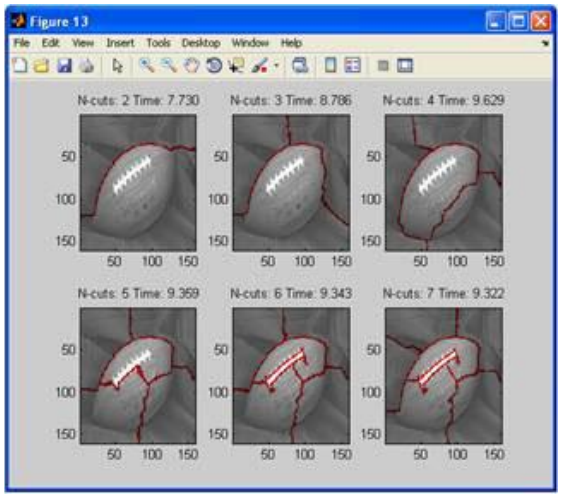

Figure 7. Segmented Images using Normalized Cut Method

IV. Conclusion

After analysis of various image segmentation algorithms and the comparison of the results of each algorithm separately with different parameter's value using MATLAB, the conclusion is that:

In Edge Based Segmentation Algorithms, the Canny Algorithm produced the best segmentation.

In Thresholding Based Algorithms, the Adaptive Thresholding and Otsu Thresholding produced good results. The Adaptive thresholding produced the good edges and Otsu Thresholding recognized the object very well.

In Region Based Algorithms, the split and merge method produced the better result.

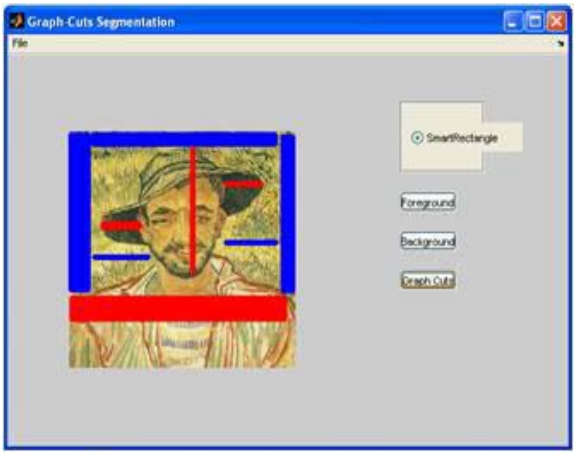

Figure 8. Foreground (Red) and Background (Blue) selection for Graph cut on an ls.bmp Image

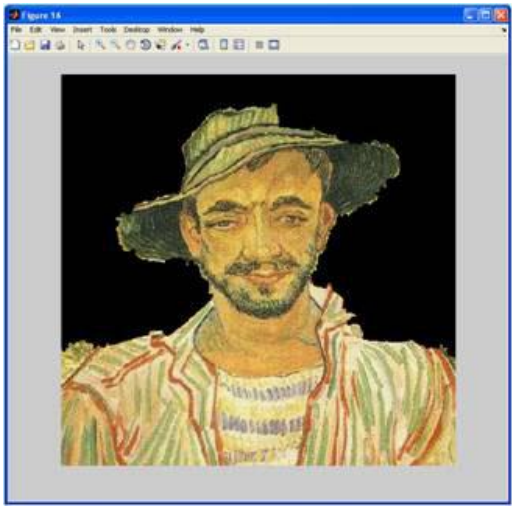

Figure 9. Segmented Image using Graph cut on an ls.bmp Image

In Cluster Based Segmentation, the mean shift method produced the good result. When the K-means and Fuzzy C-means methods are compared, the Fuzzy C-means is better than the K-means method.

In Graph Based Algorithms, Normalized-cut is used to cut an image into specified number of cuts. Other methods are interactive methods. In Graph cut, the foreground and background area is selected by a user.

In all the segmentation algorithms, the results of graph based methods are better than other methods and when the blurring is applied the result of the segmentation is improved.

The limitation of the proposed system is that the visual evaluation can not produce a perfect result. This system can help for some applications but it will not be a perfect one for all types of images.

To produce a good result with a single technique for the images of all the applications, the further research is required and from the proposed system it can be concluded that the further research should concentrate on such techniques in which the user's interaction is involved so that

the segmented result can be improved after automatic segmentation.

REFERENCES

[1] R. C. Gonzalez, R. E. Woods, "Digital Image Processing," 2nd Prentice-Hall Inc, 2002.

[2] L. G. Shapiro and G. C. Stockman, "Computer Vision," Prentice-Hall Inc., New Jersey, 2001, pp. 279-325.

[3] Y. Zhang, "A survey on evaluation methods for image segmentation," Pattern Recognition, 29(8), 1996, pp. 1335-1346.

[4] Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing using MATLAB," 2nd Prentice-Hall Inc, 2002.

[5] J. Canny, "A computational approach to edge detection," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 8, no. 6, 1986, pp. 679-698.

[6] P. K. Sahoo, S. Soltani, A. K. C. Wong, and Y. Chen, "A survey of thresholding techniques," Computer Vision Graphics Image Processing, vol. 41, 1988, pp. 233-260.

[7] N. Otsu, "A threshold selection method from gray level histograms," IEEE Transactions on Systems, Man and Cybernetics, vol. 9, 1979, pp. 62-66.

[8] K. Strasters and J. Gerbrands, "Three-dimensional image segmentation using split, merge and group approach," Pattern Recognition Letters, vol. 12, 1991, pp. 307-325.

[9] M.K. Ng, "A note on constrained k-means algorithm," Pattern Recognition, vol. 33, 2000, pp. 515-519.

[10] D. Comaniciu and P. Meer, "Mean Shift: A Robust Approach Toward Feature Space Analysis," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 24, no. 5, 2002, pp. 603-619.

[11] J. Shi and J. Malik, "Normalized cuts and image segmentation," IEEE Transactions on Pattern Analysis and Machine Intelligence, August 2000, pp. 888–905.

[12] Y. Boykov, and M.P. Jolly, "Interactive graph cuts for optimal boundary and region segmentation of objects in n-d images," ICCV, vol 1, July 2001, pp. 105–112.

[13] Y. Boykov and G. Funka-Lea, "Graph cuts and efficient n-d image segmentation," International Journal of Computer Vision, vol. 70, no. 2, 2006, pp. 109–131.