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# Analysis of Image Segmentation Algorithms Using MATLAB

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***Abstract*— Image segmentation has played an important role in computer vision especially for human tracking. The result of image segmentation is a set of segments that collectively cover the entire image or a set of contours extracted from the image. Its accuracy but very elusive is very crucial in areas as medical, remote sensing and image retrieval where it may contribute to save, sustain and protect human life. This paper presents the analysis and implementation using MATLAB features and one best result can be selected for any algorithm using the subjective evaluation. We considered the techniques under the following five groups: Edge-based, Clustering-based, Region-based, Threshold-based and Graph-based.**

***Key Words*— Image segmentation, N-cut, Mean-shift, Fuzzy-C mean, Image analysis.**

## I. INTRODUCTION

The main goal of image segmentation is domain independent partitioning of an image into a set of disjoint regions that are visually different, homogeneous and meaningful with respect to some characteristics or computed property(ies), such as grey level, texture or color to enable easy image analysis (object identification, classification and processing).

Discontinuity and similarity/homogeneity are two basic properties of the pixels in relation to their local neighborhood used in many segmentation methods. The segmentation methods that are based on discontinuity property of pixels are considered as boundary or edges based techniques and that are based on similarity or homogeneity are region based techniques. 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 cannot 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.

This paper will be organized as follows:
• MATLAB
• Segmentation Results
• Implementation of the proposed system
• Performance Evaluation
• Conclusion.

Fig.1 indicates the classification of image segmentation techniques we have considered in this paper. The methods explained and used to segment the image in fig.3, fig.4, fig.5, fig.6 and fig.7 were used only to clarify the segmentation methods.

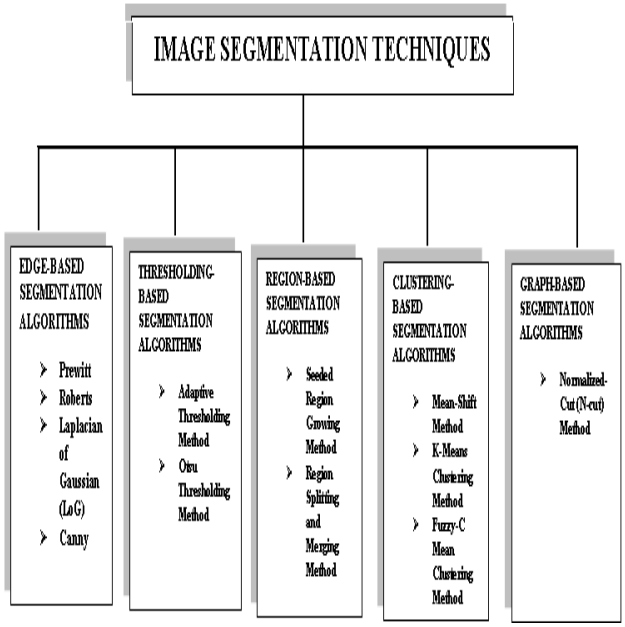


Fig.1 classification of image segmentation techniques

## II. MATLAB

Matlab (MATrix LABoratory) is a tool to do numerical computations, display information graphically in 2D and 3D, and solve many other problems in engineering and science. Developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran[3].

Matlab is an interpreted language for numerical computation. It allows one to perform numerical calculations, and visualize the results without the need for complicated and time consuming programming. Matlab allows its users to accurately solve problems, produce graphics easily and produce code efficiently [4].

In this paper, a program has been developed using MA TLAB to load the images, which contained link for all algorithms using pushbutton, pop-up menus and sliders to change the values of the parameters related to the concerned method such as number of regions in region-

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based methods value of threshold in threshold-based methods.

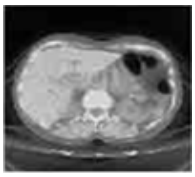
## III. SEGMENTATION RESULT

### *A. Edge-based Segmentation Algorithms*

Edge-base segmentation generally indicates the segmentation method based on the edge in an image. The simple methods apply some edge detection methods before segmentation.

For Example:

**ORIGINAL IMAGE**

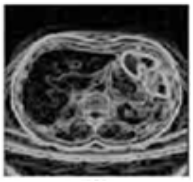


**PREWITT**

**ROBERTS**

**LAPLACIAN of GAUSSIAN (LoG)**

**CANNY**



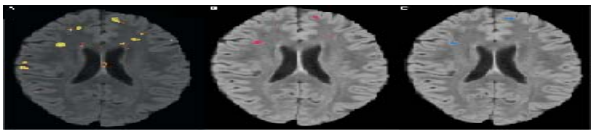
### *B. Thresholding Based Segmentation Algorithm*

Thresholding becomes then a simple but effective tool to separate objects from the background. The output of the thresholding operation is a binary image whose gray level of 0 (black) will indicate a pixel belonging to a print, legend, drawing, or target and a gray level of 1 (white) will indicate the background. Two algorithms are used:

#### *1. Adaptive Thresholding Method*

In adaptive thresholding, a criterion function is devised that yields some measure of separation between regions. A criterion function is calculated for each intensity and that which maximizes this function is chosen as the threshold.

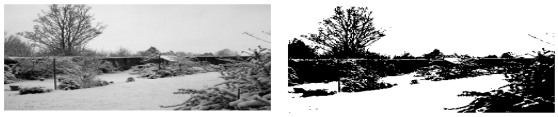
For Example:



#### *2. Otsu Thresholding Method*

Otsu's thresholding method involves iterating through all the possible threshold values and calculating a measure of spread for the pixel levels each side of the threshold, i.e. the pixels that either fall in foreground or background. The aim is to find the threshold value where the sum of foreground and background spreads is at its minimum.

For Example:



### *C. Region-Based Segmentation Algorithms*

Region-based methods mainly rely on the assumption that the neighboring pixels within one region have similar value. It compare one pixel with its neighbors. If a similarity criterion is satisfied, the pixel can be set belong to the cluster as one or more of its neighbors. The selection of the similarity criterion is significant and the results are influenced by noise in all instances. Two algorithms are used:

#### *1. Seeded Region Growing Method*

**Step1:** We start with a number of seed points which have been clustered into n clusters and the positions of initial seed points.

**Step2:** Recompute the boundary of and set those boundary points as new seed points.

**Step3:** Repeat Step2 until all pixels in image have been allocated to a suitable cluster.

For Example:

#### *2. Region Splitting and Merging Method*

**Step1:** Splitting steps: For any region Ri, split it into four disjoint quadrants.

**Step2:** Merging steps: When no further splitting is possible, merge any adjacent regions Rj and Rk.

**Step3:** Stop only if no further merging is possible.

For Example:

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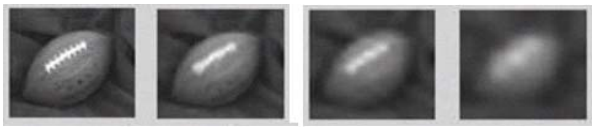
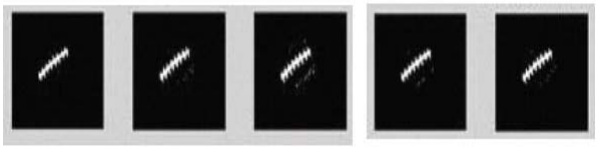


### D. Clustering Based Segmentation Methods

Clustering is one of methods widely applied in image segmentation and statistic. The main concept of clustering is to use the centroid to represent each cluster and base on the similarity with the centroid of cluster to classify. According to the characteristics of clustering algorithm, we can roughly divide into "hierarchical (i.e, nested grouping of patterns )" and "partitioned (i.e, select the number of desired output clusters )" clustering. Three algorithms are used:

#### 1. Mean Shift Method

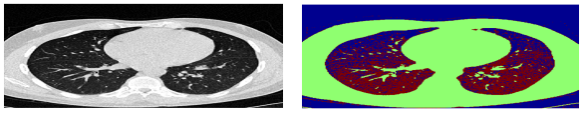
**Step 1:** Determine the number of clusters we want in the final classified result and set the number as *N*.
**Step2:** Classify each pattern to the closest cluster centroid. The closest usually represent the pixel value is similarity, but it still can consider other features.
**Step3:** Recompute the cluster centroids and then there have *N centroids of N clusters as we do after Step1*.
**Step4:** Repeat the iteration of Step 2 to 3 until a convergence criterion(no reassignment of any pattern from one cluster to another, or the minimal decrease in squared error) is met.
For example:



#### 2. K-Means Clustering Method

Choose k-data points to act as cluster centers Until the cluster centers are unchanged. Allocate each data point to cluster whose center is nearest. Now ensure that every cluster has at least one data point; possible techniques for doing this include supplying empty clusters with a point chosen at random from points far from their cluster center.

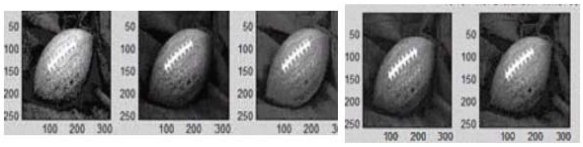
Replace the cluster centers with the mean of the elements in their clusters.
For Example:



#### 3. Fuzzy C-Means Clustering Method

An image can be represented in various feature spaces, and the FCM algorithm classifies the image by grouping similar data points in the feature space into clusters. This clustering is achieved by iteratively minimizing a cost function that is dependent on the distance of the pixels to the cluster centers in the feature domain.

For example:



### E. Graph Based Segmentation Algorithm

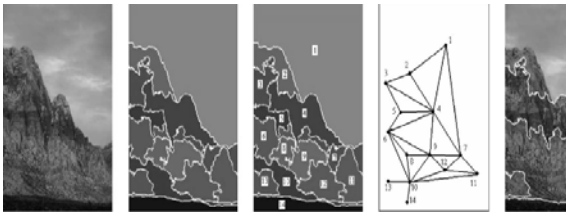
The graph based image segmentation is based on selecting edges from a graph, where each pixel corresponds to a node in the graph. Weights on each edge measure the dissimilarity between pixels. The segmentation algorithm defines the boundaries between regions by comparing two quantities – Intensity differences across the boundary and Intensity difference between neighboring pixels within each region.

#### 1. Normalized-Cut Method

**Step1:**The input is a graph

$$G = (V,E),$$

where V are the n vertices and E are m edges. Each edge has a corresponding weight.
**Step 2:** Perform the segmentation.
**Step 3:** If the weight of the edge connecting two vertices in adjacent components is small compared to the internal difference of both the components, then merge the two components, otherwise do nothing.
**Step 4:** Repeat Step3.
For Example:



## IV. Implementation Of The Proposed System

- Initially an image is selected and then converted into Binary and Gray level image of size 256x256.
- The original and resized image is displayed.
- The value of the concerned parameters, if any, is given.
- 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.

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

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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 same figure window.

## V. Performance Evaluation

There have been many image segmentation methods created and being created using many distinct approaches and algorithms but still it is very difficult to assess and compare the performance of these segmentation techniques [5]. Researchers would evaluate their image segmentation techniques by using one or more of the following evaluation methods in fig.8.

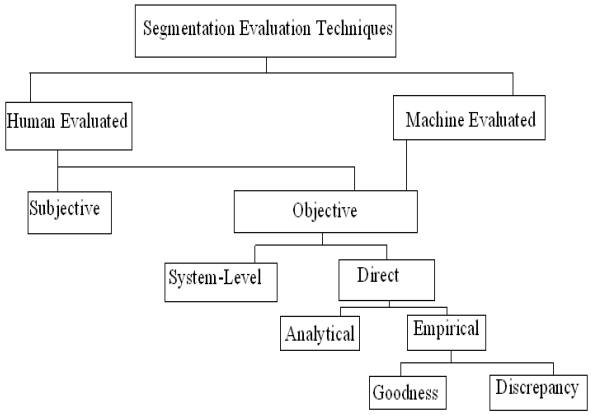


Fig.8 an Overview of Evaluation Techniques

The full description of the above evaluation methods can be found from [6]. Most of these methods ideally should be domain independent but in reality they are domain dependent. It is believed that it is difficult to develop a single model that applies to all image objects . Both the subjective and objective evaluation have been used to evaluate segmentation techniques but within a domain dependent environment [6]. It can be appreciated that whatever method used in a specific domain has been used to compare the segmentation technique in that domain. These methods have been used to adjust parameters of the segmentation techniques in order to solve the following problems in segmentation area:

- The segmented region might be smaller or larger than the actual
- The edges of the segmented region might not be connected
- Over or under-segmentation of the image (arising of pseudo edges or missing edges).

It is very sad that [7] concluded that there is no segmentation method that is better than the other in all domains. We believe that with the use of universal evaluation methods we can be able to find the segmentation techniques that we may say are better than others in all domains.

## VI. 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 comparison of Sobel, Prewitt and LoG.

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.

In Clustering 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 N-cut, the foreground and background area is selected by a user.

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.

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