AUTOMATIC SEED SELECTION ALGORITHM FOR IMAGE SEGMENTATION USING REGION GROWING

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ABSTRACT
Seeded region growing algorithm is the most effective and robust method for image segmentation, but the choice of the seed points is the major concern for this algorithm, so as to achieve efficient image segmentation. In this paper, an algorithm for automatic seed selection is proposed, which completely depends on the information of the image. The proposed algorithm computes the seed points on the basis of occurring frequency in the image, and further merging them to obtain adequate seed points, thus avoiding over-segmentation. Further, using these seed points, a region growing algorithm is implemented to achieve image segmentation. The proposed algorithm was implemented in MATLAB and produced good results for image segmentation, and can be used in future applications of object recognition. The algorithm eliminates the problem of over and under-segmentation, and requires no human interference.

KEYWORDS: *Image Segmentation, Seeded Region Growing, Automatic Seed Selection.*

I. INTRODUCTION

One of the major consideration in the field of object recognition is the presence of multiple objects in an image. It is not a trivial task to recognize multiple objects in an image, without separating them. It is even harder when the objects are touching or overlapping each other, as they may be identified as one object, and can produce an incorrect recognition. Hence, for a perfect object recognition algorithm, the separation of these multiple objects is an essential task. This problem can only be solved by applying image segmentation on such images. Thus, image segmentation is a very prime step in the process of object recognition. The main motive of image segmentation it to divide the image into various segments, that corresponds to significant objects, or parts of an object, present in the image. More precisely, image segmentation is the process of assigning labels to each and every pixel of an image, on the basis of some similarity criteria, such that the pixels with the same label combine to form a meaningful region of the image with similar properties.
Mainly four approaches are used to achieve segmentation of an image, namely, threshold based approach, region based approach, boundary or edge detection approach, and hybrid approach, which combines region and boundary approach [8],[10],[18]. In threshold based segmentation, segments are divided on the basis of a certain threshold value [14]. This method ignores the spatial information of an image, and is not good with noisy and blurred images. Boundary or edge detection approach, finds the edges of the objects on the basis of a gradient operator [15]. Region based method is the most simple, robust, and effective method of segmentation. In region segmentation [7], the regions in an image are determined directly, by comparing one pixel to its neighbouring pixel. This can be done either by region growing, clustering of pixels, or by splitting and merging method.
Adams and Bischof, (1994) proposed an algorithm of a seeded region growing based segmentation, which is controlled by a set of pixels, called seeds. A seeded region growing approach starts by locating a seed point, and further by merging neighbouring pixels into a growing region, which either

is a whole object, or a part of it. The neighbouring pixels are merged on the basis of a similarity criterion, until any more pixels can added to the region. Then, another seed point is computed and further processing is continued, until the whole image is divided into various regions. In this way, using only a small set of pixels, the whole image can be easily segmented [2]. The most critical and principal task in the seeded region growing segmentation is the selection of reliable seed points, as the overall performance of the process is dependent on the choice of seed points. Seed selection can be done either manually or automatically. But, for an effective machine vision application, the seed selection should not involve any human interference.

In this paper, a new approach for seed selection is proposed, to improve the performance of image segmentation. This method is completely automatic, and do not involve any human interventions. The paper is divided into seven sections. The first section provides a brief introduction to the requirement of image segmentation, the various approaches used to achieve it, and the main motive behind the research. The next section reviews the related research work in the field of image segmentation. The third and the fourth section outlines the seeded region growing algorithm, and the proposed algorithm for automatic seed selection respectively in detail. In further two sections, the implementation of the algorithm, its results and a brief discussion is given, and the last section concluded the work.

II. LITERATURE REVIEW

Till now, many methods have been developed for automatic seed selection, but still the problem of automatic seed generation is not fully solved. Malek et al., (2010) proposed a method based on morphological operations, in which regional and local maxima are employed in determining the initial seed point [3]. Feng et al., (2005) proposed an approach for automatic seed selection using a competitive neural network [4]. The approach by Fan et al., (2001) using edge extraction and seeded region growing was applied on color images [6]. Another approach based on edge detection for automatic seed selection was proposed by Fan et al (2005). Firstly, the edge detectors are applied to obtain the simplified structures in an image, and the centroids of the adjacent edge regions are taken as the initial seed points [5]. However, this approach may induce over- segmentation, as the edges may be over detected for the texture images. Yuvaraj and Ragupathy, (2013) proposed a feature based approach, in which statistical features are extracted in the various selected regions. If the extracted features matches with the predefined features, then a seed point is fixed in that region [9]. This algorithm is robust against noise, but it will be hard and time consuming to pre-define the features. Saad et al., (2012) applied the histogram thresholding technique, to automate the seed selection process [12].

Meenalosini et al., (2012) uses a histogram based approach, in which the histogram analysis is done to compute initial seed point [13]. In an approach proposed by Shan et al., (2008) the seed points are automatically selected on the basis of both textural and spatial features [16]. Prince Pal Singh, and Jaswinder Singh, (2013) proposed a region extraction approach, which includes dividing image into region of interests (ROI), and extracting the seed points as the centroid of each ROI [17]. This method fails to provide good results, when the foreground and background are merged together, and the region of interests (ROI) are not efficiently derived. Yashpal, and Gokhale, (2012) proposed an algorithm in which initial seeds are determined using no-edge and smoothness property of the image pixel. If the pixel is not on the edge and have high similarity to its neighbours, then it is allocated as a seed pixel [19]. The same approach is also applied by Mundhada et al. (2014) for color image segmentation [11].

III. REGION GROWING ALGORITHM

The seeded region growing algorithm for image segmentation, proposed by Adams and Bischof [2], is a completely robust, and easy to execute method. This method is very effective in machine vision applications, where the image data vary widely, as this method is completely dependent on the image composition data. This method can be easily applied to gray scale images, and can be extended to color images after suitable choice of color space.

The algorithm starts with a set of seed points, each corresponding to an individual region. The seed points are then compared to their neighbours based on a similarity criterion. The neighbours of a pixel

are computed either by 4-connectivity or 8-connectivity. In 4-connectivity, the neighbours are the pixels that are connected horizontally and vertically, while in 8-connectivity, the neighbouring pixels are the ones that are connected horizontally, vertically, and diagonally. The simplest similarity criteria generally used is obtained by calculating the difference between the intensity value of the image pixel and the corresponding region mean. If the difference is less than a specified threshold, then the pixel belongs to that region and is subsequently labelled. Otherwise the pixel is not labelled and skipped.
The algorithm for implementing the seeded region growing algorithm is as follows:
Step 1: The seed points are computed on the basis of the seed selection algorithm. Every seed point corresponds to a single region.
Step 2: For a given seed point,

- Assign the seed point as the region label.
- Initialize the region mean equal to the pixel intensity at the seed point.
- Compute the neighbours of the seed point and store them in the neighbour matrix, which stored the neighbouring pixels addresses, to be checked.

Step 3: For every pixel stored in the neighbour matrix,

- If the pixel is not labelled and the similarity criteria is fulfilled,
    - Label the pixel in the corresponding region.
    - Compute the new region mean of the corresponding region.
    - Compute the neighbours of the pixel and store them in the neighbour matrix if not labelled.
- Otherwise,
    - Skip the pixel and choose the next neighbour pixel.
- Repeat step 3, until all the pixels in the neighbour list are not checked.
- If the region size is very small, leave the region pixels unlabelled.

Step 4: Choose the next seed point and repeat step 2 for next region.
Step 5: If all the pixels are not labelled, compute the seed points again using only the unlabelled pixels.
Step 6: Repeat the process until all pixels of the image are labelled into their corresponding regions.
In this way, the image is divided into various segmented regions.

IV. PROPOSED SEED SELECTION ALGORITHM

Appropriate seed selection is the major consideration in a region growing segmentation. The selected seed pixels should fulfill the following criteria:

- The seed pixels must be highly similar to its neighbouring pixels.
- At least one seed pixel should be generated for every expected region in the image.
- Seeds for different regions should not be connected.

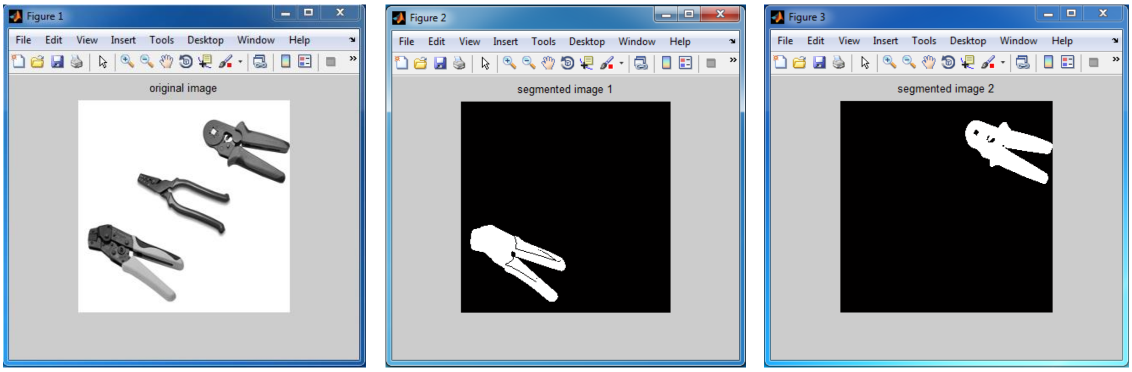
In the proposed approach, seed selection is done on the basis of their occurring frequency, after undergoing a merging procedure. For a given image, the algorithm to compute the seed points is as follows:
Step 1: Compute the grey levels present in the image, and sort them in ascending order.
Step 2: Compute the frequency of the grey levels of the image.
Step 3: Assign the first pixel as the first seed point.
Step 4: Merge the pixels to obtain improved seed point,

- If the merging criteria is fulfilled,
    - Replace seed point by the mean of the merged pixels.
    - Add frequency of the pixel to the frequency of the seed point.
    - Position of the seed point is assigned equal to the initial seed point.
- Otherwise,
    - Assign pixel as the new seed point.
- Repeat step 4, until all the pixels are not merged.

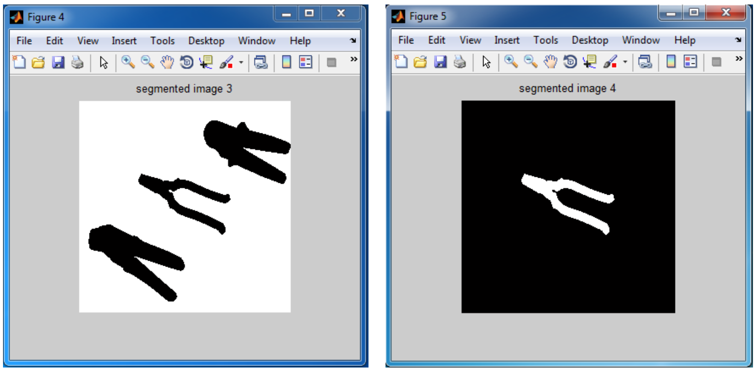
Step 5: Sort the final seed points in decreasing order of their occurring frequency.
Thus, the final seed points obtained are used in the seeded region growing algorithm for image segmentation.

V. IMPLEMENTATION AND RESULTS

The proposed seed selection algorithm together with the seeded region growing algorithm for image segmentation was implemented in MATLAB 2012a, and several gray scale images consisting of multiple objects were tested. For the grayscale image of mechanical tools in figure 1(a), the results of segmented images obtained comprised of the background of the image, and the various objects present in the image, as seen in figure 1(b)-(e).



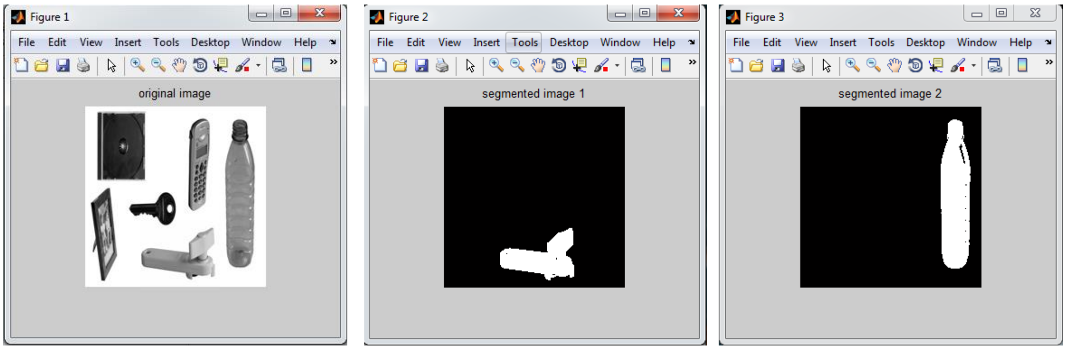
(a) (b) (c)



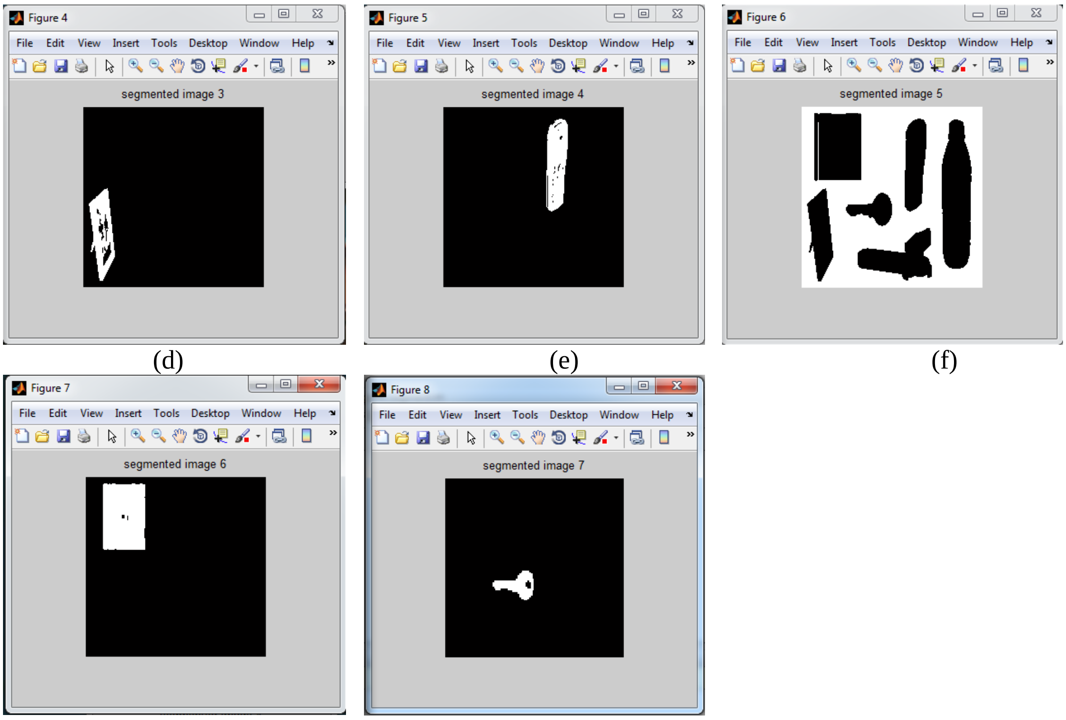
(d) (e)

Figure 1. Original image and its segmented images: (a) original image, (b) first object, (c) second object, (d) background, and (e) third object.

Another image used was of general daily use objects, as in figure 2(a), and the corresponding segmented images are obtained as seen in figure 2(b)-(h).



(a) (b) (c)



(d) (e) (f)

(g) (h)

Figure 2. Original image and its segmented images: (a) original image, (b) first object, (c) second object, (d) third object, (e) background, (f) fourth object, (g) fifth object, and (h) sixth object.

VI. DISCUSSION

The algorithm thus proposed provides an effective approach for automatic image segmentation. This algorithm requires no human interference and no initial information to obtain the seed points. The seed points are automatically generated on the basis of the knowledge of the image composition. This approach can be applied to a vast number of images, as the computation of seed points is only dependent on the image information.

In executing this algorithm, each labelled pixel is visited only once, and is skipped, if it even appears as a neighbouring pixel. This reduces the computational time of the algorithm. Also, the proposed algorithm provides a result, free from over and under-segmentation. Several small regions are not labelled, thus avoiding over- segmentation. The algorithm continues segmentation until all the pixels of the image are not labelled. This prevents under- segmentation.

VII. CONCLUSION

The algorithm for automatic seed selection for seeded region growing segmentation is proposed in this paper. The implementation results show satisfactory results for image segmentation. This implies that the proposed algorithm can be successfully used to achieve automatic image segmentation, and can be used in various object recognition algorithms. In future, this technique can be implemented with color images by providing appropriate color space.

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