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Development of Watershed Segmentation

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Abstract:

Image segmentation is the process of dividing images according to its characteristic like color and objects present in the images. A number of images segmentation techniques are available and proposed ,but there is no one single technique that is suitable to all applications. in this paper a novel and simple segmentation algorithm will be introduced by using the concept of arrow representation method, the preprocessing of this method are enhancing the image by using mean filter to remove noise, and reducing the color dimension linearly. For each pixel in the image we will draw arrows to the 8 neighboring pixels which have value greater than it has. The pixels received more than two arrows will be flooded, and the reminding arrows will represent the wanted dams between segments, finally, all the pixels in the image will be labeled with specific numbers starting from one to number of segment, so each segment can be separated by exploited this label. This method tested and gives promised results.

Key words: watershed transform, segmentation, arrow representation, and image.

1- Introduction

Segmentation is the step of dividing image into a set of isolated and homogeneous regions depending on features or characteristics presented in the image such as colors or objects

where each pixels in a specific segment has similar features than any other pixels in another segment, this is difficult and unlimited task, therefore there is no single segmentation algorithm can be applied effectively for all cases, this mean "no ideal method for all images". Generally, Segmentation algorithms are classified based on one of the two basic properties of gray-level values which are discontinuity and similarity between image pixels.

In the first class of algorithms which is called “boundary based methods", an image is segmented based on abrupt changes in gray level. The principal areas of interest within this class are the detection of lines and edges in an image, thus if we can extract the edges in an image and linking them, then each segment is described by the closed edge that contains it, so the connected set of pixels having approximately the same homogeneous intensity. While The principal approaches in the second class" Region based methods" are based on the similarity between the pixels within a region[2], there is other technique called clustering technique based on split given image into K groups or clusters. The mean of each cluster is taken and then each point p is added to the cluster where the difference between the point and the mean is smallest. Since clustering works on hue estimates it is usually used in dividing a scene into different objects [3] [4]. There are many algorithms proposed to segment images, each of them has strong or clean results in some cases and bad or poor results in specific cases.

2- Watershed transform

The watershed transform is a key building block for morphological segmentation of images**,** the most intuitive description of the watershed transform is based on a flooding simulation. Consider the input grayscale image as a topographic surface. The goal is to produce the watershed lines on this surface[4]. To do so, holes are punched at each regional minimum in the image. The topography is slowly flooded from

below by allowing water to rise from each regional minimum at a uniform rate across the image. When the rising water coming from two distinct minima is about to merge, a dam is built to prevent the merging. The flooding will eventually reach a stage when only the tops of the dams are visible above the water surface, and these correspond to the watershed lines. The final segmented regions arising from the various regional minima are called catchment basins[7]. Figure (1) illustrates this flooding process on a one-dimensional signal with four regional minima generating four catchment basins. The figure(1) shows some steps of the process: (a) input image, (b) holes punched at minima and initial flooding, (c) dam created when waters from different minima are about to merge, and (d) final flooding, yielding three watershed lines and four catchment basins[3].

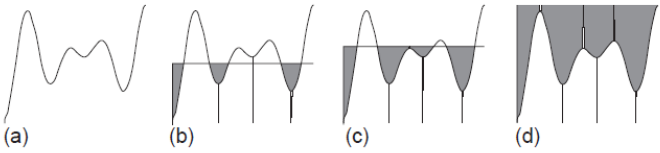


Figure (1) Simulating Flooding Process

3- The proposed method

The block diagram of the proposed system can be illustrated as in figure (2)

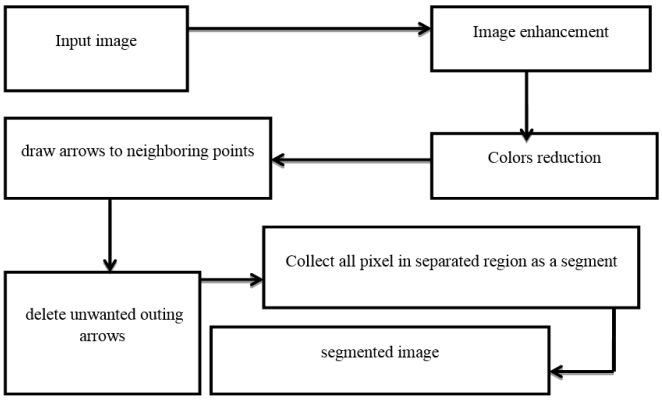


Figure (2) Block diagram of the proposed method

There are two important drawbacks in watershed segmentation which are

1. Over segmentation.
2. Using many difficult transformations to overcome over segmentation.

The proposed method focus on image enhancement and dimension reduction steps to overcome over segmentation results and this state will be reached without using any transformation function (like mosaic image transform, geodesic distance, or distance function), the proposed system consist of the following steps

3.1- Image enhancement

The first step before any process is the enhancement step to reduce image noise and as a result make the next process more efficient and the segmentation precisely, mean filter will be used to enhance image as illustrated in figure (3).

Z1	**Z4**	**Z6**
Z2	**Z**	**Z7**
Z3	**Z5**	**Z8**

1/9	**1/9**	**1/9**
1/9	**1/9**	**1/9**
1/9	**1/9**	**1/9**

$$Z_{enhance} = \frac{1}{9} \times (z+z_1+z_2+z_3+z_4+z_5+z_6+z_7+z_8) \quad \ldots(1)$$

a-original image

b-enhanced image

Figure (3) Enhanced image

3.2- Colors reduction

Image dimension will be reduced (the number of color depend on the image complexity but 5 colors is good choice approximately in all cases [5], the reduction factor (Rf) will be used to reduce gray level colors in fixed ratio for all pixels in the image. Segmentation accuracy depend on (Rf), in this paper we used reduction factor equal to (32) by using the equation (7).

$$I_{new}(i,j) = round\left(\frac{I(i,j)}{Rf}\right) \qquad \ldots (2)$$

3.3- draw arrows to neighboring points

The image will be scanned, one pixel at each time from top to down and left to right, arrow will be drawn to any neighboring pixel with gray level greater than current pixel as illustrated in figure (4).

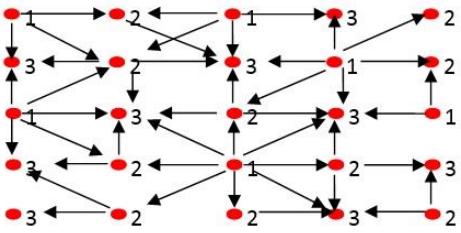


Figure (4) arrows drawing

3.4- Delete unwanted outing arrows

Any point receiving arrows from more than two neighboring pixel will be flooded (delete all input and output arrows for this point) [1], as illustrated in figure (5) and figure (6)

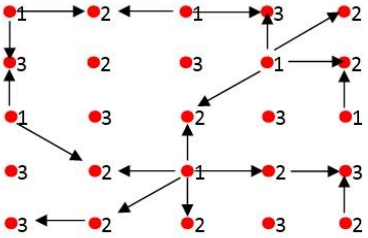


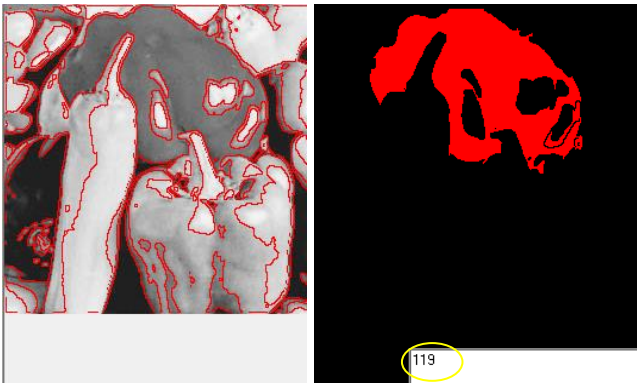
Figure (5) delete unwanted outing arrows (flooded pixels)

Figure (6) result after flooded pixels

3.5- Collect all pixels in separated region (labeling)

After detecting the regions boundaries all pixels in closed segment will be collected by giving the first pixel in this segment a label then the four neighboring pixels will be labeled with the same number, this process will be repeated with the next pixel until each pixel in the closed segment will be labeled. Labeling start from one to number of regions. The labeling process implemented to all regions.

Ultimately each segment can be drawn according to its label by creating a labeling array that contains the label for each pixel in the image as illustrated in figure (7) where we want to show segment (119).

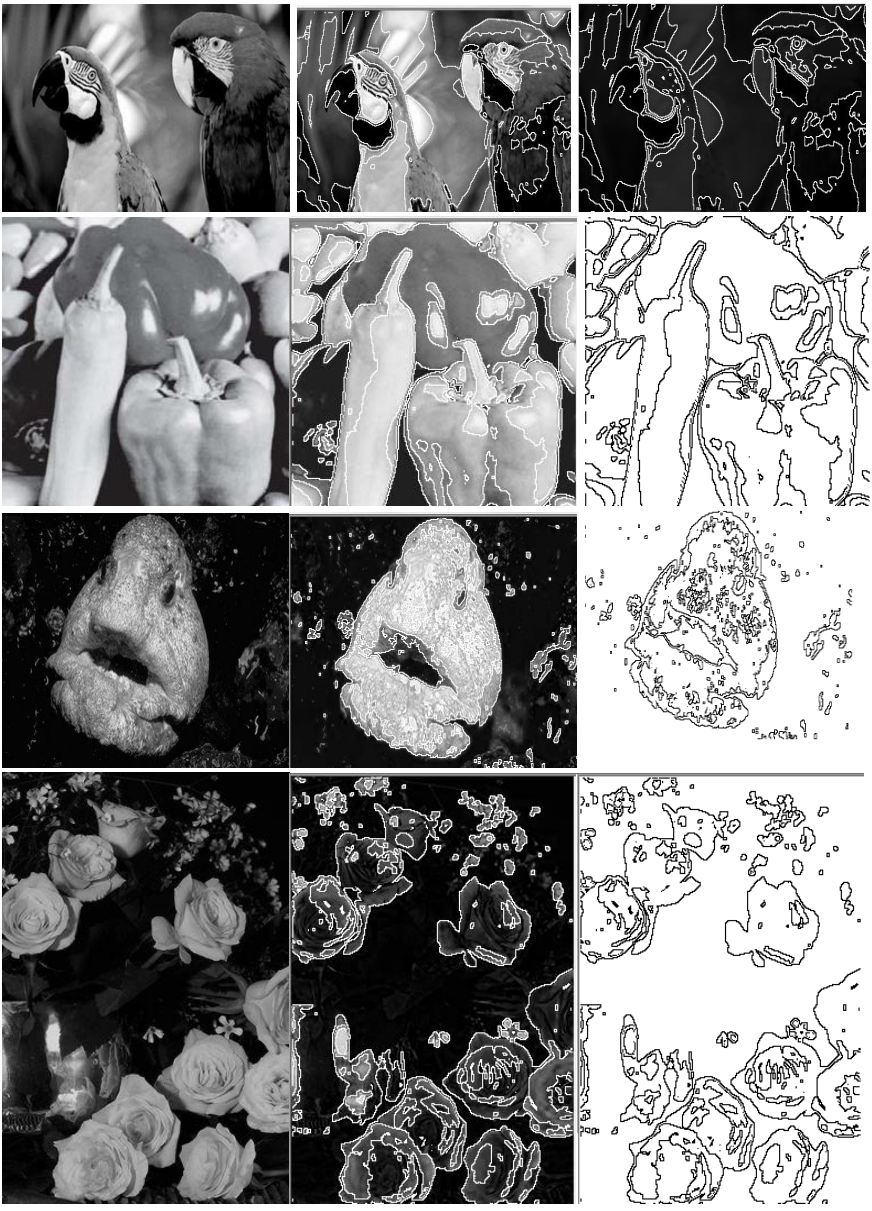


a- Segmented image b- drawing segment (119)

Figure (7) segment drawing

4- Results

When the proposed method applied on different images, we obtained the following results which illustrated in figure (8)



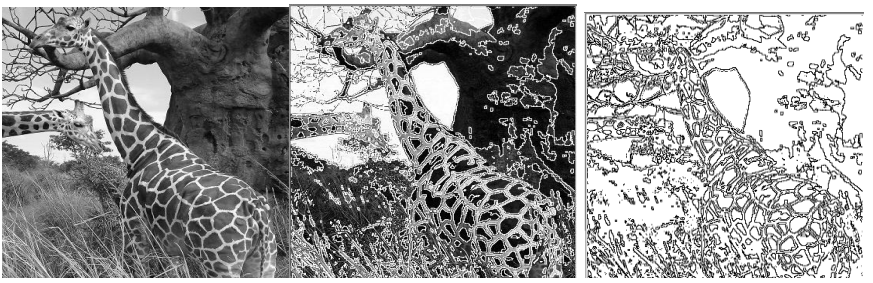
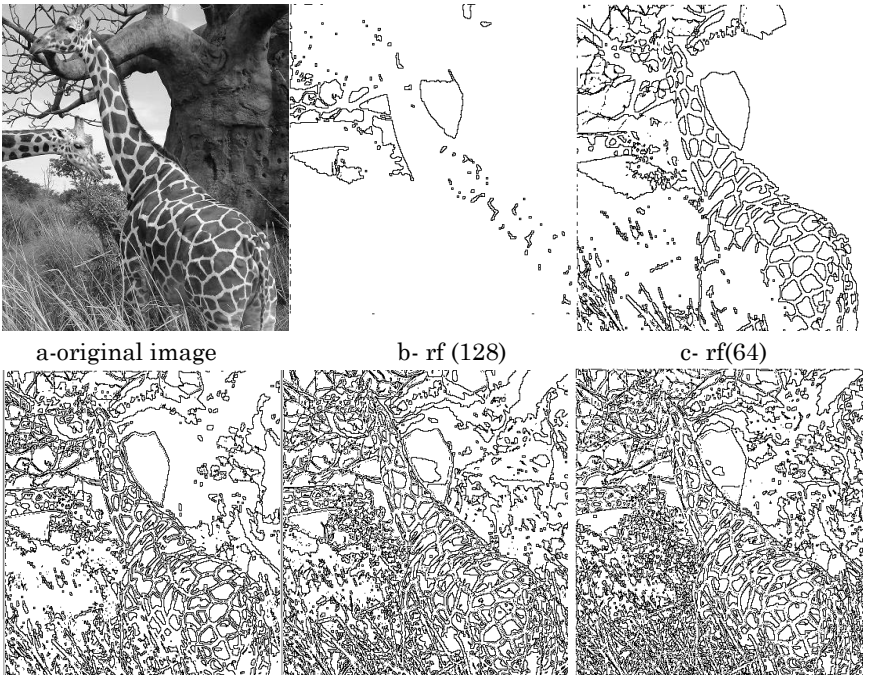


Figure (8) results of the proposed method

5- Conclusions

1-the reduction color is the most important step to decide the degree of accuracy in the results as illustrated in figure (9)



a-original image b- rf (128) c- rf(64)

d- rf (48) e- rf (36) f - rf (24)

Figure (9) the effect of reduction factor in results

2- Enhancement step reduce noise in the image and the repetition of mean filter remove much noise as illustrated in figure (10)

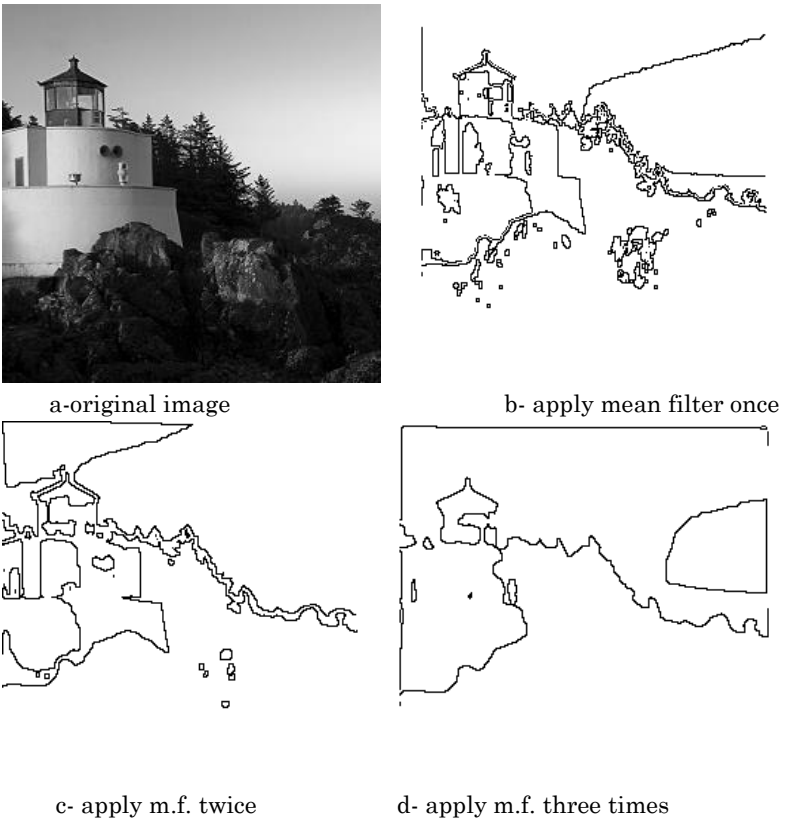


Figure (10) effect of mean filter

One of the benefit of this technique is the labeling of each segment, then each segment can processed individually.

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