Color Image Enhancement Using Local Area Histogram Equalization On Segmented Regions Via Watershed Transform

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Abstract: Since the details in quasi-homogeneous region will be destroyed from the conventional global image enhancement method such as histogram equalization. This defect is caused by the saturation of gray level in equalization process. So the local histogram equalization for each quasi-homogeneous region will be used in order to improve the details in the region itself. To obtain the quasi- homogeneous regions, the original image must be segmented. Here we applied the watershed transform to the interesting image. Since the watershed transform is based on mathematical morphology, therefore, the regions touch can be effectively separated. Hence two adjacent regions which have the similar gray pixels will be split off. The process will be independently applied to three different spectral images. Then three different colors are assigned to each processed image in order to produce a color composite image. By the proposed algorithm, the result image shows the better perception on image details. Therefore, the high efficiency of image classification can be obtained by using this color image.
Keywords: watershed transform, histogram equalization

Introduction

Segmentation is a process for dividing or partitioning the image into some regions, under the condition of gray scale similarity of each region. Image segmentation can be accomplished by many main approaches [1]. One of them is watershed transform, which uses the information of boundary and region as the criteria for segmenting the image. Watershed transform is based on mathematical morphology, which has first been proposed by Digabel and lantuejoul [2]. However, the image results are always unsatisfied, since the over-segmented problem is occurred. There will exist a number of tiny and shallow segmented regions. To overcome the mentioned problems, here we propose a method of edge preserving smoothing [3] in order to eliminate these undesired regions. Then the local area histogram equalization is applied to each segmented region, the enhanced image will be obtained. The details of proposed method will be described in the following paragraphs.

Watershed transform

The watershed transform tries to extract the close and thin edges from the gradient image. By applying gradient masks onto the original image, we will obtain a gradient image. This gradient image can be considered as a topographic map, which presents some hills and basins,at which the hill corresponds to the higher gradient pixels and the basin corresponds to lower gradient pixels respectively. To segment the gradient image, we first realize that the lower gradient area will be the basin. A hole will be made in the bottom of each basin. The water will be entered into each basin after we immerse all basins into the water. So the water level will be increased and the watershed regions will be appeared gradually. The deepest basin or the lowest gradient value will be first entered by water. While the shallower basin or the higher gradient value will be later filled up the water. The step of entering water through the holes of basins after each level of immersion can be shown in Fig. 1.

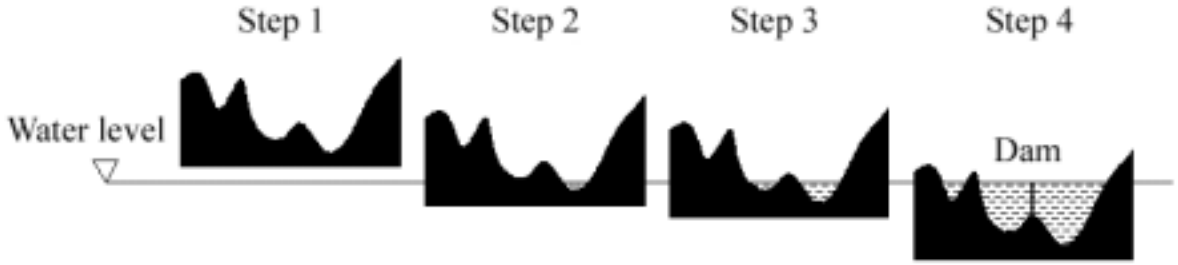

Fig. 1 The immersion of basins into the water for each height level of water

The water level in each basin will be slowly increased. Before the water in the adjacent basins will be merged together, we therefore build a dam in order to split them out. This means that the touch regions can be separately segmented.

Nevertheless, the shallow watersheds with small size will be appeared. These small segmented regions are caused by the presented noise in the original image. Therefore the over-segmented problem will be existed. To eliminate these spurious watersheds, we applied the edge smoothing preserving method [3] to the original image seeing Fig.2. The process of edge smoothing preserving is operated in the iteration manner. After a certain number of iterations, the watershed transform is applied to the smoothed image, the results of segmented image can be shown in Fig. 3

Histogram equalization

Normally, the original images especially the satellite images always have low contrast. Therefore to overcome this problem, the image must be enhanced. To enhance an image, the original histogram of image will be modified in order to improve the image perception. In general, the histogram equalization method is always selected due to its simplicity. However, it will cause the saturation of gray scales in the quasi-homogeneous regions. Some purposes such as vegetation growth classification can not be achieved by using the mentioned image. So, to eliminate this defect, the local area histogram equalization is applied to each quasi-homogeneous segmented region only. Here, the segmented regions, contained pixel more than 200, will be enhanced in order to reduce the computation times. The histogram equalization will be applied to these segmented regions, which refers to local area histogram equalization. While the smaller regions will be left without modifying their histograms

Experimental results

The process is applied onto three spectral images. After assigning the color for each processed image, we will obtain a colorful enhanced image. The result images, from the purposed method and the global histogram equalization, are shown in Fig. 4

Conclusion

As the results shown in Fig. 4, we found that some quasi-homogeneous regions (such as the enlarge area) can be enhanced without the problem of gray scale saturation, unlike the result from global histogram equalization. The gradual change in each region can be observed and distinguishable. So this will be very useful for vegetable growth surveillance and changed detection.

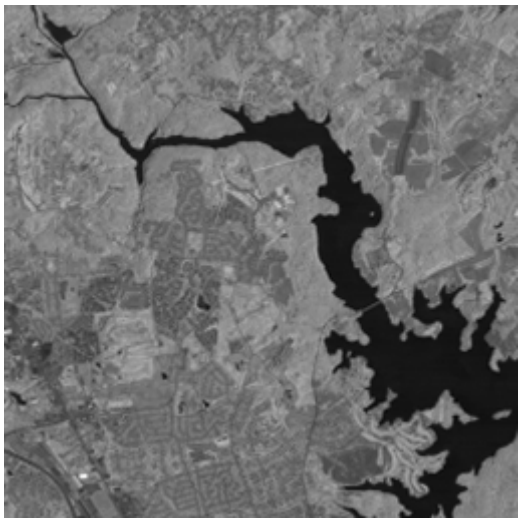

Fig. 2. Original gray scale image.

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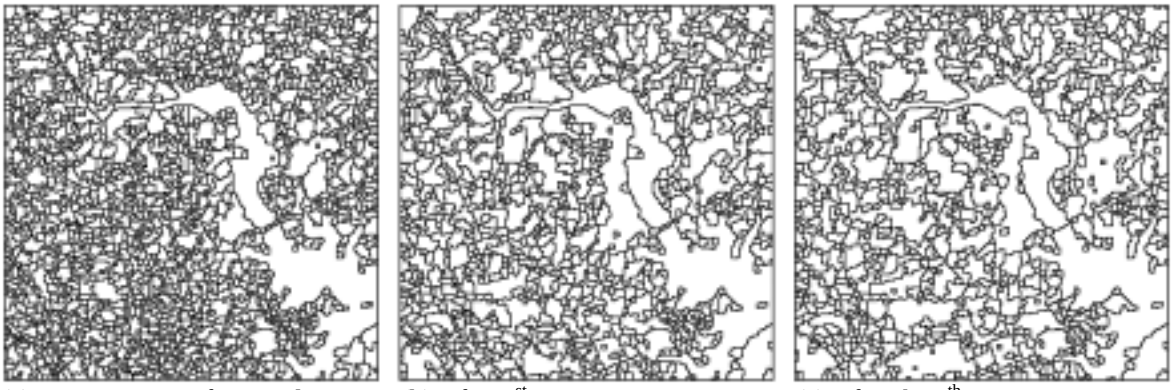
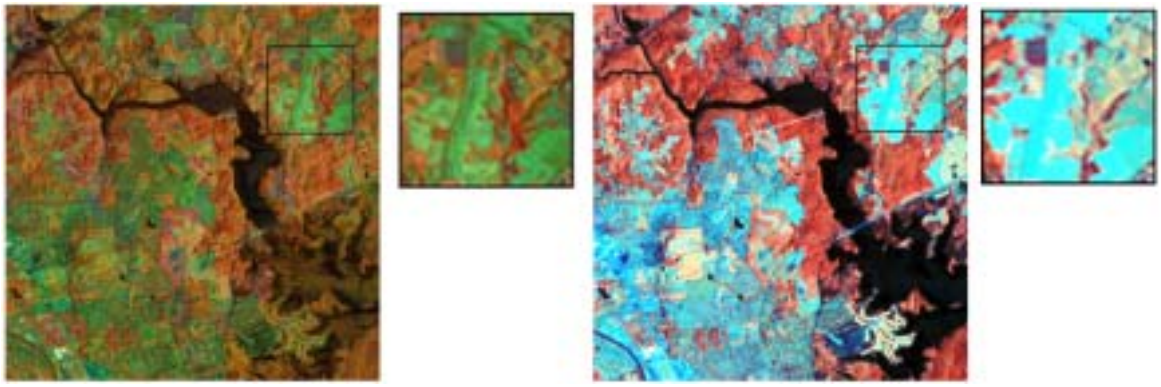


(a) Segmentation of original image (b) After 1st iteration (c) After the 5th iteration

Fig. 3 Segmented images



(a) Purposed method. (b) Global histogram equalization method.

Fig.4 Color image enhancement