ISSN (e): 2250 – 3005 || Vol, 04 || Issue, 4 || April – 2014 ||
International Journal of Computational Engineering Research (IJCER)

Performance Evaluation of the Masking Based Watershed Segmentation

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Abstract:
This paper has presented a performance evaluation of different image segmentation techniques. The image segmentation; segments a given image into separate regions and objects. It is widely used in various vision applications like face detections, motion detection etc. The overall objective of this paper is to design and implement various techniques of image segmentation. The shortcomings of image segmentation techniques will also be evaluated. This paper ends up with the performance evaluation of the over-segmentation, watershed segmentation using masking and also effect of the noise on the masking based watershed segmentation techniques. It has been shown that the noise has affected the segmentation at a great extent.

Keywords: *Image segmentation, Watershed, Clustering, Thresholding.*

I. INTRODUCTION

The purpose of image segmentation is to partition an image into meaningful regions with respect to a particular application. The segmentation is based on quantities taken from the image and might be colour, texture, grey level, depth or motion.

Applications of image segmentation range from filtering of noisy images, medical imaging, locating objects in satellite images (roads, forests, etc.), automatic traffic controlling systems, machine vision to problems of feature extraction and recognition [8]. Image segmentation means assigning a label to each pixel in the image such that pixels with same labels share common visual appearances. It makes an image easier to analyze in the image processing tasks.

There are many different methods available to implement image segmentation. There are many approaches available for the image segmentation. Examples are, edge based segmentation, region based segmentation, threshold based segmentation, markov random field based segmentation, hybrid techniques and clustering based image segmentation [12]. These segmentation methods differ from their computation complexity and segmentation quality.

II. IMAGE SEGMENTATION TECHNIQUES

Most segmentation techniques are either region-based or edge based.

1. Region-based techniques rely on common patterns in intensity values within a cluster of neighboring pixels. The cluster is referred to as the region, and the goal of the segmentation algorithm is to group regions according to their anatomical or functional roles [11].

2. Edge-based techniques rely on discontinuities in image values between distinct regions, and the goal of the segmentation algorithm is to accurately demarcate the boundary separating these regions [11].

III. MASKING BASED WATERSHED TRANSFORM

Watershed transform has concerned with great attention in recent years as an efficient morphological image segmentation tool. It is similar to region-based approach; it begins the growing process from every regional minimum point, each of which creates a single region after the transform. Watershed algorithm combines both the discontinuity and similarity properties successfully [5][16]. It performs well when it can distinguish the background location and the foreground object. It is based on grayscale mathematical

morphology. The main drawback of watershed transform is over-segmentation, sensitive to noise and high computational complexity those make it unsuitable for real-time process [6][17].

The masking operations are divided into two stages: cell and nucleus making. The better cell-mask and nucleus- mask value are determined by Eq. 3 and Eq. 4.The adaptive masking operations are used image normalization (N) and adaptive thresholding (T1 and T2) on the R, G and B color channels.

The adaptive threshold, we have used a dynamic threshold selection process (T1 and T2) by Eq. 1 and Eq. 2 based on Gray-threshold function.

$$T_1 = G_t(n) \tag{1}$$

Where, Gray threshold is calculated by Gt.

$$T_2 = G_t(N(N > T_1)) \tag{2}$$

$$M_1 = N > T_1 \tag{3}$$

Where, cell-mask and nucleus-mask are denoted by M1 and M2 respectively.

$$M_2 = N > T_2 \tag{4}$$

An image can have several regional maxima or minima but only one global maxima or minima. We have used Impose Minima to create new minima in the mask image at certain desired location by adaptively selecting threshold operation (T1 and T2) for morphological reconstruction to eliminate all minima from the image except the minima we specified. For morphological processing, we have applied Impose Minima function to create morphological process image using nucleus-masking (M2) and adaptive mask image on three-color channels

IV. LITERATURE SURVEY

Liu et al. (2008) [1] has discussed watershed transformation based on opening-closing operation and distance transform. Opening-closing operation is a kind of iterative calculation of erosion and dilation. It reflects the location feature of pixels in the image. It also overcame over-segmentation existed in traditional watershed segmentation preserving the original edges of the image.

Shan et al. (2010) [2] presented the improved watershed image segmentation method. The morphological opening/closing reconstruction filter is applied to remove the image noise. It keeps the information of object outlines when filtering the image.

Kumar et al. (2011) [3] has studied a color image segmentation method of automatic seed region growing on basis of the region with the grouping of the watershed algorithm. Texture Gradient is used for the extraction of the connected components of the image. Final Gradient image is input for the watershed algorithm.

Bala et al. (2012) [4] has described paper a novel method of image segmentation that includes image enhancement and noise removal techniques with the Prewitt's edge detection operator. It effectively reduce the over segmentation effect and achieve more accurate segmentation results than the existing method.

Ren et al. (2012) [5] has studied improved watershed segmentation method is used to raise the segmentation correctness of rock particles image. The new method used the qualities of mathematical morphology algorithm. Conventional watershed algorithm is too sensitive to noise. If it is use directly in the extraction of the rock particles, it often result is "over segment".

Chen et al. (2012) [6] authors discuss image reconstruction and segmentation in an improved watershed algorithm by using a plug-in function in flooding process. This method shows very low error rates compared with other approaches. Size filter is used to get the better result for image segmentation.

Zhang et al. (2012) [7] has demonstrated the adaptive marker extraction-based watershed algorithm is used to overcome the over-segmentation problem.

Rahman et al. (2013) [8] has discussed object counting in an image is one of the main challenges in image processing. Image segmentation is used to separate similar particles, which help calculating estimated total number of particles. Thresholding technique is desirable for counting objects in an image. It used the marker controlled watershed segmentation along with thresholding technique provides suitable result.

Fu et al. (2012) [9] presented the fast two-step marker-controlled watershed image segmentation method in CIELAB color space to resolve the over-segmentation problem, which saves a lot of execution time. The watershed super pixels segmentation technique produces over-segmented regions efficiently which adhere well to the real object boundaries

Ghoshale et al. (2013) [10] has described the several edge sharpening filters and to find the effect on the output image using watershed algorithm. A spatial sharpening filter on the performance of the segmented images and mathematical morphology plays a very important role.

Rahman et al. (2013) [11] present, a novel image segmentation method based on adaptive threshold and masking operation with watershed algorithm. Whose objective is to overcome over-segmentation problem of the traditional watershed algorithm.

V. GAPS IN EARLIER WORK

By conducting the literature survey it has been found that the most of the existing literature has neglected one of the following:

1. The over-segmentation problem is ignored i.e. as over segmentation degrades the performance or accuracy of the segmentation results by a lot; so it become an critical issue to reduce the effect of the over-segmentation by introducing some pre-processing operations.

2. The effect of the noise, dust, haze etc. is also ignored by the most of the researchers. It also degrades the performance of the over segmentation.

3. The computation time is still an issue for the most of the cases. As any enhancement on the existing method comes up with some potential overheads so it is required to reduce this time.

VI. PERFORMANCE EVALUATION

6.1. Evaluation of Over Segmentation

The watersheds transformation makes a number of regions as an output. The over-segmentation problem comes mostly from the noise and quantization error [11]. To eliminate the effect of local minima from noise or quantization error on the final results. First, the gradient of the original image is computed as a pre-processing and then the watersheds transformation is applied on the gradient of image[12][15]. Another approach is to apply a post-processing where a large number of regions are merged until the output meets a given criteria which can be the number of regions or a dissimilarity value between homogeneous regions. Figure 6.1(a) has shown the original image going to be segment. It is color image, which can be easily split, or segment into various parts.

Figure 6.1(a)

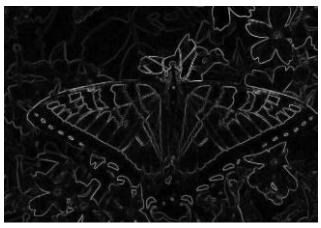

Figure 6.1(b)

(a) Original image (b) Gradient image

Figure 6.1(a) has shown the gradient image for the image shown in Figure 6.1(a). It is clearly shown that the Figure 6.1(a) shows the sharp changes areas in efficient manner.

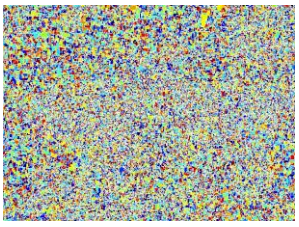

Figure 6.2(a)

Figure 6.2(b)

(a) Watershed Transform (b) Segmented output

Figure 6.2(a) has shown the watershed of the image shown in Figure 6.1(a). It is clearly shown that the watershed has been over segmented while segmenting the Figure 6.1(a) so will produce poor results as shown in Figure 6.2(b). Therefore some special aid likes masking or markers are required while using the watershed transform.

6.2. Analysis of Masking Based Watershed Algorithm for Noise Free Image.

The Watershed method, also called the watershed transform, is an image segmentation approach based on gray-scale mathematical morphology, to the case of color or, more generally speaking, multi component images. Different strategies are presented and a special attention is paid to the "bit mixing approach". This method objectively maps multi-dimensional data into a mono-dimensional space [13]. In geography, a watershed is the ridge that divides areas drained by different river systems. By viewing an image as a geological landscape, the watershed lines determine the boundaries that separate image regions. In the topographic representation of an image *I*, the numerical value (i.e., the gray tone) of each pixel stands for the evolution at this point. The watershed transform computes the catchments basins and ridgelines, with catchment basins corresponding to image regions and ridgelines relating to region boundaries.

Figure 6.3 Red, Green and Blue Channel output

Figure 6.3 has shown the red channel of the image, Green channel of the image and the blue channel of the image.

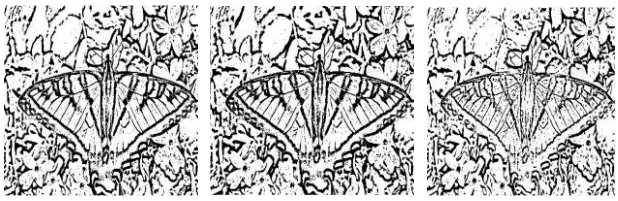

Figure 6.4 Red, Green and Blue Adaptive Mask Output

Figure 6.4 has shown the output of the masked images of each color channel shown in Figure 6.3.

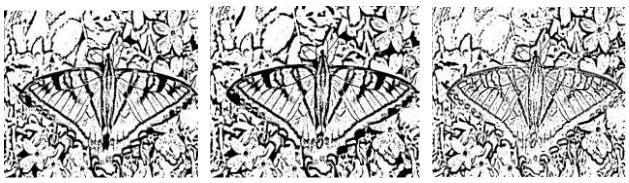

Figure 6.5 Smoothed Red, Green and Blue Segmented Image

Figure 6.5 has shown the morphological outputs of the Figure 6.4 respectively i.e. of each channel of RGB.

Figure 6.6 Red, Green and Blue Channel Segmented Image

Figure 6.6 has shown the final segmented outputs of the Figure 6.5 respectively i.e. of each channel of RGB.

Figure 6.7 has shown the final segmented image which concatenation of the Figure 6.6. The image very clearly segmented and showing the each segmented plane separately.

Figure 6.7 Segmented Output

6.3. Analysis of Masking Based Watershed Algorithm For Noisy Image.

Digital image noise may come from various sources. The acquisition process for digital images converts optical signals into electrical signals and then into digital signals and is one process by which the noise is introduced in digital images[14]. Each step in the conversion process experiences fluctuations, caused by natural phenomena, and each of these steps adds a random value to the resulting intensity of a given pixel.

A. Noise Density: .1

Figure 6.8(a) has shown the salt and pepper noise effected image with 10 % noise. Whereas the Figure 6.8(b) has sown the segmented image. It is clearly shown that the results are not much accurate than without noisy image.

Figure 6.8(a)

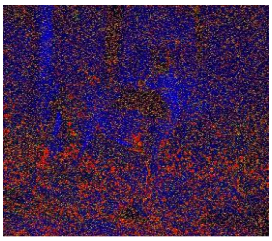

Figure 6.8 (b)

(a) Noisy image (b) Segmented image

B. Noise Density: .5

Figure 6.9(a) has shown the salt and pepper noise effected image with 50 % noise of the Figure 6.1(a). Whereas the Figure 6.9(b) has sown the segmented image. It is clearly shown that the results are not much accurate than without noisy image.

Figure 6.9(a)

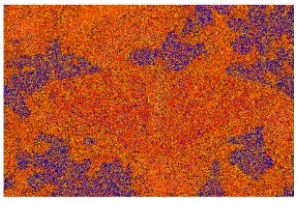

Figure 6.9(b)

(a) Noisy image (b) Segmented image

VII. CONCLUSION

The literature review has shown that the over-segmentation problem has been ignored in the most of existing work. The noise has also found to be critical issue for image segmentation techniques. So it is required to modify the existing methods in such a way that the modified technique will work better for noisy images as well and also overcome the problem of over segmentation. This performance evaluation of the over-segmentation, watershed segmentation using masking and also effect of the noise on the masking based watershed segmentation techniques have been shown. It has been proved that the noise has affected the segmentation at a great extent.

In near future we will extend this work to propose a new technique, which will modify the image watershed based segmentation using switching median filter and dynamic thresholding to improve the segmentation area even in case of noisy images.

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