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Evaluating the Performance of Modified Watershed Algorithm Based on DBMF and DT

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ABSTRACT

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. It has been found that the noise has affected the segmentation at a great extent; so to overcome this problem we have presented a modified watershed segmentation using Decision based median filtering (DBMF) and Dynamic thresholding (DT). DBMF has the ability to reduce the high density of noise in the image so will provide more efficient results. However DT has also refined segmentation process further. The comparisons have shown that the proposed algorithm provides quite significant results over the available methods.

Indexing terms/Keywords

IMAGE SEGMENTATION, WATERSHED, CLUSTERING, THRESHOLDING.

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INTRODUCTION

Image segmentation is vital step in the process of image processing. Image segmentation is to divide an image into number of regions so that each region gives information about an object or area of interest [1]. It partitions an image into a set of non-overlapping regions whose union is the entire image. Watershed is an algorithm for image segmentation developed in recent years based on mathematical morphology [1], and has draw great attention for its fast computing and high accuracy in locating the weak edges of adjacent regions.

But classical watershed segmentation is sensitive to noise and can leads to serious over-segmentation. Therefore, many researchers has proposed various methods continually for improving, such as a preprocessing step of calculating distance transform for the binary image before watershed transformation [2], or agglomerating regions after segmentation following watershed transformation [3].

In this paper, we propose a modified watershed algorithm to reduce over- segmentation that uses both pre- and post-processing. We make use of more prior knowledge in pre-processing and merge redundant minimal regions in the post-processing.

WATERSHED TRANFORM

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].

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].

RELATED RESEARCH

The watershed transformation is a powerful tool for image segmentation based on well-known mathematical morphology-based approach. In reference [7], the authors propose an improved method watershed algorithm for natural color image segmentation based on adaptive marker-extraction to overcome over-segmentation of the watershed transform.

In reference [8], the authors have presented a marked extraction based on adaptive color image segmentation algorithm to improve the watershed, the traditional marker for the lack of extraction methods, many consider the minimum characteristics of properties, and set the adaptive threshold. The authors proposed method performs better than original watershed algorithm with a strong anti-noise performance.

In reference [3], the authors presented an integrated K-Means clustering algorithm with marker controlled watershed segmentation algorithm. Several approaches exist to solve the over- segmentation problem, such as integrating watershed with region merging algorithm [9], watershed based on gradient modification and hierarchical region merging algorithms [10], combined marker-based watershed and region merger [11], marker-controlled watershed crown segmentation [12], morphological gradient applied to new active contour model [13], marker-based watershed algorithm [14], and interactive segmentation by matching attributed relational graphs are based on watershed, graph cuts, shortest paths (geodesic) and random walker [15].

PROPOSED MODIFIED WATERSHED ALGORITHM

This research work focuses on the image segmentation using masking or marker based watershed segmentation. This research work improves the segmentation by integrating the decision based switching median filter with masking based watershed segmentation to enhance the results further. The decision based switching median filter will be used as preprocessing operation to reduce the effect of the noise, haze, fog etc. to improve the marking process for watershed based segmentation we will use dynamic thresholding to mark the objects in efficient manner.

The image gradient will also be used to find the edges of the image in the efficient manner. This will help the proposed algorithm to segment the local object in efficient manner, as edges will be known in prior using gradient smoothing.

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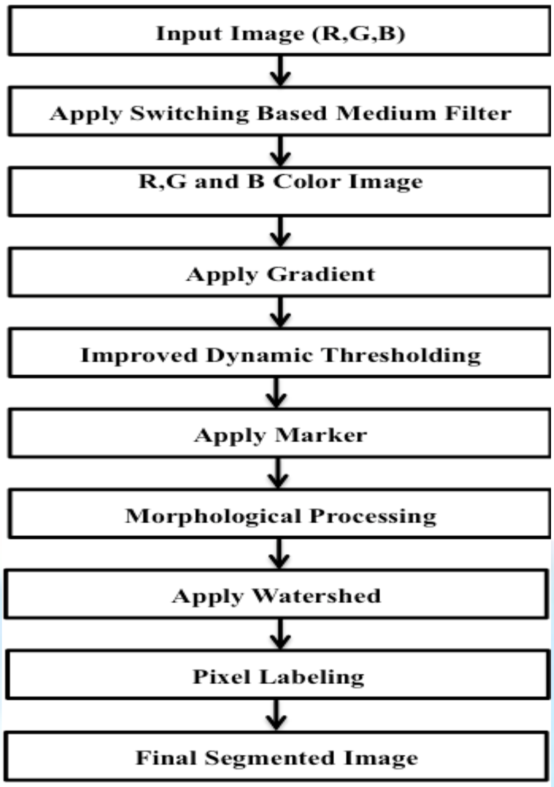

Figure 1.0: The flow chart of the proposed modified watershed algorithm

Result And Discussion

We tested the offered algorithm on images taken from the Berkeley image database [25]. The algorithms are implemented in MATLAB code and tested on a notebook (Intel (R) Core (TM) i7-2670QM 2.20GHz CPU, 4GB Memory, Windows 7 OS), using a quad core for the processing.

Step 1.Input Image: An image passed to the proposed algorithm. Image must be either 2-D or 3-D plane i.e. grey scale or color image.

Figure 1.1: Input Image

Step 2.Apply Switching based Medium Filter: It is used to restore images corrupted by salt-pepper impulse noise. The salt & pepper noise is a special type of impulse noise in which some portion of image pixel values are replaced by either minimum or maximum pixel values.

The main objective of salt & pepper noise removal is that it removes the noise from the image by preserving the other image details.

$$P'(m,n,k) = \frac{1}{U}\sum_{i=-S}^{S}\sum_{j=-S}^{S} P(m-i, n-j, k) \qquad 1$$

Where $(2S+1)$ L (Lis order of the window e.g. 3,5,7), $P(m-i, n-j, k)$ is a healthy pixel in the window, if not), $P(m-i, n-j, k)$ 0, U Total number of healthy pixel in the window.

We have used an RGB image as input color image. The original image is extracted into individual red (R), green (G), and blue (B) color channels as shown Figure 1.3.

Figure 1.2: Result of Improved Medium Filter

Figure 1.3: Extracted Original image into R, G and B channels

Step 3.Apply Gradient: Mathematically the gradient of a two-variable function at each image point is a 2D vector with the components given by the derivatives in the horizontal and vertical directions. At each image point, the gradient vector points in the direction of largest possible intensity increase, and the length of the gradient vector corresponds to the rate of change in that direction.

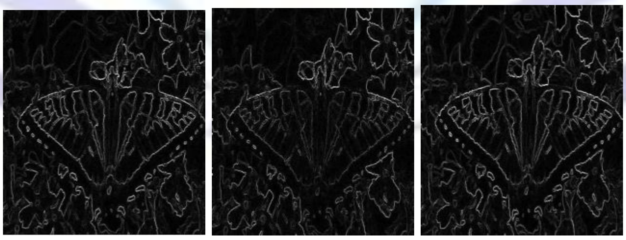

Figure 1.4:(a) **Figure 1.4:(b)** **Figure 1.4:(c)**

Figure 1.4:(a) Red Channel Gradient Magnitude
Figure 1.4:(b) Green Channel Gradient Magnitude
Figure 1.4:(c) Blue Channel Gradient Magnitude

Step 4.Improved Dynamic Thresholding: Thresholding is used to segment an image by setting all pixels whose intensity values are above a threshold to a foreground value and all the remaining pixels to a background value. Whereas the conventional thresholding operator uses a global threshold for all pixels, adaptive thresholding changes the threshold dynamically over the image.

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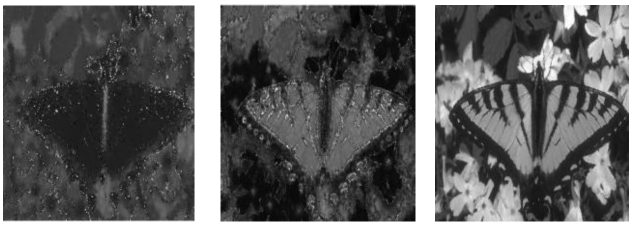

Figure 1.5:(a) Figure 1.5:(b) Figure 1.5:(c)

Figure 1.5:(a) Dynamic Thresholding of Red Channel
Figure 1.5:(b) Dynamic Thresholding of Green Channel
Figure 1.5:(c) Dynamic Thresholding of Blue Channel

Step 5.Apply Marker: Markers can be used to solve the over-segmentation problem whose goal is to detect the presence of homogeneous regions from the image by a set of morphological simplifications. The watershed transform is often applied to this problem. Segmentation using the watershed transform works better if you can identify, or "mark," foreground objects and background locations.

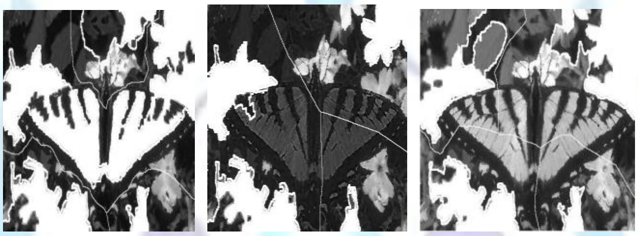

Figure 1.6:(a) Figure 1.6:(b) Figure 1.6:(c)
Figure 1.6:(a) Red Channel Markers and object boundaries
Figure 1.6:(b) Green Channel Markers and object boundaries
Figure 1.6:(c) Blue Channel Markers and object boundaries

Step 6. Morphology Processing: Mathematical morphology as a tool for extracting image components that are useful in the representation and description of region shape, such as boundaries, skeletons, etc. We assume that function $f(x)$ can express gray image I, x define gray value in pixels. Structuring element B denotes as structure operator. Its shape can be described by S, with size n*n. morphology dilation can be defined as follows:

$$f(x) \quad Max\left(f(x \quad k)\right) \quad k \subset B \qquad (2)$$

$$f(x) \quad Max\left(f(x + k)\right) \quad k \subset B \qquad (3)$$

Step 7. Apply Watershed: The Final Gradient image, which is marker, extracted is subjected to Watershed Segmentation.

Let $f \subset C(D)$ have minima $m_i)_{i \in I}$ for some index set I. The catchment basin $CB(m_i)$ of a minimum mi is defined as the set of points $x \subset D$ which are topographically closer to mj than to any other regional minimum mj :

$$CB(m_i) \quad (x \subset D | \forall j \in I(i): f(m_i) + T_i(x, m_i) < f(m_j) + T_f(x, m_j)) \qquad (4)$$

The watershed of f is the set of points, which do not belong to any catchment basin:

$$watershed(f) = D \cap (\cup_{i=1} CB(m_i)) \qquad (5)$$

Let W be some label, $W \subset I$ The watershed transform of f is a mapping $\lambda: D \rightarrow I \cup \{w\}$ such that:

$\lambda(p) \quad i \text{ if } p \epsilon CB(m_i)$

And

$\lambda(p) \quad W \text{ if } p \epsilon Watershed(f)$

So the watershed transform of f assigns labels to the points of D, such that (I) different catchment basins are uniquely labeled, and (II) a special label W is assigned to all points of the watershed of f.

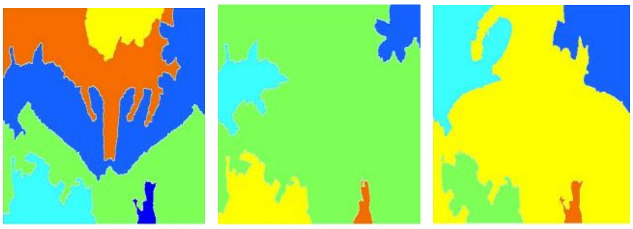

Figure 1.7:(a) Figure 1.7:(b) Figure 1.7:(c)

Figure 1.7:(a) Red Channel Watershed
Figure 1.7:(b) Green Channel Watershed
Figure 1.7:(c) Blue Channel Watershed

Step 8. Pixel Labeling: Labeling of an image is the operation of assigning a unique value to pixels belonging to the same connected region. Depending on the definition of a "connected region", different results can be obtained.

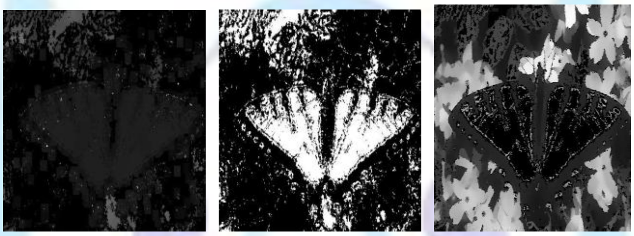

Figure 1.8:(a) Figure 1.8:(b) Figure 1.8:(c)

Figure 1.8:(a) Red Channel Segmented Image
Figure 1.8:(b) Green Channel Segmented Image
Figure 1.8:(c) Blue Channel Segmented Image

Step 9. Final Segmented Image: The Final Gradient image, which is marker, extracted is subjected to Watershed Segmentation. Watershed segmentation produces a more stable segmentation of objects including continuous segmentation boundaries by a concept of producing catchment basin and watershed line.

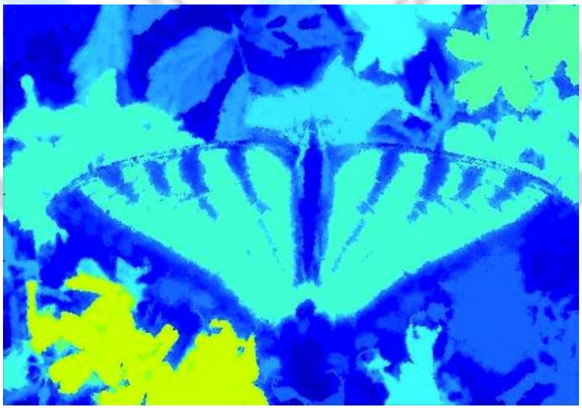

Figure 1.9: Segmented Output

CONCLUSION

It has been 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. Therefore to overcome this problem; we have presented a modified watershed segmentation using Decision based median filtering (DBMF) and Dynamic thresholding (DT). DBMF has the ability to reduce the high density of noise in the image so will provide more efficient results. However DT has also refined segmentation process further. In near future we will extend this work to propose a new technique which will modify the image watershed based segmentation using fuzzy based markers to enhance the results further.

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