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Digital Image Segmentation Using Median Filtering and Morphological Approach

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Abstract— Digital color image segmentation of noisy images is nowadays an important area of research in the field of computer vision. This paper advocates an effective image segmentation approach for noisy images. The approach can broadly be divided into application of two strategies namely noise removal from noisy images using median filtering on initial digital color image and secondly applying watershed algorithm using distance transform over noise free images obtained after median filtering of noisy images. Comparative analysis is also shown in this paper between application of only watershed algorithm on noisy image and application of proposed approach over watershed algorithm. Statistical results are included in the paper to .support our approach of median filtering and morphological segmentation of noisy digital color image.

Key words— Image segmentation, Median filtering, Watershed algorithm.

I. INTRODUCTION

Any gray tone image can be considered as a topographic surface. If we flood this surface from its minima and, if we prevent the merging of the waters coming from different sources, we partition the image into two different sets: The catchment basins and the watershed lines. If we apply the watershed transformation to the image gradient, the catchment basins should theoretically correspond to the homogeneous gray level regions of this image. However, in practice, this transform produces an important over-segmentation [1-7] due to noise or local irregularities in the gradient image [8-9].

Noise in images degrades its quality [10-12]. Deviation of pixel values from the original scene thereby producing an erroneous intensity is referred to as noise. Occurrence of noise can happen at any stage of image processing such as image capture, transmission etc. Noise removal thus being an important aspect o f image quality, image processing and image segmentation techniques is greatly influenced by the results of noise removal techniques. To be precise enough, complete removal of noise is not possible and hence we try to reduce noise. In other terms we say noise reduction is the process of removing noise from a signal. If an image is being sent electronically from one place to another via satellite or wireless transmission or through networked cables, we may expect errors to occur in the image signal. In accordance with the disturbance in the signal the distortion type in output image will be observed. Usually there are some well known type of noise that are associated with image, hence we carry out our research on some of the standard noise for eliminating or reducing noise in color image [9-12].Image Noise can be classified as Amplifier noise (Gaussian noise), Salt-and-pepper noise (Impulse noise),Shot noise, Quantization noise (uniform noise),Film grain, on-isotropic noise, Speckle noise (Multiplicative noise) and Periodic noise. Vast amount of research work has been done to perform edge detection and image segmentation tasks by using region growing approach [13-22].A new dimension has been proposed to perform the above tasks in this paper. In this paper a combination of median filtering and watershed algorithm using distance transform technique for image segmentation and edge detection procedures were used. The median filtering method was applied to obtain noise free images [23-24]. Then a watershed algorithm using distance transform technique is used to segmentation of images.

The structure of this work is the following: Section 2 introduces median filtering. Section 3 is devoted to the segmentation process done using distance transform watershed algorithm. Section 4 presents the proposed approach. The results are discussed in section 5 and we end this paper with some concluding remarks in section 6.

II. MEDIAN FILTERING

A non-linear filter changes the image intensity mean value if the spatial noise distribution in the image is not symmetrical within the window. Standard Median Filter (SMF) is one such non – linear filter. Variance of the intensities in the image is reduced by Median Filter.

The novel filter processing principles are based on the daptive median filtering. Adaptive median filtering works in a rectangular kernel area $S_{x, y}$ and changes (increases) the size of $S_{x, y}$ during filtering operation, depending on certain conditions listed below. If the filter does find that the pixel at (x, y) is noise in the kernel center, the value of the pixel will be replaced by the median value in $S_{x, y}$. Otherwise, the pixel gray level value will remain the same. Consider the following definition:

Z_{min} = minimum gray level value in $S_{x, y}$
Z_{max} = maximum gray level value in $S_{x, y}$
Z_{med} = median of gray level in $S_{x, y}$
$Z_{x, y}$ = gray level at coordinates (x, y)
S_{max} = maximum allowed size of $S_{x, y}$
The adaptive median filtering algorithm works in two levels, denoted level A and level B, as follows:
Level A
$A_1 = Z_{med} - Z_{min}$
$A_2 = Z_{med} - Z_{min}$
If, $A_1 > 0$ AND $A_2 < 0$, go to level B
Or else, increase the window size
If window size $\leq S_{max}$, repeat level A
Or else, output, $Z_{x,y}$.
Level B
B_1, $Z_{x,y} - Z_{min}$
B2, $Z_{x,y} - Z_{med}$
If, $B_1 > 0$ AND $B_2 < 0$, output $Z_{x,y}$
Or else, output Z_{med}.
Every time the algorithm outputs a value, the window, $S_{x, y}$ is moved to the next location in the image. The algorithm then is reinitialized and applied to the pixels in the new location. AMF can achieve good results in suppressing noises of various densities. It sometimes changes its kernel maximum size in order to suit for different conditions. One way is to use different kernel mean filters to process images and determine the AMF kernel maximum size.

III. WATERSHED SEGMENTATION USING THE DISTANCE TRANSFORM

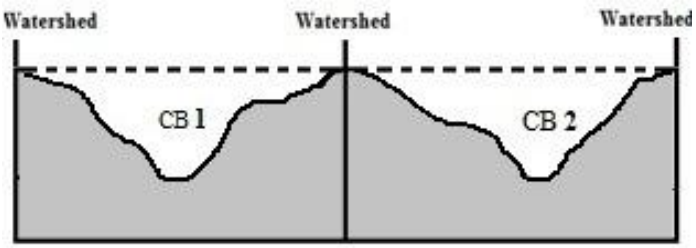

Fig. 1: Watershed segmentation-local minima of gray level yield catchment basins, local maxima define the watershed lines.

Image segmentation technique based on gray-scale mathematical morphology can be implemented using the watershed method or the watershed transform. This class of image segmentation is based on region-based segmentation approach where the underlying idea comes from topological surface. Watershed is formed along the divide lines over the topographical region. The divide lines are obtained by flooding the topographical surface with rainwater.
An alternative approach is to imagine the landscape being immersed in a lake, with holes being pierced in local minima also called catchment basins (CB).The catchment basins will fill up with water starting at these local minima, and, at points where water coming from different basins would meet, dams are built. This process continues until the water level has reached the highest peak in the landscape. The landscape is thus partitioned into regions or basins separated by dams, called watershed lines or simply watersheds For digital image segmentation, the distance transform method is commonly used in conjunction with the watershed transform. The distance transform is the distance from every pixel to the nearest pixel of a binary image. In distance transform method every 1-valued pixel has a distance transform value of 0 because its closest nonzero pixel is itself. In below, figure 2(a) shows a binary image matrix, and in figure 2(b) shows the corresponding distance transform.

1	1	0	0	0
1	1	0	0	0
0	0	0	0	0
0	1	1	1	0

(a)

0.00	0.00	1.00	2.00	3.00
0.00	0.00	1.00	2.00	3.00
1.00	1.00	1.41	2.00	2.24
1.41	1.00	1.00	1.00	1.41
1.00	0.00	0.00	0.00	1.00

(b)

Fig 2: (a) shows a binary image matrix, and (b) shows the corresponding distance transform.

IV. PROPOSED APPROACH

Normally filters are used to remove noise from images. Linear filters too tend to blur sharp edges, destroy lines and other fine image details, and perform poorly in the presence of signal-dependent noise. With non-linear filters, the noise is removed without any attempts to explicitly identify it. The median filter was one of the most popular nonlinear filter for removing Salt & Pepper noise. The noise is removed by replacing the window center value by the median value of center neighborhood.

And, watershed algorithm is a tool for morphological image segmentation. A gray scale image can be interpreted as the topographic image of landscape. This is accomplished (the image intensity) as an altitude. Using the features of these images, the technique of digital image processing called Watershed Transform. For digital image segmentation, the Watershed algorithm using distance transform method is commonly used in conjunction with the watershed transform. The distance transform is the distance from every pixel to the nearest pixel of a binary image. In distance transform method every 1-valued pixel has a distance transform value of 0 because its closest nonzero pixel is itself.

In our proposed approach these two techniques has been combined and accordingly modified to get the image segmentation process more effective. The flowchart of the proposed scheme is given in below. In initial stage four noisy color images are chosen and converted into gray scale or black and white image. In next step the noisy gray scale images are de noised using median filtering. In fourth step Edge map using Sobel operator has been calculated. In fifth step image complement is accrued. In next step distance transform is applied on the image complement and finally watershed algorithm is applied to get the final segmented image map.

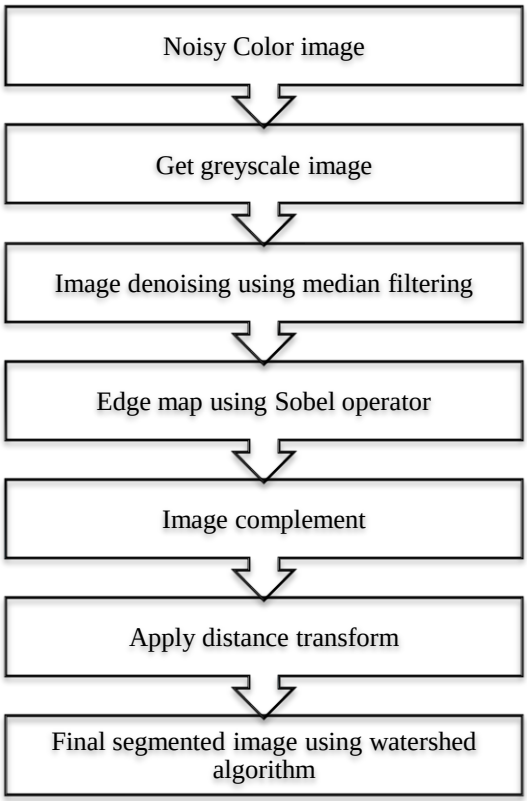

Figure 3: Flow diagram of the proposed approach.

V. EXPERIMENTAL RESULTS AND DISCUSSION

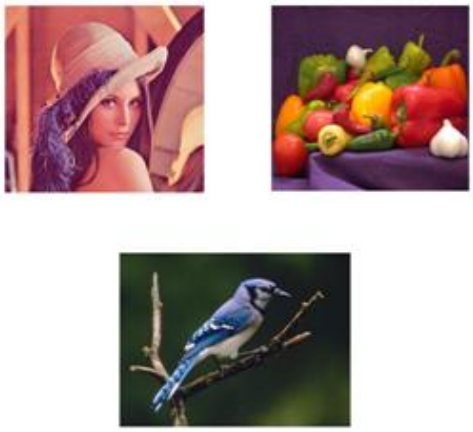

Figure 4: A collection of sample noisy images.

Figure 5: Gray scale images of the originals.

Figure 6: Noisy images of the gray scale ones.

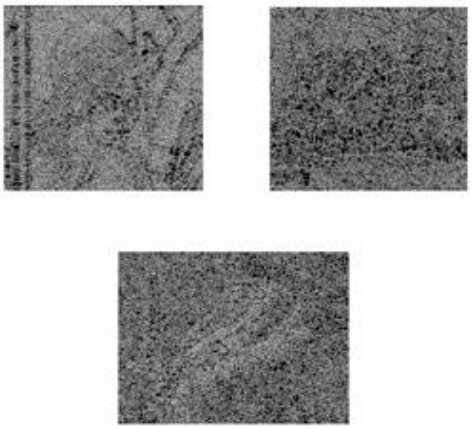

Figure 7: Segmented images obtained by using standard watershed algorithm directly on the noisy images.

Figure 8: Noise free images of originals using median filtering.

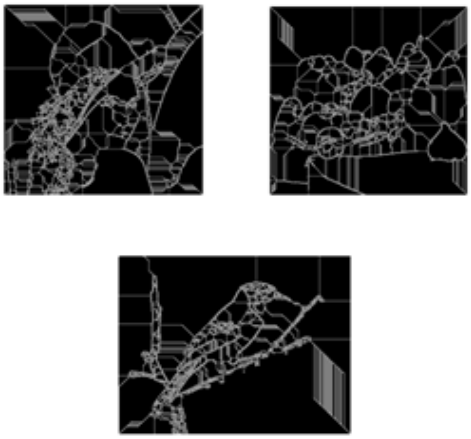

Figure 9: Final segmented images using proposed approach.

Combination of median filtering and watershed algorithm using distance transform techniques for image segmentation and edge detection procedures were used. The median filtering method was applied to obtain noise free images. Then a watershed algorithm using distance transform technique is used to segmentation of images. Three real life noisy images of Lena, Fruits, Bird of 512x512, 512x512 and 500 x dimensions (Figure 4) has been chosen to do the experimental work. The gray scale images of originals are shown in figure 5. The salt and paper noises have been added to the gray scale images and accordingly shown in figure 6. It has been observed from the segmented images after using watershed algorithm directly on the noisy gray scale images that they are extremely over segmented (Figure 7). To reduce the over segmentation a new approach of watershed algorithm using distance transform is applied with median filtering. The noise free images with median filtering are shown in figure 8. Final segmented images are shown below in figure 9 using propped and better accuracy is achieved in detection of edges with lesser over segmentation.

The statistical measurements with entropy, peak signal to noise ratio (PSNR) and mean square error (MSE) are also calculated for segmented images using conventional watershed approach applied on noisy grayscale images which are shown in figure 7 and final segmented images which are obtained by proposed approach applied on same grayscale noisy images and accordingly shown in figure 9. Image entropy is a quantity which is used to describe the `business' of an image, i.e. the amount of information which must be coded for by a compression algorithm. Image entropy is calculated with the formula:

$$Entropy = \sum_i P_j log_2 P_j \quad (1)$$

The Peak Signal to Noise Ratio (PSNR) is the value of the noisy image with respect to that of the original image. The value of PSNR and MSE (Mean square Error) for the proposed method is found out experimentally. The PSNR and the Mean Square Error of the retrieved image can be calculated by using the equation number 2 and 3.

$$PSNR(Img, Org) = 10log10_{10} \frac{S^2}{MSE(Img, Org)} \quad (2)$$

$$MSE(Img, Org) = \frac{(\Sigma c=1 \Sigma i=1 \Sigma j=1 [Org(i,j,c) - Img(i,j,c)]}{3NM} \quad (3)$$

Where Org is the original image, Img is the filtered color image of size M. M, S is the maximum possible intensity value (with m-bit integer values, S will be 2m-1). The results of the calculations for the proposed method are given in Table I.

TABLE I

STATISTICAL MEASUREMENTS

Figure No.	Image Name	Entropy	PSNR	MSE
Figure 7	Lena	3.1665	7.6766	1.1103e+004
	Fruits	3.1825	7.7566	1.0900e+004
	Bird	3.0812	7.7216	1.0988e+004
Figure 9	Lena	2.2553	9.3755	6.1900e+003
	Fruits	2.1345	9.8393	6.7477e+003
	Bird	1.9224	12.2585	3.8657e+003

VI. CONCLUSION

This paper gives an overview of the median filtering applied with watershed algorithm using distance transform for image segmentation and edge detection. The combination of these two techniques is an effective tool for image segmentation and edge detection in a variety of practical situations. The performance analysis of the proposed approach is compared with conventional watershed approach for image segmentation task. This paper also infers that the proposed approach performs best when the objects of interest in the image are well defined, with strong edges and uniform background. In such cases, it can be electively used as a substitute for classical image segmentation algorithms.

REFERENCES

[1] Sheng Liu ; Zhejiang Univ., Hangzhou, China ; Rui Cao ; Shengyong Chen ; Zichen Chen, "Novel Quality Evaluating Method for Over-Segmentation Approaches Using Real-Time Boundary Information", Workshop on Digital Media and Digital Content Management (DMDCM), pp. 252 – 256, 15-16 May 2011.

[2] Luis Patino, "Fuzzy relations applied to minimize over segmentation in watershed algorithms", Pattern Recognition Letters, Volume 26, Issue 6, Pages 819-828, 1 May 2005.

[3] Mariela Azul Gonzalez, Gustavo Javier Meschino, Virginia Laura Ballarin, "Solving the over segmentation problem in applications of Watershed Transform", ournal of Biomedical Graphics and Computing, , Vol. 3, No. 3, pp.29-40 , 2013.

[4] Pinaki Pratim Acharjya, Dibyendu Ghoshal, "A Modified Watershed Segmentation Algorithm using Distances Transform for Image Segmentation", International Journal of Computer Applications, Volume 52– No.12, pp. 47-50, August 2012.

[5] Mark Polak, Hong Zhang*, Minghong Pi, "Mark Polak, Hong Zhang *, Minghong Pi", Image and Vision Computing, Vol. 27, pp. 1223–1227, 2009.

[6] S. Thilagamani, N.Shanthi, "A Novel Recursive Clustering Algorithm for Image Oversegmentation", European Journal of Scientific Research, Vol.52, No.3, pp.430-436, 2011.

[7] Peter Eggleston, "Understanding Oversegmentation and Region Merging", Vision Systems Design, December 1, 1998.

[8] Alasdair Mcandrew.2004. Introduction to digital image processing with MATLAB, Course Technology a part of cengage learing.

[9] Tom M´elange, Mike Nachtegael, Etienne E. Kerre.2009.A Fuzzy Filter for the Removal of Gaussian Noise in Colour Image Sequences, 1474-1479.

[10] Thangavel, K., Manavalan, R., & Laurence Aroquiaraj, I. (2009). Removal of Speckle Noise from Ultrasound Medical Image based on Special Filters: Comparative Study. ICGST-GVIP Journal, vol. 9, Issue 3, pp. 25-32.

[11] Pandey, R. (2008). An Improved Switching Median nfilter for Uniformly Distributed Impulse Noise Removal. WASET, vol.28, pp. 349-351.

[12] Lakshmiprabha, S. (2008). A New Method of Image Denoising Based on Fuzzy Logic. Medwell, International Journal of Software Computing vol. 3, no. 1, pp. 74-77.

[13] S. Beucher and C. Lantuejoul, "Use of watersheds in contour detection," 1979.

[14] F. Meyer and S. Beucher, "Morphological segmentation," Journal of visual communication and image representation, vol. 1, pp. 21-46, 1990.

[15] L. Vincent, Algorithmes morphologiques a base de files d'attente et de lacets: extension aux graphes: Paris, 1990.

[16] F. Meyer, "Topographic distance and watershed lines," Signal Processing, vol. 38, pp. 113-125, 1994.

[17] A. N. Moga and M. Gabbouj, "Parallel image component labeling with watershed transformation," IEEE transactions on pattern analysis and machine intelligence, vol. 19, pp. 441-450, 1997.

[18] J. Roerdink and A. Meijster, "The watershed transform: Definitions, algorithms and parallelization strategies," Mathematical Morphology, vol. 41, pp. 187-S28, 2000.

[19] P. Soille, Morphological image analysis: principles and applications: Springer-Verlag New York, Inc. Secaucus, NJ, USA, 1999.

[20] J. Serra, Image analysis and mathematical morphology: Academic Press, Inc. Orlando, FL, USA, 1983.

[21] J. Serra and L. Vincent, "An overview of morphological filtering," Circuits, Systems, and Signal Processing, vol. 11, pp. 47-108, 1992.

[22] W. J. Niessen, K. L. Vincken, J. A. Weickert, and M. A. Viergever, "Nonlinear multiscale representations for image segmentation," Computer Vision and Image Understanding, vol. 66, pp. 233-245, 1997.

[23] D.Dhanasekaran, K. Bagan, High Speed Pipeline Architecture for Adaptive Median Filter, European Journal of Scientific Research, Vol.29, No.4, 2009, PP.454-460.

[24] Mr. F. N. Hasoon, Weight Median Filter Using Neural Network for Reducing Impulse Noise,M.S.thesis,Department Computer Sciences, University of Putra,Putra, Malaysia,2008.

