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EFFECT OF IMAGE ENHANCEMENT ON WATERSHED SEGMENTATION

*In this paper we have showed different types of noise and filters to remove noise from Image and analyze that what exact difference it makes when it comes to segmentation of the Image(via watershed Algorithm). The image processing part consists of image acquisition of noisy image. This part consists of several image-processing techniques. First, we adding the noise in the image, then applying two types of filters to remove noise from the image. Here we use Mean Filter and median (3*3) to remove the noise. Then applying watershed Algorithm on Ideal image to be the ideal result, and applying watershed algorithm on both filtered images. Finally comparing these results with ideal result by using of Chi square (χ^2) test, to get the best of these filters to be the selected filter for using with watershed algorithm.*

Keywords: *Image enhancement, noise type, mean filter, median filter, Image segmentation, watershed algorithm.*

1. Introduction

Segmentation is one of the most important problem in image processing. It consists of constructing a symbolic representation of the image: the image is described as homogeneous areas according to one or several a priori attributes [1]. The first method appeared during the sixties and then different algorithms have been constantly developed [2]. The goal is to split an image into several parts, in particular, in image restoration the detection of edges makes this operation straightforward. In Jaafar Belaid et al. [3], the authors show that it is possible to solve the image restoration problem using topological optimization tools. The basic idea was based on the topological gradient approach used for crack detection [4]: an image can be viewed as a piece wise smooth function and edges can be considered as a set of singularities.

The main purpose of segmentation is to simplify the image data in order to minimize the amount of data to be processed. Noise is any undesired information that spoil image. In digital image, noise arise during acquisition and/or transmission process. Images are corrupted during transmission because of interference of channel used for transmission [5]. For example, image transmitted using wireless network that might corrupt as result of lighting or other atmospheric disturbances. As in acquiring image with CCD camera light levels and sensor temperature are major factors affecting the amount of noise in the resulting image. The performance of image sensor is affected by variety of factors such as environmental conditions during image acquisition and by quality of the sensing elements themselves. Segmentation is difficult in noisy images, since both the noise and the edges contain high-frequency content. But in case of noisy images it is a challenging task. Noisy images are corrupted images. Their parameters are difficult to analyze and detect. In this paper, image enhancements technique is used which helps to calculate the parameters of noisy images watershed algorithm and testing result by Chi square (χ^2).

1.1 Image Noise

Noise is any undesired information that contaminates an image. Noise appears in image from various sources. The digital image acquisition process, which converts an optical image into a continuous electrical signal that is then sampled, is primary process by which noise appears in digital image. There are several ways through which noise can be introduced into an image, depending on how the image is created [6]. Satellite image, containing the noise signals lead to a distorted image and not being able to understand and study it properly, requires the use of appropriate filters to limit or reduce much of the noise. It helps the possibility of better interpretation of the content of the image.

1.2 Types of noise

Following are the different types of image noise:

i. Salt & Pepper Noise (SPN).

This type contains random occurrences of both black and white intensity values, and often caused by threshold of noise image. Salt and pepper noise is an impulse type of noise, which is also referred to as intensity spikes. This is caused generally due to errors in data transmission.

ii. Random Variation Impulsive Noise (RVIN).

This type of noise is also called the Gaussian noise or normal noise is randomly occurs as white intensity values.

iii. Speckle Noise (SPKN).

Speckle noise is a multiplicative noise. If the multiplicative noise is added in the image, speckle noise is a ubiquitous artifact that limits the interpretation of optical coherence of remote sensing image. This type of noise occurs in almost all coherent imaging systems such as laser, acoustics and SAR (Synthetic Aperture Radar) imagery. The source of this noise is attributed to random interference between the coherent returns.

iv. Blurred Noise.

Image blurring has received a lot of attention in the computer graphics and vision communities. We model a blurred, noisy image as the convolution of a latent sharp image with a known shift-invariant kernel plus additive white Gaussian noise, whose result is potentially down sampled. Specifically, blur formation is modeled as [7]:

$$B = D\,(I * K) + N\,, \qquad (1)$$

where K is the blur kernel, N is the noise, D (I) down-samples an image by point-sampling I (m, n) = I (sm, sn) at a sampling rate s for integer pixel coordinates (m, n).

1.3 Effects of noise

1. The effect on noise on digital reconstruction and enhancement are determined from the statistics of the amount of perturbation caused by the noise.
2. Salt and pepper produced by random noise in the intensity channel that affected for a particularly visible in flat fields [8].
3. Noise in the display spot deflection circuits that should be much effected result.
4. The size of the image sensor, or effective light collection area per pixel sensor, is the largest determinant of signal levels that determine signal-to-noise ratio and hence apparent noise levels.
5. Temperature can also have an effect on the amount of noise produced by an image sensor due to leakage.

2. Noise removing Filters

Mean Filter (MF): Mean Filter (MF) is a simple linear filter, intuitive and easy to implement method of smoothing images, i.e. reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images. The idea of mean filtering is simply to replace each pixel value in an image with the mean (average) value of its neighbors, including itself. Moreover, Mean Filter is a linear filter which uses a mask over each pixel in the signal. Each of the components of the pixels which fall under the mask are averaged together to form a single pixel. This filter is also called as average filter. Standard Median Filter (SMF) Median filter is the non-linear filter. Which changes the image intensity mean value if the spatial noise distribution in the image is not symmetrical within the window. Median filter reduce is the variance of the intensities in the image. Median filter is a spatial filtering operation, so it uses a 2-D mask that is applied to each pixel in the input image. To apply the mask means to center it in a pixel, evaluating the covered pixel brightness and determining which brightness value is the median value. Adaptive Wiener Filter (AWF) Adaptive Wiener Filter (AWF) changes its behavior based on the statistical characteristics of the image inside the filter window. Adaptive filter performance is usually superior to non-adaptive counterparts. But the improved performance is at the cost of added filter complexity. Mean and variance are two important statistical measures using which adaptive filters can be designed.

Gaussian Filter (GF) Gaussian low pass filter is the filter which is impulse responsive, Gaussian filters are designed to give no overshoot to a step function input while minimizing the rise and fall time. Gaussian is smoothing filter in the 2D convolution operation that is used to remove noise and blur from image. Adaptive Median Filter (AMF) The Adaptive Median Filter (AMF) is designed to eliminate the problems faced with the Standard Median Filter. The basic difference between the two filters is that in the Adaptive Median Filter, the size of the window surrounding each pixel is variable. This variation depends on the median of the pixels in the present window. If the median value is an impulse, then the size of the window is expanded.

3. Water shed Segmentation

3.1 Introduction

Image segmentation is an important and, perhaps, the most difficult task in image processing. Segmentation refers to the grouping of image elements that exhibit - similar characteristics, i.e. subdividing an image into its constituent regions or objects. All subsequent interpretation tasks, such as object recognition and classification, rely heavily on the quality of the segmentation process. The watershed transform is a broadly used technique for image segmentation. The watershed transform can be classified as a region-based segmentation approach. The intuitive idea underlying this method comes from geography: it is that of a landscape or topographic relief which is flooded by water, watersheds being the divide lines of the domains of attraction of rain falling over the region [9]. An alternative approach is to imagine the landscape being immersed in a lake, with holes pierced in local minima. Basins (also called ‘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. When the water level has reached the highest peak in the landscape, the process is stopped. As a result, the landscape is partitioned into regions or basins separated by dams, called watershed lines or simply.

In practice, the watershed is applied to the image gradient and the watershed lines separate homogeneous regions, giving the desired segmentation result. The gradient image for the transform is often found using the morphological gradient. However, noise in the gradient image results in over-segmentation which can have a significant adverse effect on the quality of the segmentation results. The quality of the gradient estimate has a major influence on them segmentation performance. So the result of different gradients on watershed has been found with the help of peak signal to noise ratio. Over-segmentation is a significant problem for most watershed algorithms, which were addressed in numerous literatures [10 – 14].

Conventionally, watershed transform is mostly designed for the purpose of image segmentation. The division of the image through watershed algorithm relies mostly on an estimation of the gradients. The low-contrast [13] edges produce an under segmentation and generate small magnitude gradients, causing distinct regions to be erroneously merged. In this paper we will discuss the image segmentation done by watershed transformation in which the image enhancement techniques are used so as to avoid under segmentation and noise removal techniques to reduce over segmentation.

These are pre-segmentation techniques applied to input image. The watershed transform [15] is a morp In grey scale the mathematical morphology watershed transform for segmentation is originally proposed by Digabel and Lantuejoul in1977 and later improved by Li et Al in 2003. The watershed transform can be classified as a region-based segmentation hological based tool for image segmentation. approach. Fig. 1 Illustration of immersion process of watershed transforms. (CB: Catchment basins).

The idea [16] of watershed can be view as a landscape immersed in a lake; catchment basins will be filled up with water starting at each local minimum. Dams must be built where the water coming from different catchment basins may be meeting in order to avoid the merging of catchment basins. The water shed lines are defined by the catchment basins divided by the dam at the highest level where the water can reach in the landscape [17]. As a result, watershed lines can separate individual catchment basins in the landscape. The idea is described in Fig. 1 which describes the flooding or rain falling process of watershed algorithm. The process of rain falling is described in Fig. 2.

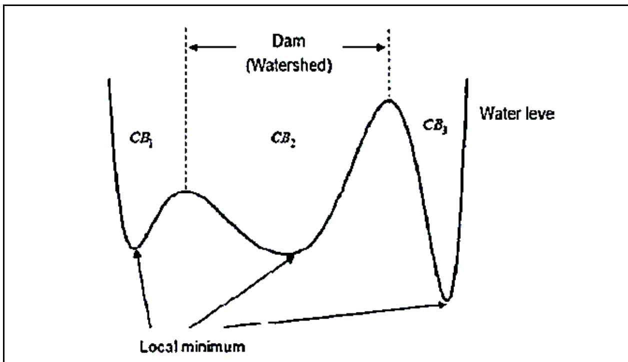


Fig. 1. Illustration of immersion process of watershed transform (CB Catchment basins)

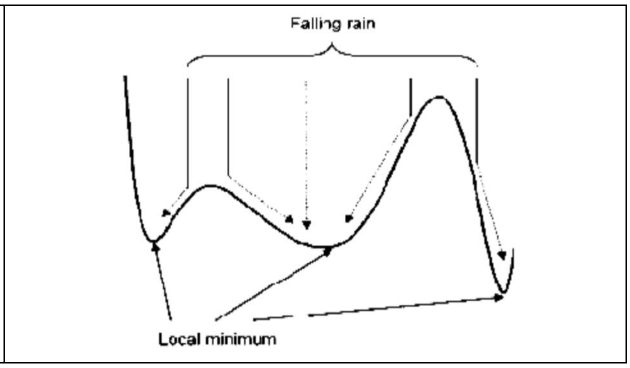


Fig. 2. Illustrations of flooding (process of watershed transform)

3.2 Marker controlled watershed segmentation

Separating touching objects in an image is one of the more difficult image processing operations. The watershed transform is often applied to this problem. The watershed transform finds "catchment basins" and "watershed ridge lines" in an image by treating it as a surface where light pixels are high and dark pixels are low. Segmentation using the watershed transform works well if you can identify, or "mark," foreground objects and background locations. Marker-controlled watershed segmentation [18] follows this basic procedure:

1. Compute a segmentation function. This is an image whose dark regions are the objects you are trying to segment.

2. Compute foreground markers. These are connected blobs of pixels within each of the objects.

3. Compute background markers. These are pixels that are not part of any object.

4. Modify the segmentation function so that it only has minima at the foreground and background marker locations.

5. Compute the watershed transform of the modified segmentation function.

4. Chi square (χ^2)

The chi-squared test is a statistic used to compare the fit of experimentally observed data to theoretically expected data [19], and is defined as

$$\chi^2 = \sum_{j=1}^{r}\left(O_j - E_j\right)^2 / E_j \text{ , } \textit{with f degree of freedom}, \quad (2)$$

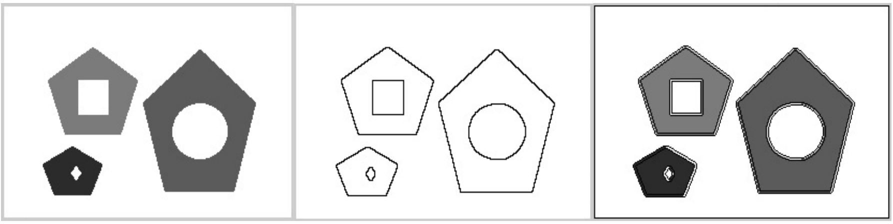
where r is the total number of cells (divisions); O_j is the number of observations occurring in cell j; E_j is the expected number of observations for cell j, based on a known distribution; f is the number of degrees of freedom, which in general is equal to (r – 1) minus the number of quantities on which the expected data are based.

Using the null hypothesis (H_0) and the alternate hypothesis (H_1): H_0 : the observed distribution is similar to the expected or theoretical distribution. H_1 : the observed distribution is not similar to the expected distribution.

And a stated level of significance, it is possible to interpret the results of the chi-squared test using tabulated values for χ^2, where H_0 is rejected if the calculated sample χ^2> the tabulated χ^2; H_0 is accepted if the calculated sample χ^2< the tabulated χ^2. The chi-squared test was used to determine the accuracy of filtered images segmentation.

5. Implementation and results

Watershed segmentation of ideal image as show in fig. 3, fig. 3, a show the ideal image, where the result of segmentation shown in fig. 3, b, 3, c. To obtain noisy image we must adding noise, and the noise type is "salt and peppers" as show in fig. 4, the implementation of watershed on image which filtered with Mean filter fig. 5, a where the result shown in fig. 5, b, 5, c. And filtered image with Media filter figure 5, d, with result of segmentation from it as show in fig. 5, e, 5, f.



a b c

Fig. 3: a – the ideal image; b – watershed segmentation's result; c – watershed segmentation's result and objects

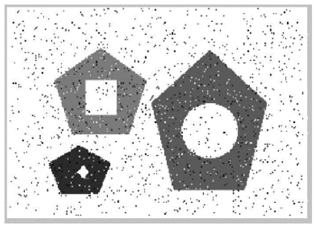
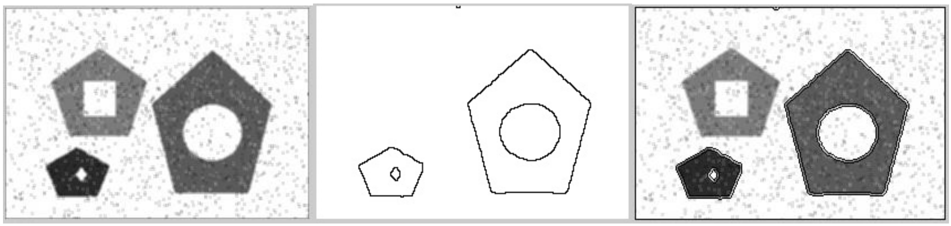
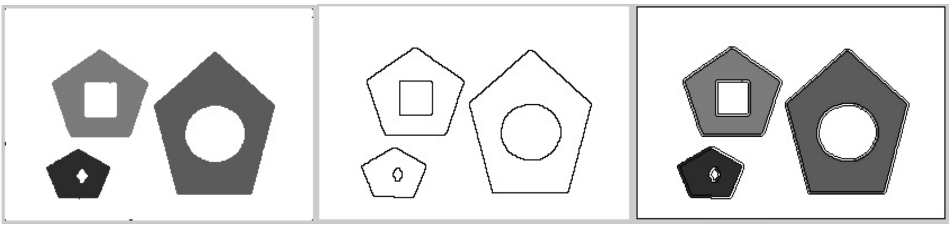


Fig. 4. Adding noise to Ideal image



a b c



d e f

Fig. 5: a, d – Filtered image with Median Filter; b,e – watershed segmentation's result; c, f – watershed segmentation's result and objects

Conclusion

Segmentation is one of the most important problem in image processing. It consists of constructing a symbolic representation of the image: the image is described as homogeneous areas according to one or several a priori attributes [20]. The goal of image segmentation process is to identify the segments of the image according to the characteristics of objects e.g. object shape, image color etc. In order to solve the over segmentation problem of traditional watershed technique an improved technique is proposed that uses preprocessing methods to reduce the noise of image. Also we use two types of filters. This work recommended to use Median filter. Because it is more efficient with watershed and the Chi square test result was agree with him.

For mean filtered image χ^2=1.2545e+004 > the tabulated χ^2, and χ^2= 0.5683 < the tabulated χ^2, for Median filter in significance level of 0.05, clash in results for filters shown in fig. 6.That mean the median filter accepted.

List of references

1. *Masmoudi M (2001). The topological asymptotic. In: Glowinski R, Kawarada H, P′eriaux J, eds. Computational methods for control applications. Gakuto Int Series Math Sci Appl, vol 16. Tokyo, 53-72.*
2. *Soille P (1992). Morphologie math′ematique: Du relief `a la dimensionnalit′e, Algorithmes et m′ethodes. Th`ese de Doctorat, Facult′e des Sciences Agronomiques del'Universit′e Catholique de Louvrain.*
3. *Jaafar Belaid L, Jaoua M, Masmoudi M, Siala L (2006). Image restoration and edge detection by topological asymptotic expansion. Compt Rend Acad Sci 342:313-8.*
4. *Amstutz S, Horchani I (2005). Crack detection by the topological gradient method. Control Cybern 34:119-38.*
5. *Mr. Ankur. N. Shah, Dr. K.H. Wandra, "Introduction to noise, image restoration and comparison of various methods of image restoration by removing noise from image" Volume : 2, Issue 1, ISSN - 2249-555X, October 2012.*
6. *Mr. Salem Saleh Al-amri, Dr. N.V. Kalyankar and Dr. Khamitkar S.D, "A Comparative Study of Removal Noise from Remote Sensing Image" Vol. 7, Issue. 1, No. 1, ISSN : 1694-0784, January 2010.*
7. *Neel Joshi, C. Lawrence Zitnick, Richard Szeliski, David J. Kriegman, "Image Deblurring and Denoising using Color Priors".*

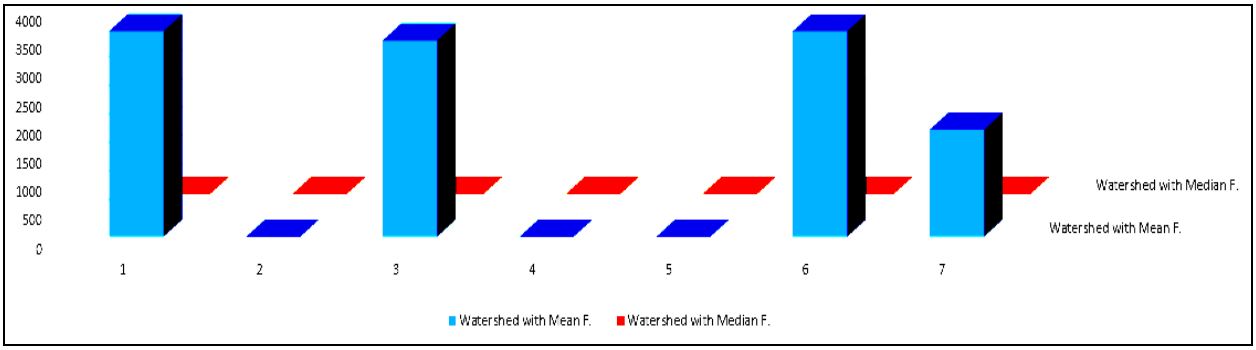


Fig. 6. Different Mean and Median Filter's result

8. Meenal Jain , Sumit Sharma, Ravi Mohan Sairam, "Effect of Blur and Noise on Image Denoising based on PDE", Volume-3, No-1, Issue-8, ISSN: 2249-727.7, March-2013.

9. Serra, J., Image Analysis and Mathematical Morphology, Academic Press, New York, 1982.

10. Beucher, S. The Watershed Transform Applied to Image Segmentation, Proceedings of the Pfefferkorn Conference on Signal and Image Processing in Microscopy and Microanalysis, pp. 299–314, September 1991.

11. Malik, Khan, ―Modified Watershed Algorithm for Segmentation of 2D Images, Journal of Information Science & Information Technology, 6, No.3, pp. 546-552. 2009.

12. Hernandez, S.E., and Barner, K.E. Joint Region Merging Criteria for Watershed-based Image Segmentation, Proceedings of the IEEE International Conference on Image Processing, 2, pp. 108–111, 2000.

13. R.M. Haralick and L.G. Shapiro, Survey: Image Segmentation Techniques, Comput. Vis. Graph. Im.Proc, 29 (1985) 100-132.

14. K. Haris, S. Efstratiadis, Hybrid Image Segmentation Using Watersheds and Fast Region Merging, [J].IEEE Transaction on Image Processing, 7, No.12, pp.1684-l699, 1998 on, National Central University, Computer Scienceand Information Engineering.

15. L. Vincent, Morphological grayscale reconstruction in image analysis: applications and efficient algorithms, IEEE Transactions on Image Proc., vol. 2, no. 2, pp. 176–201, 1993.

16. H. Digabel and C. Lantuéjoul, Iterative algorithms, in Proceedings of the 2nd European Symposium on Quantitative Analysis of Microstructures in Materials Sciences, Biology and Medicine, pp. 85–99, Caen, France, October 1977.

17. Wenli yang ,Zhiyuan Zeng;Sizhe Zhang; Application of Combining Watershed And Fast clustering Method in Image Segmentation ,Computer Modelling And Simulation, 2010.ICCMS'10.Second International Conference Volume 3Digital Object Identifier 10.1109/ICCMS.2010.407 Publication Year:2010 ,Page(s): 170-174 IEEE CONFERENCE.

18. Mohmed Ali Hamdi Modified Algorithm Marker Controlled Watershed Transform For Image Segmentation Based On Curvelet Threshold ,Canadian Journal On Image Processing and Computer Vision Vol. 2 No. 8, Dec. 2011.

19. P.J. SYMONDS. The investigation of the characterization of flotation froths and design of a machine vision system for monitoring the operation of a flotation cell ore concentrator. Master's thesis, University of Cape Town, 1992.

20. Lamia Jaafar Belaid and Walid Mourou; 'Image Segmentation: A Watershed Transformation Algorithm', Image Anal Stereol 2009;28:93-102 March 27, 2009.

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ПОКРАЩЕННЯ ЗОБРАЖЕННЯ ЗА ДОПОМОГОЮ АЛГОРИТМУ WATERSHED

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В статті розглянуті різні типи шумів та фільтрів, котрі видаляють їх із зображення та аналізують явну різницю, отриману при розподілі зображення (за допомогою алгоритму watershed). Складовою частиною обробки зображення є захват зображення, яке має шуми. Ця частина процесу складається з декількох етапів обробки зображення. Спершу додаємо шуми до зображення, потім, використовуючи два види фільтрів, видаляємо їх із зображення. Використовуємо як фільтри математичне сподівання та медіанний фільтр. Потім використовуємо алгоритм watershed для оптимального зображення та для інших двох, що були відфільтровані. Порівнюючи ці результати з оптимальним результатом за допомогою критерію χ^2 обираємо кращий фільтр для використання при роботі з алгоритмом watershed.

***Ключові слова**: покращення зображення, шум, фільтр математичного сподівання, медіанний фільтр, розподіл зображення, алгоритм watershed.*

УЛУЧШЕНИЕ ИЗОБРАЖЕНИЯ ПРИ ПОМОЩИ АЛГОРИТМА WATERSHED

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В статье рассмотрены разные типы шумов и фильтров, которые удаляют их из изображения и анализируют полученную явную разницу при распределении изображения (с помощью алгоритма watershed). Составной частью обработки изображения является захват изображения, которое имеет шумы. Эта часть процесса состоит из нескольких этапов обработки изображения. Сначала добавляем шумы к изображению, потом, используя два вида фильтров, удаляем их из изображения. Используем в качестве фильтров математическое ожидание и медианный фильтр. Алгоритм watershed применяем к оптимальному и отфильтрованным изображениям. Сравнивая эти результаты с оптимальным с помощью критерия χ^2 выбираем лучший фильтр для использования при работе с алгоритмом watershed.

***Ключевые слова**: улучшение изображения, шум, фильтр математическое ожидание, медианный фильтр, распределение изображения, алгоритм watershed.*