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Robust Edge Detection using Moore's Algorithm with Median Filter

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Abstract - *Edge detection plays a vital role in image segmentation and feature extraction for object recognition. In this paper, an edge detection method using foreground detection, final foreground segmentation and Moore-Neighbor algorithm is proposed. The Moore-neighbor algorithm is used as boundary tracing for detection and feature extraction. Further, median filter is incorporated with the Moore - Neighbor algorithm to detect the edges of object. The proposed edge detection can extract the edges as well as features of an object and is robust to noise. For experimentation, the BSD (Berkeley Segmentation Database) images are considered and the proposed method is compared with the other sate of art methods. The experimental results confirm the novelty of the proposed method.*

Key Words: **Moore Neighbor algorithm, BSD, Median Filter, Foreground Detection.**

1. INTRODUCTION

Image Segmentation plays a pivotal role in digital image processing. This process is used to identify the edges of objects from an image, which is a set of multiple contour pixels. Image segmentation can be classified into two types namely edge based segmentation and region based segmentation. This paper focuses on the edge based detection method, a challenging task to detect the true edges of an object. In recent times, the various edge detection methods are applied in various fields.

The edge detection in medical images with quasi high filter is described by authors Lin et al. in [1]. The authors presented a WL operator to detect the edges in different medical images [1]. An algorithm is developed for blurred satellite images using iterative fuzzy edge detection method [2]. The developed algorithm by Rahimzadegan et al. is compared with other edge detection methods and higher parametric values of peak signal to noise ratio (PSNR) promises the better performance of the algorithm for blurred satellite images. In [3], author proposes an efficient algorithm by improving traditional Canny edge detection algorithm for satellite images. A hybrid model of edge detection is proposed by authors Kalra et al. in [4]. The authors combined traditional Sobel and Canny edge operator to detect the edges and promises better results compared to other conventional methods. In [5], author proposed a Neighboring Algorithm which is efficient than the preceding methods. This method achieved the requirement of better clarity and good performance in noisy images. The principle used is based on finding mean and maximum again and again on every pixel and apply Moore neighborhood concept of Cellular Automata. The problems encountered during implementation of this method are, the filter used in this method is unable to preserve the edges, time required to mask the images with higher resolution is more, This method is only applicable to the images with similar resolution in both axis. In order to overcome these stated drawbacks, it is proposed to apply foreground and background detection on the input image instead of applying masking. Further Moore's algorithm is applied for edge detection and Median filtering is applied to the image. Finally, image quality parameters are analyzed.

2. METHODOLOGY

Foreground Detection

Foreground detection is one of the major tasks in the field whose aim is to detect changes in image sequences. Many applications do not need to know everything about the evolution of movement in a video sequence, but only require the information of changes in the scene. Detecting foreground to separate these changes taking place in the foreground of the background. It is a set of techniques that typically analyze the video sequences and are recorded with a stationary camera.

B. Saliency map

In computer vision, a saliency map is an image that shows each pixel's unique quality. The goal of a saliency map is to simplified and/or change the representation of an image into something that is more meaningful and easier to analyze. Like a pixel has a high grey level or other unique color quality sees in color image, each pixel's quality will show in the saliency map and in an obvious way. Saliency is a kind of Image segmentation.

The result of saliency map is set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture.

C. Moore Neighbor Algorithm

The Moore Neighboring Algorithm is used to detect the edges. The mean and maximum for every pixel are calculated using this algorithm. This is generally used for better clarity and performance in noisy images using the concept of Cellular Automata [6].

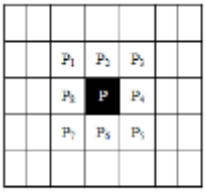

Fig. 1. Moore s Neighbor

The modified Moore-Neighborhood of a pixel, P which is a set of 8 pixels, shares its vertex or edge with that pixel. The center pixel P if black will continue to search for a white pixel in its neighborhood till it achieves success. In case it doesn't get a white pixel in its neighborhood, it will continue the process without stopping. The stopping criterion is important to improve the performance of Moore-Neighbor tracing. In our proposed Moore-Neighbor tracing, the following modifications are made:

(1) Stop the search once the white pixel is obtained. Then move to the next part of image.

(2) In case white pixel is not obtained in its search i.e. from P1 to P8, it will still move to the next part of the image.

The steps and flow chart for the proposed method are as follows:

Step1: Initially the salient map will be performed for the input image.
Step2: Centre prior is applied to the salient image.
Step3: Further the image will be enhanced and foreground detection will be performed.
Step4: The final foreground segmentation has been performed.
Step5: The moore's algorithm is applied to segmented image.
Step6: Finally median filter is applied.

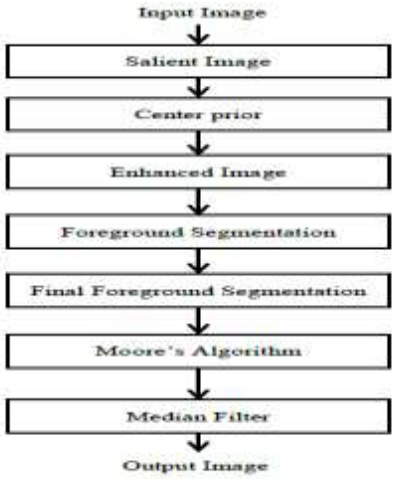

Fig. 2. Flow chart of the proposed method.

3. IMAGE PARAMETERS

The image parameters are calculated for evaluating the performance of the existing method [6] and our proposed method.

Some of the parameters which are used for the image analysis are Peak Signal to Noise Ratio (*PSNR*), Signal to Noise Ratio (*SNR*), Root Mean Square Error (*RMSE*), Pearson Correlation Coefficient (*PCC*), Mean Square Root (*MSR*).

Peak Signal to Noise Ratio

$$PSNR = 10\log\frac{(2^n-1)^2}{MSE} = 10\log\frac{255^2}{MSE} \quad (1)$$

SNR

$$SNR = 10\log_{10}\left(\frac{\lambda^2}{\sigma^2}\right) = 10\log_{10} P^{-1}\left(N, 1-P_f\right) \quad (2)$$

C. Root Mean Square Error

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=0}^{n}\left(y_i - y_i'\right)^2} \quad (3)$$

D. Pearson Correlation Coefficient

$$\rho_{x,y} = \frac{\mathrm{cov}(x,y)}{\rho_x \rho_y} = \frac{E\left((X-\mu_x)(Y-\mu_y)\right)}{\sigma_x \sigma_y} \quad (4)$$

E. Mean Square Root

$$X_{rms} = \sqrt{\frac{1}{N}\sum_{n=1}^{N}|X_n|^2} \quad (5)$$

MSE = mean square error, λ =mean, σ=Standard Deviation, = standard deviation of x dimension of image; =standard deviation of y dimension of image, =mean value of x dimension of image, =mean value of y dimension of image

4. RESULTS

For evaluating the performance of the proposed method, the test images were considered which were taken from BSD segmented data set [7].

A. Input Images

B. Output Images

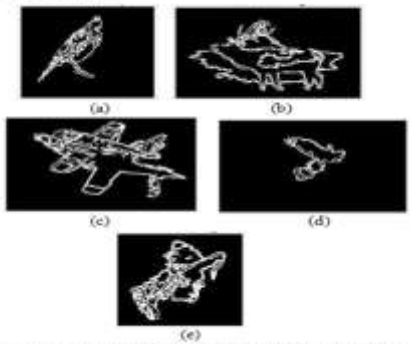

Fig. 3. A and B - (a) Bird (b) Buffalo (c) Aeroplane (d) Eagle (e) Lena

For the Segmented Image quality assessment following image quality parameters namely PSNR, SNR, RMSE, MSE, PCC, MSR are been evaluated.

Using the Moore's algorithm only the boundaries of the object are detected clearly, and the median filter is applied for removing of noise and preserving edges.. Input images which are used to evaluate the performance of the proposed method are shown in Fig. 3(A). The output images after applying proposed method are shown in Fig. 3(B). The performance of the proposed method for various images are shown in Table I. Similarly the results for the modified Moore, Canny Moore, Sobel Moore are shown in Table II,III and IV respectively.

TABLE 1PROPOSED METHOD

Image	PSNR	MSE	RMS E	SNR	PCC	MSR
Bird	40.2619	39.0396	6.2482	16.3007	- 0.1456	352.3760
Buffalo	41.0532	35.7842	5.9820	17.0568	0.0259	274.3159
Aeroplane	39.3177	43.8395	6.6299	15.2935	0.0234	274.3808
Eagle	42.8572	29.1590	5.3999	18.8354	- 0.010	274.6375
Lena	38.4256	47.9102	6.9217	14.5222	-0.017	157.2400

TABLE 2 MODIFIED MOORE'S

Image	PSNR	MSE	RMS E	SNR	PCC	MSR
Bird	30.1837	109.7974	10.4784	7.1390	- 0.304	609.427
Buffalo	31.1152	101.4799	10.0737	8.0032	0.1340	472.008
Aeroplane	30.0953	110.401	10.5073	7.2711	- 0.090	473.808
Eagle	38.9683	45.1173	6.7169	15.0439	- 0.132	475.560
Lena	27.8226	125.8996	11.2205	6.1303	- 0.0069	272.136

TABLE -3 CANNY MOORE

Image	PSNR	MSE	RMSE	SNR	PCC	MSR
Bird	30.0640	110.605	10.5169	7.2553	- 0.27	12.9572
Buffalo	29.9973	111.167	10.5436	7.2112	0.2347	8.0991
Aeroplane	29.9573	111.503	10.5595	7.1850	0.1902	6.3962
Eagle	40.1667	39.4533	6.2812	16.2091	0.1044	7.5240
Lena	29.3499	116.426	10.7901	6.8098	0.0283	4.0613

TABLE-4 SOBAL MOORE

IMAGE	PSNR	MSE	RMS E	SNR	PCC	MSR
Bird	64.3153	2.4776	1.5740	40.2503	0.0028	12.9572
Buffalo	34.7666	71.1492	8.4350	11.0874	0.0602	8.0991
Aeroplane	35.0096	69.3610	8.3283	11.3085	0.2794	6.3962
Eagle	61.0383	3.6129	1.9008	36.9737	0.0076	7.5240
Lena	36.1287	61.5798	7.8473	12.320	0.0519	4.0613

From the above results , it is observed that the proposed method is superior compared to the existing methods

5. CONCLUSION

In this paper, we used a method which is efficient for detection of object and extraction of features from an image. The proposed model operates in two steps, namely Moore-Neighbor algorithm followed by median filtering to detect the edges. The quantitative results illustrate that the proposed model performs much better than the other existing edge detection methods.

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