COMPILER
Vol. 13, No. 1, May 2024, pp. 39~44
ISSN: 2252-2403 (Print), ISSN: 2549-2403 (Online)
Accredited Fourth Grade by Kemenristekdikti, Decree No:200/M/KPT/2020
DOI: 10.28989/compiler.v13i1.2116

Impact of Wolf Thresholding on Background Subtraction for Human Motion Detection

Elindra Ambar Pambudi*, Muhamad Ivan Nurhidayat
Department of Informatics Engineering, Universitas Muhammadiyah Purwokerto, Indonesia

Article Info

Article history:

Received February 21, 2024
Accepted May 2, 2024
Published May 31, 2024

Keywords:

Wolf Threshold
Background Subtraction
Motion Detection
Segmentation
MSE

ABSTRACT

Series of motion detection based on background subtraction there is an image segmentation stage. Thresholding is a common technique used for the segmentation process. There are two types that can be used in thresholding techniques namely local and global. This research intends to implement local adaptive wolf thresholding as the threshold value of the background subtraction method to detect motion objects. The proposed method consists of the reading frame, background and foreground initialization of each frame, preprocessing, background subtraction, wolf thresholding, providing a bounding box, and running frame sequentially. Based on MSE and PSNR obtained on four videos, it has shown that wolf thresholding has succeeded in outperforming of global threshold.

Corresponding Author:

Elindra Ambar Pambudi,
Department of Informatics Engineering,
Universitas Muhammadiyah Purwokerto,
KH. Ahmad Dahlan road, Dusun III, Kembaran, Banyumas, Central Java 53182
Email: *elindraambarpambudi@ump.ac.id

1. INTRODUCTION

Humans utilize motion detection (motion tracking) extensively in their daily lives, both on an industrial or corporate scale and for personal purposes. Automatic vehicle parking, CCTV, traffic bottlenecks, security, and other applications all make use of motion detection technology. Motion detection (motion tracking) aims to predict the location of moving objects in sequential image frames.

There are various methods for motion detection. In this study, the background subtraction method was applied, which caused the background subtraction algorithm to be highly adaptable, the common approach for static cameras and fixed background in surveillance video is a crucial technique for motion detection tasks. It means that responding to background changes is faster than other similar methods.

Identification of moving objects can utilize a variety of combinations with the background subtraction method. Segmentation is one of the steps of the background subtraction technique [4]. Thresholding, also known as floating, is the process of converting a grayscale image into a binary image by altering all pixels with a value of zero when below the threshold and one when above the threshold [5]. Thresholding is a simple but effective tool for separating foreground objects from the background, therefore it essential technique for background subtraction [6]. Thresholding approaches can be classified as global or local, depending on how many thresholds are necessary for detection [7]. Thresholding is the process of separating an image into areas based on its intensity or attributes. It divides the image into two classes based on the threshold setting. Thresholding might be global or local. While the global threshold is a single number that applies to all pixels in the image, the local threshold calculates a threshold for each pixel. It derives some attributes of the pixel based on its neighbor's pixels [8]. According paper [10] which determine appropriate thresholding is an effective technique for improving background subtraction.

Wolf local thresholding is a binarization approach used to calculate image contrast, average gray level, and standard deviation inside a local window and across the picture [7]. Wolf local thresholding succeeded in enhancing the results of segmentation in Blood Vessel Segmentation [11], CT image segmentation [8]. Research [7] did a comparative study and image analysis on local adaptive threshold approaches. The threshold techniques compared are the Niblack technique, the Sauvola technique, the Wolf

technique, the Darek Bradley methodology, and the Nick technique. According to the publication, the wolf algorithm normalizes images' contrast and average grey value more than the Sauvola method does.

Some implementations of wolf thresholding are limited to segment of medical images based on research [8], [11]. This paper has the purpose of improving the performance of background subtraction based on appropriate thresholds. Based on the advantage of wolf threshold, this paper utilizes wolf thresholding as an option and will be compared with a global threshold.

2. RESEARCH METHOD

This study uses visual data for each frame from four video samples of people walking. The researchers collected the data themselves, using a smartphone camera with MP4 video and PNG per-frame image format. Shooting is divided into two categories: indoors and outdoors. Capture the video using a smartphone camera with the extension format *.MP4* with an estimated duration of 2 – 3 seconds. Our research was conducted on 4 videos. It was divided 2 indoor videos and 2 outdoor videos. The resolution of the video taken with a smartphone camera is adjusted again to 512 x 288 pixels.

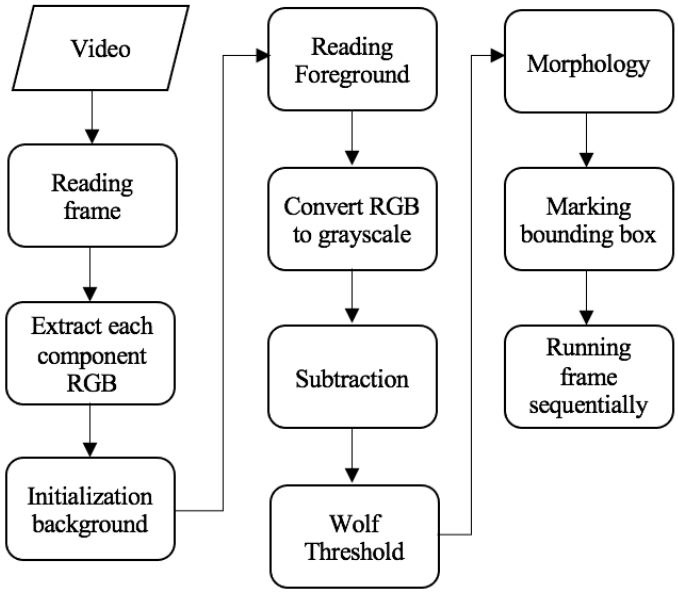


Figure 1. Flowchart of our proposed method

The steps used in this research method:
1. Reading video files.
2. Initialize the number of frames in the video.
3. Extract each RGB image component.
4. Initialize the background by finding the mode of each RGB component and then combining it.
5. Read the foreground image in each frame.
6. Convert the RGB background and foreground image to a grayscale image.
7. Perform subtraction using wolf thresholding following equation (1). One of the techniques in the field of image processing and computer vision aims to detect or extract the foreground from the background for further processing. Background subtraction is usually used for moving object detection with a static camera. If the difference between the subtracted pixel values is greater than the threshold value, the pixel will be categorized as part of the foreground. After subtracting pixels, do the binarization process, but before doing that, we need to determine the threshold value based on the wolf technique following equation (2). Set the parameter k = 0.5, M the minimum number of gray values of an image, R the highest grayscale of global standard deviation, σ local standard deviation. How to calculate local standard deviation can be followed by equation (3).

$$\Delta_t(x,y) = |B(x,y) - I_t(x,y) \quad (1)$$

$$Thres\,(x,y) = (1-k) \times m + k \times M + k \times \frac{\sigma}{R}(m-M) \quad (2)$$

$$\sigma = \sqrt{\frac{n\sum_{i=1}^{n} x_i^2 - (\sum_{i=1}^{n} x_i)^2}{n(n-1)}} \quad (3)$$

$$O_t(x,y) = \int_0^1 \begin{matrix} if\ abs(\Delta_t(x,y)) \geq Thres \\ Otherwise \end{matrix} \quad (4)$$

O_t = result of threshold, Δ_t = *background subtraction,* $Thres$ = result of threshold from pixel neighbors (*threshold wolf*)

9. Use morphological methods to cover unwanted holes or pixels in the image.
10. Marking/bounding boxes on each frame. Frames that have been given a bounding box are executed sequentially.

Evaluation

The findings of this research will be evaluated using MSE (Mean Square Error) and PSNR (Peak Signal to Noise Ratio) calculations. According to a study [12], a high PSNR value and a low MSE value result in a very smooth image for eye perception. The MSE formula can follow equation (5).

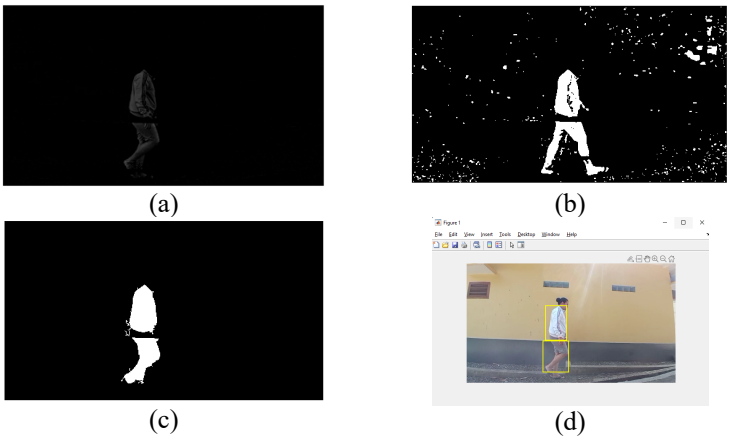
$$MSE = \frac{\sum_{a=0}^{x-1}\sum_{b=0}^{y-1}(M_{(a,b)} - N_{(a,b)})^2}{x \times y} \quad (5)$$

$$PSNR = 10\ \log_{10}\frac{Max_i^2}{MSE} \quad (6)$$

In equation (5) where *M* is the segmented image of wolf thresholding while N is ground truth image. PSNR in equation (6) Max_i^2 symbolize the maximum pixel from the image.

3. RESULTS AND ANALYSIS

After the acquisition process from reading the video until extracting the video into frames. The next process converts the RGB frame to a grayscale frame. The next stage is to calculate the difference between foreground and background. The result of subtraction can be seen in Fig. 2 (a). After the subtraction process, our research carries out thresholding using the wolf technique. The k value is set to 0.5 according to the paper [13], The Result of wolf thresholding can be seen in Fig. 2 part (b). The final stage implemented the morphological process in Fig. 2 (c) and added a bounding box for the detected object in Fig. 2 (d).



(a) (b) (c) (d)

Figure 2. Several results of the proposed method in frame 30: (a). Subtraction; (b). Wolf thresholding; (c). Morphology; (d). Result

The threshold wolf method's background removal for moving object recognition was tested using MSE (Mean Square Error) and PSNR (Peak Signal to Noise Ratio). There were four video samples of persons walking that were analyzed, two indoor and two outdoor, with three frames taken from each movie. The image quality improves when the MSE value decreases, whereas the PSNR value increases. The test results can be found in Tables 1 and 2.

Table 1. Comparison MSE and PSNR in indoor (a). Sample 1, (b). Sample 2

Frame at	MSE		PSNR	
	Wolf Threshold	Global Threshold	Wolf Threshold	Global Threshold
1	1026,2354	1379,952	18,0183	16,7322
30	1460,2526	1571,0779	16,4865	16,1688
60	3138,4059	3604,8024	13,1637	12,562

(a)

Frame at	MSE		PSNR	
	Wolf Threshold	Global Threshold	Wolf Threshold	Global Threshold
1	2525,7439	2869,4825	14,1069	13,5528
30	1503,842	1537,4539	16,3588	16,2628
59	7492,2138	9246,1483	9,3847	8,4712

(b)

Table 2. Comparison MSE and PSNR in outdoor (a). Sample 1, (b). Sample 2

Frame at	MSE		PSNR	
	Wolf Threshold	Global Threshold	Wolf Threshold	Global Threshold
1	1329,2421	2322,8754	16,8948	14,4705
30	2111,0551	3118,8342	14,8858	13,1909
60	6836,3455	8615,7824	9,7826	8,7779

(a)

Frame at	MSE		PSNR	
	Wolf Threshold	Global Threshold	Wolf Threshold	Global Threshold
1	5561,2212	6932, 502	10,6791	9,7219
30	1653,5795	3614,6324	15,9466	12,5502
60	4015,4451	6278,9533	12,0935	10,1519

(b)

The results of MSE and PSNR tests on four video clips of individuals walking utilizing the threshold wolf approach for detecting moving objects using the background subtraction method. It was discovered that the MSE and PSNR values which have been shown in Table 1 part (a) and part (b) which wolf threshold outperformed the global threshold, as well as when it comes to outdoor video samples, where the result value MSE and PSNR in table 2 part (a) and part (b), the threshold wolf approach outperformed the global threshold in terms of MSE and PSNR across all frames. Based on the MSE and PSNR results, the Wolf approach is a better choice as a reference threshold value for background removal than global thresholding when detecting moving objects.

4. CONCLUSION

The conclusion obtained from the analysis of thresholding wolf research on 4 video samples is that thresholding wolf's ability as a reference for threshold values in background subtraction based on MSE and PSNR values means that thresholding wolf is quite good to use as a threshold value in background subtraction compared to global thresholding. Of the four samples, the MSE value for wolf thresholding is smaller than for global thresholding, where the smaller the MSE value, the better the image quality. Meanwhile, the PSNR thresholding wolf value gets the highest value, compared to global thresholding. The higher the PSNR value, the better the image appearance.

ACKNOWLEDGEMENTS

We would like to thank Lembaga Penelitian dan Pengabdian Masyarakat (LPPM) Universitas Muhammadiyah Purwokerto for providing money for our research, as well as my research partners, Mr. Muhamad Ivan Nurhidayat, for their useful suggestions and many contribute of our research. This paper would not have been possible without the advice and help of numerous individuals.

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