Low-Complexity Technique to Improve Detectable Motion of Moving Objects in a Sequence of Images

Zohair Al-Ameen,[1], Shamil Al-Ameen[2], Roua Al-Taie[1],and Ghazali Sulong[3]*

[1]*Department of Information Technology, Lebanese French University, Erbil, Kurdistan Region – Iraq*
[2]*Department of Computer Science, Cihan University, Erbil, Kurdistan Region – Iraq*
[3]*Faculty of Computing, Universiti Teknologi Malaysia, Skudai, Johor, Malaysia*
**Corresponding Author (qizohair@lfu.edu.krd)*

Abstract: The use of low-intricacy techniques for fast and efficient detection of moving objects is considered quite challenging because it often leads to undesirable results. In this study, we propose an innovative technique that improves the motion detection process for moving objects. The proposed technique employs only a few distinct steps to obtain desirable results. First, the intensity difference between every two images is determined by an ameliorated image-difference detection method to identify the eminent regions of movement. Second, an abridged grayscale conversion method is proposed to provide more detailed information about the identified motion. Third, a two-dimensional order-statistic filtering process is applied to enhance the details and contours of the detected motion. Finally, a proper post-processing method is used to reduce the number of unwanted artifacts and refine the overall quality of the output. The results of our study revealed the efficiency of the proposed technique. Specifically, it performed extremely well in detecting the motion of objects and enhanced their displayed regions of movement.

Keywords: Absolute Difference, Motion Detection, Regions of Movement

Received Oct. 05, 2015; revised manuscript received Nov. 21, 2015; accepted for publication Nov. 25, 2015; published online Nov. 28, 2015. DOI: 10.15323/techart.2015.11.2.4.48 / ISSN: 2288-9248.

1. Introduction

Motion detection is a field of research that has attracted increased attention [1]. The purpose of motion detection techniques is to recognize moving objects in a sequence of images and has become a major topic requiring further analysis and processing [2]. In addition, this type of detection is considered a multi-step process that combines several methods in one [3]. The importance of this topic is increasing because of its high potential for use in many areas of computer vision and image processing. Contemporary studies have examined several related topics, including video processing systems [4], traffic tracking [5], analysis and recomposition of video footage [6], intelligent surveillance systems [7], road traffic density estimation [8], moving vehicle detection [9], moving object detection [10], tracking of fully occluded objects [11], and many others. Thus, producing a simple technique that can improve the methods of detecting motion in moving objects is required because of its multidisciplinary uses. Accordingly, in this study we introduce a low-complexity technique for global motion estimation that can perform effectively in motion identification while maintaining fast processing. The remainder of this paper is arranged as follows. In Section 2, we explain the proposed technique in detail. Results and related discussion are provided in Section 3. We provide a conclusion in Section 4.

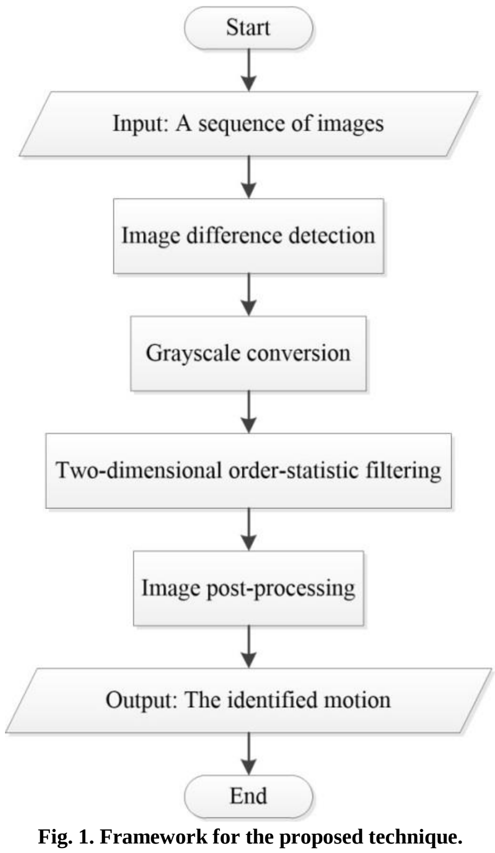


Fig. 1. Framework for the proposed technique.

2. Proposed Technique

In this section, we describe the framework for the proposed technique. First, a sequence of images is inputted and the difference between every two images is detected. The detected difference is then converted to grayscale and two-dimensional order-statistic filtering is applied to the detected difference. A post-processing procedure is then applied. Finally, the detected motion is displayed as a sequence. Fig. 1 shows the framework of the proposed technique.

A. Image Difference Detection

Many low-complexity techniques have been used to detect motion in a sequence of images. One interesting method is the classical absolute of differences (CAD) technique. This technique is often used because it is simple, fast, and requires low processing time to generate results. In addition, it detects changes in intensity between every two images by identifying pixel-based differences to determine motion. CAD can be obtained by using the following equation [12]:

$$CAD = \left| I_1 - I_2 \right| \tag{1}$$

where (I_1) and (I_2) represent the current and subsequent images, respectively. In this study, we propose an improved version of the aforementioned technique, wherein the square of the absolute difference is computed to increase the amount of detectable motion. This improved technique can be calculated as follows:

$$M = \left(\left| I_1 - I_2 \right| \right)^2 \tag{2}$$

where (M) represents the identified motion. Specifically, when a sequence of images is examined, the motion between the current and subsequent images is detected by means of the improved detection method. The other images are then processed in the same manner (the subsequent image becomes the current one, and the image that follows that subsequent one becomes the next image, and so forth). In this study, only two consecutive frames are involved because using the aforementioned feature allows us to detect the slightest motion, which yields improved motion identification results.

B. Grayscale Conversion

Essentially, a color image can be converted to grayscale by various means. Thus, a modified grayscale conversion method is proposed to provide more detailed information about identified motion. Every colored image is known to be separated into three distinct layers of red, green, and blue. In addition, converting a color image to grayscale is not a unique process because various weightings of the color channels can efficiently represent an image. Luminosity is a reliable conversion method used by an image processing software called GIMP. This method uses weightings for color channels, which accounts for human perception. Luminosity can be computed as follows:

$$L = (0.21 \times R) + (0.72 \times G) + (0.07 \times B) \tag{3}$$

where (L) represents the output and (R, G, B) represent the red, green, and blue channels of an image, respectively. In this study, equation (3) is amended by removing the weights, because experiments show that removing the weights can yield better information about the identified motion. It also facilitates subsequent operations. The grayscale conversion equation can be described as follows:

$$L = R_M + G_M + B_M \tag{4}$$

This is probably the fastest but least versatile option for applications. However, it is suitable for use in the proposed technique because it provides a satisfactory conversion.

C. Two-Dimensional Order-Statistic Filtering

In this step, we perform two-dimensional order-statistic filtering. This process replaces each element in the matrix of the detected motion with a definite element selected from an arranged set of neighboring elements. This filter moves over the entire image of the identified motion in blocks of a predefined size. In this study, the size of the aforesaid blocks is 6×6. For each 6×6 block, all elements are arranged from minimum to maximum and the block's corresponding output block is filled with several copies of the 30th smallest element of the processed block [13]. In Matlab, the function *ordfilt2* is used to perform this task.

D. Image Post-Processing

A post-processing technique is required to improve the perceived quality of the output. The results of the previous step are filtered by means of a straightforward post-processing method that reduces unwanted artifacts and refines the overall quality of the output. This can be achieved by converting images to double-precision versions using an *im2double* function in MATLAB. All image pixels are then raised to the power of a certain scalar according to the following:

$$R = F^{\lambda} \tag{5}$$

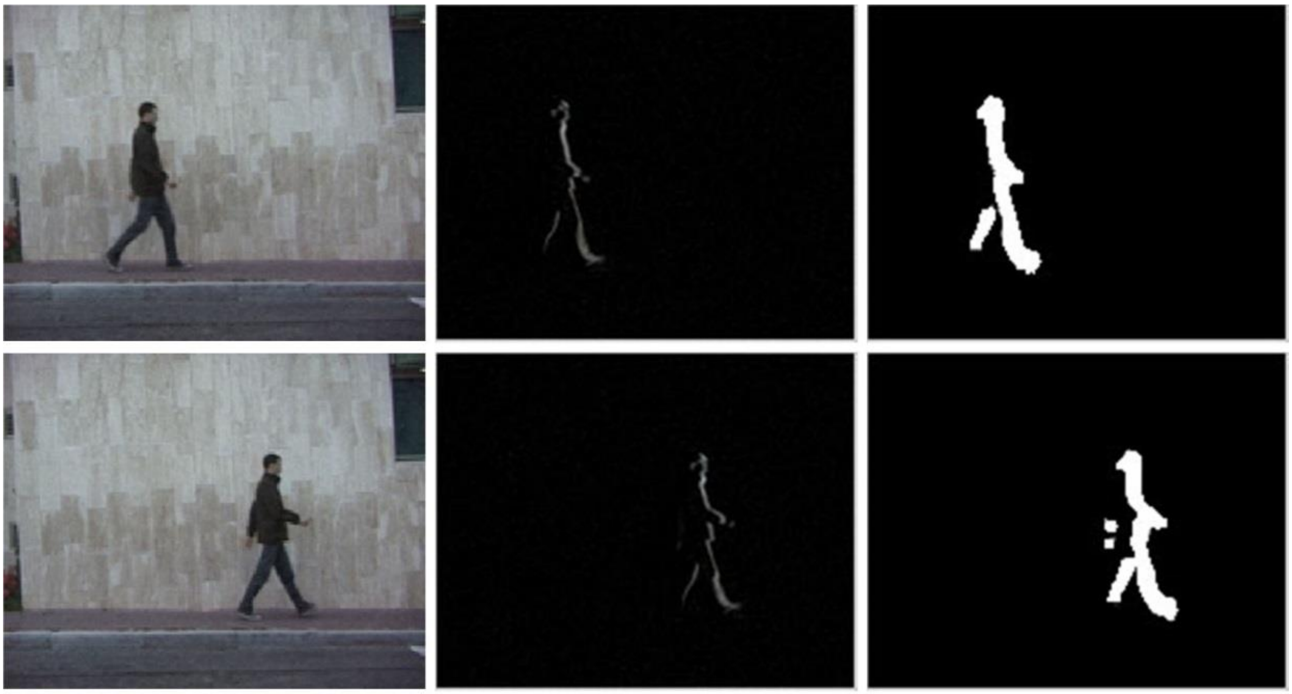
where (R) represents the output, (F) denotes the processed images by a two-dimensional order statistic filter, and (λ) is a predefined scalar that fulfills ($\lambda > 0$).

3. Results and Discussion

In this section, we confirm the effectiveness of the proposed technique by comparing empirical results with those from the CAD technique. These two techniques were assessed using a dataset obtained from the video analysis projects website of the vision group of the Weizmann Institute. The dataset contains many videos of people in motion recorded for the purpose of motion detection. Evaluating the extent of improvement in detecting moving objects in images by using a specialized metric is an important yet challenging task because it is considered an impartial assessment method. However, no standard metric exists that can provide accurate results. Therefore, human sight remains the best mean for measuring the extent of improvement in detecting moving objects in a sequence of images. The proposed technique was tested using different sequences of images and the results are presented in this section. Fig. 2–5 show some motion detection results from the proposed and CAD techniques based on moving people recorded in several video files.

(a) (b) (c)

Fig. 2. Processing a video file that contains a moving person: (a) original scenes, (b) identifying motion using the CAD technique, (c) identifying motion using the proposed technique (λ=2).



(a) (b) (c)

Fig. 3. Processing a video file that contains a moving person: (a) original scenes, (b) identifying motion using the CAD technique, (c) identifying motion using the proposed technique (λ=8).

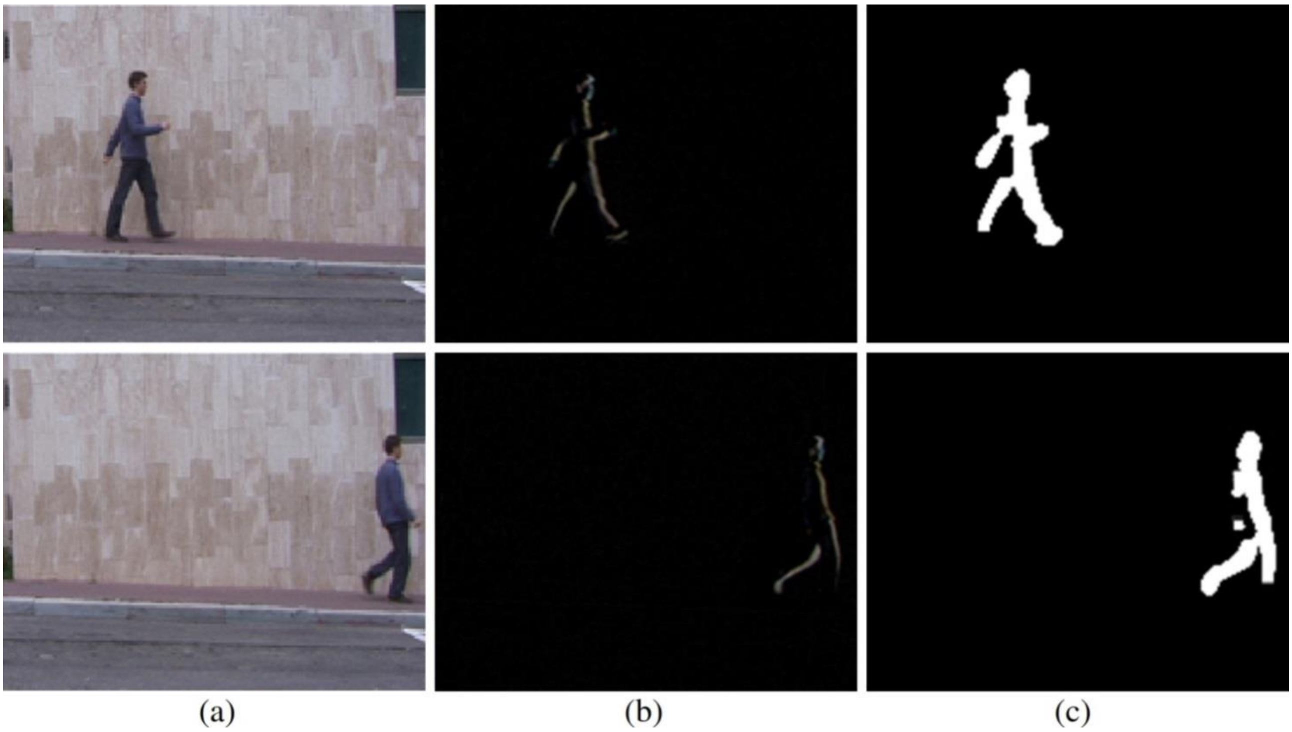


Fig. 4. Processing a video file that contains a moving person: (a) original scenes, (b) identifying motion using the CAD technique, (c) identifying the motion using the proposed technique (λ=7).

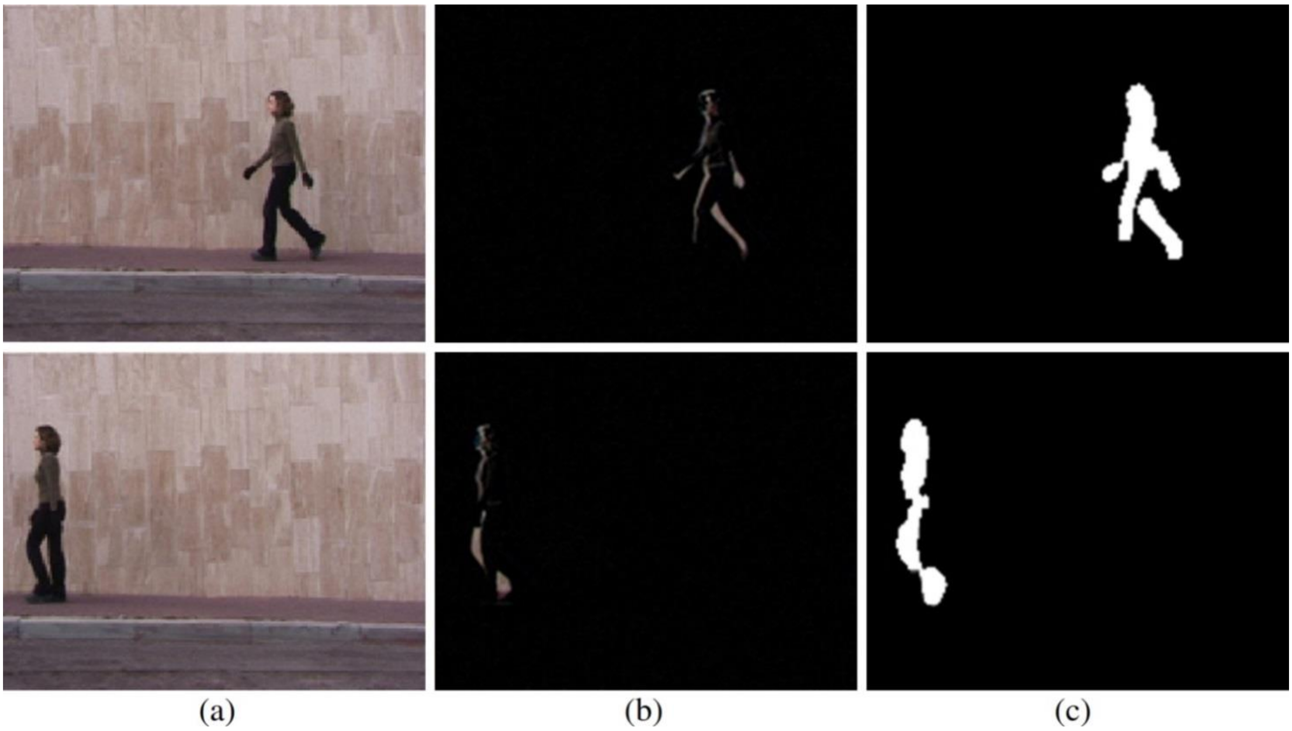


Fig. 5. Processing a video file that contains a moving person: (a) original scenes, (b) identifying motion using the CAD technique, (c) identifying motion using the proposed technique (λ=5).

The obtained results reveal that the proposed technique performs well in terms of identifying motion and regions of movement, as these aspects improved considerably compared to those when using the CAD technique. These acceptable results are convenient for use in many multidisciplinary applications. Developing a fast technique that effectively detects motion in moving objects in images is critical. Such a task is clearly achieved in which the displayed regions of movement are clearer and thus provide more details than those examined using CAD.

4. Conclusion

An adequate technique for motion detection was developed in this study. The study showed that the technique is effective at discovering motion in moving objects in a sequence of images. The technique is innovative in its use of an improved image difference detection method, an abridged grayscale conversion method, a two-dimensional order-statistic filtering process, and a straightforward post-processing method. These processes enabled us to detect motion in a fast and efficient manner. Our experimental results were obtained quickly and exhibited high detection in regions of movement. In general, the results showed the efficiency of the proposed technique, which performs extremely well at detecting object motion and enhancing regions of movement. We believe this technique can be used with other computer vision and image processing applications.

Acknowledgement

The authors state that they have no conflict of interests.

References

[1] K. Youssef and P. Woo, "Difference of the Absolute Differences–A New Method for Motion Detection," *International Journal of Intelligent Systems and Applications*, vol. 4, no. 9, pp. 1-14, 2012.

[2] C. Stauffer and W. Grimson, "Learning patterns of activity using real-time tracking," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 22, no. 8, pp. 747-757, 2000.

[3] I. Ahmad, W. Zheng, J. Luo, and M. Liou, "A fast adaptive motion estimation algorithm," *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 16, no. 3, pp. 420-438, 2006.

[4] J. Olivares, J. Hormigo, J. Villalba, I. Benavides, and E. Zapata, "SAD computation based on online arithmetic for motion estimation," *Microprocessors and Microsystems*, vol. 30, no. 5, pp. 250-258, 2006.

[5] X. Yu, X. Chen, and M. Jiang, "Motion detection in moving background using a novel algorithm based on image features guiding self-adaptive Sequential Similarity Detection Algorithm," *Optik-International Journal for Light and Electron Optics*, vol. 123, no. 22, pp. 2031-2037, 2012.

[6] M. Guttmann, L. Wolf, and D. Cohen-Or, "Content aware video manipulation," *Computer Vision and Image Understanding*, vol. 115, no. 12, pp. 1662-1678, 2011.

[7] S. Huang and F. Cheng, "Motion detection with pyramid structure of background model for intelligent surveillance systems," *Engineering Applications of Artificial Intelligence*, vol. 25, no. 7, pp. 1338-1348, 2012.

[8] O. Asmaa, K. Mokhtar, and O. Abdelaziz, "Road traffic density estimation using microscopic and macroscopic parameters," *Image and Vision Computing*, vol. 31, no. 11, pp. 887-894, 2013.

[9] D. Huang, C. Chen, W. Hu, and S. Su, "Reliable moving vehicle detection based on the filtering of swinging tree leaves and raindrops," *Journal of Visual Communication and Image Representation*, vol. 23, no. 4, pp. 648-664, 2012.

[10] A. Ghosh, A. Mondal, and S. Ghosh, "Moving object detection using Markov Random Field and Distributed Differential Evolution," *Applied Soft Computing*, vol. 15, pp. 121-136, 2014.

[11] C. Liu and H. Cheng, "Multi-Object Tracking and Occlusion Reasoning Based on Adaptive Weighing Particle Filter," *New Mathematics and Natural Computation*, vol. 10, no. 03, pp. 225-238, 2014.

[12] N. Singla, "Motion Detection Based on Frame Difference Method," *International Journal of Information & Computation Technology*, vol. 4, no. 15, pp. 1559-1565, 2014.

[13] T. Huang, G. Yang, and G. Tang, "A fast two-dimensional median filtering algorithm," *IEEE Transactions on Acoustics, Speech, and Signal Processing*, vol. 27, no. 1, pp. 13-18, 1979.

Biographies

Zohair Al-Ameen was born in 1985. He received his MSc and PhD degrees in Computer Science from the Technological University of Malaysia in 2011 and 2015, respectively. His research interests include image processing and computer forensics. Currently, he is a full-time lecturer at the Department of Information Technology, Lebanese French University.

Shamil Al-Ameen was born in 1987. He received his BSc and MSc degrees in Software Engineering from the University of Mosul in 2009 and 2011, respectively. His research interests include software engineering, image processing, and computer vision. Currently, he is a full-time lecturer at the Department of Computer Science, Cihan University.

Roua Al-Taie was born in 1987. She received her BSc and MSc degrees in Software Engineering from the University of Mosul in 2009 and 2012, respectively. Her research interests include software engineering, artificial intelligence, and image processing. Currently, she is a full-time lecturer at the Department of Information Technology, Lebanese French University.

Ghazali Sulong received his MSc and PhD degrees in Computing from the University of Wales, United Kingdom in 1982 and 1989, respectively. He is currently a full professor at the Faculty of Computing, Universiti Teknologi Malaysia. His research interests include image processing, computer vision, computer graphics, and artificial intelligence.