NIPES

Journal of Science and Technology Research

Journal homepage: www.nipesjournals.org.ng

Human Motion Detection with a Triggered Alarm in University of Benin Computer Engineering Laboratory Using Frame Difference

[1]Iruansi U. & *[1]Oputa C.J.

[1]Department of Computer Engineering, Faculty of Engineering, University of Benin, Benin City, Edo State, Nigeria.
*chumaoputa10@gmail.com

Article Info

Keywords: *Frame Difference, Human Motion Detection, Image processing and Computer vision*

Received 13 June 2022
Revised 09 May 2023
Accepted 11 July 2023
Available online 27 August 2023

https://doi.org/10.5281/zenodo.8287009

ISSN-2682-5821/

Abstract

Human motion detection with a triggered alarm system plays an important role in University of Benin Computer Engineering Laboratory by intelligently gathering information of unauthorized personnel from malicious activities. Traditional video surveillance takes a huge amount of storage space and hence limits the duration of video that can be stored. In addition, the traditional video surveillance is time-consuming for a human to review the stored video. All these disadvantages limit the effectiveness of traditional video surveillance. This paper presents an algorithm using Matrix Laboratory (MATLAB) software for detecting human motion from a static background scene based on frame difference and subsequent generation of an alarm condition as soon as the human motion is detected. The experiment shows that the method is robust to noise and can detect the human body under both simple and complex circumstance with good performance and efficiency. The overall efficiency of the work was found to be 63.64 percent.

1. Introduction

Security has always been one of the greatest challenges in today's society. It is very important to protect certain areas from malicious activities such as theft and vandalism. However, if these malicious activities are not identified at the right time or the criminals are unable to be prosecuted without eligible proofs of their criminal activities, it therefore means that the whole vicinity is at risk [1,2]. An example of such vicinity that needs a security is the University of Benin Computer Engineering Laboratory (UNIBEN-CPEL) with various equipment. One way to curb this insecurity in the UNIBEN-CPEL is the use of surveillance camera placed at different locations in the UNIBEN-CPEL. Surveillance cameras are video cameras used for the purpose of observing an area in order to keep the properties and human safe. Traditional video surveillance takes a huge amount of storage space and hence limits the duration of video that can be stored. In addition, the traditional video surveillance is time-consuming for a human to review the stored video. All these disadvantages limit the effectiveness of traditional video surveillance.

There are different approaches to video surveillance namely; manual, semi-autonomous or fully-autonomous [1]. For the manual video surveillance, the significant judgment is based on humans who have to watch monitors continuously for a long period of time which result in negligence or tiredness. Semi-autonomous video surveillance involves some form of video processing but with significant human intervention. In a fully-autonomous system, the system is expected to be able to help justify, based on some predetermined norms without human's intervention. To achieve the fully-autonomous system, there is a need to add image processing and computer vision algorithm to the surveillance system. Frame differences method is an algorithm used for the detection of human motion.

Current research on image processing focuses solely on developing an algorithm that can detect moving object [3]. There are many researches on motion detection based on inter-frame difference, optical flow and background subtraction as an additional method to accompany the frame difference in order to enhance the system [4], but background subtraction has a few limitations and weakness such as losing their effectiveness when used on an environment with unstable lighting and shadow projected by foreground objects [1,5,6]. In this paper, it is based on stable lighting without shadows since it is an indoor (laboratory) experiment. Also, Frame difference can be combined with correlation coefficient while classifying the background in groups of pixel blocks to give promising results [7].

2 Materials and Methods

2.1 Materials

The following tools and hardware were used in this work to achieve motion detection namely; MATLAB R2015a version, a Read Access Memory (RAM) of 4GB, a system processor specification as Intel ® Core ™ i5-4210M CPU @ 2.60GHz, and FJ webcam (640x480 resolution)

2.2 Methods

2.2.1 Video Capture & Frame Extraction:

As the system is initialized, snapshots are taken in real time through the static camera. These snapshots are then used as a means to extract the frames of the surveillance video.

2.2.2 Frame Difference:

The frame difference method is then used to capture motion detection. This method adopts pixel-based difference to find the moving object. The absolute differential image is defined as follows [8]:

$$I_d = |I_{k+1} - I_k| \quad (1)$$

where I_{k+1} and I_k are the current and previous frames in sequence respectively. The frame difference is then calculated and it is stored in its Red, Green and Blue (RGB) value.

2.2.3 Grayscale Transformation:

The frame differential value stored in RGB is then converted and stored in grayscale. This is given as [8]:

$$Y \leftarrow 0.299*R + 0.587*G + 0.114*B \quad (2)$$

2.2.4 Binary Transformation:

The gray image is now binarized using binary threshold and a binary image is then created. The binary equation is given as [9]:

$$S_{th}(x,y) = \begin{cases} 1, if\ O(x,y) \ > T \\ 0,\ otherwise \end{cases} \quad (3)$$

where, T is the threshold and (x, y) is a pixel coordinate in the image.

An indication of any white pattern in the binary image will reveal motion has been detected in real time.

2.2.5 Alarm Generation

Once motion has been detected by the system, an alarm is triggered and 100 snapshots will be taken by the camera in sequence of the detection and saved in a storage to create a short video to identify what is currently occurring in the surveillance area.

3 Results and Discussion

In the experimental setup, eleven cases were considered for motion detection. All sample videos were taken from a webcam at a resolution of 640x480. The experiments were carried out in the computer engineering laboratory as the surveillance area.

3.1 Successful Case Results

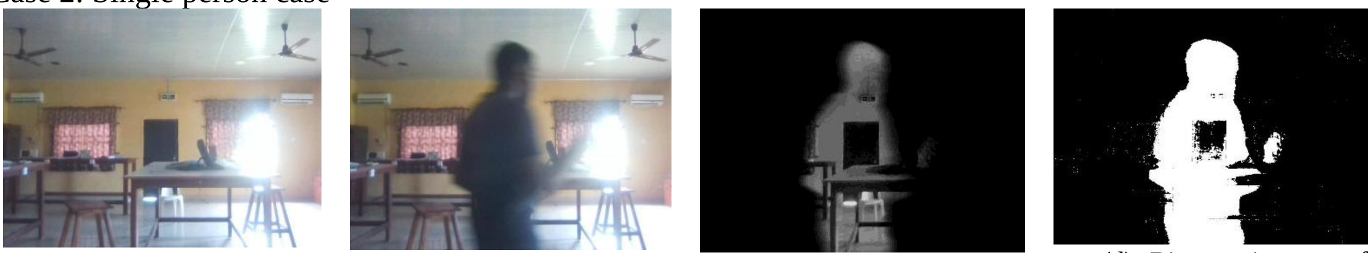
Case 1: Nobody in the laboratory

(a) Input first frame (b) Input second frame (c) Difference Between the two frames (a) and (b) (d) Binary image of difference image

Figure 1: Nobody in the computer laboratory (no motion)

Figure 1 show the extracted frames from the captured video, where Figure 1(a) is the input first frame, Figure 1(b) input second frame, Figure 1(c) is the converted grayscale image of the frame difference between the frames in Figures 1(a) and 1(b). Figure 1(d) is the binary image of Figure 1(c). In Figures 1(a) and 1(b), it is observed that there was no difference (no motion) in the extracted frames, hence, the result image in grayscale is seen to be a fully black image. A continuous black binary image will indicate no motion is being detected in the environment.

Case 2: Single person case



(a) Input first frame (b) Input second frame (c) Difference Between the two frames (a) and (b) (d) Binary image of difference image

Figure 2: Single person case (motion detected)

In case 2, a single person walked into the room and passed the camera as shown in frame (b) of Figure 2. The result of the frame difference for Figures 2(a) and 2(b) is seen in grayscale in Figure 2(c) as a white capture of the moving body in the foreground. This image in Figure 2(c) is then binarized using a threshold to create the image in Figure 2(d).

In case 3, the movement of the head was detected as shown in Figure 3.

Case 3: Change of pose (movement of the head)


(a) Input first frame


(b) Input second frame


(c) Difference Between the two frames


(d) Binary image of difference image

Figure 3: Change of pose (movement of the head detected)

Case 4: Two people's case


(a) Input first frame


(b) Input second frame


(c) Difference Between the two frames

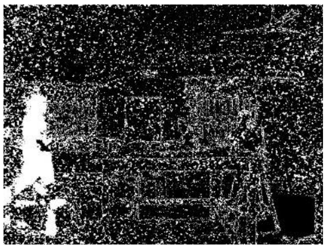

(d) Binary image of difference image

Figure 4: Two people's case

In Case 4, a single person was in frame (a) of Figure 4 while the detector was activated, this person wasn't detected by the system as his motion remained stationary. A second person then walked into the room in frame (b). As seen in (c) and (d), the movement of the second person is detected in the environment.

Case 5: Half body detection


(a) Input first frame


(b) Input second frame


(c) Difference Between the two frames

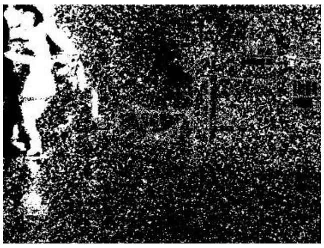

(d) Binary image of difference image

Figure 5: Half body detection

In case 5, motion was detected as the person was moving slowing into the room. (c) and (d) show the white patterns indicating the motion. Revealing the ability of the system to detect slow motion.

Case 6: Multiple people's case


(a) Input first frame


(b) Input second frame


(c) Difference Between the two frames

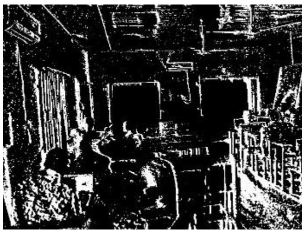

(d) Binary image of difference image

Figure 6: Multiple people's case

In case 6, the system was used in a crowded area, and with its sensitivity (d) shows white patterns around the crowd. This then showed that within a crowded place, the system can detect any random motion.

Case 7: Running across camera

(a) Input first frame (b) Input second frame (c) Difference Between the two frames (d) Binary image of difference image

Figure 7: Running across camera

In case 7, a person which ran across the room was captured in (b), and his motion was detected by the system.

3.2 Failed Cases Results

Table 1: Analysis of Failed Cases

Case No.	Case	Successful/Failed
Case 8	Object thrown at a high speed across the camera	Failed
Case 9	Moving camera	Failed
Case 10	Shadow eliminations	Failed
Case 11	Changes in light	Failed

In the failed cases, objects which were thrown at high speeds across the camera could not be detected. Moving the camera also cause the motion detector to be triggered falsely. Shadows created from the changes in the room lighting also caused false motion detection. In all the eleven cases applied to the system, it failed in case 8 to case 11 (see Table 1).
Based on the cases used in this work, the overall efficiency is computed in percentage as: successful cases divide by the total number of cases ((7/11) x100 = 63.64%). Overall efficiency of the work is about 63.64%, i.e., most of the cases gave the successful result by the proposed detection algorithm. The algorithm is robust to noise and can detect the human bodies under complex circumstance.

4.0. Conclusion

The experiment shows that frame difference method can be used to effectively guard restricted areas such as laboratories, bank vaults, and places where persons are not permitted to be at a particular time. Also, this system will greatly reduce the video storage capacity which modern surveillance systems use with real time video recording.

References

[1] Sharma, A. Pathak, M. Tripathi, A. Vijay, P. Jain, S. A. (2019). Automated human detection and tracking for surveillance applications. *International Journal of Advance Research, Ideas and Innovations in Technology,* 5(3), pp. 1311-1314.

[2] Husein, A. Calvin, Halim, D. Leo, R. William, (2019). Motion detect application with frame difference method on a surveillance camera. *Journal of Physics: Conference Series.* 1230(1), pp. 1-10.

[3] Singla, N. (2014). Motion Detection Based on Frame Difference Method. *International Journal of Information & Computation Technology.* 4(15), pp. 1559-1565.

[4] Guo, J. Wang, J. Bang, R. Zhang, Y. Li, Y. (2017) "A New Moving Object Detection Method Based on Frame-difference and Background Subtraction" *IOP Conference Series: Materials Science and Engineering,* 242(1), pp. 1-4.

[5] Kavitha, K. Tejaswini, A. (2012) Background Detection and Subtraction for Image Sequences in Video, *International Journal of Computer Science and Information Technologies,* 3(5), pp. 5223-5226.

[6] Zhang, Y. Wang, X. Qu, B. (2012) Three-Frame Difference Algorithm Research Based on Mathematical Morphology *Procedia Engineering,* 29, pp. 2705-2709.

[7] Wu, Y. G. Qiang, C. Z. Jian, G. Dan, X. Jian, L. R. Yuan, H. J. (2014) A Moving Object Detection Algorithm Based on a Combination of Optical Flow and Three-Frame Difference. *Information Technology Journal*, 13(11), pp. 1863-1867.

[8] Gopinathan, S. Gayathri, S. (2016) "A Study on Image Enhancement Techniques using YCbCr Color Space Methods" *International Journal of Advanced Engineering Research and Science (IJAERS).* 3(8), pp. 105-112.

[9] Iruansi, U. Omoruyi, O. E. (2021). Comparison of Filtering Techniques for Cell Image Segmentation. *NIPES Journal of Science and Technology Research 3(3),* pp. 206-210