

## **The Motion Detection on Video Surveillance by Using Background Subtraction**

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**Abstract:** Video surveillance has been widely used for monitoring incidents at facilities and public places. Surveillance systems that are used in general are still using people as video surveillance. The surveillance system has been developed with a semi-automatic and automatic system. Video surveillance in this study aims to detect motion in the room by estimating static cameras and static backgrounds. Object detection starts by reading the video file and the number of video frames. The background subtraction method is used to find differences between frames by reducing the current frame to the background frame. The difference in pixels that appear in the current frame shows the pixel location of a motion. Through threshold operations in the range 0.2 to 0.3, binary images of motion can be produced better. Noise problems that arise are resolved using morphological operations in the form of holes or points. The results of research on videos with a size of 1,280 x 720 pixels and FPS 25 can detect motions marked with bounding boxes.

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**Keywords:** Background Subtractions, Motion Detection, Video, Surveillance

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### I. Introduction

The surveillance system using surveillance cameras has been widely used by both government and private agencies (Rakibe 2014). The camera installed records events in the form of facilities and activities of people in a surveillance area (ATM room, service room, public places, and other special rooms). Video surveillance results have become an active and broad area of research in the fields of computer vision, artificial intelligence, and digital image processing (Sharma, Lohan and Yadav 2017). Research conducted by Mandal (2016) using video surveillance successfully detected unusual activity on ATM machines. Furthermore Le (2014) also conducted research with surveillance video and was proven to be able to know that a patient had fallen out of bed. Then, a fight in the parking lot was also successfully detected with the help of a surveillance camera by Cosar (2017). In addition, a research conducted by Zhang (2015) successfully detected mass movement behavior in open space.

Furthermore, Chaudhari, Khan and Bhatnagar (2017) explained that the type of surveillance system is distinguished by manual, semi-automatic and automatic. Furthermore, Khadse, et al (2016) explained that the monitoring system process by manual (traditional) method uses humans to monitor events through a monitor. During the monitoring process, the person in charge must pay attention to the show and make a decision on what happened on the video. This manual monitoring process has a weakness on the side of the reaction to the event and allows for a time-consuming solution. The involvement of supervision by humans has begun to be used less in semi-automatic surveillance systems, whereas in automatic systems it has become an intelligent system that is free from human involvement in supervision.

Video surveillance system can work automatically because it is supported by the ability of the system to do video analysis. In general, video analysis is divided into 3 levels, namely object detection, object recognition, object behavior recognition (Sun, et al. 2016). Automatic video analysis can be done through the training stages and without going through the training stages using motion-based methods (Vijayakumar and Narmatha 2017). This method uses object motion information in the video to separate objects from the background. Detection of objects is done by classifying pixels based on patterns of motion

In video surveillance system applications, object detection is a basic stage for recognizing activities in an environment. The next steps are object tracking, object classification and finally recognize the activities carried out by the object. There are four techniques used to detect moving objects. The first is frame difference or time difference which functions to get moving objects (motion) using frame comparison techniques every time (Gupta,

Singh and Gupta 2014). Then optical flow to detect moving objects in moving camera conditions (Zhang, Zheng, Zhang & Li 2018), background subtraction is used to detect moving objects (motion) under surveillance conditions with a background and static camera (Sahu and Choubey 2013) and statistical methods can be selected better in a more unrestricted situation (Sharma and Gupta 2018).

There are 2 main types Scenarios in object detection applications, namely permanent and dynamic backgrounds. Video surveillance is currently widely used with a fixed mounted camera. This condition is a type of application with a fixed background. While dynamic backgrounds are generated from a moving camera for example mounted on a vehicle dashboard. Research conducted at this time uses fixed background conditions in the service room. The application of background subtraction aims to detect moving objects that occur in the video surveillance area

## II. An Implementation of Background Subtraction into Video Surveillance

Background subtraction is a popular technique to separate the target objects in video frames (Sun 2016). A simple approach to detect motion in a video sequence (Nascimento 2005). This technique has advantages in simple structure and little calculation (Vijayakumar and Narmatha 2017). The background subtraction method uses the difference between the active frame that is read and the background frame to get a moving or foreground object (Rakibe and Patil 2014). Background frame or also referred as a reference frame / background image / background model is a description of the state of the place with the atmosphere that is maintained without object movement. the Conditions on the background frame will affect the effectiveness of the object detection results. Motion can be generated after threshold operations.

Background subtraction is implemented by comparing each video frame with a background frame. The results of differences that appear will be detected as objects. Differences between frames are generated by reducing the current frame read with background frames (Rakibe and Patil 2014). The current frame is stated with  $I(x, y)$  and the background frame as  $B(x, y)$  as shown below. The difference in pixels that appear in the current frame shows the pixel location of a moving object. The group of pixels that represent the object is then separated from the background frame using a threshold provided that if the pixel difference is greater than the threshold then specify the pixel to appear as a moving object, otherwise the pixel is determined as background.

$$D(x, y) = |I(x, y) - B(x, y)|$$

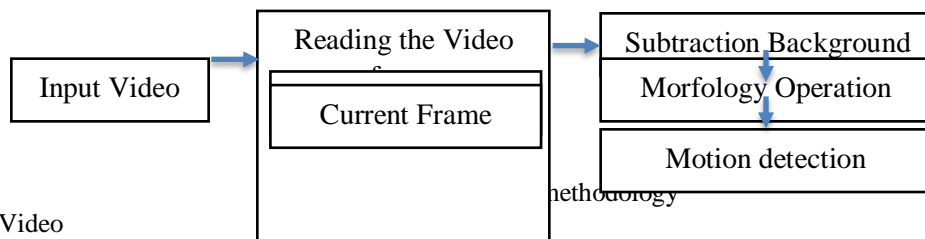
The binary imagery resulting from subtraction background normally still has noise problems. The solution is done by morphological operations to eliminate the shape of lines, points, or shadows that appear with objects in the image. Morphological operations are operations on binary images to change the shape structure of objects contained in the image (Madenda, 2015). The closing operator is a series of image dilation operations and followed by erosion operations, while the opening operator is a series of image erosion operations and followed by dilation operations. Mathematically stated in the following equation:

$$\text{Closing} : f \bullet B = (f \oplus B) \ominus B$$

$$\text{Opening} : f \circ B = (f \ominus B) \oplus B$$

## III. An Implementation of Background Subtraction into Video Surveillance on Motion Detection

The method of motion detection is conducted by following these steps below: read the video frame, subtraction background process and morfology operation as shown in the picture 1.



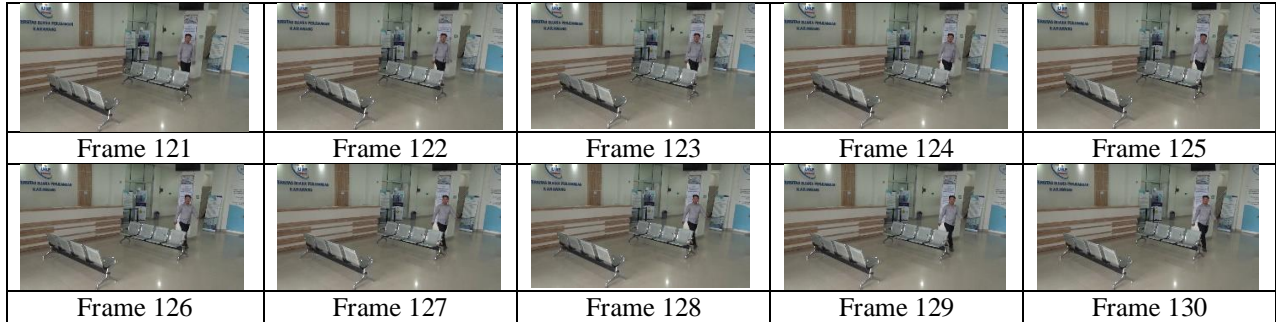
### A. Input Video

Video input comes from the surveillance video of the service room with fixed camera scenarios, a fixed background and a moving object. The condition of the service room as a background model there are chairs and service desks and areas for walking. The camera is statically installed in the room with the Sony HDR-PJ410 brand specifications, image size of 1,280 x 720 pixels and a frame rate of 25 frames per second

### B. Reading the Video Frame

The video in the service room used in this study has 489 frames that record events of people's activities. There are recorded people's walking activities towards sitting in a chair. Background frame uses the first frame with

service room conditions without moving objects. The current frame is read in the video sequence from the second frame to the last frame.



**Figure 2.** Image on video frame at service room

C. Background Subtraction

The object detection application using background subtraction is applied using Matlab. The background subtraction process starts after reading the current frame  $I(x, y)$  and the background frame is  $B(x, y)$ . Images on frames in absolute reduction operations use RGB images to get more detailed pixel differences. The result of the reduction between the two frames, namely  $D(x, y)$ , then a threshold operation is performed to separate the moving objects as foreground and background. The result of a threshold operation converts an RGB image into a binary image. The binary image of the subtraction background will show the moving object in its appearance location. Here is the background subtraction algorithm:

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Algorithm 1 : Subtraction Background

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Input : Frame RGB

Algorithm :

1. Reading background frame  $B(x, y)$
2. Reading current frame  $I(x, y)$
3.  $D(x, y) = I(x, y) - B(x, y)$
4. If pixel value on  $D(x, y) \geq \text{Threshold}$ , then pixel intensity on  $D(x, y) = 1$  else, pixel intensities on  $D(x, y) = 0$
5. Visualitation on  $D(x, y)$

Output : Binary Foreground Frame

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In the process of converting to binary images, the threshold value is needed as a color conversion limiting value to round up or down for each intensity value of the pixels that are above or below the threshold value. A pixel intensity value is bigger than or equal to the threshold value will be converted to a binary color intensity value of 1 (white). While the pixel intensity value that is less than the threshold value will be converted to a binary color intensity value of 0 (black).

D. Morphology operation

Morphological operation is conducted after the background subtraction process. if the object detection results are still found leaving noise display. Lighting conditions and the movement of objects in the room in the image in the video displays the noise in the form of points of light in the foreground binary image. Objects that have noise are displayed with a bounding box that extends around the object and noise.

Foreground binary frames are read by displaying objects that have noise. Noise problems in the form of dots / holes are solved by using closing operators. The closing operator is then run to close the holes that appear so that the object can be detected completely.

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Algorithm 2 : Morphology Operation

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Input : Binary Foreground Frame

Algorithm :

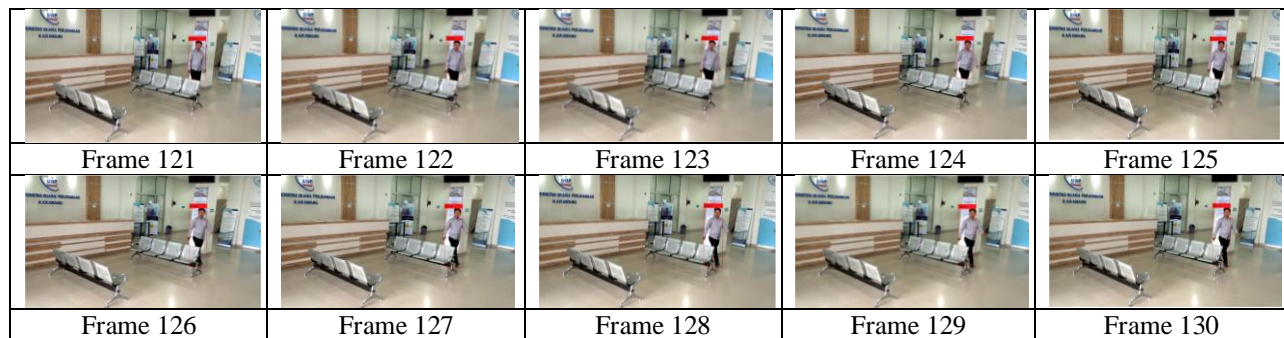
1. reading the binary foreground frame
2. closing Operation
3. Visualization binary foreground frame as the result of morphology

Output : Binary Foreground Frame morphology result

#### IV. HASIL DAN PEMBAHASAN (RESULT AND DISCUSSION)

##### A. Implement results for each process

Video frames at service room conditions without object movements are set as background frames. Video surveillance records events in the service room including moving objects in the form of people's activities. Moving objects can be detected by reducing the frame containing objects with a background frame using background subtraction. In Picture 3, it appears that a moving object is detected that is marked / detected by bounding box as a feature and follows the direction of the object's movement



**Figure 3.** motion detection object detected by bounding box

##### B. Testing the Implementation of Background Subtraction on an RGB image

The object detection testing is carried out at the frame reduction stage by setting the background subtraction threshold value. In MATLAB the threshold value is set in double data class. Thus, to set the threshold value by using a comparison with a maximum intensity value of 255. The test results in the conversion of RGB images to binary images, moving objects can be detected using gray intensity value levels with threshold values between 0.2 to with 0.3.

The motion in the video starts to appear in frame 12. The level of the object threshold value detected starting at frame 12 is 0.2863. At frame 116 the threshold value starts to stay at 0.3. The values on frame 116 and frame 489 are worth 0.3020 and 0.2341. In picture 4 objects are detected in the image with the bounding box feature in the RGB image



**Figure 4.** motion detected in binary image and RGB

##### C. Testing the implementation process of morphology

Object detection produces object shapes that display objects incomplete in binary imagery. The incomplete form referred to is the appearance of holes (holes) and part of the object as shown in Picture 5. Bounding boxes appear to cover only those objects that are detected. The application of closing morphology operation can close the hole and complete the object part more completely

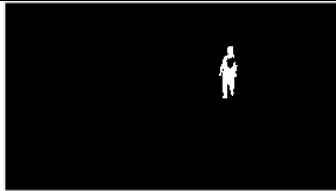
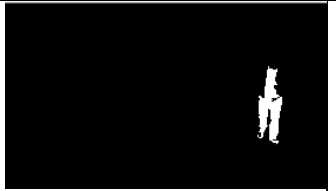



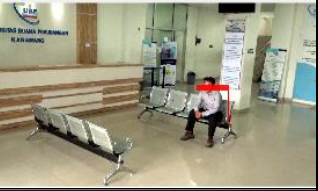
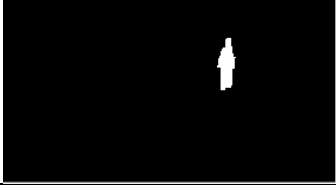

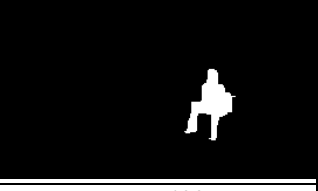
Binary Image before morphology operation			
Image RGB Before Morphology operation			
Binary Image after morphology operation			
	Frame 50	Frame 150	Frame 400

Figure 5. Motion detected with and without noise

#### V. Summary

The motion in the video can be detected by using background subtraction based on the results of reducing the current frame with the background frame. A man walking and running is characterized as a motion by using a bounding box. The bounding box dimensions appear according to the detected object. Threshold test results can detect objects in the range of 0.2 to 0.3. The recommendation for further research is to detect and classify the motion in the type of normal and abnormal activity in an area.

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