# A Comparison between Moving Object Detection Methods Including a Novel Algorithm Used for Industrial Line Application

Muhamad Azhar Abdilatef
Dept. of Mechatronics Engineering
College of Engineering, University of Mosul,
Mosul, Iraq

## ABSTRACT

In this paper a comparison between many types of moving object detection methods is presented, one of these used methods is proposed depending on a combination between many detection methods with many enhancements. A novel method is proposed depended on a combination between one of the previous method with some enhancement and the edges technique. All of these methods are applied to detect three types of objects their movement. The objects are moved through a conveyer belt, thus these movements have a known speed and direction. The objects have to be griped and moved to a known location using a robot arm. The most important issue here is how to detect the objects according to their details in order to grip and move them to other location in a real time; the processing time, the robot movement time inside the images capturing time must be adjacent to zero, Thus it is important to apply many well methods over the same environment for the same types of objects to compare between the methods and select the best one to be used according to the time and the detection accuracy. The objects are detected by a stationary camera mounted with the conveyer belt, it is used to see any changes happened inside the used conveyer, thus a real time video using this camera is recorded immediately and the video's frames those included some changes (objects detected) have to be sent to a processing unit (Matlab code in pc); when the process operation is completed, the objects will be selected according to their features to be moved to other location, a robot arm (type Rios) is used here for gripping the selected objects (during their movement) to a known location. The comparison between the used detection methods is done according to the processing time and the detection accuracy. Firstly the used moving object detection methods are classified into two groups according to their processing time, the best group that has the lowest processing time will be selected to be used in real time applications, and then the best detection accuracy method in this selected group has to be used for the application. The (PCC) Percentage Correct Classification is used as a selection factor to choose the best method in the selected group. The obtained results shown that the new proposed method (Morphological Operation with the Prewitt Edge Detection with the region of interest), is selected according to its low processing time and high detection accuracy to be used for the industrial application.

## Keywords

Moving Objects Detection, processing Time, percentage correct classification (PCC), Detection Accuracy, Conveyer Belt, Robot Arm, and Camera

## 1. INTRODUCTION

Today the detection which is considered as one of the most important methods in the image processing fields has become one of the frequently used methods in most of fields. It is used in the fields of military, medicine, Robotics, Industrial Application, and ext. In the industrial field many type of detection can be used, many of these types are not depended on image processing but on using sensors and laser techniques (Figure 1), other types are depend on the detection under image processing field, the camera is used here as a sensor for detection. The image processing detection methods can be classified according to the detected objects into two types: moving and non- moving objects.

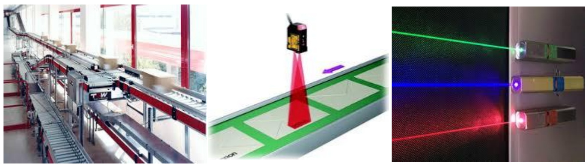


**Fig. 1: industrial line used laser in detection**

The detection of non-moving objects is used mostly in the biological and chemical researches and some medical fields, while the moving object detection is used more than the first type. In this paper it is assumed that many types of objects (three objects (Figure 2)) are moved through a conveyer belt with a constant velocity. These objects will be captured by a stationary camera mounted on the top of the conveyer belt, then these captured images is processed under an image processing program to detect the objects by using six types of detection techniques, after that results of the detected objects (detected region in pixel, color, centroid) have to be sent to the robot arm, according to the given result the decision will be to make the robot moves to reach the object, grip it and move it to a known location.

**(a) Object 1 (b) Object 2 (c) Object 2**

**Fig. 2: The three used object**

As shown in (Figure 1), two colored cans toys with a sub texture, and yellow poly are used here. Six method for the purpose of detection are used in this paper, the first four of them are used depend of many previews works. The edges technique is usually give much information about the objects that it used for, this method success in many applications those need for detection, it is used in the medical fields, computer vision, robotics fields [1], according to that, this method is used in this paper through many famous types. Depending on the mentioned methods a novel method is proposed by using a combination between the fourth method and many types of the edges detection techniques. All of these methods are applied over the mentioned objects, then classified according to their processing time into groups (A, and B), the best one with the least processing time is selected to do another comparison between their methods according to the detection accuracy using the percentage correct classification. The application line that used is as shown in Figure (3). The application set that used in our work consists of the conveyer belt, Servo motor, stationary camera, stationary robot type Rios, power supply used to drive the conveyer belt and the robot arm, personal computer, and the used five random object to be detected.

**Fig. 3: The Application Set**

## 2. BACKGROUND THEORIES

During many years ago, the researchers was working in the fields of detection which is an important branch of the image processing field, many techniques are discovered, many others are improved, especially the moving objects detection techniques. In [1], Albiol A. and et.al try to reduce and solve many problems happens in the urban traffic which are considered as real problems in the large cities. They used special methods to detect the stopped vehicles which are represented as stationary objects; they detect both the background and the foreground and considered the stopped cars for a long time as a part of the background. A stationary camera is used for one road from a high building to detect any moving objects (cars). The low level points (Harries corners or Shi Tomassi) are used in this work to detect the objects without any especial selection for the objects, the morphological operation is used to eliminate the unwanted points of harries' corners, like the white lines inside the roads. The mask operation is used here to select the region of interest in order to select the object inside this selected region. In this paper, this method is applied for the three objects, the mask operation is used to select the background of the conveyer belt in where the objects are to be moved, the conveyer belt be instead of the street and the objects used instead of the cars and the vehicles. The moving object detection has four mainly methods used usually, these methods are s the following: (1) background subtraction, (2) temporal differencing, (3) statistical method, and finally (4) optical flow. In many researches, one of these methods are used individually using a special algorithm, in other works, two more of these methods are used together, while some other works used them with other types of methods. Heikkila and Silven used the simplest version for the background subtraction representation [3] in where a pixel at location $(x, y)$ in the current image $I_t$ (first used frame of video) if the following equation is satisfied:

$$|I_t(x, y) - B_t\,(x, y)| > T \qquad (1)$$

Where T is the known as threshold, while $B_t$ which represent the background is updated by using the Infinite Impulse Response according to the following equation:

$$B_{t+1} = \alpha I_t + (1 - \alpha)\, B_t \qquad (2)$$

This representation is applied for all the background representation in the used method in this paper. In [4], Guanglun L, and et.al, are presented a new method using a combination between the temporal differencing and background theory. By using this combination, the presented method been more adaptive to the light and other sudden changes or movements, this method is applied here for the same objects and under the same environment of work. Because of the high sensitivity to the sudden illumination during the use of the background subtraction, other type of detection techniques are used with it to reduce these problems and make the algorithm more adaptive to them [5][6] is mostly used with other techniques .

In [7], C. Cuevas, et.al are presented a novel method with a fast strategy for the moving object detection by the non-parametric foreground and background modeling, the background modeled using only the color, while both the color and the space are considered in the foreground segmentation, a high quality results are obtained using this considering two cases. This method is used here with two cases, firstly any color expect the white color which represent the background color must detected with the space of the foreground, while in the second case only one color be detected inside the foreground space (area in pixels). Inside the mainly detection methods those used mostly, many feature detection can be used individually or combined with the detection methods, like the edges detection techniques[8] and the blobs (region of interest). The edges detection techniques have many famous used methods, the Canny, Sobel and Prewitt techniques are used for detection to extract the feature more easily. Three types of edges detection techniques are used in this paper for the same used object and under the same environment. Sometime all of the detection methods are not enough to be used in detection to extract the real values, thus other image processing techniques are used with it or inside the morphological operation which is used with a suitable threshold value to build the structure of the un-cleared object and then eliminate the unwanted region and decrease the noisy parts. In many researches this operation is used individually or with the blobs (MBR) for the moving objects detection [9].

## 3. METHODS

As mentioned in the introduction and the background theories, the following methods are used in this paper:

- Detection using Harris corner inside masking operation (method1).
- Combination between the temporal differencing and the backgrounds subtraction inside using blobs (the region of interest) (method2).
- Combination between the Foreground modeling and the background subtraction (method.3).
- Morphological operation with blobs (region of interest) (method4).
- Edges detection techniques (Canny, Sobel, and Prewitt) (method5).

- Combination of morphological operation and Prewitt edges detection using region of interest (MOTED-ROI) (Method6).

Some improvement are done for their result, finally proposed method 6 is selected as the best method according to its low processing time and its high detection accuracy.

## 4. RESULTS

A special Industrial line application is used for this work, this application consist of a conveyer belt that has two ploys, one of these polys driven using motor type servo (Figure 4); a wired camera mounted on the top of the conveyer belt, power supply a Rios robot arm type Lynx-6 motion RIOS SSC-32 V1.04, and laptop. The Rios robot is connected to the laptop by using the RS232 port. The Matlab is used to apply the detection methods for the used objects.

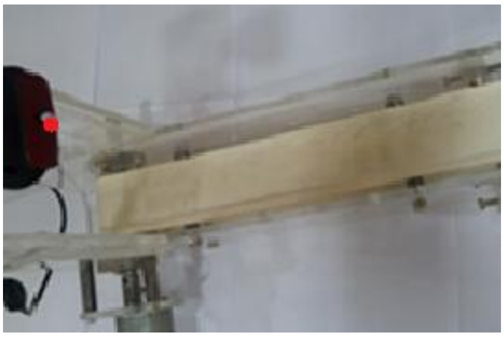


**Fig. 4: The Implemented Conveyer Belt**

Three random objects: red plastic can, green plastic can, yellow plastic poly, are used to be moved through the conveyer belt under the same environment. These objects are detected by the used camera. The captured images (video frames) are sent to the laptop to enter the detection process; finally the results sent to the robot arm (Figure 5) to make it reach the object and move it to other location. The flowchart which is in (Figure 6), illustrate the steps of the application and work.

**Fig. 5: The Rios Robot Arm**

When the first method is applied for the three random objects, the mask operation is used to select smaller region than the original image, the masked region must include the object that needed to be detected. After that the Harris corner detection is applied for the masked region to find the region of interest, inside these operations the detected objects are bounded by a rectangular given the centroid, dimensions, area in pixels, and the orientation.

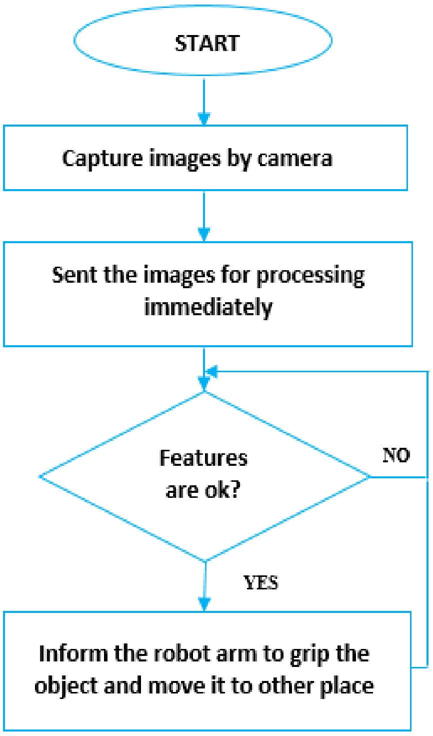



**Fig. 6: Flowchart**

The method's algorithm is applied for all the three objects, the captured images include shadow and luminance distortions, the results in steps of using method 1 is as shown in (figures 7-9) (Masked images, the gray binary images for the Harris detected corners, the bounded detected regions).

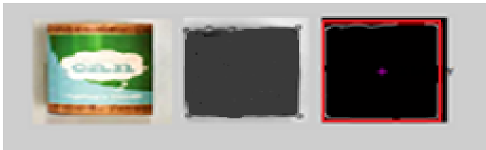


**Fig. 7: Method 1first object detection results**

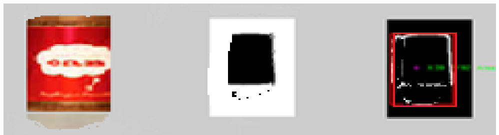


**Fig. 8: Method 1 second object detection results**

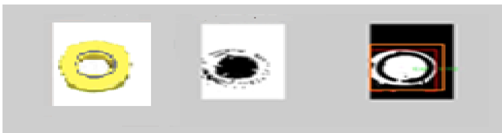


**Fig. 9: Method 1 third object detection results**

The shadow and the illumination is detected as a part of the objects, that is because of the used threshold which is equal al to 0.15 as it is used on the original used method. To solve this problem, the threshold value is changed to 0.33, according to the results shown in Figures (10-12), good enhancements are appeared during to the changes in the threshold value, the effects of shadows and the luminance is disappeared.

**Fig. 10: First object result - new threshold value**

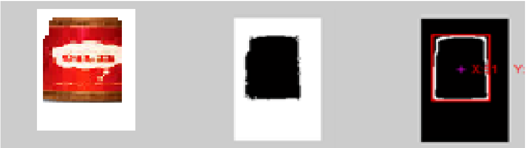


**Fig. 11: Second object result - new threshold value**

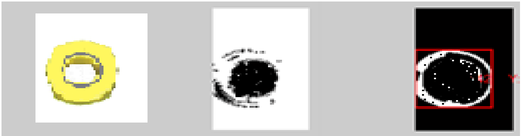


**Fig. 12: Third object result - new threshold value**

The obtained results are including the processing time, the area of the detected object in pixels, the centroid using the second threshold value as shown in the following table (1), In the final column (table1), the ratio between the detected pixels per second is used by the following formula :`

Ratio = Number of detected pixels/ processed time (3)

**Table 1. Method 1 obtained results**

| Detected Object | processing Time(Sec.) | Detected Region (pixels) | Ratio Pixels/Sec. |
|---|---|---|---|
| **Object 1** | 4.258881 | 2324 | 545 |
| **Object 2** | 4.669005 | 981 | 210 |
| **Object 3** | 4.631721 | 3958 | 854 |

The results that have been reached are somewhat unrealistic, the pixels those detected in Figure 3 is more than the pixels in objects one and two, while the processing time that is needed for object 2 is the highest one. Thus this method appeared to be not accepted to be used as shown in Figure (13).

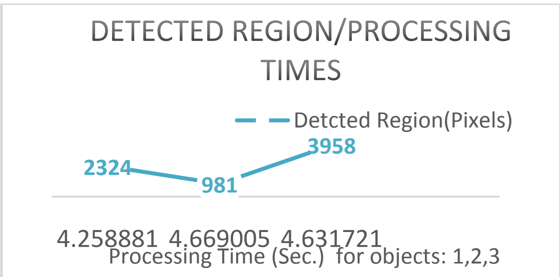



**Fig. 13: Method 1 results' relationship**

According to table 1, and figure 13, it is declared that the method needs a high proceeding time to complete the detection operation, inside that it has not stable during the detection operation, and there is a wide difference in ratios when different objects are used.

In the second applied method, a combination between the temporal differencing and the background subtraction is presented. The detected objects results in images can be seen in the Figures (14-16) bellow.

**Fig. 14: Method 2 for the first object**

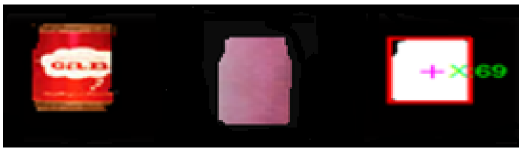


**Fig. 15: Method 2 for the second object**

**Fig. 16: Method 2 for the third object**

As shown, the third object is not detected using this method, this is because of its color which is not able to be detected using this method. The results of the detection operation for the used objects when the mentioned method is applied are as shown in table (2), the ratio between the detected pixels and the processed time is calculated and recorded in with the other obtained results in table(2).

**Table 2. Method 2 obtained results**

| Detected Object | Processing Time(Sec.) | Detected Region (pixels) | Ratio Pixels/Sec. |
|---|---|---|---|
| **Object 1** | 0.138505 | 6701 | 48380 |
| **Object 2** | 0.245856 | 5638 | 22932 |
| **Object 3** | 0.275304 | 230 | 835 |

Very small noisy regions of the third object are appeared in figure (16), these tiny parts are not detected according to the resulted values of using this method is as shown in table (2). The ratio is also has a wide differences for the detected objects (table 2, figure 16), although that the first object is bigger than the second object, but the detected area of object 1 is least than the second object (figure 17), it is clear that the processing time of used this method is less than the first method, but this it cannot be used for all objects.

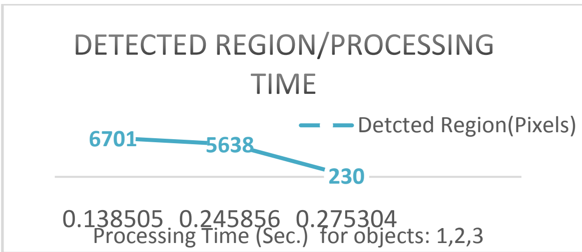



**Fig. 17: Method 2 results' relationship**

In method 3, the foreground and the background modeling combination method is used. The background is very important for any moving object detection and considered as a key of any video surveillance or automatic video analyses [10], the background is modeled using many captured images then the average operation has to be applied to obtained the background modeling, Figure (18), the foreground are also modeled and combined with the background, Figures (19-21)), this mechanism is applied for all the three used object and the following results as shown in table(3) are obtained.

**(a)First model (b) second model (c) inverse average model**

**Fig. 18: The Background modeling**

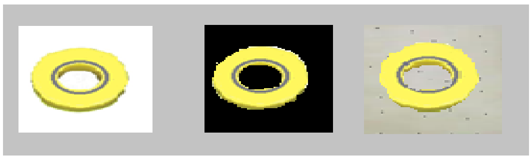
In figure (18 - a), the first selected background is modeled during the beginning of capturing video, figure (18-b) the second selected background is modeled through the capturing video, figure (18-c) the inversed average background is modeled depended on first and second modeled background.

**(a)Original image (b) Foreground modeling (c) combination**

**Fig. 19: object 1 results**

**(a)Original image (b) Foreground modeling (c) Combination**

**Fig. 20: object 2 results**



**(a)Original image (b) Foreground modeling (c) Combination**

**Fig. 21: object 3 results**

**Table 3. Method 3 obtained results**

| Detected Object | Processing Time(Sec.) | Detected Region (pixels) | Ratio Pixels/Sec. |
|---|---|---|---|
| **Object 1** | 0.887163 | 9592 | 10811 |
| **Object 2** | 0.863135 | 5807 | 6727 |
| **Object 3** | 1.344973 | 1807 | 1343 |

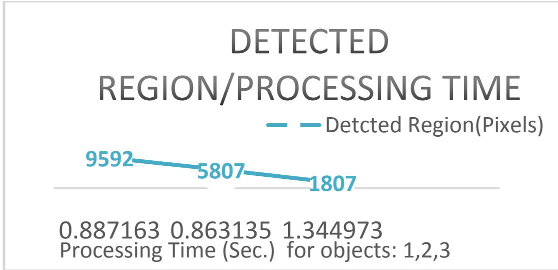



**Fig. 22: Method 3 results' relationship**

According to the results shown in table (3) and figure (22), the method is best than method 1 and 2, the ratio's range for the detected objects is smaller than the first and the second object, the detected regions of the used objects using this methods are more accepted than the regions those detected using method 1 and 2. Method 4 (morphological operation) is also used in this paper to detect the objects. In this type of detection, the object's area is detected without any details of its colors or other things. This method is applied for all the used objects. The results of using this method are as shown in the following table (4), Figure (23):

**Table 4. Method 4 Detected Regions Results**

| Detected Object | Processing Time(Sec.) | Detected Region (pixels) | Ratio Pixels/Sec. |
|---|---|---|---|
| Object 1 | 0.2455 | 9740 | 39674 |
| Object 2 | 0.2331 | 6433 | 27597 |
| Object 3 | 0.2513 | 1506 | 5992 |

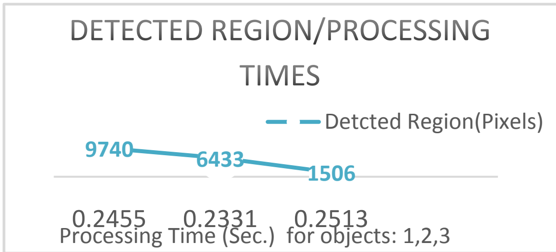



**Fig. 23: Method 4 results' relationship**

As a method 5, many of edge detection techniques are applied separately, to select the best suitable one to be used in this work. As mentioned before, the Canny, Sobel, Prewitt, are used, the following table (5) includes the results of the detected regions and the consuming times for all the used objects:

**Table 5. Method 5 detected regions results**

| Method | Detected Region (pixels) | | |
|---|---|---|---|
| | Object 1 | Object 2 | Object 3 |
| **Canny** | 9906 | 6093 | 1400 |
| **Sobel** | 9945 | 6080 | 1358 |
| **Prewitt** | 9708 | 6047 | 1349 |

**Table 6: Method 5 processing time results**

| Method | Time (Sec.) | | |
|---|---|---|---|
| | Object 1 | Object 2 | Object 3 |
| **Canny** | 0.3206 | 0.3412 | 0.4923 |
| **Sobel** | 0.2247 | 0.2270 | 0.2564 |
| **Prewitt** | 0.2381 | 0.2369 | 0.2441 |

The given results obtained by using method 5, illustrate the different between it and the methods used before in this paper, as shown in table 6, the time needed for the Canny edge type is between 0.3206 sec. and 0.4923 sec., which is used to detect the depended objects, while the needed time to detect the same objects using Sobel and the Prewitt edge detection methods is between 0.2247 sec. and 0.2564 sec., figure 24 illustrate the difference between the three used edges detections techniques according to the processing time.

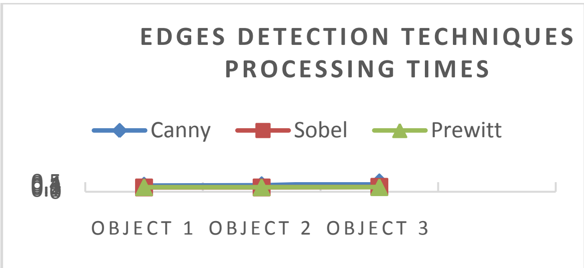



**Fig. 24: Processing time comparison for edges techniques**

Now we can separate the edges techniques according to their processing time into two groups A, and B, group A will be includes the edges techniques those consume more than 0.3 second, while group B includes the methods with less than 0.3 second processing time; according to this idea and referring to figure 24 and table 5, canny type will be individually in group (A), while Sobel and Prewitt will be in group (B). The following table 7, includes the edges groups with their detection results.

**Table 7. Edges detection techniques groups**

| Groups | Method | Time (Sec.) | | |
|---|---|---|---|---|
| | | Object 1 | Object 2 | Object 3 |
| **Group A** | **Canny** | 0.3206 | 0.3412 | 0.4923 |
| **Group B** | **Sobel** | 0.2247 | 0.2270 | 0.2564 |
| | **Prewitt** | 0.2381 | 0.2369 | 0.2441 |

Because of the high proceeding time and the instability in group A, group B is only will depended, while the canny edge detection which represent the methods in group A will be neglected and not used . Now two edges techniques in group B will be compared one with each other to select one of them to be selected as the best edges type in detection in our application, this selection will be according to the detection accuracy. For this issue, the actual number of pixels in each object have to be calculated firstly. The captured images is converted into gray level format then the background subtracted from it pixel by pixel according to the following equation (4):

Foreground Pixels (x,y) = Gray Level (x,y) –Background (x,y) (4)

The actual number of pixels for each of the used objects are as shown in table 8.

**Table 8. Actual detected region**

| Region | Actual Number of Pixels |
|---|---|
| Object 1 | 9712 |
| Object 2 | 6040 |
| Object 3 | 1353 |

Now, Sobel and Prewitt have to be compared depending on the error in pixels, the percentage correct classification (PCC) is used here to select the best type according to the detection accuracy using the following equation (5):

$$PCC = \frac{TP + TN}{TP + TN + FN + TN} * 100\% \quad (5)$$

TP: True positive classification.

FP: False positive classification.

TN: True negative classification.

FN: False negative classification.

Positive: Foreground Pixels.

Negative: Background Pixels.

Inside the PCC, the Hit rate (*tp)* and the False alarm rate (*fp*) or False positive rate is used for more accurate results [11], had to be calculated according to the following equations (6-7):

Hit Rate = TP / total positive. (6)

False Alarm Rate = FP / total negative. (7)

In order to use this why for the purpose of detection accuracy comparison, it is important to know the details for each captured image by the camera, table (9) include the details for these used images.

**Table 9. Image details**

| Property | Value |
|---|---|
| **Image Height** | **244 Pixels** |
| **Image Width** | **152 Pixels** |
| **Image Dimensions** | **152 X 244 Pixels** |
| **Number of Image's pixels** | **37088 Pixels** |
| **Horizontal Image's Resolution** | **96 dpi** |

| | |
|---|---|
| **Vertical Image's Resolution** | **96 dpi** |
| **Original Image's Bit Depth** | **24** |
| **Gray Level Image's Depth** | **8** |

To find the error in detection, both the actual foreground and background have to be calculated, then the foreground and the background for the processed images must be calculated also, the differences between the actual values and the detected values represents the error in detection. Table 10 includes the detected regions with their PCC factor details for objects 1, 2 and 3 depending to tables(8-9) and equation(5).

**Table 10. Details of group B regions' pixels detection results**

| EDGES | TP | FP | TN | FN | PCC |
|---|---|---|---|---|---|
| | | | Object 1 | | |
| Sobel | 9689 | 256 | 27120 | 23 | 99.24735% |
| Prewitt | 9707 | 1 | 27375 | 5 | 99.98382% |
| | | | Object 2 | | |
| Sobel | 5992 | 88 | 30960 | 48 | 99.63330% |
| Prewitt | 6035 | 12 | 31036 | 5 | 99.95416% |
| | | | Object 3 | | |
| Sobel | 1348 | 10 | 35725 | 5 | 99.95955% |
| Prewitt | 1347 | 2 | 35735 | 4 | 99.98382% |

The given PCC results in table (10), exhibited that using the Prewitt Edge technique to detect the samples used objects is achieved best results in compared with the Sobel edge technique, the differences of the PCC between Sobel and Prewitt techniques are appeared more clearly in figure 25.

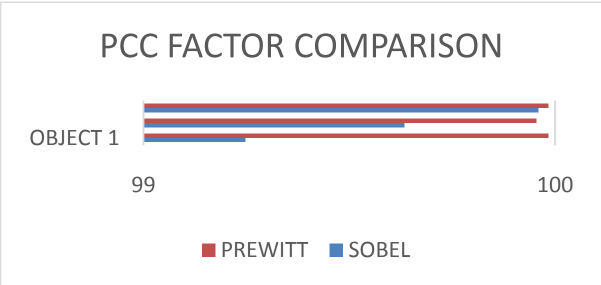



**Fig. 25: PCC diagram for Sobel and Prewitt edges techniques**

Referring to the given results in table (10,) and the differences appeared in figure 25, the Prewitt edges technique has to be selected as the best suitable edges type (method 5) to be used in our application. After used these methods for the same objects under the same environment, a novel algorithm (method) of detection is proposed (**MOPET-ROI**) depended on a combination between the morphological operation and the Prewitt edges technique, inside the region of interest. The obtained results using this proposed method are recorded in tables (11-12).

**Table 11. Method 6 obtained results**

| Method | Detected Region (pixels) | | |
|---|---|---|---|
| | Object 1 | Object 2 | Object 3 |
| **Method 6** | 9711 | 6041 | 1350 |

**Table 12. Method 6 processing time results**

| Method | processing Time (sec.) | | |
|---|---|---|---|
| | Object 1 | Object 2 | Object 3 |
| **Method 6** | 0.33504 | 0.31987 | 0.34149 |

After applied all of the mentioned methods before, many of them had needed a high time, others had spent low time to complete the detection operation, and these methods are classified into classes according to their processed time, Figure 26 shown the differences between these methods according to their spent time.

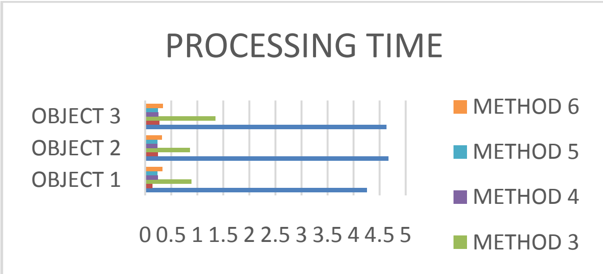



**Fig. 26: Method classification according to the processing time**

The methods with their high processing time (more than 2 second) would be classified as class 3 methods (method 1), while those methods with a less than 0.5 second processing time classified under class 2 methods (methods 2,5, and 6), the others between class 1 and 2 would be classified under class 2 (method 3). Class 1 methods had to be compared one with each other to select the best method can be used for the application. The PCC is used again to compare between the adjacent methods (2, 5, and 6), table (13) and figure 27 includes the details of detections and the PCC results for methods 2, 5 and 6.

**Table 13. Details of Methods 2, 5, and 6 regions' pixels results**

| METHODS | TP | FP | TN | FN | PCC |
|---|---|---|---|---|---|
| | | | Object 1 | | |
| 2 | 6693 | 8 | 27368 | 3019 | 91.83833% |
| 5 | 9707 | 1 | 27375 | 5 | 99.98382% |
| 6 | 9709 | 2 | 27376 | 1 | 99.99191% |
| | | | Object 2 | | |
| 2 | 5638 | 17 | 31031 | 402 | 98.88702% |
| 5 | 6035 | 12 | 31036 | 5 | 99.95416% |
| 6 | 6039 | 2 | 31046 | 0 | 99.99191% |
| | | | Object 3 | | |

| | | | | | |
|---|---|---|---|---|---|
| **2** | **227** | **3** | **35732** | **1126** | **96.95588%** |
| **5** | **1347** | **2** | **35735** | **4** | **99.98382%** |
| **6** | **1349** | **1** | **35736** | **2** | **99.99191%** |

The differences results in table 12 can be seen clearly, but methods 5 and 6 are still have very adjacent results (one to each other) as seen in figure 27. For more accuracy in both selection and testing methods, the hit rate (*tp)* and the false alarm rate (*fp)* rate is used for both methods and the results are compared as shown in table 14 and figures (28-29).

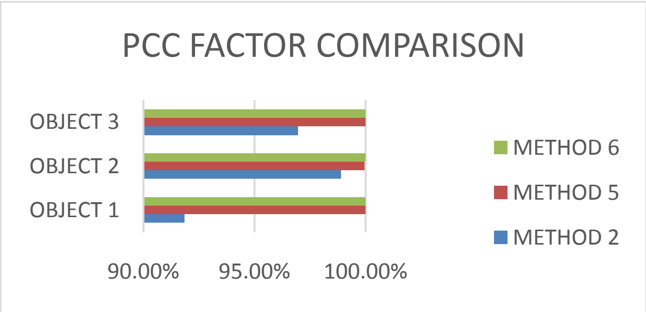



**Fig. 27: PCC diagram for Methods 2, 5, and 6**

**Table 14. *tp* rate and *fp* rate results for methods 2, 5, and 6**

| **METHODS** | **TP** | **FP** | **Negative** | ***tp*** | ***fp*** |
|---|---|---|---|---|---|
| | | | **Object 1** | | |
| **2** | **6693** | **8** | **30387** | **99.88 %** | **0.02632 %** |
| **5** | **9707** | **1** | **27380** | **99.98 %** | **0.00365 %** |
| **6** | **9709** | **2** | **27377** | **99.97 %** | **0.00735 %** |
| | | | **Object 2** | | |
| **2** | **5638** | **17** | **31433** | **99.69 %** | **0.05408 %** |
| **5** | **6035** | **12** | **31041** | **99.80 %** | **0.03865 %** |
| **6** | **6039** | **2** | **31046** | **99.96 %** | **0.00644 %** |
| | | | **Object 3** | | |
| **2** | **227** | **3** | **36858** | **98.69 %** | **0.00813 %** |
| **5** | **1347** | **2** | **35739** | **99.85 %** | **0.00559 %** |
| **6** | **1349** | **1** | **35738** | **99.92 %** | **0.00279 %** |

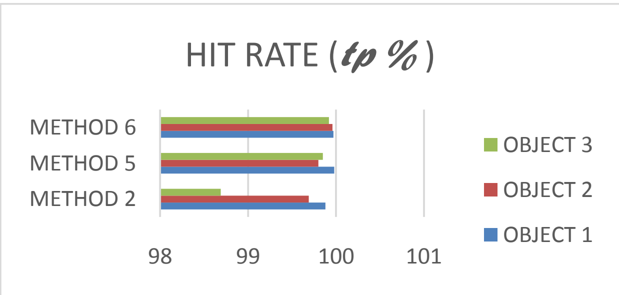



**Fig 28: Hit rate (tp) for methods 2, 5, and 6**

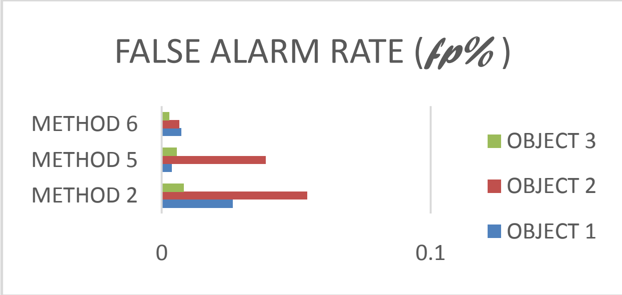



**Fig 29: False alarm (p) for methods 2, 5, and 6**

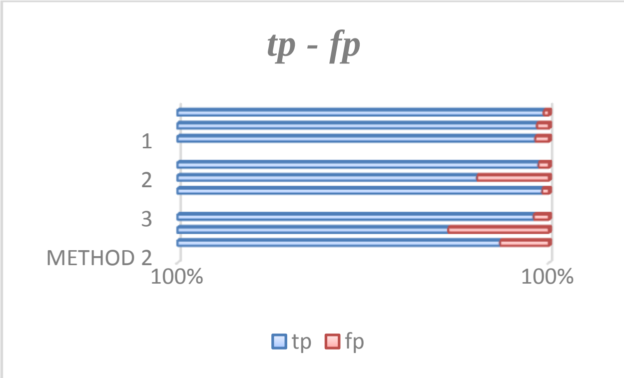



**Fig. 30: tp and fp rates**

Referring to the given results in figures (28-30), and table (14), the best method according to the detection accuracy is the proposed novel method 6 (MOPET-ROI).

## 5. CONCLUSION

In this paper many detection methods are used to detect moving objects, these methods are applied for three random objects, two cans and one poly, the most important depended in this paper is the percentage correct classification (PCC) which is used for the purpose of the comparison and the classification between the used methods, whenever that the real time is very important issue for the moving object detection, the PCC is used after a primary comparison done between the methods according to the processing time. Finally, the hit rate and the false alarm rate are used for more accurate results. According to final results, many methods are suitable to be used for this application or other like it, but the best method used is the proposed novel method: the morphological operation with the Prewitt edge detection technique inside using the region of interest (**MOPET-ROI**).

## 6. FUTURE WORK

In this paper many methods are used and analyzed for a many captured images from a real video recorded, this issue is used usually in the real time applications[12], the camera is connected (wired) to a Laptop, according the detection and the processing time, no texture ore internal objects details adopted as an important issue during the detection operation, the paper focus on that the objects are moved in a constant speed, the detection methods are used to select the dimensions of objects' bodies which had to be griped by the robot arm. In the future work, many other type of detection methods could be used, the internal details of the objects would be depended inside the dimensions of the objects' bodies, other complex objects could be used, and also the speed of the objects' movement could be assumed unstable, and the camera could be mounted directly to the robot arm, the captured video could be encrypted and send in wireless technique to the Laptop, and tried to do that in a real time.

## 7. REFERENCES

[1] Xing Wang, 2007, "Laplacian Operator- Based Edges Detectors", IEEE Trans. Pattern Analysis and Machine Intelligence, Vol 29, No. 15 pp. 886-890.

[2] Albiol A., Sanchis L., Albiol A. , Mossib J., 2011, "Detection of Parked Vehicles Using Spatiotemporal Map", IEEE Trans. Intelligent Transportation Systems ,Vol. 12, No. 4, pp. 1277-1291.

[3] Heikkila J., Silvan O., 1999, "A Real – Time System for Monitoring of Cyclists and Pedestrians", Second IEEE Workshop on Visual Surveillance, pp. 74-81.

[4] Gonzalez R., Woods R.,(2001, "Digital Image Processing", Second Edition, Prentice Hall, University of Tennessee, New Jersey, pp.45-67.

[5] Thompson W., Lechleider P., Stuck E., 1993, "Detecting Moving Objects Using the Rigidity Constraint", IEEE Trans. Pattern Analysis and Machine Intelligence, Vol. 15, No. 2, pp. 162-166.

[6] Wanhyun C., Sunworl K., Gukdong A., Sangcheol P., (2012),"Detecting and Tracking of Multiple Moving Objects in Video Sequence Using Entropy Mask Method and Fast Level Set Method", IEEE, Vol. 1, pp.1-6 .

[7] Cuevas C., Mohedano R., Jaureguizar F., Garcı´a N., 2010, "High-Quality Real-Time Moving Object Detection by Non-Parametric Segmentation", Electronics Letters, Vol. 46, No. 13, pp.910-911.

[8] Seungwon L., Lee J., Hayes M., Paik J., 2012, "Adaptive Background Generation for Automatic Detection of Initial Object Region in Multiple Color-Filter Aperture Camera- Based surveillance System", IEEE Trans. Consumer Electronics, Vol. 58, No. 1, pp. 104-110.

[9] Foresti, 1998, "A Real -Time System for Video Surveillance of Unattended Outdoor Environments", IEEE Trans. Circuits and Systems for Video Technology, Vol. 8, No. 6, pp. 697-704.

[10] Wei Liu, Hongfei Yu, Huai Yuang, Hong Zhao, and Xiaowei Xu, 2015, "Effective background modelling and Subtraction approach for moving object detection", IETComputer Vision, Vol. 9, No. 1, pp. 13-24.

[11] Deepak Kumar Panda, and Sukadev Meher, 2016, "Detectionof Moving Objects Using Fuzzy Color Difference Histogram Based Background Subtraction", IEEE SIGNAL PROCE-SSING LETTERS, Vol. 23, No. 1, pp. 45-49.

[12] Zhihu Wang, Kai Liao, Jiulong Xiong, and Qi Zhang, 2014 "Moving Object Detection Based on Temporal Information", IEEE SIGNAL PROCESSING LETTERS, Vol.21, No. 11, pp. 1403-1407.