Evaluation and implementation of stationary foreground object detection algorithms based on background subtraction techniques

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***Abstract*—In many video surveillance applications, for example detection of abandoned/stolen objects or parked vehicles, the detection of stationary foreground objects is a critical task. In this work we propose the implementation of an efficient object detection algorithm that can be employed in real time embedded system due to its fast processing. Morphological method is used for further processing to remove noise and to preserve the shape of moving object. First video is converted into streams and the applied filter which remove high frequency noise components to obtain smoothened subtraction algorithm with an adaptive threshold that gives detected object is then applied to a convolution filter to remove the distorted pixels which improve the quality of an image**

Keywords—Background Subtraction method, Object tracking, Static background, Threshold amount

Introduction (Heading 1)

Currently the automatic analysis of videos surveillance sequences become a very active research topic in the last few years due to its growing importance in security, law, enforcement and military application. More and more surveillance cameras are installed in security sensitive are such as banks, train stations, highways and borders.

In this context, the detection of stationary object is receiving a special attention because it is a critical analysis stage in applications like the detection of abandoned objects or parked vehicles frequently used in the surveillance of public area. Additionally, the recognition of stationary objects in crowded unconstrained contexts is a challenging task.

Computationally, real time computer vision is an expensive task due to the fact that even small images need to be submitted to many processes. So that large quantities of calculation are need to be avoided. So, we use background subtraction due to the fact that it is not a computationally expensive algorithm and also presents high performance in term

I. PROPOSED METHODOLOGY

A. Pre-processing

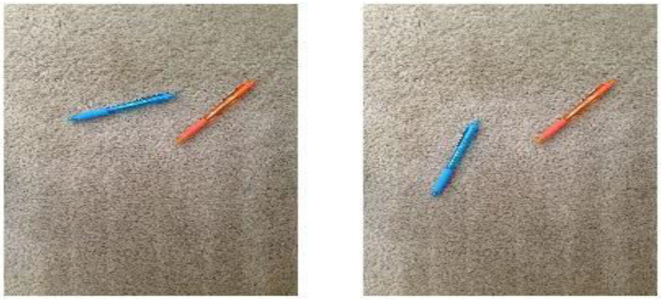

Figure 1 The images are going to be sequential in time series.

Let us consider that we do not have knowledge about which object is going to be moving in this image. Since the background is stationary we will be using background subtraction to subtract the common background from the image, here stationary, information from two sequential images. The function that OpenCV provide for this purpose is "absdiff()".

"absdiff()" is a function which helps in finding the absolute difference the pixels of the two image arrays. By using this we will able to extract just the pixels of the object that are moving.

To use "absdiff()" we will need to convert our images to grayscale (grayscale is a range of shades of gray ranging from black to white).

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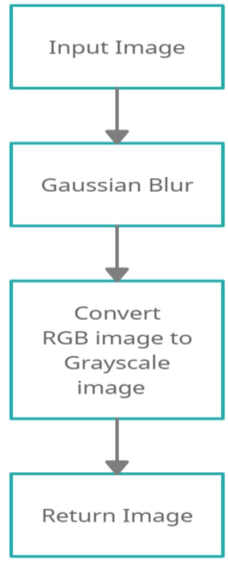
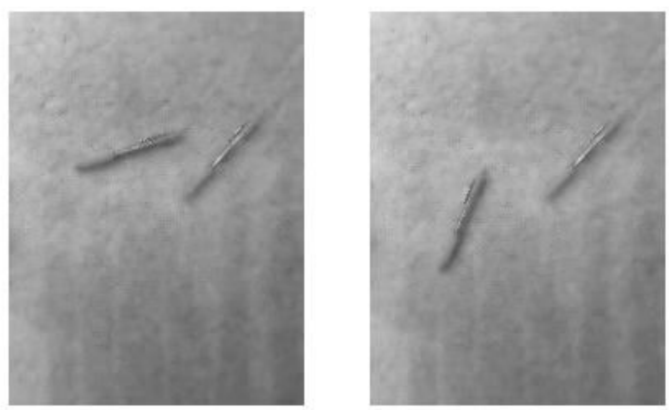


In the process of converting the images from color to grayscale, we do some preprocessing to reduce noise. We'll perform preprocessing by applying a gaussian blur. It can be done with "GaussianBlur". OpenCV Gaussian Blur is a technique which helps in reducing the noise in the image. Image may contain various types of noise because of camera sensor. It basically eliminates the high frequency (noise, edge) content from the image, so edge are slightly blurred in this operation.



Once we preprocess both the images, we can subtract the second sequential image form the first using "absdiff". Now we're left with the two positions that the blue pen had over time.

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B. Image sharpening (Image segmentation)

In this process image sharpening refers to enhancement technique that highlights edges of area of interest. In our case, area of interest is position changing object in the sequential images.

For image segmentation, we will use thresholding technique. Thresholding is a type of image segmentation, where we change the pixels of an images to make the mage easier to analyze. In thresholding, we convert an image from color or grayscale into a binary image, for example, one that is simply black and white. We use thresholding as a way to select area of interest of an image, while ignoring the parts we are not concerned with.

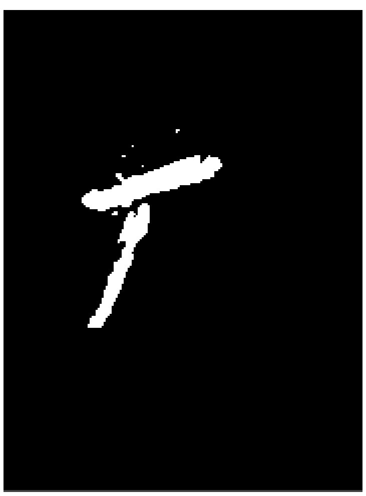
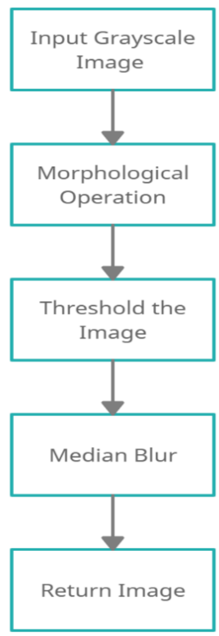


Figure 2 Threshold image of the difference image of grayscale images

Before we do that, let's first apply a morphological operation. Where morphological operation are a set of operation that process image based on shapes. They apply a structuring element to an input image and generate an output image. The most basic morphological are two: **Erosion and Dilation**

1. Erosion:
   - It is useful for removing small white noise.
   - Used to detach two connected object.
2. Dilation:
   - In case like noise removal, erosion is followed by dilation. Because, erosion remove white noise, but it also shrinks our object. So we dilate it. Since noise is gone, they won't came back, but our object area increases.
   - It is also useful in joining broken parts of an object.

After applying the morphological operation we'll apply threshold technique.



C. Find and Draw contours

Next we'll find the contours of the objects in the images. Contours are defined as the line joining all the points along the boundary of an image that are having the same intensity.
Contours came handy in shape analysis, finding the size of the object of interest , and object detection. We will be using OpenCV "findCountours" function that helps in extracting the contours from the image.

There are two types of Contour Approximation Method "CHAIN_APPROX_NONE" and "CHAIN_APPROX_SIMPLE", If we pass "CHAIN_APPROX_NONE", all the boundary points are stored and if we pass "CHAIN_APPROX_SIMPLE", it will store the end points of the lines.

After storing the contour's co-ordinates, we have highlight the contours in the image with the help of "drawContours", it take the argument of image which we want to highlight object, contours stored variable, index of the contour, boundary color of contour and thickness of the boundary.

Figure 3 Area of interest has highlighted boundary

D. Draw the bounding box on the detected object

Now we'll draw the bounding box on the detected object by the help of detected contours "findCountours" return array of all the co-ordinates of the contours present in the fig.3.

First, we iterate through the all the contours and find the area of the contours by the function "contourArea" and measure the area of the contours. The measurement of the area is user to achieve accuracy by this we can remove small areas and by fixing the range of area we can get area of interest

After getting perfect area now we have to place the bounding box on the last frame by the function.

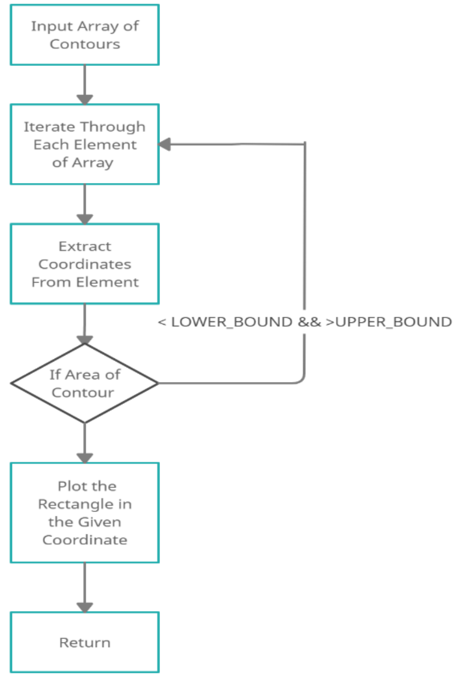


Figure 4 Represent initial position and the final position of the pen

The upper bounding box represent initial position in the first frame and the second bounding box represent the final position in the second frame

II. SIMULATION AND RESULTS

We now proceed to evaluate the accuracy of background subtraction technique. Most of the evaluation was done via simulation. In this column we present the details of our evaluation, including the chosen simulator, the metrics, the evaluation methodology, and the simulation results in two real life scenarios which is tracking the object in the road and tracking the peoples in the crowded place. The simulation in this column aims to explore the trade-offs, performance, and scalability of the background subtraction technique. By reading this column, the reader will understand how background subtraction performs under various topologies and their limitation. Situations are completely dynamic and the result may slightly vary which is depending on the Hardware configurations

A. Traffic Simulation

In this simulation, we try to track the vehicles from the video frame capture by the camera which is install at the intersection of the road. We measure the result by the three parameters "Actual number of objects in the frame", "Number of objects tracked by the algorithm", and lastly is "Accuracy".

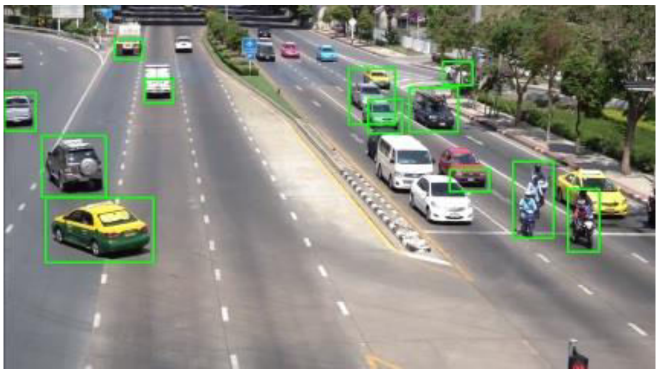
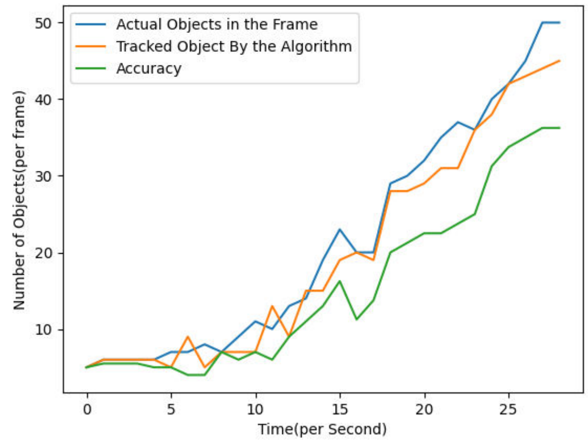


Figure 5 Screenshot of Simulation

The above figure is the screenshot of the mid of the working simulation. In the figure, there are 22 vehicles in the view frame and 9 of them are stopped in front of a traffic light, and the rest of them are in the moving state. We can tell by looking at this there many cars that are present in the frame but not all tracked by the algorithm and there is one tracking box that does not even track any vehicle. All these things can affect the accuracy of the algorithm.
On the basis of the above observation, we can plot the graph which easily descries the whole simulation result in a very brief



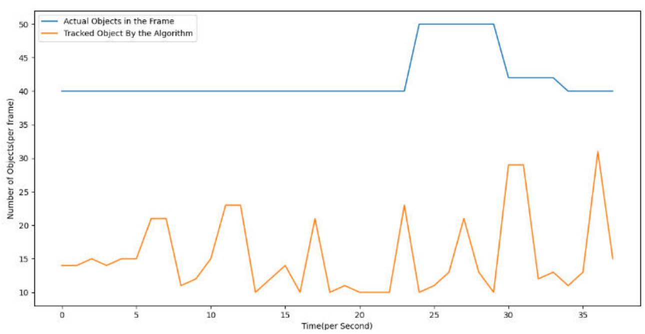
The data show by the above graph is linear and simplified. The accuracy is the simulation is inversely proportional to the actual number of objects present in the frame. But a number of the tracked objects is giving a good result because accuracy is inversely proportional to the actual objects in the frame that why the error per frame is as per actual objects in the frame is increased. We also see that at some places there are more tracked object than actual object in the frame because at that timeline camera will be shaking that increase the error per frame. We also can see that when the inclination of the slope of the blue line is constant the inclination of the green line is also
constant.

B. Crowd Simulation

In this simulation, we try to track the person from the video frame capture by the camera which is installed at a crowded place. We measure the result by the two-parameter "Actual number of objects in frame" and "Accuracy". In this test case, we only use a two-parameter because in this case number of objects tracked by the algorithm is equal to accuracy. The reason why it equal because there is the background is clear.

The above figure is the screenshot of the mid of the working simulation. In the figure, there are 50 people in the view frame and it tracks 19 people correctly. We can tell by looking at this there are many people present in the frame but not all tracked by the algorithm and there are many tracking boxes present in the frame that will consider a group of people as one person. All these things can affect the accuracy of the algorithm.

On the basis of the above observation, we can plot the graph which easily descries the whole simulation result in a very brief



The data show by the above graph is linear and simplified. In this case, the accuracy of the algorithm is fluctuating irrespective of the actual number of objects present in the frames. In the whole simulation most of people are come in and go out constantly and some people are standing at rest in whole simulation. The crest on the fluctuation of the graph shows that at that time the movement of people is more that's why the algorithm is on more active state and the valley of the fluctuation shows that at that time most of the people are at steady state.

It has the same problem as the traffic simulation, it also considers a group of people who walk closely and at the same speed as one person and it does not track the rest state objects.

III. CONCLUSION

Through the medium of our research paper, we target the problem of object tracking in the static background. By the brief evaluation and implementation of the algorithm, we can say that algorithm is impressive in terms of computation and accuracy but it has many flaws when it works on the dynamic background. Besides the simplicity of the algorithm, it does not track non-moving objects present in the given frame which makes it less accurate. The Algorithm is suitable for a static background

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