Video Analytics Trip Wires for Surveillance System

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ABSTRACT

In this paper, trip wire is implemented using video analytics technology. This trip wire is used to maintain security for outdoor and also indoor scene. Undesired motions in restricted areas are detected and tracked. This restriction to specific area of video scene is provided by drawing trip wires. Alarm indication will appear on moving objects which crossed trip wires. Direction of tripping is selected by user. Main advantage of this application is user can select single trip wire mode or two trip wire mode. Continuous Adaptive MeanShift (CAMShift) Algorithm is used for motion tracking. Mouse callback events are implemented to draw trip wires on video. Application is developed by using OpenCV library functions and C code.

General Terms

Algorithm, Security, Mouse callback.

Keywords

CAMShift, OpenCV, Trip Wire, Video Analytics.

1. INTRODUCTION

Object Tracking is one of the key tasks in the field of computer vision. This is a useful operation in automated security solutions, traffic monitoring system, etc. Various methods of object tracking are available. But two main methods used of tracking are widely used in real time application [1]. MeanShift algorithm is designed for static distribution. The method tracks targets by finding the most similar distribution pattern in a frame sequences with its sample pattern by iterative searching. It is simple in implementation. But it fails to track the object when it moves away from Camera. [1].

Continuous adaptive mean-shift (CAMShift) was used to overcome this problem. CAMShift [5] is designed for dynamically changing distributions. These occur when objects in video sequences are being tracked and the object moves so that the size and location of the probability distribution changes in time. The CAMShift algorithm adjusts the search window. Initial window size can be set at any reasonable value.

Feature selection plays an important role in object tracking. The most commonly used features are color, edges, [2] and various color spaces other than RGB are used for tracking purposes such as HSV. Because RGB color space does not correspond to the color differences seen by humans [3].

In this paper CAMshift algorithm is used to track multiple objects. Instead of providing any features of object to be tracked, binary foreground image is provided to CAMshift function. Link list structure of C code is also implemented for contours and tracked objects. Mask image is generated in order to convert contours into tracked object. A Mouse callback event of OpenCV is used to draw a trip wire on video stream. System indicates Alarm when any moving object crosses this trip wire. Single trip wire mode and two trips wire mode is available for user.

Paper further includes method of background building, Motion contour detection and multiple objects tracking using CAMshift algorithm and followed by implementation of trip wire in horizontal, vertical and inclined manner. Experimental result screenshots are also shown in this paper to get idea of concept implementation.

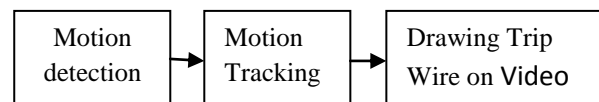Three stages of application are as follows:

| Motion detection | Motion Tracking | Drawing Trip Wire on Video |

Fig 1: Application Stages

1.1 Surveillance System without Video analytics features OVER Surveillance system with Video analytics features

In security control room there are number of CCTV cameras. It has been shown in research that a human can effectively watch 9-12 cameras for only 15 minutes. Hence to effectively monitor and take preventive measures to counteract security threats, it is need to increase the security personnel in control room. This causes increase in cost on surveillance. In order to overcome this problem surveillance system with video analytics features is best option. This will minimize the human presence in control room. with a video analytics system installed, it is like having a dedicated 24x7 security personnel monitoring each CCTV cameras simultaneously for user and alerting the actual human operator when some suspicious events are observed from the monitored cameras. Such as in order to restrict undesired motions entry into particular area, trip wire is drawn on video by operator. After that he is not required to monitor video for all the time because he will get alarm indications when any moving object enters into restricted area by crossing trip wire. At a same time video analytics tracks their motion in throughout video. Hence, use of video analytics features like motion detection, motion tracking, and trip wire mode in surveillance provides higher level of security than that of surveillance system without any video analytics features.

Video Analytics is on the rise with improved technology and smarter security system. Following is the chart of video analytics market [9], projected to grow very high by rear 2016.
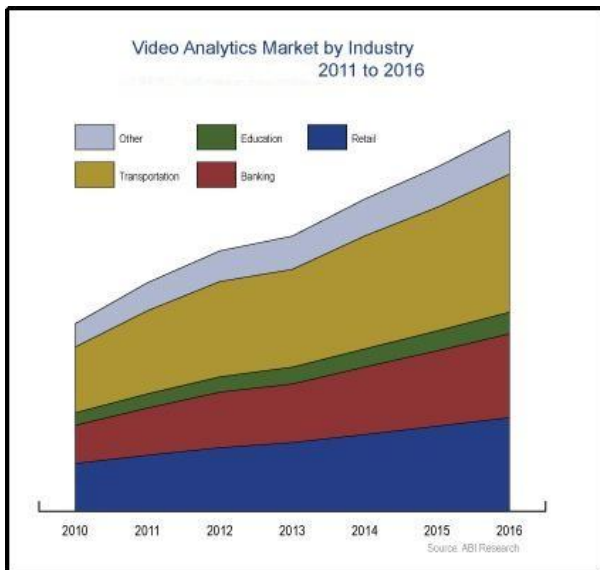
Fig 2: Motion Contour Detection in video

2. MOTION DETECTION

Moving object detection is first step toward Tracking of moving objects. In motion detection, following steps are performed.

First step is to grab a file from camera. For that cvQueryFrame( ) function is used. The function cvQueryFrame grabs a frame from a camera or video file, decompresses it and Returns it. This function is just a combination of Grab Frame and Retrieve Frame [3].

In order to get background accumulation information we use basic function such as cvRunningAvg ( ). The function cvRunningAvg [7] calculates weighted sum of two images. Once a statistical model is available, there is often a need to update the value slowly due to may be change in environment lighting conditions, etc.

Next step is to find the absolute difference between current frame and calculated running avg. for this cvAbsDiff() function is used. Further image obtained from this operation is converted into Grey scale image and then thresholded to get Binary image. In order to remove small holes in binary image closing operation is performed.

Where there is a motion in video, motion contours are formed at that place. Now, our task is to find these contours. To achieve this cvFindContours( )[7] function is used. The function cvFindContours retrieves contours from the binary image and returns the pointer to the first contour. Other contours may be accessed through the h_next and v_next fields of the returned structure. The function returns total number of retrieved contours.

Once Contours are obtained, bounding rectangles are drawn around them in order to get it visible on screen. In this way multiple motion contours are detected in each video frame by incorporating above mentioned steps in appropriate c code sequence.
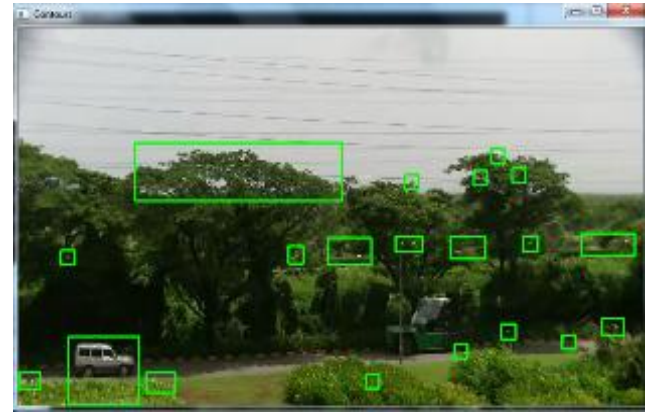

Fig 3: Motion Contour Detection in video

3. MOTION TRACKING

CAMShift algorithm is implemented for multiple objects tracking in video frames. Ellipse is drawn around tracked objects and this ellipse follows this tracked object in further consecutive video frames.

Background building with quarried video frames is achieved [8].Running average of motion frames is calculated by function cvRunningAvg( ). As the new frame is quarried, Current image frame is subtracted with background image and absolute differences is calculated by using function cvAbsDiff( ). If difference is observed in current frame and background frame then that is detected as motion. Motion contours are found out. Some area threshold is set for contour area. Contours which satisfy this area threshold only that motion contours are inserted into link list of contour. In order to display position of motion contours, rectangle box is drawn around each motion contour.

Link lists for motion contours as well as for tracked objects are formed and checked whether they are empty or not.

Tracked object is created with help of this mask image. In this mask image initial location of object is available. Following steps are performed to form a Mask image of required video frame.

➢ Create a black image.
➢ Draw a filled Rectangle on black image. Dimensions of this rectangle are same as that of bounding box drawn on required motion contour.
➢ AND the image with filled rectangle with Binary foreground image resulted from closing operation.
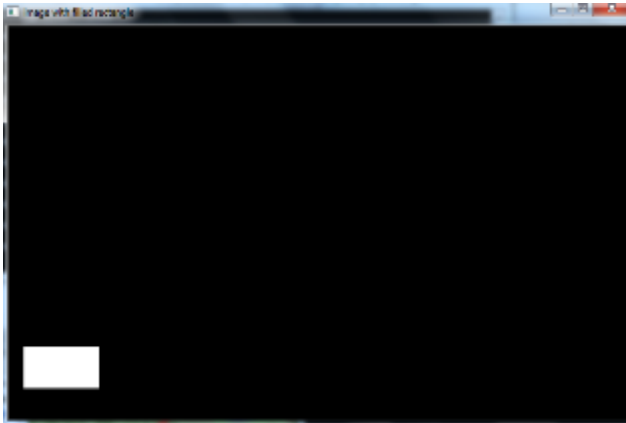

Fig 4: Binary foreground image per quarried frame
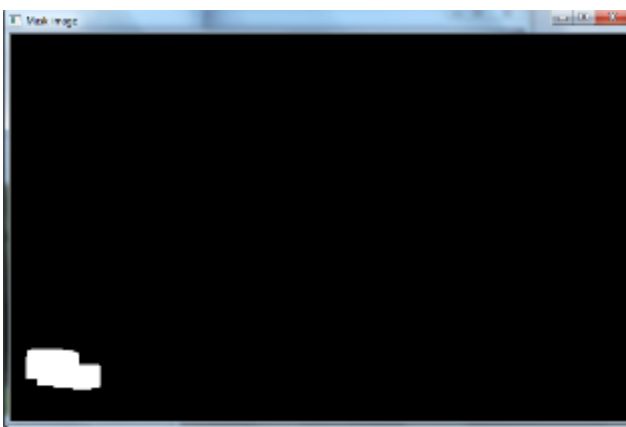
Fig 5: Black Image with Filled Rectangle

Fig 6: Mask Image

This mask image shown in figure 6 is keep on updating as binary foreground image changes as per change in detected motion contours for every quarried frame. Mask image provides initial location of object so depend upon this updated mask image, tracked object is created with some other OpenCV functions and c code. Created tracked object is stored in some location whose return type is same as that of created tracked object.

These created tracked objects along with quarried frames are fed as an argument to CAMshift function. In CAMshift, new position of tracked object is predicted. If it matches with its previous position then it is getting tracked in every consecutive video frames. In scope of CAMshift, RGB to HSV colour space conversion is performed by using cvCvtColor( ) and Hue value of object is extracted using function cvSplit( ). Back projected image is calculated. This back projected image is nothing but histogram image of "hue" value of object to be tracked. This hue image is getting updated every time when frame changes and so object position. But in this application hue information of objects is not used to track desired objects in it further video frames. CAMshift function returns one 2D box which is nothing but a position of object in new frame. If this box position and contour bounding box satisfies predefined overlapping criteria written in scope of CAMshift algorithm then ellipse is drawn around that objects only. Ellipse follows these tracked objects in further video frames.

Fig 7: Motion Tracking

Now as shown in Figure 7 multiple motions in video frame is getting tracked. But some motion contours which are getting tracked are undesired. For example- leaves of trees waving because of wind and these leaves motions are also tracked by algorithm. In order to avoid this Contour area threshold is defined in scope. Hence motion contours which are having area lesser that defined threshold are not getting tracked by algorithm. So all small area contours are eliminated.

Fig 8: Motion Tracking (With Contour Area Threshold)

4. DRAWING TRIP WIRE ON VIDEO

Trip wire is nothing but a line drawn on video with help of mouse callback events. OpenCV supports mouse callback events. This line will used to restrict some part of captured video stream. Depend upon user requirement, Trip wire can be drawn in vertical, horizontal or in inclined manner. In this application two modes are implemented. First is single trip wire mode and second is two trip wire mode. User will select mode of operation. Direction selection for tripping is also user choice. Tripping is available for motion travelling from left hand side toward right hand side and vice versa. Bidirectional tripping is available with application

In Two trip wire mode, User can select two different directions for tripping. It's not compulsory that both trip wire drawn has same direction for tripping. Following results shows screenshots for single trip wire mode as well as two trip wire mode. As shown

Single trip Wire Mode-

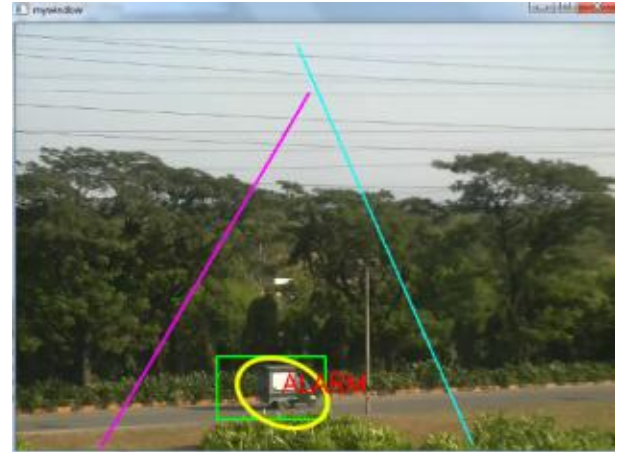**Fig 9: Vertical Trip wire. Alarm for Motion travelling
from Rhs toward Lhs side**

**Fig 10: Vertical Trip wire. Alarm for Motion travelling
from Lhs toward Rhs**

**Fig 11: Horizontal Trip Wire. Alarm for Motions
travelling from Rhs toward Lhs**

**Fig 12: Object has crossed First trip wire
(One Alarm Indication)**
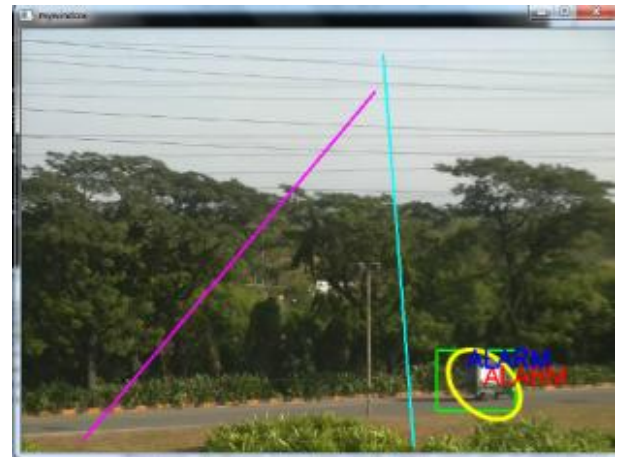
Fig 13: Object has crossed Second trip wire after first

(Two Alarm Indications)

As shown in figure 9 and figure 10, Vertical trip wire is
drawn. In figure 9, direction for tripping is for motion
travelling from Rhs to Lhs and vice versa in figure 10. In
figure 11 Horizontal Trip wire is drawn.

Two trip Wire Mode-

In two trip wire mode, when object crosses first trip wire then
only one alarm indication will appear on that moving object.
And when it crossed second trip wire then one another alarm
indication will imposed on that moving object. This shows
moving object has crossed both trip wires.

As shown in Figure 12 and figure 13, two trip wires are drawn
on video. Here direction is selected for both trip wires are
same. Tripping is for motions travelling from Lhs side toward
Rhs side. When moving object crossed first trip wire then
only one Alarm indication will appear on that object as shown
in figure 12. And when in further quarried frames when
moving object crosses second trip wire also then another
Alarm indication is imposed on that moving object. This is an
indication that object has crossed both trip wires. As shown in
figure 13.

5. CONCLUSION

This Trip wire application is one of the surveillance features developed using video analytics. Just by drawing trip wire line on video user can restrict any part of video scene. Also undesired motions entering into restricted areas are getting tracked by tracking algorithm. Provision of two modes of trip wire is key advantage of application. Direction of tripping is also selected by user. This application is beneficial to use for outdoor as well as indoor security by taking care of good illumination.

6. ACKNOWLEDGMENTS

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