International Journal Of Engineering Research And Development
e- ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 20, Issue 5 (May. 2024), PP. 215-222

Suspicious Activity Recognition from Video Surveillance System

Dr.kiran B.M
(Professor)
Dept of Computer Science and Engineering
Sphoorthy Engineering college
Hyderabad,India

B.Nithya Sree
Dept of Computer Science and Engineering
Sphoorthy Engineering college
Hyderabad,India

K.Saikiran
Dept of Computer Science and Engineering
Sphoorthy Engineering college
Hyderabad,India

P..Charan Kumar
Dept of Computer Science and Engineering
Sphoorthy Engineering college
Hyderabad,India

Abstract-
In today's insecure world the video surveillance plays an important role for the security of the indoor as well as outdoor places. With the increasing in the number of anti-social activates that have been taking place, security has been given utmost importance lately. Many Organizations have installed CCTVs for constant Monitoring of people and their interactions. For a developed Country with a population of 64 million, every person is captured by a camera 30 times a day. A lot of video data generated and stored for a certain time duration. A 704x576 resolution image recorded at 25fps will generate roughly 20GB per day. Constant Monitoring of data by humans to judge if the events are abnormal is near impossible task as requires a workforce and their constant attention. This creates a need to automate the same. Also , there is need to show in which frame and which part of it contain the unusual activity which aid the faster judgment of the unusual activity being abnormal. This is done
by converting video into frames and analyzing the persons and their activates from the processed frame .Machine learning and Deep Learning Algorithms and techniques support us in a wide accept to make Possible

Keywords-*videosurveillance,anti-social activities, Constant Monitoring*

Date of Submission: 14-05-2024 Date of Acceptance: 26-05-2024

I. INTRODUCTION

Humanfaceandhuman behavioural pattern play an important role in person identification. Visual information is a key source for such identifications. Surveillance videos provide such visual information which can be viewed as live videos, or it can be played back for future references. The recent trend of 'automation' has its impact even in the field of video analytics.

Video analytics can be used for a wide variety of applications like motion detection, human activity prediction, person identification, abnormal activity recognition, vehicle counting, people counting at crowded

places, etc. In this domain, the two factors which are used for person identification are technically termed as face recognition and gait recognition respectively.

Among these two techniques, face recognition is more versatile for automated person identification through surveillance videos. Face recognition can be used to predict the orientation of a person's head, which in turn will help to predict a person's behaviour. Motion recognition with face recognition is very useful in many applications such as verification of a person, identification of a person and detecting presence or absence of a person at a specific place and time. In addition, human interactions such as subtle contact among two individuals, head motion detection, hand gesture recognition and estimation are used to devise a system that can identify and recognize suspicious behaviour among pupil in an examination hall successfully. This paper provides a methodology for suspicious human activity detection through face recognition.

II. RELATED WORK

The main objective of video surveillance is to acquire & process the data so that any suspicious movement can be detected. A lot of research has been done addressing the detection of anomalies in the video data. The problem of abandoned bag detection is handled by the most of the researchers. Bitch et. al. 2011 [4], Tian et. al. 2010[5] they handled the abandoned bag detection problem as the static object detection with the application of the object tracking. While Evangelio & Sikora 2011 [3], Porikli et. al. 2008 [6] they did the static object detection without the use of tracking.

In [2] Elhamod & Levine proposed a technique based on semantic approach to detect suspicious activity in public places. They use the background subtraction to identify the foreground object. This object is tracked using the foreground silhouettes. Then the activities are classified as normal or predefined suspicious activity. In [7] James David Hogg et al described the video surveillance framework to detect abandoned object in scene with multiple interacting objects. They use the standard datasets. The object (bag) detection is done by the dual background approach using Gaussian Mixture Model(GMM). The multi hypothesis tracker which is modified for tracking of extended objects is used. Then the situation analysis is done based on relationship between bag and people. Finally the threat assessment is done using logic based approach.

In [9] Fuentes & Velastin present an algorithm based on trajectories to detect an event in video surveillance. Any event can be described in terms of position, trajectory, and split/ merge event. Then the matching matrices are used for tracking purpose. Kim et al deal with detecting & tracking multiple moving objects through a single camera. They use RGB color background modeling to extract moving regions. The blob labeling is used to group the moving object together.

Most of the work related to anomaly detection uses the background subtraction for obtaining the foreground image.. As background subtraction does not require prior training we use this technique in our system.

Most of the researchers use the machine learning approach for object detection. This approach requires a standard reliable dataset for training which is not easily available. So the machine learning approach becomes less reliable. In our system we are making use of the hierarchical semantic based approach.

III. METHODOLOGY

A. System model-

The fig. 1 shows the flow of the system for the detection of suspicious activity. The different block are explained as follows-

Input data-

The input for the system is video stream. As the system is to be implemented to detect the suspicious activity its input is to be taken from the CCTV. But for the project/ demo we use the standard datasets. These input images are not in proper form so the different image preprocessing techniques are used to enhance the quality of the image.

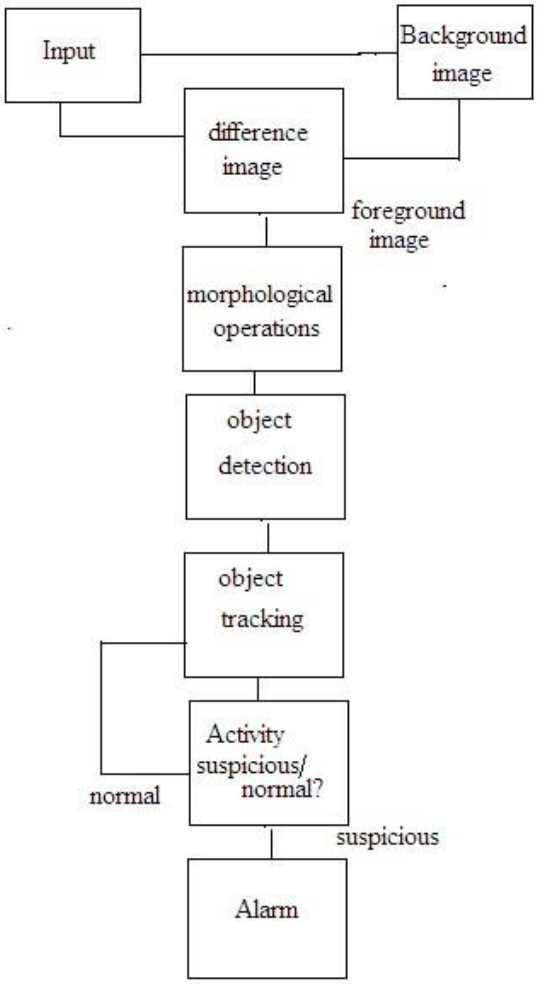
Background image acquisition-

The illumination effect can be corrected by the background image. A reference image/standard background is taken as reference for the further image processing.

The background image is dynamically updated so that any new object entered in the scene can be captured.

Image Preprocessing-

The different image preprocessing techniques are used to improve the image so that the unwanted distortions are get suppressed or some required features enhanced.



. Fig.1. Block diagram of Activity Detection. [1]

The changing light conditions, movement of reference background cause some noise introduced in the image. We use the thresholding technique to remove the noise. Then the image undergoes the morphological operations. The Morphologically open operation is used to shrink the area which is distorted by the noise. The opening operation is defined as the opening of an image A by a structuring element B. It is basically a erosion followed by a dilation.

It is given as-

$$A \quad o \quad B = (A\theta \ B) \oplus B \qquad \ldots.[1]$$

Where o - indicates opening operation, θ - is the erosion of image A by structuring element B,

$\oplus$ - indicates dilation

The open operation causes the holes to create in the image. These holes are covered by allowing the image to pass through the morphological close operation. The closing operation is defined as the closing of an image A by a structuring element B.

Basically it is a dilation followed by erosion.

It is given as

$$A \bullet B = (A \oplus B)_{\theta} \quad B \qquad \ldots.[2]$$

Where • - is closing operation, $\oplus$ - dilation of image A by structuring element B, ɵ – indicates erosion.

Object Detection-

The foreground image is obtained by the subtraction of the input image from the background image. From this foreground image the required object is detected.

Object Tracking-

The detected object is tracked in the scene so that we can determine if any new object is entered in the scene or if any object left the scene i.e. the person walk off the scene. The detected object (human being or bag) is tracked using correlation tracking algorithm.

B. Implementation

Object detection-

The template matching is used for the object detection. In this method the cross correlation between a template image & the new image is performed. The different geometrical parameters are used for matching the reference image with the input image to find the required object. Suppose S(x,y) is the input image & we have to find the object from this input image. Then the image $T(x_t,y_t)$ is taken as the template image. This template is considered as a mask & the centre of the mask is moved over each pixel in input image. Then the sum of product between coefficient of input image S(x,y) & template image $T(x_t,y_t)$ is calculated over the whole area spanned by the template. By considering all the position of the template the position which has the highest score is considered as the best position where object can be detected.

Object Tracking-

For tracking the objects detected in the scene we use the correlation based tracking method. In this method a small tracking window is centered on the object in first frame. This object is considered as target. For every object in the frame their color histogram is calculated. Thus for any object the Red, Green & Blue histograms are calculated. If the color histogram of the object in the current & the previous frame are matches then the object is one & the same. By knowing the color histogram we can track a specific object in number of frames. Also if a new object entered in the frame is easily identified.

To match the object in two frames their histogram for individual color is calculated. Now the correlation between red histogram of object in two frames is calculated. Similarly the correlation for blue & green color is calculated. This correlation can be denoted as $Corr_{R,}$ $Corr_{G,}$ $Corr_B$. To get the correlation of the object these individual correlations are added. The resultant correlation is –

$Corr_{RGB} = Corr_{R,} + Corr_G + Corr_B$ …..[3] When the two objects are exactly same then correlation between these two objects is equal to 1. Thus the correlation $Corr_{RGB}$ can take the max. value of 3.

The correlation is also checked against the threshold to check the entry of the new object. The correlation value smaller than threshold value denotes the presence of new object. If the old object does not match with current object for certain time period then it is deleted. Thus by using correlation information and distance between two objects in consecutive frame the object detected is tracked.

Object Features extraction-

Once the object in the frame to be tracked is fixed then its features are required to be extracted. Most of the work use the shape based features but they require large training dataset with large number of variations in both the animate and inanimate shapes. In this work we make the use of motion features. By using motion features the object are classified in four different categories. The state diagram for this classification is as shown below.

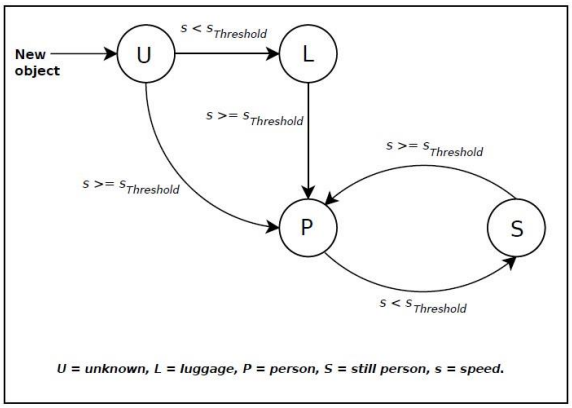


Fig.2. Classification of Objects [2]

U (Unknown)- entry of a new object (may It be a person or inanimate object) in the scene.

O (Object)- If velocity of the object is less than threshold value then it is inanimate object.

P (person) - If velocity is greater than threshold value then it is classified as the animated object.
SP (Still person)- First the person is identified then its velocity is compared to decide whether it is a still person. Using this transition model ensures that a still person is not misclassified as luggage.
The features such as position and speed are calculated for the single object while the feature such as distance is calculated between two objects. The features are as shown in table-

TABLE I: Object Features. Subscripts and superscripts describe object ID(s) and time respectively[5].

	Feature	Formula
Single object	Position	Pit = (Xit , Yit)
	Speed	Sit = (Pit - Pit-Δt) /Δ t
Two objects	Distance	$D_{i,j}{}^{t}$ = (–) +(–)

Defining the suspicious activities-
There are lots of activities which come under the suspicious activity. But for the project work we have selected the following activities-

Abandoned luggage-
Researchers define abandoned bag as- stationary object that is not touched by a person for some time duration [3].
Abandoned object is semantically defined as- obj1 abandoned obj2 ≡ classication(obj1) Є {P, S}
^ classication(obj2) Є O ^ obj1 = owner(obj2)
D(1,2)> dabon for t > tabon
……[4]
Where d_{abon} - distance between bag & person
t_{abon} - Time in seconds for which bag is untouched.

Unauthorized Access-
In the restricted area the entry for common people is not allowed. If somebody tries to access the place without any authentication then it is harmful and it should be detected. The unauthorized access is semantically described as – obj1 enters restricted area ≡ class (obj1) Є {P, S}
^ $p_{obj1}{}^{t=tnow}$ falls inside restricted area ……[5]

where, p is position of the object.

Loitering-
If the presence of a person in a particular place exists for a period longer than the time required for a activity then it is called as loitering. It is semantically
defined as-
Obj1 is loitering ≡ class(obj1) Є{P,SP}^
time $obj_1 \geq t_{loitering}$ ……[6]
where, $t_{loitering}$ is time threshold in seconds for an object to be classified as loitering. The value of $t_{loitering}$ can be anywhere from 30 seconds to a few minutes depending on the scenario.

IV. RESULTS

The suspicious activity detection in the video data is challenging task. It has number of difficulties such as complexity of scene, illumination of light, camera angle etc. Also the definition of the suspect activity is scene/place dependant. For e.g. the bag left in classroom for more than half an hour is normal whereas the bag at

railway station for half hour is suspicious. Another problem is that the standard and challenging data sets are not easily available for testing. We have make use of standard public data sets to test the proposed framework. These data sets are CAVIAR (PETS 2004) [14], and PETS 2006
[15].

Object detection

Fig. 3. Object detection

The different objects in the image are detected. As there are multiple objects in the image the detection is quite blurred.

Object Tracking

The different objects are detected in the first step. A bounding box is drawn across the object which is to be tracked.

The object to be tracked is highlighted with green rectangle. Every person is given a unique ID in the red as seen in image. In all the subsequent frames, the detected objects are compared with objects in their respective previous frames. The object can be tracked in consecutive frames. The result of object tracking is shown in figure 4.

Fig. 4. Object Tracking

Detection of Suspicious Activities-

The result obtained for different suspicious activities are illustrated as follows- *1.Loitering at an ATM-*

Fig. 5. Loitering at ATM

In ATM approximately 1 minute is required for the withdrawing of money. For the detection of loitering the time taken by the person in ATM should be greater than the loitering time. We selected loitering time of 2 minutes. The result of loitering is as shown in fig. 5.

2.Abandoned Luggage-

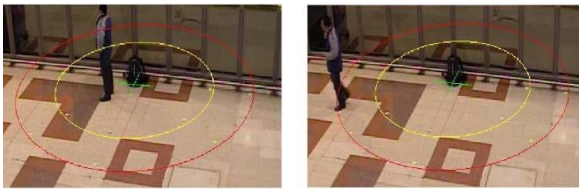


Fig.6. left- distance between bag & person is 2 m(normal). Right- distance between bag & person is more than 2 m(abandoned).

For abandoned bag detection the distance between bag & person should be less than 2 m for certain time period. If the distance between two increases more than 2m for a certain time threshold then the bag is said to be abandoned. The result of same is shown in fig. 6.
Table II gives the results of our framework. The precision and recall scores are provided for the particular scene. An incorrectly raised alarm is a false positive, while a missed detection is a false negative. These conditions are applied to every frame. The detection of abandoned luggage and loitering are highly reliable.

TABLE II: Experimental results for different stages-

Stage	Behavior of interest	Detection	Accuracy
Object detection	To Detect objects in scene	Due to multiple objects the detection is blurred	57%
Object Tracking	The detected object should be tracked	The object is tracked successfully	90%
Activity detection	Loitering at ATM	Loitering is detected successfully	93%
	Abandoned bag detection	detected successfully	96%

V. CONCLUSION-

In present world, almost all the people are aware of the importance of CCTV footages, but most of the cases these footages are being used for the investigation purposes after a crime/incident have been happened. The proposed model has the benefit of stopping the crime before it happens. The real time CCTV footages are being tracked and analyzed. The result of the analysis is a command to the respective authority to take an action if in case the result indicates an untoward incident is going to happen. Hence this can be stopped. Even though the proposed system is limited to academic area, this can also be used to predict more suspicious behaviors at public or private places. The model can be used in any scenario where the training should be given with the suspicious activity suiting for that scenario. The model can be improved by identifying the suspicious individual from the suspicious activity.

REFERENCES

[1]. P.Bhagya Divya, S.Shalini, R.Deepa, Baddeli Sravya Reddy,"Inspection of suspicious human activity in the crowdsourced areas captured in surveillance cameras",International Research Journal of Engineering and Technology (IRJET), December 2017.

[2]. Jitendra Musale,AkshataGavhane, Liyakat Shaikh, Pournima Hagwane, Snehalata Tadge, "Suspicious Movement Detection and Tracking of Human Behavior and Object with Fire Detection using A Closed Circuit TV (CCTV) cameras ", International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 5 Issue XII December 2017.

[3]. U.M.Kamthe,C.G.Patil "Suspicious Activity Recognition in Video Surveillance System", Fourth International Conference on Computing Communication Control and Automation (ICCUBEA), 2018.

[4]. Zahraa Kain, Abir Youness, Ismail El Sayad, Samih Abdul-Nabi, Hussein Kassem, " Detecting Abnormal Events in University Areas ", International conference on Computer and Application,2018.

[5]. Tian Wanga, Meina Qia, Yingjun Deng, Yi Zhouc, Huan Wangd, Qi Lyua, Hichem Snoussie, "Abnormal event detection based on analysis of movement information of video sequence" ,Article-Optik,vol152,January-2018.

[6]. Elizabeth Scaria, Aby Abahai T and Elizabeth Isaac, "Suspicious Activity Detection in Surveillance Video using Discriminative Deep Belief Netwok", International Journal of Control Theory and Applications Volume 10, Number 29 -2017

[7]. Sandesh Patil and Kiran Talele "Suspicious Movement Detection and Tracking based on Color Histogram", 2015 International Conference on Communication, Information & Computing Technology (ICCICT), Jan. 16-17.

[8]. Mohannad Elhamod, and Martin D. Levine, "Automated Real-Time Detection of Potentially Suspicious Behavior in Public Transport Areas",IEEE Transactions On Intelligent Transportation Systems, Vol. 14, No.2, June 2013.

[9]. Evangelio, R., Sikora, T., "Static object detection based on a dual background model and a finite-state machine". EURASIP Journal on Image and Video Processing 2011.

[10]. Birch, P., Hassan, W., Bangalore, N., Young, R., Chatwin, C., "Stationary traffic monitor". In Proc. 4th Internat. Conf. on Imaging for Crime Detection and Prevention (ICDP-11), pp. 1–6, 2011.

[11]. Tian, Y., Feris, R., Liu, H., Humpapur, A., Sun, M.-T., "Robust detection of abandoned and removed objects in complex surveillance videos". In Proc. IEEE 2010.

[12]. Porikli, F., Ivanov, Y., Haga, T., 2008. "Robust abandoned object detection using dual foregrounds" EURASIP Journal on Advances in Signal Processing 2008.

[13]. James Ferryman et al, "Robust abandoned object detection integrating wide area visual surveillance and social context" in Pattern Recognition Letters 34 (2013) 789–798 Elsevier 2013.