Detection and Identification of Unattended/Removed Objects in Video Surveillance

Lakhan H. Jadhav, Bashirahamad F. Momin,

Abstract—**This paper presents an unattended or removed Object detection method for video surveillance data captured by single static camera. Two backgrounds are modelled with different learning rates; one for transient and another for permanent. These both backgrounds are defined as a mixture of Gaussian model, it uses online Bayesian for updating. Two binary foregrounds are extracted by subtracting those backgrounds from current frame. Then shadow removing algorithms are applied to extract the real shape of the foreground objects. Then blob level likelihood image model is used to detect temporary static objects. Then we classify the extracted object using features like size, height, width, colour of that object. Input to this is video and the output will be detection and classification of abandoned objects. Finally, we trigger an alarm on detection of abandoned object. We provide good results and efficient model which can be used in real time surveillance systems.**

Keywords—***video surveillance, background modeling, abandoned object.***

I. INTRODUCTION

Consumer surveillance cameras are available in low cost and everywhere. Advancement in smart surveillance cameras and high processing capabilities of computer has made it possible to design video surveillance system which can contribute for people safety in public places. Now a days there are various cases of explosive attacks with luggage left unattended or suicide bombing in case of still person. Automatically detection of left baggage unattended or removed objects is important in criminal investigation. Unattended object detection in consumer video surveillance becomes more difficult due to high volume of data, illumination, different weather conditions, occlusion and moving backgrounds. In these situations a traditional approach like object tracking fails. This paper proposes a method for detection of unattended/removed objects which works well under these conditions and helps to develop end-to-end system for automatic video surveillance. We detect temporarily static objects by maintaining multiple backgrounds with different learning rate. Attributes selected for classification and identification of static object are height, width, size, colour, time. The consumer requirements from unattended object analyzers are: identify suspicious, unattended objects within time of its abandonment and allow fast recognition of existence of threat. As a surveillance application automatic detection of abandoned object requires high accuracy and computation complexity should be low enough which will assure real time performance.

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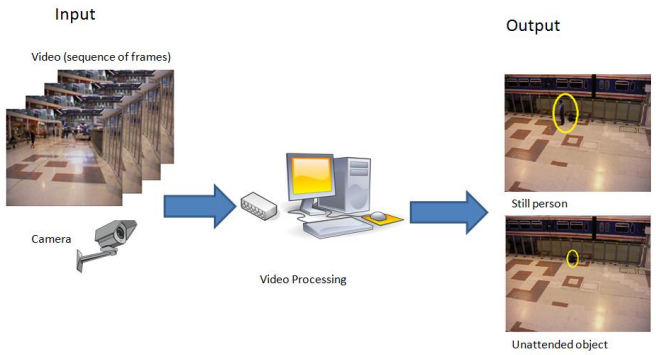

Fig.1: Surveillance system for unattended object detection.

Consumer surveillance system takes video as an input captured by surveillance cameras. It processes those videos and provides the required results. Fig:1 shows this structure, it takes video (I. e. The sequence of frames) as an input from camera, process that video and finally gives the output.

A. System requirements of unattended/removed object detection

In consumer surveillance system, detection of left or forgotten baggage and detection of removed or stolen objects is vital feature of any surveillance system. For this some surveillance system requirements are as follows:

1) Detection of static and moving objects should have sufficient accuracy for end user acceptance.

2) Low computational cost that will gives the real time results.

3) The conversion of visual data to semantic level data like still person existence, object stolen, baggage left.

The rest of the paper is organized as follows: section II covers the related work. Methodology is described in section III. Section IV shows the Experimental results. Finally, concluding remarks are presented in section V.

II. RELATED WORK

In literature, many approaches of object detection using background subtraction were proposed [1-4]. These methods mainly differ in the type of background model and procedure used to update background. Gaussian distributions have been utilized for updating the pixel intensities [4]. [4] shows good results in illumination and different lightening conditions. For motion based background subtraction and the detection of moving objects in complex backgrounds Adaptive Kernel Density estimation is used in [1]. [2] presents Background Modelling Approach for Moving Object Detection in

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illumination sensitive environment, to sudden illumination changes. A good review of Background subtraction techniques is given in [2], it introduces various background subtraction techniques and discuss the pros and cons of each.

Some papers are in literature which focuses on foreground analysis [5,6]. In [7] author uses spatial, temporal and spectral features to discriminate the background presence at each pixel. A model-based framework to segment static foreground objects against a moving foreground objects method used in [6]. Block matching has been used to calculate motion vector in [8].

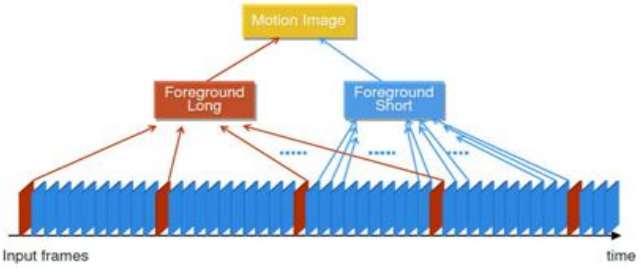

Fig.2: Long-term and short-term backgrounds are learned by processing video at different frame rates. Ref [11]

Stationary or static object detection using two backgrounds is discussed in [9][10][11]. In this two backgrounds are maintained for short and long length. Long-term and short-term backgrounds by processing video at different frame rates has been given in [11], It also presents Hypotheses on the long-term and short-term foregrounds. This hypothesis differentiate the moving, stationary , removed objects and scene background.

Abandoned/unattended object detection is discussed in [9][10][12]. [9] propose an intelligent vision based analyzer for semantic analysis of objects left unattended but it fails to handle the relation of unattended objects with human. A hybrid version of two level, timeliness background and edge features used in [10] for object detection and classification. [12] uses boundary matching to classify objects as abandoned or removed. In many surveillance systems, the initial background contains objects that are later removed from the frame or left into the frame. Classifying whether a foreground blob corresponds to unattended or removed objects or still person is an essential problem with background model, but current systems ignore it.

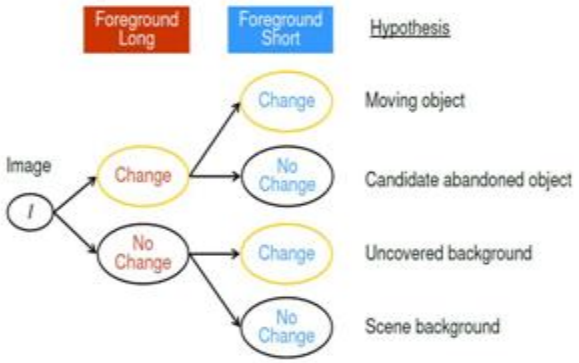

Fig. 3:Hypotheses on the long- and short-term foregrounds. Ref [11]

III. METHODOLOGY

This section presents how we are going to implement this system. The block diagram of the proposed system is shown in fig: 4. It consist of three main components we will see each in brief.

A. Foreground Blob Extraction

The timely foreground blob extraction is done for that we model two timely updating backgrounds; one for Short Length and another for Long Length by simply varying learning rates of background updating. The main reason behind this is to differentiate between static regions that was changed and original background regions. After background modelling, background subtraction is performed to extract foreground objects. To get accurate foreground object shadow removal is applied, shadow removing technique eliminates the shadow pixels that are detected as foreground at time of background subtraction. Shadows changes the original shape of the object which will affect feature values so it need to be eliminated. The intensity and texture information is used to identify shadow pixels.

After background subtraction and shadow removing, the resulting detected moving objects may have multiple regions that correspond to a single object, this is called as split detections. Also, it may have multiple objects, which is called as combined detection. These both events split and combined detection, make the object detection and identification critical. To overcome this system should ensure one-to-one correspondence between detected regions and the actual object present.

Then features of each blobs are extracted. These features to be used in object identification. Features extracted are:

1) *Location*: It is the coordinates of centre of the blob.
2) *Height*: Height of blob in pixel.
3) *Width*: Width of blob in pixel.

B. Object Classification

Extracted object needs to be classified as moving, stationery and removed objects. Following algorithm describes this classification process:

ALGORITHM 1: Object Classification
Input: Two arrays of m and n elements respectively; Element contains Location, height and width of object

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1: //a1[] : Array having m elements
2: //a2[] : Array having n elements
3:for i = 1 to m do
4:    for j = 1 to n do
5:        if (a1[i].location ≈ a2[j].location and a1[i].height ≈
              a2[j].height and a1[i].width ≈ a2[j].width )
          then
6:            a1[i] is moving object;
7:            Discard a2[j] element from array a2;
8:            Continue i;
9:        end if
10:  end for
11:  //a1[i] doesn't match with any element in a2[].
12:   a1[i] is removed object;
13:   Pass a1[i] to rule based classifier;
14: end for
15: for each a2[k] do
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16: //a2[k] is stationary object.
17: Pass a2[i] to rule based classifier;
18: **end f**

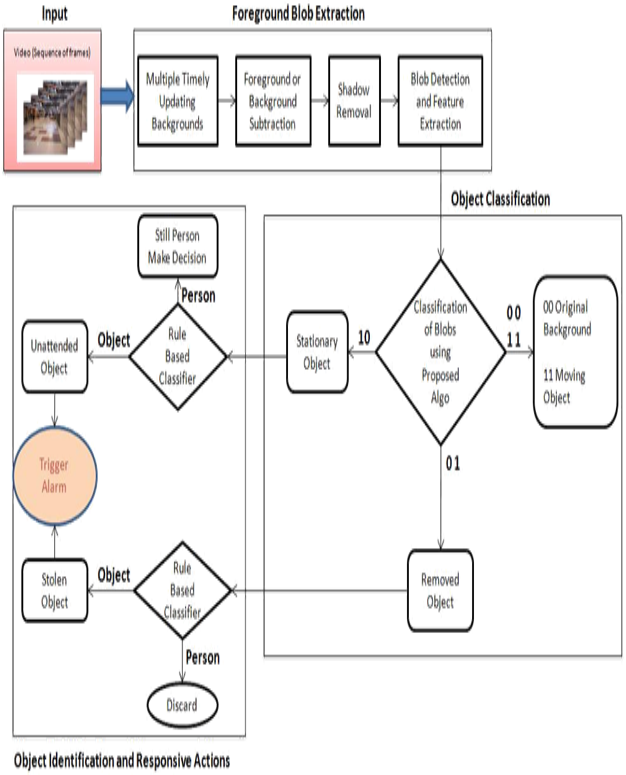

Fig. 4:Block diagram of proposed system

Objects are classified on the basis of its presence in Short Length and Long Length foreground. Below table clears this concept very well.

TABLE I: OBJECT CLASSIFICATION USING TWO FOREGROUNDS

Long Length Foreground	Short Length Foreground	Object Type
1	0	Stationary Object
0	1	Removed Object
1	1	Moving Object

C. Object Identification and Responsive Actions

After classification of objects as stationary or removed, they are identified and proper action is taken. To identify object rule based classifier is used. If static object identified as a person then it's considered as still person; but abandoned still person cannot be recognized automatically as he may waiting for someone so system leave that decision manually. If the object identified as baggage that is unattended baggage so system triggers alarm.

If object is removed one and identified as a person then it is the event of still person leaving the place so system discards it and is identified as baggage then it's the case of stolen objects, the system triggers alarm

TABLE II: PERFORMANCE OF PROPOSED SYSTEM

Data Set	Detection Rate	Classification Rate	Identification Rate	False Alarms
S1-T1-C	83%	89%	82%	8%
S2-T3-C	87%	90%	86%	10%
S3-T7-A	85%	87%	79%	17%
S4-T5-A	84%	93%	86%	13%
S5-T1-G	83%	92%	84%	9%
S6-T3-H	84%	88%	81%	9%
S7-T6-B	86%	91%	83%	12%

IV. EXPERIMENTAL RESULTS

Set of experiments carried out on surveillance data obtained from college campus using CA-IP600P camera and standard dataset PETS2006 to evaluate the performance of proposed system.

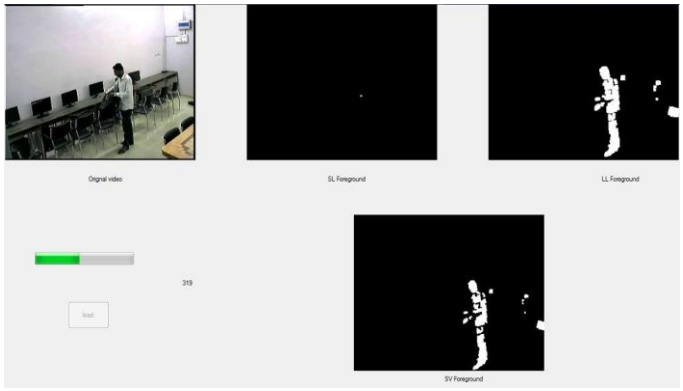

Fig.5: Long-term and short-term backgrounds , and identification of still person

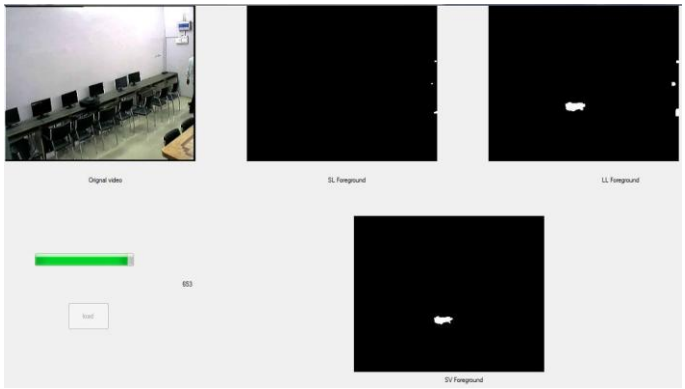

Fig.6: Long-term and short-term backgrounds and abandoned object

Modelling of two backgrounds, learning rates used are 0.005 and 0.0001 for short length and long length backgrounds respectively. Proposed system gives 84.57 percent accurate detection of objects, error occurs in crowded scenes and occluded regions. Classification of detected objects is performed 90 percent accurately using above algorithm.

In the experiment, for rule based classifier the training samples were randomly selected, and the remaining was for testing. It gives 83 percent average accuracy. Average detection of false alarms is 11.14 percent, false alarm occurs due to inability of recognize human behaviour. It can be improved by using human behaviour analysis; we put it for future work.

Following graph shows the performance of this system.

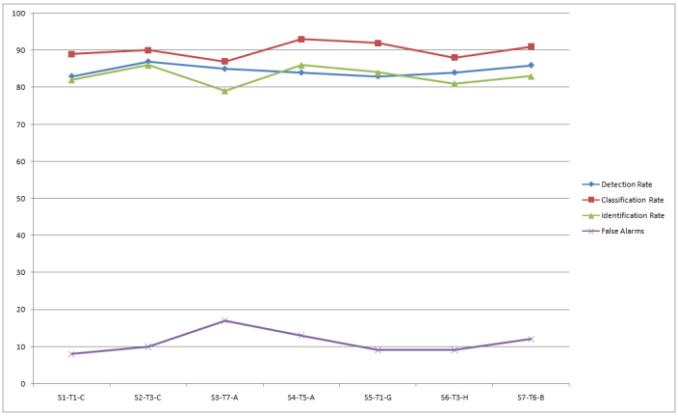

Fig.7: Performance of proposed system

V. CONCLUSION

This paper presents a method for detection and identification of unattended/removed objects in the consumer video surveillance system. For stationary object detection two foregrounds extracted using a dual background model. A hybrid model is used to detect stationary objects. Once stationary object is detected it's attributes are extracted in order to classify the object. Attributes extracted are height, width, size, colour and time. It is reliable and efficient in terms of computational complexity. For more accuracy more features like human baggage relation, human postures can be used.

ACKNOWLDGEMENT

I would like to express my sincere thanks to all who helped me directly or indirectly in this esteemed work. This is part of my Master's Dissertation work and sponsored under Research Promotion Scheme (RPS), AICTE, New Delhi, India (2013-2016).

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