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Abandoned Bag Detection in Video Surveillance Using Image Processing

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***Abstract:* - A key technology to fight against terrorism and crime for public safety, moving object detection and tracking has become very popular and one of the challenging research topic in various security areas of computer vision and video surveillance applications. Generally, an object is said to be abandoned if it is kept at a particular space in a video surveillance system & unattended for long time. An automatic abandoned object detection system typically uses a combination of background subtraction and object tracking to look for certain predefined patterns of activity that occur when an object is left behind by its owner. We propose a method to detect abandoned object from surveillance video using Image Processing. In first step, foreground objects are extracted using background subtraction methods. In second step, static objects are detected by using contour features of foreground objects of consecutive frames. In third step, detected static objects are classified into human and non-human objects by using edge based object recognition method. Nonhuman static object is analyzed to detect abandoned object. Experimental results show that proposed system is efficient and effective for real-time video surveillance.**

Keywords: - Image processing, Abandoned Objects, Video Surveillance, Background Subtraction, Static object.

I. INTRODUCTION

Nowadays the whole world is worrying about the problem of terrorism. The probability of an emergency situation is especially high in crowded places. In such a situation any bag left unattended can be potentially dangerous. Therefore, the abandoned object detectionion of the great importance for ensuring security in the public areas. Abandoned object detection is the most challenging task in video surveillance system. The fear of terrorism has grown among people in the world. There were threats for more attacks and the world live in fear. People fear to take public transportation with the attacks in their mind. When using public transportation, people now tend to be more scared for abandoned luggage. To provide people a safe feeling when travelling with public transportation, it is necessary to have better security systems at transportation areas and their surroundings. Security cameras that can recognize suspicious circumstances automatically are convenient in this case. Even though security guards are watching the security videos, they are not always able to detect all the crime. With software that is able to detect crime automatically, the guard will be warned and he can watch at the videos and trigger an alarm if necessary. An increasing number of places are covered with Closed-Circuit Television (CCTV) cameras to prevent terrorism. The captured videos are fed to central control rooms with the security staff monitoring the videos. By that, the security staff will be able to detect suspicious activities and thus ensure public safety. For this reason, the use of surveillance cameras has increased rapidly and has become a part of the daily life in public and private places.

Although public areas are observed by many surveillance cameras, humans can monitor a few cameras at a time. This causes the scarcity that humans are unable to observe all kind of situations on certain cameras simultaneously. If a crime is committed, the cameras are only able to help with the investigation. Also the tasks of the security staff includes more than The problem can be defined as, develop a user-friendly system which is able to detect abandoned luggage in public transportation and surroundings using video captures as the input of the system. When a suspicious left behind luggage is detected, the system must trigger a warning signal to the user. The objective of the project is: Design and implement an abandoned luggage detection system on the train or the area around it. This system will trigger a warning when an abandoned luggage is detected ,To extract the foreground objects from the background, the background model must be developed first; the light condition must remain constant as much as possible and the environment should not be over exposure and light conditions must remain constant as much as possible to avoid occlusion.

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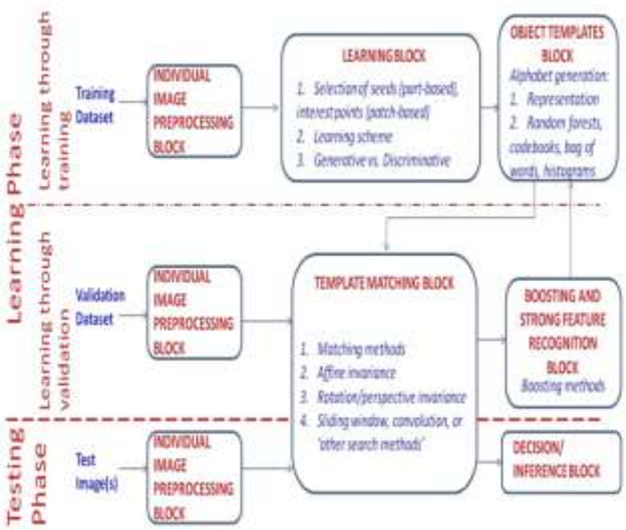

Fig.1. Block Diagram of Typical Object Detection

II. RELATED WORK

There are several systems that have been presented that can detect abandoned objects. Most of those use only intensity-level images such as the system presented by Sachi and Rigzone [1]. Lately, however, some have moved on to use colour images such as the system presented by Yang and the system by Beynon[2]. The work presented here utilizes colour information as a useful clue for background segmentation These works also present results only on scenes with very few, non-occluding people[3]. It should be noted that the system presented by Beynon, utilizes multiple cameras focused on the same scene, and is not practical for many areas where automated abandoned object detection may be desirable[4]. The system developed must be able to stay active around the clock, thus requiring a dynamically learned background model that can change as the natural lighting does throughout the day[5]. The system must be able to deal with people who stop and sit for extended periods of time and not regularly detect them as abandoned objects[6]. A logic-based system is introduced to classify detected objects as either an abandoned object or a still person[7].

An automated system which will alarm the security staff when abandoned luggage is detected or warn the traveler when he or she leaves the luggage unattended[8]. This proposed system aims at detecting abandoned luggage at the train station and its surroundings[9]. Generally, the users of this version are the security staffs[10]. The user of this version will only see the end visual output of the process and its related information which is relevant for the users[11]. With this, the users can observe the danger of detected abandoned luggage and therefore take the necessary[12]. Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it[13]. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image[14]. Nowadays, image processing is among rapidly growing technologies[15].It forms core research area within engineering and computer science disciplines too[16]. Image processing basically includes the following three steps: Importing the image via image acquisition tools,, analyzing and manipulating the image ,Output in which result can be altered image or report that is based on image analysis[17]. There are two types of methods used for image processing namely, analogue and digital image processing. Analogue image processing can be used for the hard copies like printouts and photographs[18]. Image analysts use various fundamentals of interpretation while using these visual techniques[19]. Digital image processing techniques help in manipulation of the digital images by using computers[20]. The three general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement, and display, information extraction The different video and image processing methods are often grouped into the categories listed below[21]. There is no unique definition of the different categories and to make matters worse they also overlap significantly. Here is one set of definitions: Video and Image Compression This is probably the most well defined category and contains the group of methods used for compressing video and image data. Image Manipulation This category covers methods used to edit an image[22]. For example, when rotating or scaling an image, but also when improving the quality by for example changing the contrast[23]. Image processing originates from the more general field of signal processing and covers methods used to segment the object of interest. Segmentation here refers to methods which in some way enhance the object while suppressing the rest of the image (for example the edges in an image)[24]. Video processing covers most of the image processing methods, but also includes methods where the temporal nature of video data is exploited. Image Analysis Here the goal is to analyze the image with the purpose of first finding objects of interest and then extracting some parameters of these objects[25]. For example, finding an object's position and size[26].

Machine Vision When applying video processing, image processing or image analysis in production industries it is normally referred to as machine vision or simply vision. Computer Vision Humans have human

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vision and similarly a computer has computer vision. When talking about computer vision we normally mean advanced algorithms similar to those a human can perform, e.g., face recognition. Normally computer vision also covers all methods where more than one camera is applied.

Fig.2. Feature extraction using edge based techniques

In recent years, the use of visual surveillance has increased rapidly, as described in Introduction. This is also a major research area in computer vision. The purpose of using video surveillance is to prevent crime and terrorism, secure public safety and manage transport network and public facilities efficiently. As a result, the necessities for 'smart' surveillance system are needed. Such system must be able to observe and obtain detailed information about the activities and behaviors of people. The system will be able to allow security services to respond quickly to potentially critical situations, improving the safety and security in public environments. Therefore, object detection and tracking is very important and challenging, since, we must deal with merging, splitting, entering, leaving and correspondence in crowded areas. The problem becomes more complex, when the public area is observed by multiple cameras at once. Several 'smart' cameras have been developed, but they need to be evaluated in order to prove the quality of the implemented system and to highlight the possibilities for system improvement. To achieve this, it is convenient for researchers to use the same video data for evaluation. Most surveillance system uses the following steps to develop a good quality system such as Object Detection, Object Tracking ,Object Classification ,Object Recognition and Alarm Warning.

III. PRESENT AND PRELIMINARY WORK

To track the various objects in the scene precisely, the evaluation of Object Detection algorithms will have a great influence in the overall performance of the whole system. So, the segmentation between foreground and background object is crucial in Object Detection. Therefore, Object Detection is normally the first step in the developing process. Tracking the detected object (Object Tracking) is for understanding the event, which is observed by the surveillance cameras. The challenge in this step lies in tracking multiple targets which overlap each other within crowded areas. Having the result of the tracking, the object will be classified (Object Classification) according to various features such as color and shape in order to recognize the luggage and persons (Object Recognition). After developing all these steps, an Alarm Warning will only be given if the detected and recognized luggage is abandoned. The system which is presented in this paper for detecting abandoned luggage uses a low-level tracking module and a high-level event inference to solve the tracking and event recognition problem. The tracking module is a combination of a blob tracker and a human tracker, whereas a Bayesian inference framework is used for the event recognition.

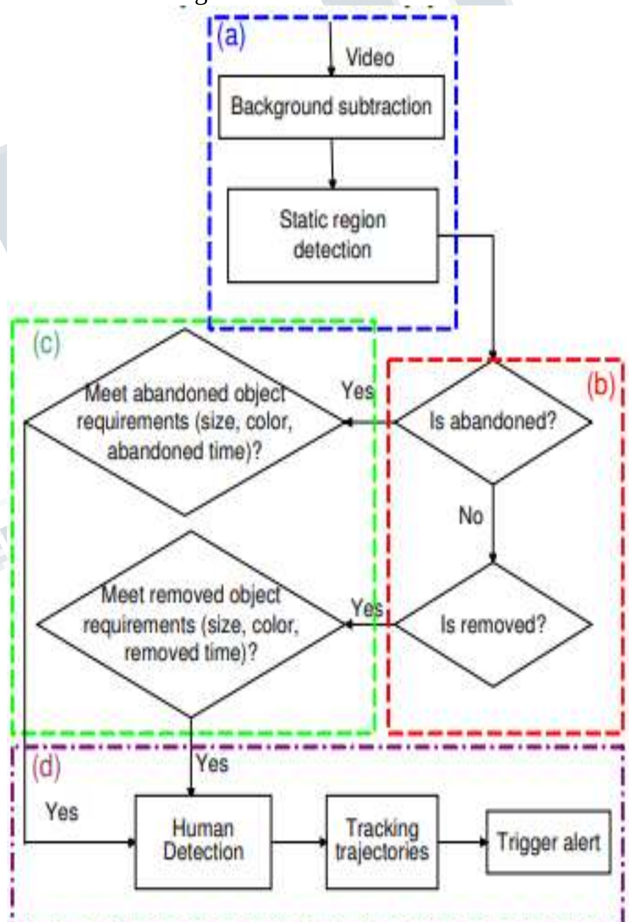


Fig.3. System Architecture

To detect the foreground objects including human and carried objects, a Kalman filter is used. By applying the background model, which is trained using the first five hundreds frame, the pixels of interest is detected and constructed into blobs. Each blob has information about its size, location and appearance (color histogram). Blob merging and splitting is done by assigning an association value based on overlap between the blob and object bounding boxes. Once the blobs are created and all the blob merging and splitting are done, the luggage is detected and located based on their mobility. The reason of using mobility is because luggage hardly moves after it has been tracked. However, this blob tracker has some shortcomings. That is, the tracker cannot separate a previously merged human object well. Also, detecting object based on mobility will sometimes lead to misidentifying.

Algorithm: Contour edge based detection algorithm

Step1:Compute image derivatives (with smoothing) by convolution

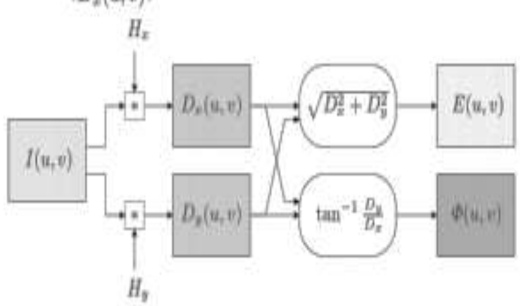
$$D_x(u,v) = H_x * I \quad \text{and} \quad D_y(u,v) = H_y * I$$

Step2:Compute edge strength - gradient magnitude

$$E(u,v) = \sqrt{(D_x(u,v))^2 + (D_y(u,v))^2}$$

Step3: Compute edge orientation - gradient direction

$$\Phi(u,v) = \tan^{-1}\left(\frac{D_y(u,v)}{D_x(u,v)}\right) = \mathrm{ArcTan}(D_x(u,v), D_y(u,v))$$



The human tracker algorithm based on human shapes, is a simplified version of Wu and Nevada’s work and it is only meant for tracking humans. It uses three trained full-body detector, each with a different view (left, front/rear and right), to scan the image. The angles of the detectors are in the range [0°, 45°].The union of the scanning results will be the detected multi-view human detection result. Then, the detected human objects are tracked in 2D using data (frame detection result) association style method. Although the learned detectors are in the range of [0°, 45°], when the angle is a bit to large, detecting human will become less reliable. By combining these two trackers, both limitations will be compensated.

Algorithm: Kalman filter

```
def  Kalman_Filter() :
  for n in range(measurements):
     x = A*x+B*u[n]
     P = A*P*A.T + Q
 # Measurement Update (Correction)
 # ================================
 # Compute the Kalman Gain
    S = H*P*H.T + R
    K = (P*H.T) * np.linalg.pinv(S)
 # Update the estimate via z
    Z = mx[n]
    y = Z — (H*x) # Innovation or Residual
    x = x + (K*y)
 # Update the error covariance
    P = (I — (K*H))*P
```

Since the properties of the result of the tracking module are measured in world coordinates, 2D object must be mapped to 3D world coordinates first. This mapping is based on the camera model. Next for the event recognition, an event model for each possible event is developed. Because it is necessary to handle each ambiguity in the event definition, therefore the event model is based on Bayesian inference. Events are considered as hypotheses, whereas related cues as evidences. By detecting abandoned luggage based on those events, an alarm or warning is triggered with high probabilities. The first prototype is the simplest of all prototype phases. The system will take only one input image and it has to be able to recognize the luggage. In the first phase, the object and the background are static. At the end of this phase, the system is able to classify the luggage. In the second prototype phase, the input will be a sequence of images and thus not a single image anymore. The objects, the luggage and the travellers are now allowed to be dynamic but still the background should be static. The output from this phase will be a system which is able to distinguish travellers and luggage.

Algorithm: Bayesian Inference Algorithm

Input: Bayesian network variables X where Xn ∈ X is the
only leaf representing the failure
Output: A sorted set of the root variables S
begin
Step1:Calculate the prior marginal probability of failure P(xn)
Step2: for each root node do
Step3:Calculate the posterior marginal probability P(xn|x¯i)

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Step4: Calculate the variable's effect $P(xn) - P(xn|\bar{x}i)$
Sort variables descendant according to their effect
Step5:Determine the variable Xi with the greatest effect
Step6: Store the variable Xi in the set S
Step7: Define the partial set
Xr as the set of roots excluding Xi
while The set Xr is not empty do
for each node Xj ∈ Xr do
Step8:Calculate the posterior marginal probability
$P(xn|\bar{x}i , \bar{x}j)$
Step9: Calculate the variable's effect
$P(xn|\bar{x}i) - P(xn|\bar{x}i , \bar{x}j)$
Step10:Determine the variable Xj with the greatest effect
Step11: Store the variable Xj in the set S
Update the set Xr = Xr \ Xj
return S

IV. IMPLEMENTATION & RESULTS

In order to extract the region of interest, the foreground should be extracted from the image. This way the background does not have to be considered anymore in further processing. The result of the foreground subtraction will affect the accuracy of the object recognition.

People and Luggage recognition: To understand the semantics of the extracted foreground, this process has to distinguish the various kinds of objects that may occur in the scene. These objects include people, luggage and other moving objects. However, before the recognition can take place, we have to examine the input first and then extract the features that are useful. Examples of these features are shapes, texture and colour. Using the generated rules from the knowledge based system, it will be possible to classify the various objects.

Fig.4. Identification of suspicious bag

Object Tracker: This is to keep track of the recognized objects in the scene. Because the proposed system has to process images received, it is important that objects in the scene are being tracked over time. The information in each processed frame will be used in the next step to classify different behaviours. Behaviour recognition Since the objects are recognized and its movement are analysed with respect to its surroundings, the behaviour can be determined. Depending on the actions of the objects that are being tracked, we can classify the recognized behaviour into two classes: normal and suspicious behaviour. Some techniques that can be used to realize this are pattern recognition techniques and neural networks. The features that are used to classify the behaviours are velocity, distance to other objects, etc.

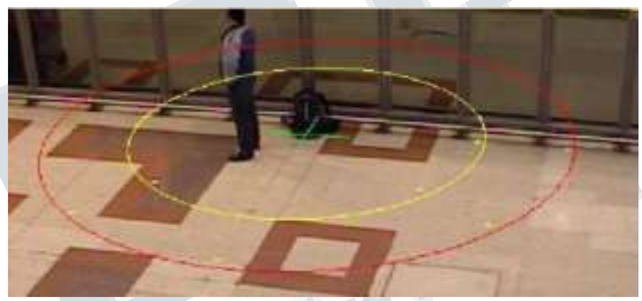

Fig.5. A person within the 2 meter radius

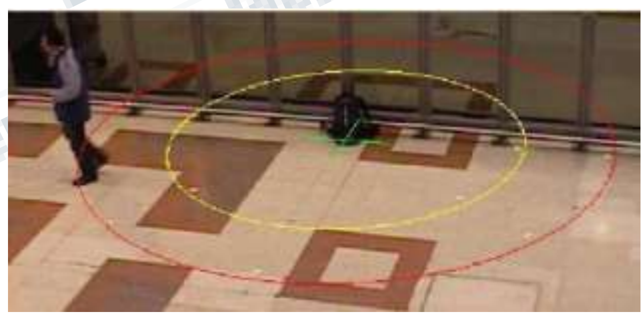

Fig.6. A person crossing the 3 meter

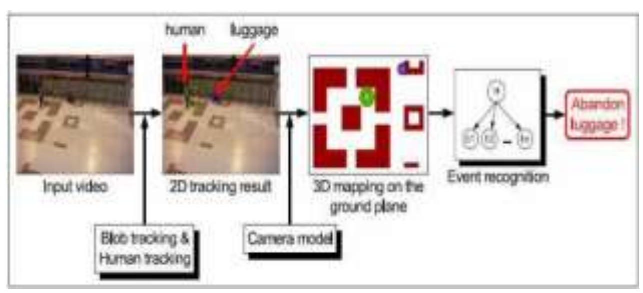

Fig.7. Overview of the system

In this, we propose the approach for abandoned bag detection. Obtained results indicate that the proposed approach for real-time bag detection ensures high quality characteristics for difficult crowded scenes.

V. CONCLUSION

In this, we propose the approach for abandoned bag detection, obtained results indicate that the proposed approach for real-time bag detection ensures high quality characteristics for difficult crowded scenes. While the concept of the proposed system may be really helpful to improve the level of safety and comfort, there are still improvements that are possible in the future. Some of the thinkable improvements are, Instead of using single input from the camera, it is possible to use a network of cameras. This will reduce the number of false positives. By having multiple views of the various object problems that can occur with only one camera such as occlusion and overlapping objects can be tackled. If the cameras can communicate with each other it is very helpful to track the moving objects in bigger areas. To track a person for a longer period, it is convenient for the system to know who this person is. For this an identical face tracking is important. This way a person can be identified by the system

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