A Study on Abandoned Object Detection Methods in Video Surveillance System

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Abstract

Now a day, there is a need to do research in abandoned object detection due to increase in attack by terrorists or anti social elements at public places. The traditional way to observe the places or to track the places is the CCTV cameras which require a human operator to monitor the digital camera images. Although public areas are observed by many surveillance cameras, humans can monitor a few cameras at a time. In real world monitoring applications, abandoned object detection remains to be a challenging task due to factors such as background complexity, illumination variations, noise, and occlusions and "ghost" effect which is left by the removed object. As a fundamental first step in many computer vision applications such as object tracking, behavior understanding, object or event recognition, and automated video surveillance, various algorithms have been developed ranging from simple approaches to more sophisticated ones. In this paper, the study on the different methods proposed so far for detecting the abandoned object in the surveillance area is provided.

1 Introduction

Many public or open areas are facilitated with cameras at multiple angles to monitor the security of that area for keeping citizens safe. This is known as the surveillance system. Video surveillance is a process of analyzing video sequences. There are three types of Video surveillance activities. Video surveillance activities can be manual, semi-autonomous or fully-autonomous. The detection of suspicious object is one of the most important tasks in video surveillance. Suspicious objects are generally unattended packages left in public places. Detecting abandoned object is a very important in places including airports, railway stations, big shopping malls where there is potentially high security threat. An abandoned object is an object which

is left at a particular place under surveillance and unattended over a period of time. First, the object is said to be abandoned if it is a foreground object. Second, it should remain static in recent frames or for some time t. The surveillance should be 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. There is a probability that any immobile object can be flagged as suspicious, causing a high number of false alarms. These costly incidents could be prevented by classifying suspicious objects as either living or non-living [1]. So the system needs to prevent from false alarm which is caused by partially static objects.

2 Related Works

Many algorithms and methodologies were introduced in abandoned object detection in video surveillance system in the last few decades. Tracking of stationary foreground regions is one of the most critical requirements for surveillance systems based on the tracking of abandoned or stolen objects or parked vehicles. Object tracking based techniques are the most popular choice to detect stationary foreground objects because they work reasonably well when the camera is stationary and the change in ambient lighting is gradual, and they also represent the most popular choice to separate foreground objects from the current frame [3]. In [3], various object detections and tracking techniques were analyzed. And they proposed a method to provide a real time application. They used BGFG method to detect the captured video for component analysis. And indentify the object using viola John algorithm which can indentify complex and complete object accurately and able to handle the problem of occlusion.

Detection of moving objects in video streams is the first relevant step of information and background subtraction is a very popular approach for foreground segmentation. In [13], there are different simulation of background subtraction methods to overcome the problem of illumination variation, background clutter and shadows. They surveyed the object detection and tracking methods to improve the performance of motion segmentation algorithm and Block matching technique.

Similar work is done in [8] where various background subtraction methods such as Background Subtraction with Alpha, Statistical Method, Eigen Background Subtraction and Temporal frame differencing to detect moving object were analyzed. They also described tracking methods including point tracking, kernel tracking and silhouette tracking.

3 Video Surveillance System

In recent years, video surveillance system has become extremely active application-oriented research areas in computer vision, artificial intelligence, and image processing. The monitoring system in the early days used the tube camera to broadcast and monitor the industrial processing. The traditional video surveillance system which is normally called Close-Circuit Television (CCTV) was defective and costly. No matter how vigilant the operators, manual monitoring inevitably suffers from information overload, as a result of periods of operator inattention due to fatigue, distractions and interruptions. In practice, it is inevitable that a significant proportion of the video channels are not regularly monitored, and potentially important events are overlooked. Furthermore, fatigue increases dramatically as the number of cameras in the system is increased. Automating all or part of this process would provide significant benefits, ranging from the capability to alert an operator to these potential events of interest, through to a fully automatic detection and analysis system. However, the reliability of automated detection systems is a very important issue. Therefore, automated video surveillance systems succeed to assist security staffs by generating real-time alerts and forensics investigation due to support advanced video analysis techniques.

Now a days, video surveillance system has been expend to various prominent domains of technology and science such as homeland security, crime prevention through indoor and outdoor monitoring, elder care, accident detection, traffic monitoring, controlling and traffic flow analysis, airborne traffic management, maritime traffic control, counting moving object (pedestrians, vehicles), human behavior understanding, Motion detection, activity analysis, identification, tracking, and classification of (vehicles, peoples, and any object of interest). There is also a growing demand for applications to support monitoring indoor and outdoor environments like parking lots,

shopping mall, airport, train station and so on due to the development, availability, and low price of processors and sensors [6]. Different types of video surveillance systems can be used for object tracking, behavior analysis, motion analysis and behavior understanding

4 Methods for abandoned object detection

The methods used to detect abandoned objects in video surveillance system may differ due to various aspects. Such as, some system used static camera and some used moving cameras. The most popular method is background modeling method and tracking based method. Background modeling method usually based on the Gaussian mixture model. Many researchers then modified this method according to their need. In a typical system for event detection, a set of processing stages needs to be performed. First, the relevant objects present in the observed scene need to be detected. In the next step, object classification should be performed which allows distinguishing various object types. Such an operation allows for further analysis depending on the object category.

4.1 Background Modeling Methods

Many algorithms have been proposed by the researcher to detect static foreground region in the video frames. A. Singh has proposed the method on dual background segmentation in which blob detection, tracking is done but main methodology is to find out the object through intensity and frame delay [2]. The most popular method is based on background subtraction because they are robust in complex real-world scenario. In this method, the two major task background maintenance and static foreground object detection. Gaussian Mixture Model is the most popular choice for modeling the background and foreground. GMM can be use for pixel level analysis. The existing methods can be divided into two categories based on the use of one or more background subtraction models.

In the first categories, some researcher made frame-by-frame analysis which is based on the typical background subtraction techniques then followed by another type of analysis (e.g., Tracking). Such approach is use in [9]. Their approach differs in at least two major ways from previously reported work. First, they analyze relationships

between objects. Second, they have exploited multiple cameras with overlapping fields of view to cope with occlusions of various types, and have empirically observed this to be essential in realistic situations.

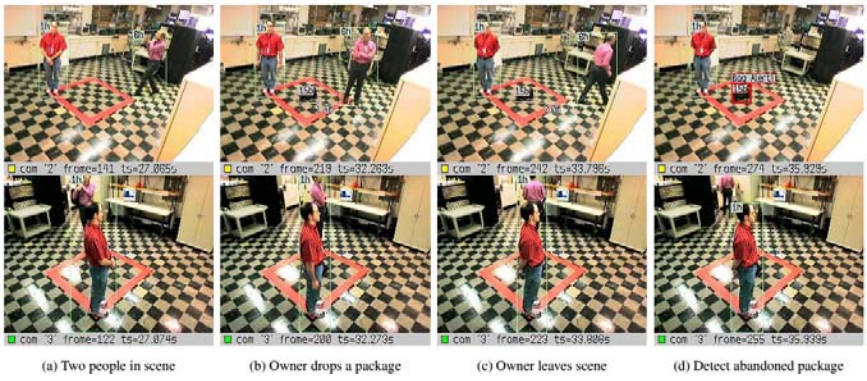

Fig. 1. Alert notification snapshot illustrating the owner relationship correctly alerting when the owner leaves [9].

[16] Introduced a probability based method which uses multiple backgrounds. And also introduce logic-based system to classify detected objects as either an abandoned object or a still person. They analyze the intensity variance of recently changed pixels that still static after change to distinguished form the actual background pixels. They used three background models namely Frequently-updated Background model (FB), Occasionally-updated Background model (OB), and Probability-based Background model (PB) and update them by introducing the stable history maps and difference history maps. This approach does not require the construction of the original background.

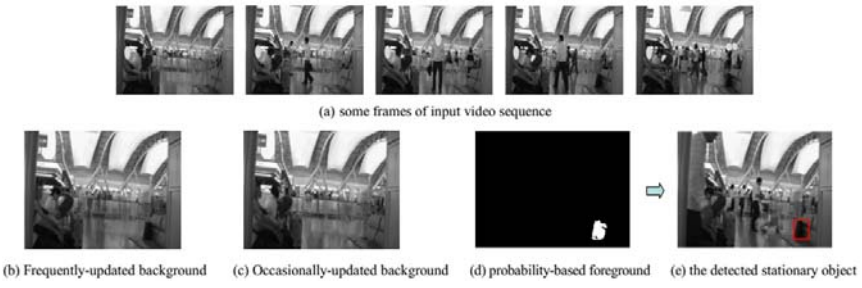

Fig. 2. The result of stationary object detection [16]

The approach in [5] maintains two backgrounds one for long term and the other for short term, both of them are modeled using GMM, And for every frame long and short term foregrounds are estimated by comparing the current frame by the background models BL (Long term background) and BS(short term background). The long term foreground mask FL(Long term foreground) shows the color variations in the scene that were not there before including moving objects, temporarily static objects, as well as moving cast shadows and illumination changes that the background models fail to adapt. The short-term foreground mask FS (Short term foreground) contains the moving objects, noise, and so forth. Adaptation of the long- and short-term background models by a Bayesian update mechanism.

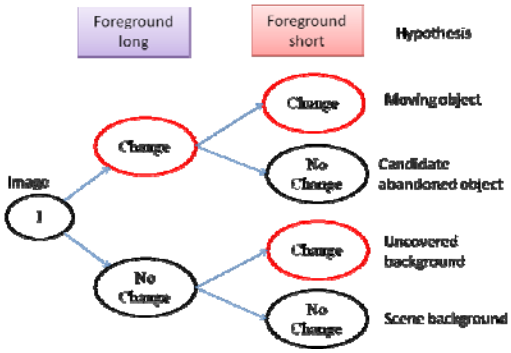

Fig. 3. Combination of two background substation methods to detect stationary regions

The conventional approach usually rely on pixel-level processing while the approach in [7] use region-level analysis for both background maintenance and static foreground object detection. In their approach, the preliminary foreground map is obtained by eliminating the pixels could include in the background with high probability. The threshold for “foregroundness” is given for each pixel to adaptively update the background. Then differentiate the foregroundness score based on the global properties of the blob the pixel belongs to. Again, the “abandoness score” is defined for each pixel in candidate foreground object. Region-level analysis is done to each candidate abandoned blob in order to eliminate false alarm.

4.2 Tracking Based Methods

Most tracking-based approaches are designed for multiple camera systems, and they need to detect all moving objects accurately. They usually encounter the problem of merging, splitting, occlusion, and identity correspondence. These problems are not easy to solve in many cases. And it is difficult to track all the objects precisely in crowded situations [16].

A tracking based approach is proposed in [4] which there are three levels of processing, even in this tracking based method the first step is background modeling, in low-level processing to maintain object position the background updating is modified through feedback from high-level modules. In the middle level for tracking the object, position and color features are used. The next is the high-level processing which is important, in which if there is person object split the system classifies objects as abandoned or stolen and an alarm is raised.

In the system proposed in [15] abandonment of a object is defined in terms of four sub-events that lead to it entry of the owner with the bag, departure of the owner without the bag, abandonment of baggage and consequent timed alarm, and the possible return of the owner to the object, in this at the first sighting of unattended baggage, the system traces it back in time to look for its owner. The owner of the bag is conservatively defined as the person who brings it into the scene. Once a candidate owner has been associated with the bag, a search for the owner is initiated. If the owner is found to be missing from the detection zone for longer than t seconds, the bag is deemed as abandoned and an alarm is raised. If eventually the person returns to the bag, the alarm is stopped

The proposed system in [11] and [12] detects the abandoned object using different modules. In the first module, the initial live video stream is segmented into individual images to extract a region of interest. The second module converted the accepted video in to frames and apply Gaussian blur to reduce the noise. Then the frame has to go through pre-processing steps. The pre-processing step include convert the color images into gray scale images in order to simplify the computation. The intensity image will get through the calculation of Max (RGB). Then the dual background subtraction and object tracking is performed.

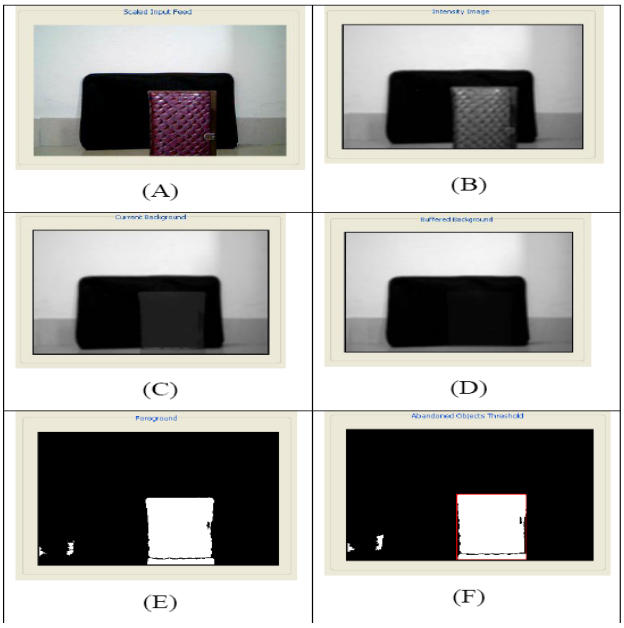

Fig. 4. Experimental Result [11]

Still object tracking module track the blobs which correspond to abandoned objects. A set Track is created as a first step which has three variables: blob properties, hitCount and misCount. Then the input images are analyzed for all the blobs. If the area change and the centroid position change, as compared to any of the elements of the set Track are below a threshold value then increment hitCount and reinitialize missCount with a zero; otherwise create a new element in the Track-set, initializing the blob-properties variable with the properties of incoming blob and hitCount and missCount are initialized to zero. Then run a loop through all the elements of the set. If the hitCount goes above a user defined threshold value, an alarm is triggered. If the missCount goes above a threshold, delete the element from the set. These two steps are repeated until there are no incoming images [11].

4.3 Other Detection Methods

The methods which does not use background modeling or tracking is very less. A robust method is proposed in [10] in which

unattended and stolen object detector is based on the fusion of evidences derived from three fast detectors that are independently applied and it exploit different types of information (shape similarity, contour similarity, background similarity) and to fuse them to increase the detection process robustness. First preprocessing is done to adjust the shape extracted from the binary foreground mask to the real object shape. This adjustment is made by using active contours proposed earlier. Then three independent detectors are applied to the candidate object. Each detector calculates two evidence values of the being unattended and stolen object hypothesis. Finally, a fusion scheme is applied on the evidences which are derived from the three detectors. As a result of the fusion process, two confidence measures are calculated for the likelihood of the object of being unattended or stolen. Afterwards, the maximum a posteriori criterion is selected to decide if the object is unattended or stolen.

The abandoned objects on the road can also threaten the security of the road. It can caused car accident and reduce the efficiency of transportation. Once an abandoned object is on the road, it may lead to economic losses and even cause loss of life, so it is very important to handle abandoned objects efficiently and in time [17]. So the researchers introduce road traffic surveillance systems based on three-dimensional image information. In their system, multiple cameras with overlapping view are used to construct 3D image of abandoned object. They implemented their system based on the proposed BIRR algorithm. First they detect suspected abandoned objects by static foreground region segmentation algorithm. Then its 3D information is reconstructed by the proposed algorithm and sends the information to the administrator.

Another method proposed in [14] detect abandoned object by analyzing geometric alignment of video frames. These approach has four main ideas, including the inter sequence geometric alignment, the intra sequence geometric alignment; the local appearance comparison and the temporal filtering are done for detecting the abandoned objects.

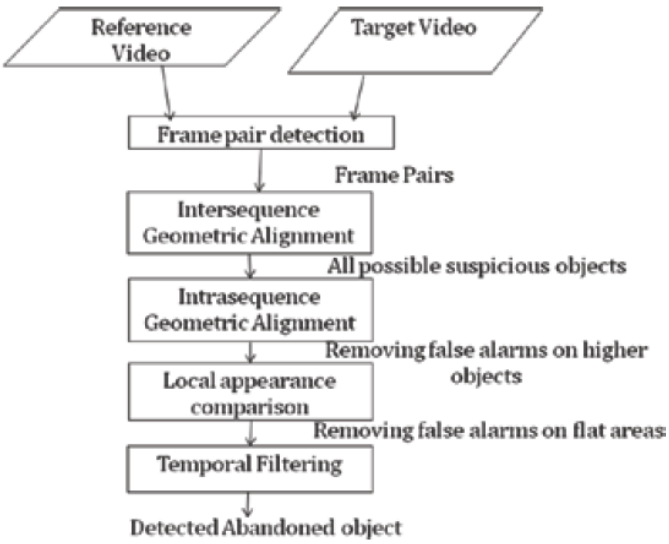

Fig. 5. Flowchart of proposed approach [14]

A moving camera is used to capture the reference video in which there is no suspicious object in the scene. Then they used another camera to take the target video using the similar trajectory. The inter sequence geometric alignment step is done to align the reference and target frames. It compares the two frames by using Scale Invariant Feature Transform to detect suspicious areas. The intra sequence geometric alignment step can be used to reduce false alarm. This consists of two steps: removal of false alarms on high objects and removal of false alarms in the dominant plane.

5 Conclusion

In this work, various methods for abandoned object detection in video surveillance system are studied. Different researchers introduced different methods to provide more effective way to detect abandoned object. In background modeling, the Gaussian Mixture Model is the most popular choice among other algorithm such as Kernel Density Estimation (KDE) and Eιγεν Βαχκγρουνδσ. Ηοωεϖερ, ινφορματιον χαρριεδ βψ ινδιϖιδυαλ πιξελσ ισ ηιγηλψ λιμιτεδ. Ασ α ρεσυλτ, Γαυσσιαν Μιξτυρε Μοδελ (ΓΜΜ) ισ φρεθυεντλψ οβσερϖεδ το

γενερατε ρατηερ νοισψ βαχκγρουνδ εστιματιον. Ιν αδδιτιον, πιξελ–λεϖελ αναλψσισ ισ ρατηερ διφφιχυλτ το ηανδλε ραπιδ ιλλυμινατιον χηανγε ασ ωελλ ασ □γηοστσ□ λεφτ βψ ρεμοϖεδ οβφεχτσ. Τηε ϖαριουσ ωορκσ βασεδ ον τηε τραχκινγ μετηοδ ηαϖε αλσο βεεν στυδιεδ ηερε. Βυτ τηε τραχκινγ βασεδ μετηοδ ισ νοτ εφφιχιεντ ιν ϖερψ χροωδεδ σιτυατιον. Σομε οτηερ ρεσεαρχηερσ ιντροδυχεδ τηε μετηοδσ τηατ αρε διφφερ φρομ τηε αβοϖε τωο μετηοδσ. Τηεσε ινχλυδε φυσιον οφ εϖιδενχεσ φρομ διφφερεντ δετεχτορσ ορ γεομετριχ αλιγνμεντ οφ ϖιδεο φραμεσ. Ανοτηερ ρεσεαρχηερ αλσο ιντροδυχεδ τηε ιδεα οφ υσινγ αβανδονεδ οβφεχτ δετεχτιον ιν ροαδ συρϖειλλανχε σψστεμ.

References

1. Alptekin Temizel.:Reducing the false alarm rate in abandoned object detection. SPICE (2011)
2. A. Singh, S. Sawan, M. Hanmandlu, V.K. Madasu, B.C. Lovell.:An abandoned object detection system based on dual background segmentation. IEEE 2009 Advanced Video and Signal Based Surveillance (2009)
3. Chandrashekhar D.Badgujar1, Dipali P.Sapkal.:A Survey on Object Detect, Track and Identify Using Video Surveillance. IOSR Journal of Engineering (IOSRJEN), vol. 2, pp.71-76 (2012)
4. Chih-Yang Lin, Wen-Hao Wang.:An Abandoned Objects Management System Based on the Gaussian Mixture Model. International Conference on Convergence and Hybrid Information Technology (2008)
5. Chuan-Yu Cho, Wei-Hao Tung, Jia-Shung Wang.:A Crowd-Filter For Detection Of Abandoned Objects In Crowded Area. 3rd International Conference on Sensing Technology, Nov. 30 – Dec. 3 (2008)
6. Fereshteh Falah Chamasemani, Lilly Suriani Affendey.:Systematic Review and Classification on Video Surveillance Systems. MECS, I.J. Information Technology and Computer Science (2013)
7. Jiyan Pan, Quanfu Fan, Sharath Pankanti.:Robust Abandoned Object Detection using Region-Level Analysis. ICIP, pp. 3597-3600. IEEE, (2011)
8. Kinjal A Joshi, Darshak G. Thakore.:A Survey on Moving Object Detection and Tracking in Video Surveillance System. International Journal of Soft Computing and Engineering (IJSCE), vol.2 (2012)
9. Michael D. Beynon, Daniel J. Van Hook, Michael Seibert, Alen Peacock, Dan Dudgeon.:Detecting Abandoned Packages in a Multi-camera Video Surveillance System. In IEEE Conference on Advanced Video and Signal Based Surveillance (2003)
10. Nathaniel Bird, Stefan Atev, Nicolas Caramelli, Robert Martin, Osama Masoud, Nikolaos Papanikolopoulos.:Real Time, Online Detection of Abandoned Objects in Public Areas. Proceedings of IEEE International Conference on Robotics and Automation, Orlando, Florida(2006)

11. Pallavi S. Bangare, Nilesh J. Uke, Sunil L. Bangare.:An Approach for Detecting Abandoned Object from Real Time Video. International Journal of Engineering Research and Applications (IJERA). vol. 2, Issue 3, pp. 2646-2649(2012)
12. Pallavi S. Bangare, Nilesh J.Uke, Sunil L.Bangare.:Implementation of Abandoned Object Detection in Real Time Environment. International Journal of Computer Applications, Vol.57, pp. 0975 – 8887(2012)
13. Rup esh Kumar Rout.:A Survey on Ob ject Detection and Tracking Algorithms. Master Of Technology Thesis, National Institute of Technology Rourkela Rourkela,India (2013)
14. S.S.Karthiga, B.Pandeeswari.:Detection of Abandoned Objects by Geometric Alignment of Video Frames. International Journal of Advanced Research in Computer Science & Technology (IJARCST), vol. 2 (2014)
15. Simon Denman, Sridha Sridharan, Vinod Chandran.:Abandoned Object Detection Using Multi-Layer Motion Detection.
16. Thi Thi Zin, Pyke Tin, Takashi Toriu, Hiromitsu Hama.:A Probability-based Model for Detecting Abandoned Objects in Video Surveillance Systems. Proceedings of the World Congress on Engineering, vol.2 (2012)
17. Yiliang Zeng, Jinhui Lan, Bin Ran, Jing Gao, Jinlin Zou.:A Novel Abandoned Object Detection System Based on Three-Dimensional Image Information. Sensors 2015, pp. 6885-6904(2015)