ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)

Detection of Abandoned Objects by Geometric Alignment of Video Frames

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Abstract

The traditional way to observe the places or to track the places is the CCTV cameras. The proposed system aims at detecting the abandoned objects, by using a moving camera to collect the target and the reference videos. The reference video covers the area under surveillance initially when there is no suspicious object. Then the target video is taken by following the similar trajectory where there may be some suspicious object. In particular, four steps are used to achieve the objective. First is the inter sequence geometric alignment, where we detect all possible suspicious areas. Then we go in for intra sequence geometric alignment, where the false alarms on high objects (e.g. trees) are removed. A local appearance comparison of two aligned intra sequence frames is used o reduce false alarms on flat areas. Finally, temporal filtering is done to confirm the existence of abandoned object. The proposed work is effective under different illumination conditions since a feature based technique is used here. Experiments on different pairs of reference-target videos reduce the false alarms than the previous methods considerably.

Keywords

Abandoned objects, Geometric alignment, temporal filtering, video matching and False alarms

I. Introduction

Research in abandoned object detection is a need nowadays due to increase in attack by terrorists or anti social elements at public places. Many video surveillance systems have been in operation for with the human controlled or monitored CCTV systems. Here the quality and the effectiveness of humans are not up to the mark. The number of algorithms have been suggested and implemented by researchers across the globe. But due to their complexity and probability issues, the implementation was not so fruitful using languages like Matlab, Java etc. The available work is done by implementing some algorithms to reduce noise but it was not as impressive as the noise was still creating hurdle in getting the output. To deal with this detection problem, a simple but effective framework based upon matching a reference and a target video sequence is proposed.

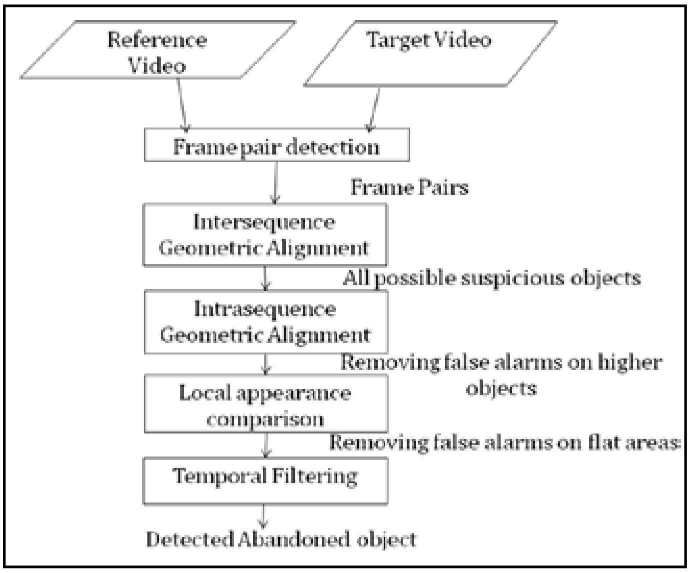

Fig. 1: Flowchart of proposed framework

The reference video is taken by a moving camera when there is no suspicious object in the scene, and the target video is taken by a second camera following a similar trajectory, and observing the same scene where suspicious objects may have been abandoned in the mean time. The objective is to find these suspicious objects. As shown in fig. 1, Four main ideas: 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.

II. Related Work

Many algorithms and methodologies have been proposed for Abandoned Object Detection. 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 [3]. Another method has also been proposed based on double illumination invariant Foreground mask and also proposes an automatic and robust method to detect and recognize the abandoned objects for video surveillance systems. Two Gaussian Mixture Models (Long-term and Short-term models) in the RGB color space are constructed to obtain two binary foreground masks [7]. The comprehensive solution for managing abandoned objects is proposed by Linet.al which means that the system can deal with the objects that are abandoned and removed. The system contains two adaptive abandoned object detection methods that are both based on the Gaussian mixture model for real environments. The first method is more efficient than the second one, but the latter is more robust than the former. The proposed methods are proved to be characterized with prominent efficiency and robustness according to the experimental results [6]. Similarly H. Kong et.al (2009) proposes a technique for detecting the vanishing point in an image. Initially SIFT features are applied to images to find the key points. SIFT is applied only to the valid key points. To reduce the effect of SIFT features of high objects (e.g. trees) on the homography estimation, it is better to apply it only to the image area which corresponds to the ground plane. This method is used to estimate the horizon line passing through the vanishing point of the road [5].

III. Proposed Approach

The proposed system has various approaches such as vanishing point detection, SIFT descriptor, geometric alignments and finally temporal filtering.

A. Vanishing Point Detection

Vanishing Point is detected in the frame under process. To find out the scale invariant features, instead of applying it in high objects the vanishing point of the image if found.Then,a horizon line passing through the vanishing point is computed and the pixels above that are removed to make the computation easier.

B. Scale Invariant Feature Transform

Scale Invariant Feature Transform which is useful in finding the key points which are further used in the processing to detect the suspicious object. Features are the most important things which are important in finding the key points. Because local appearance comparison has a high probability of showing a false location as a key point.

C. Intersequence Geometric Alignment

The inter sequence geometric alignment step is done to align the reference and target frames. The SIFT feature descriptor is initially applied to the target and the reference frames. To reduce the effect of SIFT features of high objects on the homography estimation, it is better to apply it only to the image area which corresponds to the ground plane. Therefore the horizon line passing through the vanishing point of the road is determined. Only the SIFT features below the vanishing point are viewed as valid. Coarse correspondences between the valid SIFT features of Ri and Ti are constructed. Specifically, first compute a 128-dimensional SIFT descriptors for each key point of the reference and target frames. For each descriptor in the reference frame, search its nearest neighbour in the target frame. Similarly, for each descriptor in the target frame, search its nearest in the reference frame. If the two nearest neighbours are consistent, view them as a match. The mRANSAC algorithm gives the homography model Hinter that optimally fits the input data. Based on Hinter, the reference frame Ri is warped into Ri to fit the target frame Ti. Get the NCC image between Ri and Ti and then binarize the NCC image into B1 in two frames of these videos. However, there are many false alarms in them. The intra-sequence geometric alignment removes these false alarms. All the possible suspicious areas have been highlighted by the inter sequence geometric alignment. But it includes many false alarms which is to removed by subsequent phases.

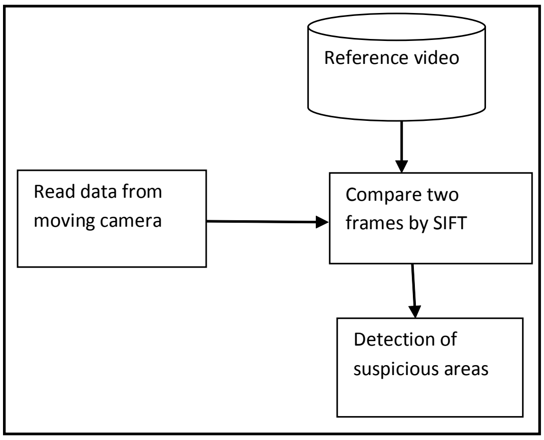

Fig. 2: Intersequence geometric alignment

D. Intra Sequence Geometric Alignment

The reference and the target frames are taken from the same video and warped. For intra-sequence alignment on R (reference sequence), align Ri and Ri-k. For intra-sequence alignment on T (target sequence), align Ti and Ti-k .k is an integer that depends on the speed of the moving camera. Since the speed of the moving camera is a constant take k as 5.Since the illumination variation between the intra-sequence reference and target frames is usually small, the intra-sequence alignment generally aligns the dominant planes very well (even when shadow appears in one and disappears in the order).Removal of false alarms consists of two steps,

- Removal of False Alarms on High Objects
- Removal of False Alarms on the Dominant Plane.

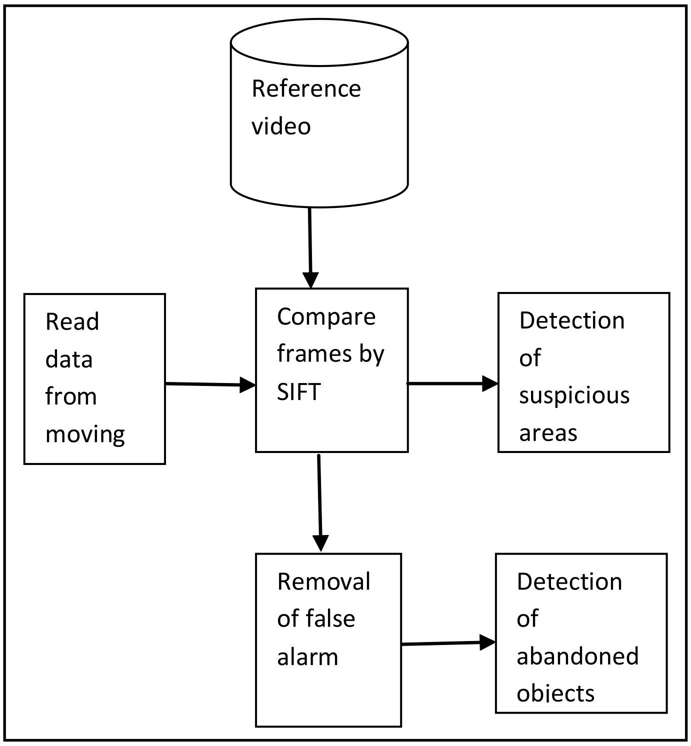

Fig. 3: Intrasequence geometric alignment

E. Local Appearance Comparison

The local appearance comparison is done between two aligned intra sequence frame pairs. The local appearance comparison is just as same as image subtraction method but done with two intra sequence aligned frame pairs. The local appearance comparison is done to reduce the false alarms that are caused by the flat areas.

F. Temporal Filtering

Temporal Filtering is used to get our final detection. Let K be the number of buffer frames used for temporal filtering. To assume that Ti after inter- and intra- sequence alignment is denoted by Bi3.B having i values 3,2,i-1, i are stacked into a temporal buffer T_{buffer}. The homography transformations between any two neighbouring frames of the buffer are also stacked into H_{buffer}. Based on these transformations, the B values for i-3,i-2, and i-1 are respectively transformed to the state which temporally corresponds to the ith frame, and are intersected with Bi3 respectively. The final detection map is the intersection of these intermediate intersections. A threshold for the size of the smallest non-zero cluster in the final detection map is also set. All possible suspicious areas are found using normalized cross correlation. Then further all the false alarms are reduced. The same steps which were used in

ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)

inter-sequence geometric alignment were used here. Instead of comparing target and a reference frame, either Ti and Ti-k or Ri and Ri-k are used here. K here depends on the speed of the moving camera. Then all the suspicious areas obtained from intersequence geometric alignment and intrasequence geometric alignment are maintained in a stack and using the threshold the abandoned object was detected.

TABLE 1: TEMPORAL FILTERING

INPUT : Target video sequence, T, buffer size K, and potential suspicious area B_{i3}, where I is the frame index
OUTPUT: Detection map: I_{dp}

Initialisation: Stack the initial B_{i3}, i=0,….,K-1 into the temporal buffer T_{buffer}. Compute the homography matrix H for any two neighboring frames f the initial K-1 frames of T and stack them into H_{buffer}.
For an incoming frame, T^i ,i=K,….,delta ,do:
1. Get B^i_3 and let $T_{buffer}(K) = B^i_3$; Compute H between T^{K-1} and T_K, and let
$H_{buffer}(K-1)=H$; Let $I_{dp} = T_{buffer}(K)$.
2. For u=1 to K-1
- $M1= T_{buffer}(u)$;
- For v=u to K-1
  $M2 = H_{buffer}(v) * M1$;
  M1=m2;
- $I_{dp} = I_{dp} \cap M1$;

3. Update T_{buffer};
  For j=1 to K-1
  $T_{buffer}(j) = T_{buffer}(j+1)$;
4. Update H_{buffer};
  For j=1 to K-2
  $H_{buffer}(j) = H_{buffer}(j+1)$;

IV. Experimental Results

To test the proposed system the Reference and Target videos are downloaded from the website http://sites.google.com/site/huikongsite/Home/Research. Here the videos are collected by the camera mounted in front of a car. About 3 reference-target video pairs from different road sequences are collected and tested for abandoned object detection. Among the 3 test video the number of objects present varies from 1 to 5. The proposed system detects almost all the objects but fails to detect one object in the third test video. Also the number of false alarms varies from none to 2.Detection fails in only one video where the objects is highlighted by inter sequence and intra sequence geometric alignment by eliminated as false alarm by the temporal filtering. All videos consists of road side sequence of images whereas the proposed system has been tested using reference and target video taken manually. In manually taken video sequences the proposed system also detects the things which are not present in reference video but present in target video sequence. But all the abandoned objects present are detected correctly by the proposed system. Some results are shown in following figures.

Fig. 4: Reference and Target frame pairs considered

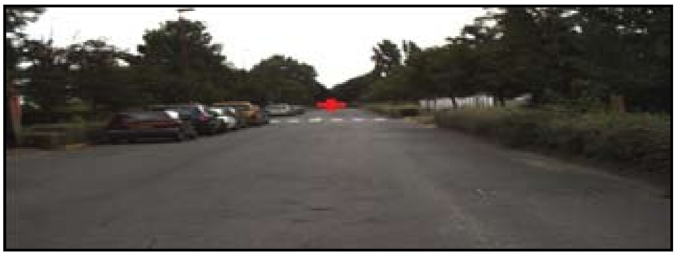

Fig. 5: Vanishing point detected for the given target frame

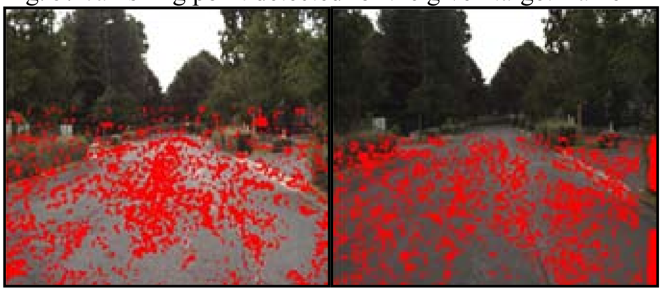

Fig. 6: Inter and Intra Sequence geometric alignment for target frame

Fig. 7: Abandoned object detection by temporal filtering

Table 2: Detection Results For 3 Reference-Target Video Pairs

Test video number	Test video 1	Test video 2	Test video 3
Number of abandoned objects actually present	1	3	5
Number of abandoned objects detected by proposed system	1	3	4

V. Conclusion and Future Work

The proposed System detects the non flat abandoned objects by a moving camera. Our algorithm finds these objects in the target video by matching it with a reference video that does not contain them. Four main ideas: the inter sequence geometric alignment, the intra sequence geometric alignment, the local appearance comparison and the temporal filtering based on homography transformation are used. Inter sequence geometric alignment was done and all possible suspicious areas were found. Then with intra sequence geometric alignment false alarms was reduced considerably. Then the suspicious areas obtained from both inter sequence geometric alignment and intra sequence geometric alignment were processed and abandoned object was detected by temporal filtering. The future work is to use Gaussian mixture model for vanishing point detection and to completely reduce the false alarms.

VI. Acknowlegement

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Author's Profile and Image

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