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Moving Object Detection and Tracking from Moving Camera

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Abstract – In this paper, we deal multi moving object detection and tracking under moving camera. Moving objects are detected by homography-based motion detection. After moving objects are detected, we apply online-boosting trackers to track moving objects. Because each tracker and detector is measured independently, we integrate two systems into one system. Hence, our algorithm detects and tracks multi moving objects without background modeling. We show experiment results from sequences which are obtained from natural outdoor scene.

Keywords – Moving object detection, multi-object tracking, online learning, surveillance.

1. Introduction

Moving object detection is an essential part of the surveillance system. Usually, moving object is detected under the static camera by the background subtraction algorithm. However, the assumption of the stationary camera has limits of the application of detection algorithm because of increase of moving camera platforms such as vehicles, robots and cellular phones. In this paper, we deal the moving object detection under the moving camera. And, to strengthen the detection rate, we integrate the tracking and detection into our system. Moving objects are detected by homography-based detection and we used online-boosting algorithm [1] to track the object. This paper is organized as follows: In section 2, we will explain the homography-based detection for the moving object detection. In Section 3, online-boositng alogithm will be reviewed and, in section 4, system integration of detection and tracking is described and we will discuss about the experiment result in section 5.

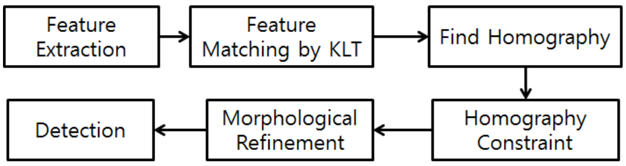

Fig. 1. Overflow of moving object detection.

2. Homography-Based Motion Dection

Overall system flow is depicted in Fig. 1. First we extract features as explained by J. Shi and et. Al [2]. After we extract features from images, we apply Kanade-Lucas-Tomasi (KLT) feature tracker [3] between two frames, and homography H is obtained by RANSAC scheme [4]. From homography H, we compare all pixels between two frames and get residual pixels which do not consistent in pixel intensity. Because these residual pixels only appear in the border of moving object, we need to refine pixels by morphological process. The results of each step is shown is Fig. 2.

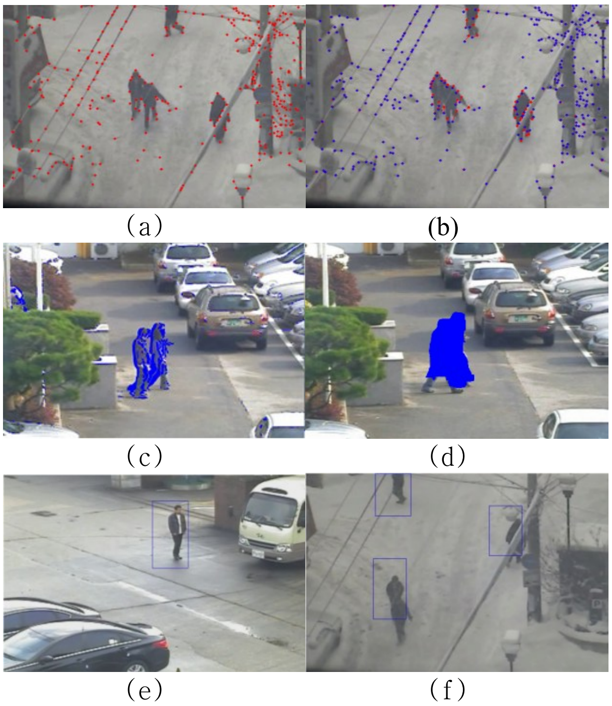

Fig. 2. (a) Features from Good Feautures to Track. (b) KLT tracker result. (blue points are static and red points are moved) (c) Residual pixels. (d) After applying morphological process from residual pixels. (e) (f) Result of the detection of moving person.

3. System Integration of Detection and Tracking

3.1 Online-Boosting Tracker

We use online-boosting algorithm from Grabner et al. [1] to track the objects which are detected. By using the boosted-classifier as a tracker, we can deal appearance changes of the targets

Each detected object is used to train a boosted classifier. Integral images are operated on all images to reduce computation complexity. Haar-Like feature [6] is used to boost classifier. To train classifier, we sample the patches form within the box of the associated detection to give the positive training examples. The negative training set is sampled from nearby targets.

3.2 Tracking condition

A. Initialization and Termination of Tracker

Tracker is initialized when an object is detected more than T percent (we set this parameter as 0.8) among last frame sequences. And tracker is terminated when an observation model has lower value than some threshold. The observation model is explained in Sec. 3.3

B. Detector and Tracker Matching

Tracker and detector is associated 1 to 1 by matching function by the method of M D. Breitenstein and et Al. [7]. We check size and position of tracker and detection and tracker to measure gating function. Gating function $g(tr, d)$ is described as next:

$$g(tr, d) = P_N\left(\frac{size_{tr} - size_d}{size_{tr}}\right) \cdot P_N(\| d - tr \|) \quad (1)$$

The first normal distribution measures the similarity between the sizes of target and detection and the second term measures the agreement of target and detection by distance of them. We match each detection to a target by the most high-scored matching function if matching function score is above τ .

3.3 Observation Model

A new position of target will be tracked at the position where confidence of observation model has the most highest value. This observation model is as following:

$$p(y_t \mid x_t) = \alpha \cdot P_N(\| tr - d \|) + \beta \cdot d_r + \gamma \cdot c_{tr} \quad (2)$$

tr is the position from boosted-classifier tracker and d is the position of detector. $P_N(\| tr - d \|)$ computes the distance between the tracker and detector, evaluated under a normal distribution. d_r is the detection rate which is calculated by the success of detection of several last frames. c_{tr} is a value evaluated from boosted classifier which is trained from past frames.

4. Experiment Result

Table 1 The result of the proposed system.

	Success Rate
Detection	85.6%
Detection + Tracking	89.6%

Table 1 is the result of proposed system. When we combine tracking algorithm and integrated into the detection result, we get more successful rate to find targets.

Figure 3. shows the result of our method. To distinguish of each target, we labeled the each target by number. In (a) and (b), because sequences has no occlusions of targets, targets are tracked continuously along the sequences. In (c) and (d) there is a situation that targets are totally occluded by some obstacles. In these conditions, our

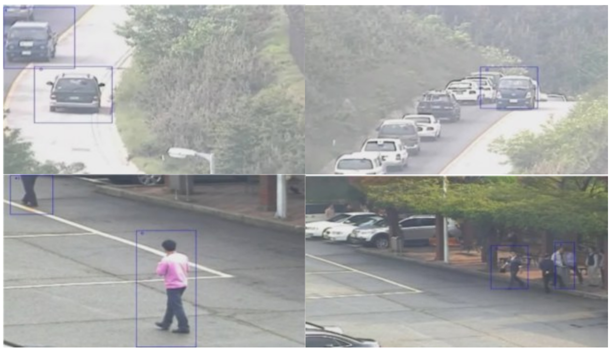

Fig. 3. The result of proposed system. (a) (b) shows the movign cars from sequences. (c) (d) is the result of moving person. In (d) non-moving person is not detected.

System automatically stops tracking objects and starts to follow up targets when they appears in new sequences. And, without manual select of targets, our system detects multiple moving objects and tracks them.

5. Conclusion

We have presented a method for muliple moving object detecgion and tracking system. The key factors of our algorithem are: (1) homography-based motion detectiom, (2) onlne-boosting tracker, and (3) the integration of tracker and detection. Our experiments has shown the result of high success rate in outdoor scence.

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