

# Chapter 19

## Object Tracking by Multiple State Management and Eigenbackground Segmentation

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### ABSTRACT

*This paper presents a multiple target tracking system through a fixed video camera, based on approaches found in literature. The proposed system is composed of three steps: foreground identification through background subtraction techniques; object association through color, area and centroid position matching, by using the Kalman filter to estimate the object's position in the next frame; object classification according to an object management system. The obtained results showed that the proposed tracking system was able to recognize and track objects in movement on videos, as well as dealing with occlusions and separations, while encouraging future studies in its application on real time security systems.*

### 1. INTRODUCTION

There are immediate needs for the use of video cameras in environment monitoring, which can be verified by the task of assisting the entrance, exit and transit registering of people or vehicles in a site. In this context, automated surveillance systems based on video images has increased in

recent years, both to the academic and the commercial area, seeking for robust systems that work in real time (Zhang et al., 2007; Jung et al., 2008; Liu et al., 2009).

As requisites for these systems, it can be identified the treatment of entrances and exits of objects on a scene, shape variation and movement of followed targets, interactions between targets (such as meetings and splits), lighting variations and video noise (Lei, 2006).

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Tracking systems based on a fixed video camera are made up of three main steps: identification and segmentation of moving objects, usually using background subtraction models; object tracking, which associate detected objects frame to frame; and finally, classification or activity recognition.

Background Subtraction is one of the most used method for moving object segmentation thought video images. A background model is created and “subtracted” from a new frame, resulting in pixels that differ from the built model. The “subtraction” term refers to both simple subtraction operations as more sophisticated probabilistic models. The result of subtracting background pixels are classified as foreground, however, these pixels may represent noise and need to be filtered and grouped deciding which objects should be tracked.

The goal of tracking phase is to generate the trajectory of targets through the video associating objects of a given frame with the objects identified in the next frame, identifying the position and space occupied by the target in each video frame. However, object association is not a trivial task since objects can change its direction of displacement, speed or vary in size and shape.

Linear estimators, such as the Kalman filter, have been widely used in tracking systems to assist in the association of objects, estimating the object’s position in the following frame based on their previous states (Kalman, 1960). In this case, the position of the object provided by the filter is compared to the positions measured in the current image, so the association is performed if the predicted position and the measure are close to or obey any metric of association, thus the new target position is used to update the filter.

Object association based only on its position, however, may present ambiguities when multiple objects are tracked (Pinho et al., 2004): two predicted positions can be associated to a unique position or a predicted position may not be associated with any position measurement. Thus, beyond the objects position, other criteria for

object association, such as area, color and shape, are used to supplement the positions estimated by Kalman filter. In addition, a robust tracking system should consider that the tracked objects are constantly interacting with the scene and other objects, resulting in partial or total occlusions, separations, appearances and disappearances. To deal with these interactions, Lei and Xu (2006) proposed an object management system, classifying them in seven classes according to their condition, maintaining information about the interaction of objects over time.

This work analyses and evaluates the main steps of a multiple target tracking system through a fixed video camera and proposes a tracking system based on approaches found in the literature. The proposed system is composed of three steps: foreground identification through Eigenbackground model; object association through color, area and centroid position matching, by using the Kalman filter to estimate the object’s position in the next frame, and, lastly, object classification according an object management system.

In order to assess the efficiency of the proposed tracking system, tests were performed by using videos from PETS and CAVIAR datasets. The object management system was evaluated through manual classification and counting of objects on each video frame. These results were compared with the output of the object management system.

## **1.1. Eigenbackground**

The identification of the foreground is a fundamental step in a tracking system, defining not only the targets to be tracked, as well as its size, shape and position. Thus, the chosen model for background subtraction is crucial for the success or failure of the tracking system.

Background subtraction can be defined as a set of techniques used to detect objects in a video. Such techniques are based on building a model that represents the background of the scene.

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