

## Chapter 53

# Building a Multiple Object Tracking System with Occlusion Handling in Surveillance Videos

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### ABSTRACT

*Video tracking systems are increasingly used day in and day out in various applications such as surveillance, security, monitoring, and robotic vision. In this chapter, the authors propose a novel multiple objects tracking system in video sequences that deals with occlusion issues. The proposed system is composed of two components: An improved KLT tracker, and a Kalman filter. The improved KLT tracker uses the basic KLT tracker and an appearance model to track objects from one frame to another and deal with partial occlusion. In partial occlusion, the appearance model (e.g., a RGB color histogram) is used to determine an object's KLT features, and the authors use these features for accurate and robust tracking. In full occlusion, a Kalman filter is used to predict the object's new location and connect the trajectory parts. The system is evaluated on different videos and compared with a common tracking system.*

### INTRODUCTION

Object Tracking is the process of locating an object in every frame of the video frames and using its locations to generate a trajectory. The efficient object tracking is important for many computer vision applications, such as surveillance, security, monitoring, robotic vision, etc. Although many

object tracking systems have been proposed, tracking is still one of the most challenging research topics in computer vision. Tracking systems face a big challenge arises from dealing with abrupt object motion, illumination variations, occlusions, scale variations, and various types of objects (Park, Makhmalbaf, & Brilakis, 2011). So, in most cases, a proposed system shows best results under specific situation.

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In complex scenes, overlapping of moving objects greatly affects the accuracy and robustness of tracking. Thus, occlusion handling plays a central role in building a tracking system. In this chapter, we describe a system to automatically track multiple objects which are partially or fully occluded in a moving or standing pose.

Recently, there has been an increasing interest in tracking objects in moving cameras, such as cell phones, vehicles and robots. Tracking objects in moving cameras are more complicated than stationary cameras where the image motion is induced by both the camera motion and the object motion. Different techniques are suggested, such as homography-based motion detection (Kim & Kweon, 2011), Pattern Matching (Reddy, 2012), background subtraction (Sheikh, Javed & Kanade, 2009) and contour (Yilmaz, Li & Shah, 2004). In this chapter, our system uses the videos that are captured by using a stationary camera. In future work, we are going to develop our system to deal with objects in moving cameras.

## **BACKGROUND**

Generally, Object tracking can be divided into three major categories (Yilmaz, Li, & Shah, 2004): Correspondence-based object tracking, transformation-based object tracking and contour-based object tracking.

### **Correspondence-Based Object Tracking**

Tracking is performed by collecting the object information during tracking and using this information to predict and verify the object new location. The researchers used different object previous information such as object state (velocity and acceleration) and regional information (color, texture, area and shape) (McKenna, Raja, & Gong, 1999; Zhang, & Freedman, 2005). Different filtering techniques are suggested to model object

information such as Kalman filtering (Stauffer, & Grimson, 2000) and particle filtering (Rittscher, Kato, Joga, & Blake, 2000).

### **Transformation-Based Object Tracking**

Tracking is performed by using the object information in consecutive frames to estimate the motion of the object. The most common transformation based trackers are “template matching” (Lipton, Fujiyoshi, & Patil, 1998), “Mean shift” (Comaniciu, Ramesh, & Meer, 2003) and KLT (Kanade-Lucas-Tomasi) (Shi, & Tomasi, 1994). Template matching tracker is implemented by searching the whole image for a similar template. The template matching tracker is challenged by the heavy computation required and the sensitivity to illumination variation. Mean shift, on the other hand, tracks the distribution of an object in real time with robust tracking performance. However, Mean shift tracker does not deal with deformable objects and the appearance variations decreases the tracker performance (Allili, & Ziou, 2008). KLT tracker finds features that are optimal for tracking first, and then computes the translation of these features and the quality of each tracked path (Zhou, Yuan, & Shi, 2008).

### **Contour-Based Object Tracking**

Tracking is performed by evolving the contour of the target object in the current frame and finding its new position in the next frame. Snake (Sun, Haynor, & Kim, 2003) and level set (Paragios, & Deriche 2005) are mainly used to track object contours. Snake, active contour, uses the contour in the previous frame as an initial contour in current frame, then uses external and internal energies to fix the contour. Level set is used to represent contour as zero level set where the zero set function equals zero for each point on the contour (Yilmaz, Li, & Shah, 2004).

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