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Chapter IV

Real-Time Analysis of Human Body Parts and Gesture-Activity Recognition in 3D

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Abstract

This chapter focuses on real-time processing techniques for the reconstruction of visual information from multiple views and its analysis for human detection and gesture and activity recognition. It presents a review of the main components of three-dimensional visual processing techniques and visual analysis of multiple cameras, i.e., projection of three-dimensional models onto two-dimensional images and three-dimensional visual reconstruction from multiple images. It discusses real-time aspects of these techniques and shows how these aspects affect the software and hardware architectures. Furthermore, the authors present their multiple-camera

system to investigate the relationship between the activity recognition algorithms and the architectures required to perform these tasks in real time. The chapter describes the proposed activity recognition method that consists of a distributed algorithm and a data fusion scheme for two and three-dimensional visual analysis, respectively. The authors analyze the available data independencies for this algorithm and discuss the potential architectures to exploit the parallelism resulting from these independencies.

Introduction

Three-dimensional motion estimation has a wide range of applications, from video surveillance to virtual animation. Therefore, reconstruction of visual information from multiple cameras and its analysis has been a research area for many years in computer vision and computer graphics communities. Recent advances in camera and storage systems are main factors driving the increased popularity of multi-camera systems. Prices continue to drop on components, e.g., CMOS cameras, while manufacturers have added more features. Furthermore, the evolution of digital video, especially in digital video storage and retrieval systems, is another leading factor.

In this chapter, we focus on real-time processing of multiple views for practical applications, such as smart rooms and video surveillance systems. The increased importance of applications requiring fast, cheap, small and highly accurate smart cameras necessitates research efforts to provide efficient solutions to the problem of real-time detection of persons and classification of their activities. A great effort has been devoted to three-dimensional human modeling and motion estimation by using multi-camera systems in order to overcome the problems due to the occlusion and motion ambiguities related to projection into the image plane. However, introduced computational complexity is the main obstacle for many practical applications.

This chapter investigates the relationship between the activity recognition algorithms and the architectures required to perform these tasks in real time. We focus on the concepts of three-dimensional human detection and activity recognition for real-time video processing. As an example, we present our real-time human detection and activity recognition algorithm and our multi-camera, test bed architecture. We extend our previous 2D method for 3D applications and propose a new algorithm for generating a global 3D human model and activity classification.