Chapter 13
Video-Based Motion Capture for Measuring Human Movement

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ABSTRACT

Through the advancement of electronics technologies, human motion analysis applications span many domains. Existing commercially available magnetic, mechanical and optical systems for motion capture and analyses are far from being able to operate in natural scenarios and environments. The current shortcoming of requiring the subject to wear sensors and markers on the body has prompted development directed towards a marker-less setup using computer vision approaches. However, there are still many challenges and problems in computer vision methods such as inconsistency of illumination, occlusion and lack of understanding and representation of its operating scenario. The authors present a video-based marker-less motion capture method that has the potential to operate in natural scenarios such as occlusive and cluttered scenes. In specific applications in sports biomechanics and education, which are stimulated by the usage of interactive digital media and augmented reality, accurate and reliable capture of human motion are essential.

INTRODUCTION

Work on motion capture and analysis started as early as the 19th century, when Eadweard Muybridge began photographing horses to analyze their movement. During that period, a French physiologist Etienne-Jules Marey also embarked on his chronophotography work in studying the human performance filmed. Chronophotography is an application of the study of movement (science), and photography (art).The importance of motion capture (mocap in short), is motivated by its applications over a wide spectrum of areas. Tracking and following the movement of human joints over an image sequence, and recovering the 3D body posture and kinematics are especially useful for the study of the human locomotion and bio-mechanical applications (Corazza, 2006), such as gait analysis, injury prevention, rehabilitation and sports performance enhancement.

Since the mid-1970s, human motion analysis applications have made significant progress thanks largely to the tremendous advancement in digital electronics technologies. The measuring and analyzing of human movement have applications in many domains ranging from kinesiology, ergonomics, sports, 3D animation, 3D tele-presence, augmented reality, video surveillance, video data compression as well as medicine and clinical practice. Many, if not all, of these systems require the tracking of the motion trajectory of the subjects to yield kinematic information for further analysis.

There are many technologies developed to capture the human motion. They range from magnetic, mechanical and optical systems, for which the subject needs to wear sensors and markers on the body, to the non-intrusive one which is based purely on using video cameras. The kind of set-ups, methods and technologies that are used for motion capture are largely determined by their respective operational needs, that is, application specific. For example, it is a common practice in biomechanical studies for the subjects to wear reflective markers for movement analysis while operating in a very well-controlled environment.

In order to be suitable for human biomechanical applications, which is our main focus, the motion capture technique has to yield accurate and reliable quantitative information. To extend the applications, cluttered, outdoor and occlusive environments have to be considered. Also, the freedom of movement to the performer is an important consideration, which implies that wearing of sensors on the body has to be avoided. These issues are especially crucial if we are to consider a real scenario such as a sports tournament. Therefore, it has prompted many researchers to explore the use of video-based computer vision motion capture, which do not need any sensor or marker on the subject, for measuring the human movement.

Over the years, the use of video applications in the teaching of sports and physical activities have ranged from qualitative analyses to augment feedback in learning new sports skills (Koh & Anwari, 2004) to multimedia online environments with rich displays of animations and videos and embedded discussion forums to facilitate analysis and critique. These were designed to convey multiple representations of actual skilled sports performances and to facilitate the use of cognitive and social processes in learning and inquiry in a collaborative manner (Lim & Koh, 2006). However, efforts to use learning technologies are often hampered by prevailing attitudes and logistical issues. It is hoped that a marker-less motion capture system will circumvent the logistical issues and make for a seamless integration into novel pedagogical approaches in teaching sports and physical activities. Done well, this new form of learning technology has the potential to bring about a cultural change in the way we teach and learn.

Motivated by the enormous potential and widespread applications that lead to the pursuit of a video-based marker-less motion capture system, in this chapter we describe the application

GuideMe: A Complete System for Indoor Orientation and Guidance
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