Chapter 32
Multi-Modal Motion-Capture-Based Biometric Systems for Emergency Response and Patient Rehabilitation

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ABSTRACT

This chapter outlines the current state of the art of Kinect sensor gait and activity authentication. It also focuses on emotional cues that could be observed from human body and posture. It presents a prototype of a system that combines recently developed behavioral gait and posture recognition methods for human emotion identification. A backbone of the system is Kinect sensor gait recognition, which explores the relationship between joint-relative angles and joint-relative distances through machine learning. The chapter then introduces a real-time gesture recognition system developed using Kinect sensor and trained with SVM classifier. Preliminary experimental results demonstrate accuracy and feasibility of using such systems in real-world scenarios. While gait and emotion from body movement has been researched in the context of standalone biometric security systems, they were never previously explored for physiotherapy rehabilitation and real-time patient feedback. The survey of recent progress and open problems in crucial areas of medical patient rehabilitation and rescue operations conclude this chapter.

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INTRODUCTION

Rapid development of biometric technology has opened doors to a new class of fast and reliable identity management solution and has forever changed the research landscape (Jain et.al. 2008; Kisku et.al. 2013). Biometric relies on using observable unobtrusive traits (such as iris, fingerprint, face, voice or gait), to remotely authenticate a user. There has been a significant surge in the number of effective approaches to user authentication, discretionary access control to secure resources, and integration of biometric recognition algorithms with consumer products (such as cell phone with iris and/or fingerprint recognition, biometric door locks, industrial and military robots with voice recognition, self-driving cars with human silhouette identification, game consoles with gait recognition, etc.) (Jain et.al 2008; Kisku et.al 2013; Gavrilova & Monwar 2012). This chapter presents an overview of the most recent uses of Kinect sensor technology for biometric user identification and activity recognition, and presents an emerging methodology for emotion and intention recognition from body position and movement. The applications in real-world scenarios for medical diagnostics and search and rescue operations are discussed, along with numerous open problems in this domain.

Traditional definition of biometrics research scope usually includes recognizing someone's identity from the collected biometric data, which includes physiological, behavioural, soft, and social traits. Physiological features can be often collected visually (facial image, ear, iris etc.) or through some specialized devices, such as infrared sensors, remote temperature measuring devices, and so on. Behavioural characteristics include the way a person walks (gait), talks (voice) and writes (typing patterns, keystroke pressure). Soft biometrics include data which can be easily collected but not highly unique, such as age, gender, height or weight. One significant area where the development of biometric technologies can have a high tangible effect on society is emergency response and medicine. It is generating a lot of interest and getting traction in biometric research, as well as in related fields looking into human interaction, physiological studies, user profiling, pattern recognition, authorship identification and collective intelligence.

This book chapter outlines the current state of the art of Kinect sensor gait and activity authentication, while focusing on emotional cues that could be observed from human body and posture. It then presents a prototype of a new system which combines recently developed behavioral gait and posture recognition for human emotion identification. A backbone of the system is Kinect sensor gait recognition method, which explores the relationship between joint-relative angles and joint-relative distances through machine learning. The chapter then introduces a real-time gesture recognition system, developed using Kinect sensor and trained with SVM classifier, to recognize four emotions of the human body. Preliminary experimental results demonstrate accuracy and feasibility of using such systems in real-world scenarios. While gait and emotion from body movement has been researched in the context of standalone biometric security systems, they were never previously explored for physiotherapy rehabilitation and real-time patient feedback. Thus, the survey of recent progress and open problems in crucial areas of medical patient rehabilitation and rescue operations conclude this chapter.

BACKGROUND STUDY AND LITERATURE REVIEW

Rapid technological advancement has led to a new field of biometric security, in which emotional state of an individual can be predicted by analysing body movement patterns. Recognition of a person's emotional state and appropriate response is the foundation of all social interactions. As computing resources