Chapter 76
Towards Continuous Authentication Based on Gait Using Wearable Motion Recording Sensors

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ABSTRACT

Nearly all systems conduct some kind of user authentication before granting access to the objects or services. Moreover, humans pass through authentication steps more than once in their everyday activity, e.g. for entering a house you have to possess the correct key to open the door, to use a computer you need to know its password, etc. These authentications are one-time or static which means once the user's identity is verified the authentication lasts forever. However, some high security systems require ensuring the correct identity of the user throughout the full session. This then requires verification of user identity continuously or periodically. One of the important requirements for continuous authentication is that the method should be unobtrusive and convenient in usage. If this is not satisfied the users are not going to accept continuous authentication. Therefore not all authentication methods can be suitable for continuous authentication even if they provide higher security.

In this chapter we present continuous authentication using gait biometric. Gait is a person's manner of walking and gait recognition refers to the identification and verification of an individual based on gait. This chapter discusses advantages and disadvantages of gait biometrics in the context of continuous authentication. Furthermore, we present a framework for continuous authentication using gait biometrics. The proposed framework extends on traditional static (one-time) user authentication. The framework can also be applied to other biometric modalities with small modifications.

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INTRODUCTION

A particular way or manner of moving on foot is a definition for gait (Farlex). Every person has his or her own way of walking. From early medical studies it appears that there are twenty-four different components to human gait, and that if all the measurements are considered, gait is unique (BenAbdelkader, et al., 2001). This has made gait recognition an interesting topic to be used for identifying individuals by the manner in which they walk. Figure 1 illustrates the complex biological process of the musculo-skeletal system, which can be divided into several types of sub events of human-gait. The instances that are shown in this figure are used to extract parameters for being used as an identification system of each individual.

The analysis of biometric gait recognition has been studied for a longer period of time (Larsen, et al., 2008; Nixon, et al., 2002; Nixon, et al., 2005; Niyogi & Adelson, 1994; Wang, et al., 2003) for the use in identification, surveillance and forensic systems and is becoming important, since it can provide more reliable and efficient means of identity verification.

Today, computer systems demand authentication in case of using the system. Typically, the authentication is performed at login time either with a password, token, biometric characteristic and/or a combination of these. Performing the last mentioned might give further guarantee that the claimed user logging in is the authorized user instead of a burglar. However, once the user has been granted access; most systems assume that the user is continuously legitimated into the system.

In critical or high security environments, it should be ensured that the user must be the legitimated throughout usage. Therefore, user authentication needs to be performed in a continuous way within the time the system is actively being used. Furthermore, authentication needs to be "*attractive*" for the user. This means that in the authentication process the users do not need to do anything special, like for example periodically entering a password. Continuous authentication using biometrics can fit these needs. Thus, one of the important requirements in continuous authentication is unobtrusiveness, since this can be monitored in a non-intrusive way. The Wearable Sensor (WS) based method can be a very good candidate to fulfill this requirement, compared to current knowledge-based mechanisms.

This chapter is structured as follows: Section 'Background' gives the state of the art overview of gait recognition and activity recognition. Section 'Evaluation of a Biometric System' introduces the definition of static and continuous authentication. The next section introduces the biometric

Figure 1. Division of the gait cycle into five stance phase periods and two swing phase periods (Adapted from (Sminchisescu, et al., 2004))