Chapter X

Movement Pattern Recognition Using Neural Networks

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Abstract

This chapter provides an overview of artificial neural network applications for the detection and classification of various gaits based on their typical characteristics. Gait analysis is routinely used for detecting abnormality in the lower limbs and also for evaluating the progress of various treatments. Neural networks have been shown to perform better compared to statistical techniques in some gait classification tasks. Various studies undertaken in this area are discussed with a particular focus on neural network’s potential in gait diagnostics. Examples are presented to demonstrate the suitability of neural networks for automated recognition of gait changes due to aging from their respective gait patterns and their potential for identification of at-risk or non-functional gait.
Introduction

Neural networks have been shown to be successful in a variety of applications, including solving problems in biomedical, financial, and engineering areas. Recently, there has been particularly rapid growth in biomedical and health-related applications because of better predictive abilities and non-linear modeling capabilities compared to traditional statistical techniques. Specifically, recognition of movement patterns, especially gait, has benefited as a result of neural network usages. The aim of this chapter is to provide an overview of neural network applications in movement pattern identification for possible use of neural networks as a diagnostic tool. A brief overview of gait analysis is first provided followed by neural network applications in various gait studies.

Gait Analysis

Gait analysis is the analysis of various aspects of human walking and running patterns, the most common forms of human locomotion. Winter (1991) describes it as one of the most complex and totally integrated human movements involving coordinated processes of the neural and musculoskeletal systems. Many studies have investigated human gait to understand the process of movement control and to quantify the changes due to various diseases and with aging. Gait is periodic in that the normal gait cycle starts with the heel contact or foot contact and finishes with the next heel or foot contact of the same foot. The gait cycle time is generally calculated as the time interval between two successive events (e.g., heel contact) of the same foot (Figure 1). It is characterized by a stance phase (~60% of the total gait cycle) and a swing phase (~40%). The stance phase includes, among many events, the main events of heel contact, foot flat, midstance, heel off, and toe off. The swing phase starts from toe off, through midswing and ends with the heel contact of the same foot (see Figure 1). While performing gait analysis, deviations or abnormalities in gait are frequently referred to these events (Perry, 1992).

Instrumentation used to study gait ranges from the least sophisticated approaches to complicated and expensive devices (Begg et al., 1989). Researchers have extracted hundreds of parameters from the gait cycle to characterize aspects of the gait pattern. Most of the gait parameters may be grouped under the following main headings:

- Basic time-distance measures such as cadence, walking velocity, stride lengths, stance/swing times;
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