Chapter 11
Review of Smart Wearables Sensor-Based Techniques and Machine Learning for Change of Direction Detection in Sports

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ABSTRACT

Change of Direction (COD) is a critical movement skill during athletic gameplay. In team sports like football, basketball, and rugby, the on-field performance is often assessed by the ability to change direction quickly. Optimizing COD reduces injury risk and improves team outcomes. This review examines algorithmic approaches for detecting COD using wearable sensor data. Each method's process, results, strengths, and limitations are summarized. An exploratory methodology was used to search databases like Google Scholar, PubMed, IEEE, and Science Direct. Findings show ongoing progress in COD detection, but also highlight gaps, such as non-standardized sensor placement, inconsistent sampling rates, and limited open datasets. These issues hinder the use of Machine Learning (ML) and Deep Learning (DL) models. To address this, we propose an AI-based framework to automate COD detection. This review aims to support decision-making and future research in wearable-based COD monitoring.

INTRODUCTION

Advances in sensor technology have transformed athlete performance analysis in sports through precise assessment of movement patterns, performance metrics, and biomechanical characteristics, which have replaced traditional observational methods (Migliaccio, Padulo, & Russo, 2024). The analysis of an athlete's sports performance depends on three main metrics, which include distance and speed measurements (Losada-Benitez et al., 2023), acceleration (Delves et al., 2021), and energy expenditure (Polglaze et al. 2016). These performance metrics deliver important information about athlete performance and training effectiveness, as well as fatigue monitoring and improvement opportunities. Athletes use agility to outperform opponents through their ability to dodge defenders (Young et al., 2022) and their quick movements to reach balls in football (Morral-Yepes et al., 2022) and their fast cuts to the basketball basket (Sugiyama et al., 2021). The essential athletic ability known as Change of Direction (COD) plays a vital role in complete athletic growth and injury avoidance and is essential for performance.

Sports scientists and researchers have studied the biomechanics and performance consequences of COD in various sports over the years. Neuromuscular adaptations (muscle activation and coordination) (Spiteri, Newton, & Nimphius, 2015), biomechanical factors (joint angles, balance, and ground reaction forces) (Spiteri, Newton, Binetti, et al., 2015), and metabolic demands (energy, power for quick bursts) (Jones & Dos'Santos, 2023), are involved in executing rapid directional changes across various sports disciplines. Athletes undergo rapid transitions from one movement

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