Designing a Wearable Sensor-Fusion Toolkit for Motor Skill Learning

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ABSTRACT

User movement data is essential for providing feedback in the area of motor-skill learning. For instance, when learning a new sport such as dancing, people can benefit from meaningful technology-based feedback. However, movement tracking equipment for real-time feedback is costly and challenging to implement. In contrast, wearable devices tracking users' movements are accessible and lightweight. While their lower cost makes them available to a broader audience, several open issues include sensor placement, sensor count, and data synchronization. To address these issues, we propose a wearable sensor-fusion approach for motor skill learning that allows researchers and developers to use one or multiple body-worn sensors for motion tracking. The extracted motion can then be used to deliver real-time feedback on the user's performance, supporting positive learning experiences.

CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**.

KEYWORDS

toolkit, sensor fusion, wearables, movement tracking

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VISION

Body tracking is one of the main components of generating meaningful automated feedback for supporting motor skill learning. To illustrate, Villa et al. [9] derived design requirements for a wearable feedback system for motor skill learning. While Ahuja et al. [1] estimated the user's pose only using the smartphone' built sensors, working with several sensors across different body parts provides more accurate data for body position tracking.

Existing challenges in motion tracking using wearable sensors such as sensor drift [10], sensor synchronization [4], and the recognition of specific movements have been addressed over the last few years. Yet, the identified solutions have never been combined into one toolkit. Moreover, sampling frequency, latency, and other hardware-specific characteristics also impact the tracking quality (e.g., [2, 7, 8]) as well as sensor placement (e.g., [3, 10, 11]). Finally, various sensors (e.g., depth cameras) have been used for sensor-fusion approaches for body tracking (cf. [1, 6]). We propose designing a toolkit that handles data synchronization and processing. We envision that this will facilitate the development of scalable wearable devices for motor skill learning.

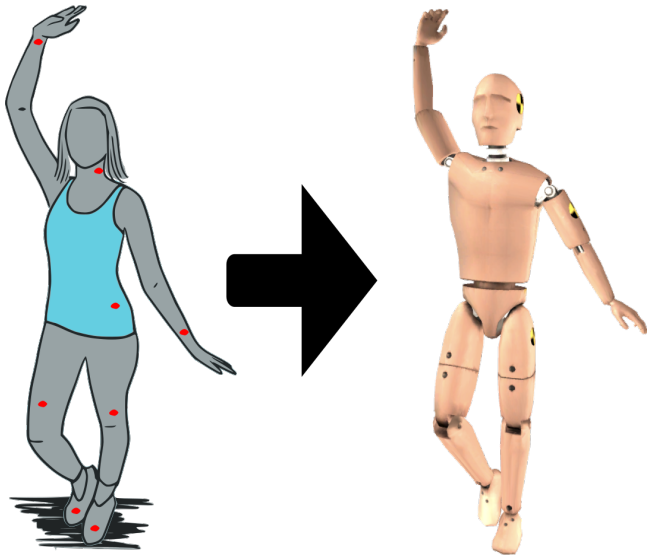

Figure 1

DESIGNING THE TOOLKIT

When designing a wearable sensor-fusion motion tracking system for motor skill acquisition, we consider various aspects, such as positioning of the body and the number of sensors (cf. 1). Further, the system could be adapted to different tasks or scaled using different sensors. Considering the design requirements for a wearable feedback system [9], learners benefit from implicit feedback while allowing them to focus on their performance [5]. Thus, the toolkit needs to process the incoming data from multiple sensors in real-time to generate feedback. Depending on the movement to be investigated, the system consists of multiple sensors across the body. We envision that our toolkit will guide potential users in sensor selection, sensor placement, and connection. Our toolkit caters to researchers and developers designing a wearable feedback system without in-depth sensor knowledge, allowing them to create a use case tailored system.

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