Computational Pipeline for Gait Analysis using 4D Body Scanning

Ingrid Estefany Peraza Melendez*†[1], Anselm Naake[1], Yordan Kyosev[1], and Lukáš Čapek[2]

[1]Chair of Development and Assembly of Textile Products, ITM, TU Dresden – Germany
[2]Technical University of Liberec – Czech Republic

Abstract

Gait and posture are both closely related to pelvic biomechanics. A person's posture is largely influenced by the position of their pelvis, and the pelvis's dynamic movement in three dimensions directly determines gait. Therefore, together they describe movement patterns, body alignment, and in this way, they can also help us understand problems related to pelvic floor function and how forces are distributed across the pelvic floor.
Optical motion capture systems like Qualisys are the gold standard for movement analysis. They use multiple high-speed infrared cameras and retroreflective markers that are placed at different anatomical landmarks to reconstruct the trajectories of the markers and obtain quantitative skeletal kinematics such as pelvic orientation, hip flexion, knee extension, etc. In contrast, 4D scanning captures the complete 3D surface geometry of the body over time (fourth dimension) and automatically constructs a digital skeleton (rigged FBX files) without needing retroreflective markers. However, although current 4D scanning systems are capable of capturing gait, they have not been designed or tailored for its analysis, and extraction of standardized kinematic parameters.

This study investigates the development of a computational methodology to extract gait-related kinematic information directly from 4D body scan data and to examine its relationship with traditional optical motion capture measurements. A gait sequence was captured using the 4D body scanner MOVE4D. The recorded FBX sequences are processed to automatically identify the anatomical reference points and extract their coordinates throughout the movement cycle. Afterward, these data are analyzed to characterize joints and pelvic motion kinematic parameters that can be compared with measurements obtained with the Qualisys optical motion capture system (Göteborg, Sweden).
The goal is to investigate the extent to which the kinematic data obtained from both systems can be correlated, and to integrate 4D body scan data into gait and posture analysis workflows relevant to pelvic floor research, in a way that is also compatible with other motion capture technologies for future research, such as inertial sensors.

Keywords: Gait Analysis, 4D Body Scanning, Qualisys system, Pelvic Biomechanics, Skeletal kinematics

*Speaker
†Corresponding author: ingrid.peraza@tu-dresden.de