Oral Communication
OC-864

Use of Inertial Sensors for Quantitative Gait Assessment: A State-of-the-Art Review

Topic: Biomechanics

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BACKGROUND

Gait analysis is fundamental in rehabilitation, as it allows for assessing locomotion patterns and the detection of abnormalities. Inertial sensors have emerged as an efficient alternative to traditional optical systems due to their portability and lower cost. However, the literature presents a significant variability in methodologies, protocols, and extracted features, complicating comparisons across studies. This work reviews the state-of-the-art on the use of inertial sensors for gait assessment, considering the following variables: number and location of sensors, the extracted features, and the algorithms used. The objective is to compare these variables to determine if there is a relationship between them. It also seeks to identify starting points for the development of a standardized protocol that will facilitate future research on gait analysis and its clinical application.

METHODS

A review was followed using the PRISMA methodology in PubMed, ScienceDirect, and Web of Science, using MeSH terms and Boolean operators, 2,619 articles were identified. Those published between 2014 and 2024, open access and published in English were selected. Excluding studies of pathologic gait, artificial intelligence, upper extremities, stress testing, and those without comparison with a reference system. Systematic reviews and meta-analyses were also excluded. After reviewing titles and abstracts, 34 studies were finally included to extract variables such as the number and location of sensors, the extracted features, and the data processing algorithms.

RESULTS

The reviewed studies showed variability in the number, from 1 to 17 sensors, authors who used fewer sensors focused primarily on obtaining constants, while those with a larger number focused on joint angles; about the sensors' location, the most common parts of the body were the lumbar region, the feet, and the thighs. The features extracted correspond to the gait cycle phases, the spatio-temporal constants and the joint angles. Regarding data processing, 24 authors mentioned the use of Kalman filters to obtain joint angles; Mahony and Foot Velocity Algorithm for spatio-temporal constants and gait cycle; and Butterworth for filtering raw data. All studies validated their measurements with a reference system, with optical systems being the most commonly used.

CONCLUSION

We could think that the major number of sensors, the major number of extracted features, however, after the analysis, there is no linear relationship between the number of sensors and the extracted gait parameters; it is also necessary to consider the methodology and algorithms used in the feature extraction.

Statement of Disclosures

None

Doi: 10.5606/archisprm.2026.OC-864

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