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Publication date:
2024-02-06

Permanent link:
https://doi.org/10.3929/ethz-b-000658852

Originally published in:
Current Issues in Sport Science 9(2), https://doi.org/10.36950/2024.2ciss047

Optimizing Wearable Motion Tracking by Assessing Sagittal Joint Angle Accuracy with Minimal Sensor Use

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Keywords: strain sensor, running kinematics, sensor reduction

Introduction Wearable motion tracking technology often focuses on reducing the number of sensors to simplify design and lower costs. Research has shown that single IMUs can reconstruct leg kinematics (Gholami et al., 2020; Hossain et al., 2022; Lim et al., 2020) and ground reaction forces (Jiang et al., 2020) effectively. Additionally, model-based methods have demonstrated the feasibility of using fewer gyroscopes to estimate stride length and motion range in healthy individuals and patients with coxarthritis (Salarian et al., 2013). In this study, we aim to assess the precision of sagittal joint angle estimations using strain sensors while minimizing sensor count.

Methods We conducted a study with ten participants based on our previous work that involved collecting single-leg treadmill running data to monitor lower limb joint angles with piezoresistive strain sensors. Subjects ran on an instrumented treadmill at 8–10 km/h, wearing athletic pants embedded with nine strain sensors located on the hip, knee, and ankle. Optical motion capture provided reference kinematics. Our prior research achieved less than 1.5° error in the sagittal plane using a machine-learning approach. The current study explores the extent to which sensor reduction is possible without meaningful loss of accuracy. Three evaluation measures were used for assessesement: Pearson correlation, dynamic time warping, and root-mean-squared error.

Results : The results from our correlation analysis will be used to develop a model that optimally balances between accuracy and minimizing the number of sensors. This has practical implications in sports science, where athletes could benefit from less intrusive and more comfortable performance monitoring, and in healthcare, for remote monitoring of patients with mobility issues.

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