AIgait: Enhancing Accessibility in Gait Biomechanics Through Mobile-Based Open Pose Estimation

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Summary

Gait biomechanics analysis is hardly accessible due to high costs and expertise required. This work introduces AIgait, a smartphone-based application using open pose estimation, to assess spatio-temporal gait parameters. While temporal parameters aligned well between AIgait and Optogait, distance-related parameters showed discrepancies due to camera limitations. Further research is needed to validate AIgait in real-life conditions and expand its capabilities to population with gait impairment and by assessing joint angle and kinetic measurements. AIgait shows potential for accessible and efficient gait analysis.

Introduction

Gait biomechanics analysis is crucial for monitoring patients' progress during rehabilitation and assessing compensatory mechanisms in degenerative diseases. It provides insights into walking quality parameters beyond simple performance metrics like time and distance. However, the high costs, time requirements, and expertise needed make this analysis less accessible. Our goal is to develop a smartphone application using MediaPipe solutions [1] (GoogleAI, Google, USA) to simplify gait measurement and analysis from video recordings.

Methods

Participants performed a 4-minute walking test at a comfortable pace. To measure spatiotemporal gait parameters, participants walked on a treadmill equipped with an Optogait photoelectric cell system (Microgate, Bolzano, Italy), and were filmed with a phone camera at 120 frames per second. The Optogait software automatically calculated the spatiotemporal gait parameters (step length, cadence, step duration, phases of the gait cycle). Videos were processed using MediaPipe landmark pose to detect joints and body segments. From this segmentation, the same gait parameters were calculated. The acquisition and processing of videos were centralized in AIgait a software we developed.

To identify gait cycles, a signal was created from the signal of the difference between both knees' positions in x-axis. A signal value of 0 corresponded to the knees crossing in reality. Within each of these cycles, toe-off was detected as the shortest distance between the hip and toe on one side, and heel-strike as the longest distance on the other side. Each gait cycle was segmented so that the beginning of the cycle corresponded to the heel strike. Time parameters were calculated in seconds and as a percentage of the cycle, and spatial parameters were calculated by converting to pixels based on femur length.

Results and Discussion

Three participants from the control group were studied. The results in temporal gait parameters, we obtained low difference between both methods (Table 1). The results regarding the estimation of distance-related parameters, however, showed a significant discrepancy between our measurement via AIgait and the one with Optogait (104.64 ± 51.51 vs. 74.03 ± 1.60 m). These results highlight the limitations of the camera device and the need to consider potential distortions between the middle and bottom of the image. Further research is warranted to further investigate the potential of this new tool in real life condition. To test the robustness of the tool, we aimed to assess on participant with gait disorder such as in neuromuscular disease. The AIgait analysis should also include joint angle measurements and kinetic measurements in order to overview the biomechanical analysis of gait in patients with neuromuscular disease.

Conclusions

Within this small group, the use of the AIgait software seems promising. Assessing human movement is essential for monitoring daily life activities in patients' recovery or assessing disease progression.

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References

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Table 1: Comparison of temporal gait parameters from OptoGait and AIgait application. The data are presented as mean ± SD.

	Cadence (steps/min)		Step duration (s)		Stance time (% gait cycle)		Single support (% gait cycle)	
Device	AIgait	Optogait	AIgait	Optogait	AIgait	Optogait	AIgait	Optogait
Control (n = 3)	121.31 ± 15.07	112.68 ± 2.55	0.50 ± 0.06	0.53 ± 0.01	73.65 ± 9.58	69.19 ± 1.12	26.35 ± 9.58	30.81 ± 1.12