An Activity Recognition Framework for Monitoring Non-Steady-State Locomotion of Individuals with Parkinson's Disease

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Research

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Abstract

Background: Fundamental knowledge in activity recognition of individuals with motor disorders such as Parkinson's disease (PD) has been primarily limited to detection of steady-state/static tasks (e.g., sitting, standing, walking), and identification of non-steady-state locomotion on uneven terrains (stairs, ramps) has not received much attention. Furthermore, previous research has mainly relied on data from a large number of locations which could adversely affect user convenience and system performance.

Methods: Here, individuals with mild stages of PD and healthy subjects performed non-steady-state circuit trials comprising stairs, ramp, and changes of direction. An offline analysis using a linear discriminant analysis (LDA) classifier and a Long-Short Term Memory (LSTM) neural network was performed for task recognition. The performance of accelerographic and gyroscopic information from varied lower/upper-body segments were tested across a set of user-independent and user-dependent training paradigms.

Results: Comparing the F1 score of a given segment across classifiers showed improved performance using LSTM compared to LDA. Using LSTM, even a subset of information (e.g., feet data) in subject-independent paradigms appeared to provide F1 score > 0.8. However, employing LDA was shown to be at the expense of being limited to using a subject-dependent paradigm and/or biomechanical data from multiple body locations. **Conclusion:** The findings could inform a number of applications in the field of healthcare monitoring and developing advanced lower-limb assistive devices by providing insights into classification schemes capable of handling non-steady-state and unstructured locomotion in individuals with mild Parkinson's disease.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the latest manuscript can be downloaded and accessed as a PDF.

Tables

Due to technical limitations, table 1 & 2 is only available as a download in the Supplemental Files section.

Figures

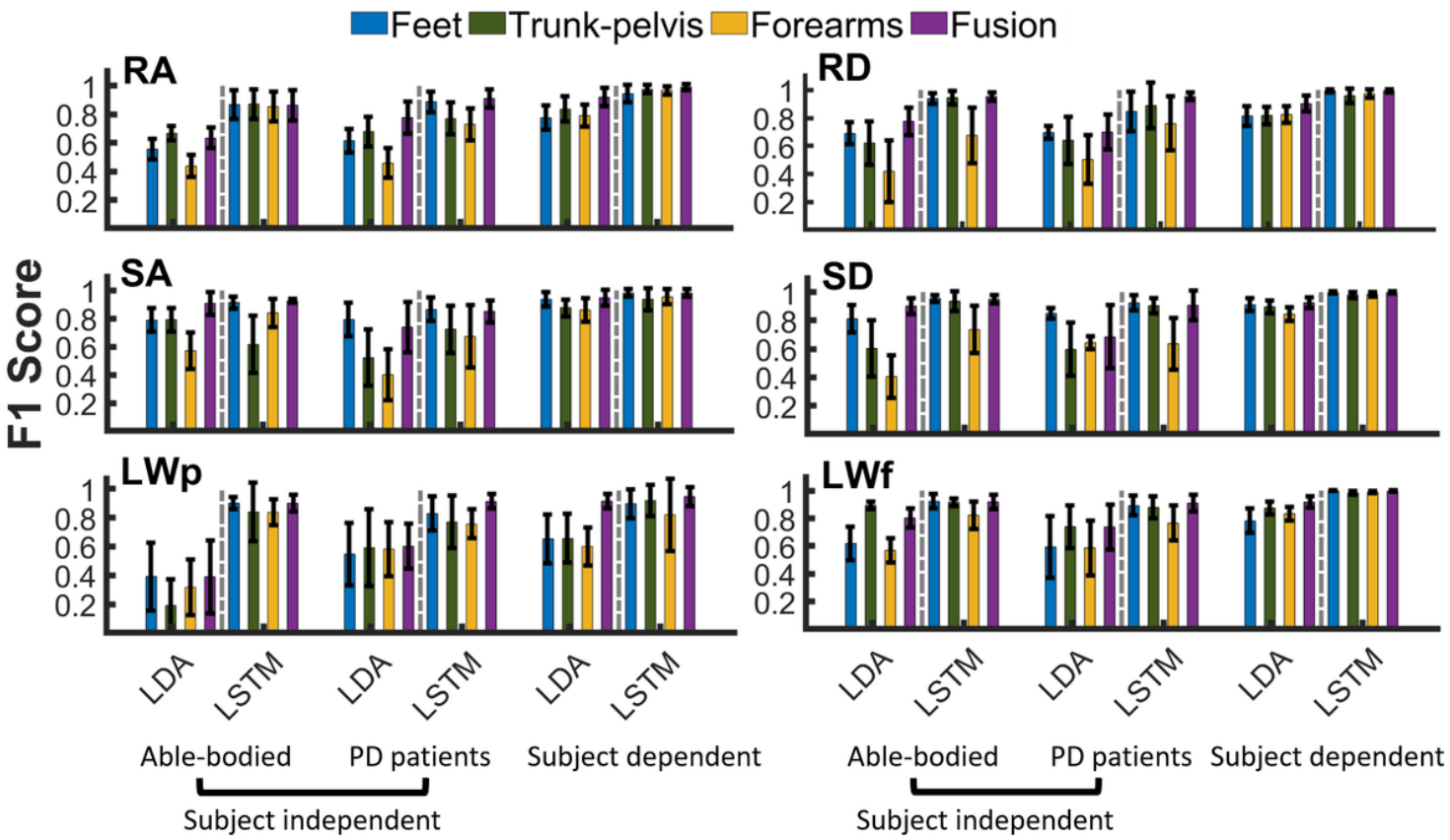

Figure 1

Detection of ramp ascent (RA), ramp descent (RD), stair ascent (SA), stair descent (SD), level-walking preceding (LWp) and following (LWf) ramp/stairs using a linear discriminant analysis (LDA) and a Long-Short Term Memory (LSTM) neural network. Task recognition outcomes using segments biomechanical data were compared across subject-independent (trained on able-bodied and PD patient's data) and subject-dependent training paradigms.

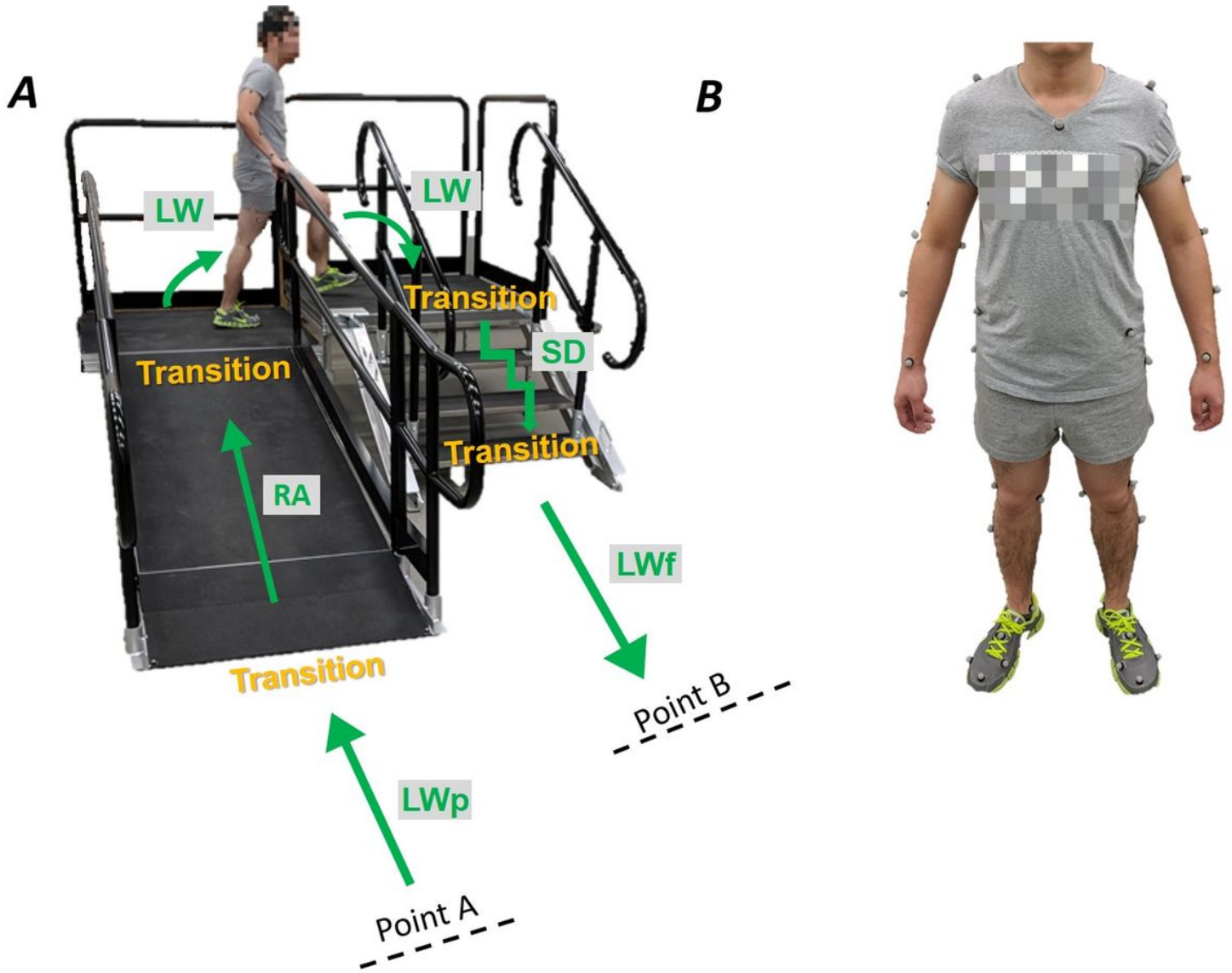

Figure 2

A) “Terrain park” circuit setup was comprised of a four-step staircase, a ramp and elevated platforms. Subjects performed trials of the circuit in the following orders: They started at point A, performed the locomotion as shown, and stopped at point B. They executed the tasks in the reverse order in the next trial, starting at point B and ending at point A. Circuit trials were performed for both left leading and right leading legs. B) Sixty-six reflective markers were attached to anatomical body locations to track 12 body segments of the arms, legs, and torso.

Supplementary Files

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- TablesBioMedOnline.pdf