EEG-Based Detection of Acceleration and Deceleration Intentions for Self-Paced Gait Rehabilitation

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Summary

This study proposes an electroencephalography (EEG)-based intention recognition model for detecting acceleration and deceleration intentions during self-paced gait rehabilitation. The LSTM-based model achieved classification accuracies of 64.64% for intact human subjects and 58.14% for stroke survivors, demonstrating the potential of EEG-based intention detection for self-paced gait rehabilitation systems.

Introduction

Several studies show self-paced gait rehabilitation system could promote rehabilitation for neurological disorder patients [1]. For effective and responsive self-paced interaction, detecting speed change intentions is essential. Conventional kinematic-based intention detection has relatively long delays due to post-movement detection. EEG could provide capture of pre-movement neural activity capture for faster intention detection [2].

Methods

EEG and kinematic data were collected during self-paced treadmill [3] gait rehabilitation using Kinect v2 (Microsoft, Washington) and actiCHamp (BrainProduct, Germany) (Figure 1(a)). Data was classified into four speed phases: fixed low/high speed, acceleration, and deceleration, based on motor speed. 12 participants (60.82 years old; 4 intact, 8 stroke survivors: 6 acute (13.43 ± 4.54 days), 2 chronic (2.5 and 28 years)) participated(IRB: B-1608/358-004). Using a sliding window (size=50, stride=25), 254,701 samples were generated and split (80/20%) for training/testing. LSTM model (epoch=6) was trained for acceleration/deceleration distinction and speed phase identification (Figure 1(b)).

Results and Discussion

Classification accuracies for intact human subjects were 64.64% and 55.92% for acceleration/deceleration and all four speed phases, respectively. For stroke survivors (2 chronic, 6 acute), the accuracies were 58.14% and 42.82%, respectively.

Table 1: Classification accuracy for acceleration/deceleration and all speed phases in intact subjects and stroke survivors.

Classification Prediction Accuracy	Acceleration, Deceleration (%)	Low speed, High speed, Acceleration, Deceleration (%)
Intact Subjects	64.64	55.92
Stoke Survivors (2 chronic, 6 acute)	58.14	43.82

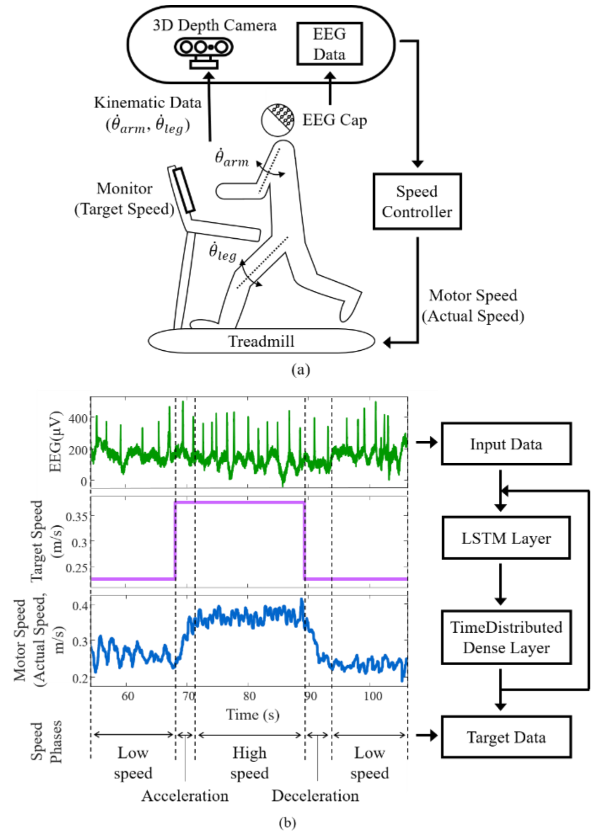

Figure 1: (a) Treadmill control system setup. (b) LSTM model for speed intention classification.

Conclusions

For classifying acceleration and deceleration phases, intact subjects showed 64.64% accuracy, and stroke survivors showed 58.14%. These results suggest that the proposed method can be utilized for intention recognition when developing other gait rehabilitation systems and wearable assisting systems. Future work will focus on improving model performance through signal preprocessing and data augmentation, as well as enhancing intention prediction speed by feature extraction.

Acknowledgments

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