Motion Intent Recognition in Intelligent Lower Limb Prosthesis Using One-Dimensional Dual-Tree Complex Wavelet Transforms

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Research

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Abstract

Background: Most traditional intent recognition methods are to recognizing the movement of lower limb prosthesis through statistical features, which are unstable in short-term signals. The another key problem with recognition of lower limb prosthesis motion intent is to explore the instantaneous change between the two different steady modes. Based on the above considerations, the one-dimensional dual-tree complex wavelet transform (1D-DTCWT) is introduced for motion intent recognition in intelligent prosthesis.

Methods: 1D-DTCWT adopts two-way complex wavelet transforms with a binary tree structure as functional data analysis (FDA) method that preserves the time-frequency local analysis capabilities of wavelet transforms while maintaining translation invariance and direction selection. Therefore, the 1D-DTCWT can amplify the instantaneous change information hidden in the data while retaining the continuity of the motion behavior, so as to better recognize the motion intention. Furthermore, the feature vector composed of low-frequency wavelet coefficients decomposed by 1D-DTCWT is classified and recognized by support vector machine (SVM), which can effectively classify and recognize the motion intent of the unilateral lower limb amputees.

Results: The data of the experiment comes from ten able-bodied subjects and one amputee subject to analyze 5 steady modes, 8 transitional modes, and 13 total motion modes adopting user-dependent and user-independent methods. The experimental results from the user-dependent methods show that the recognition rate for able-bodied subjects reached 98.91%, 98.92%, and 97.27% for the movement modes of steady modes, transitional modes, and total motion modes, respectively. The recognition rate of the amputee subject reached 100%, 91.16%, and 89.27%, respectively, for the three modes.

Conclusions: The method in this paper can effectively solve the problem of short-term signal instability reflected by traditional statistical feature recognition of motion intent and explore the instantaneous change information of transitional modes while retaining the continuity of the motion behavior.

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.

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