NONLINEAR ANALYSIS TO QUANTIFY MOVEMENT VARIABILITY IN HUMAN-HUMANOID INTERACTION

by

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Abstract

Nonlinear analysis can be applied to investigate the dynamics of time-ordered data. Such dynamics relate to sensorimotor variability in the context of human-humanoid interaction. Hence, this dissertation not only explores questions such as how to quantify movement variability or which methods of nonlinear analysis are appropriate to quantify movement variability but also how methods of nonlinear analysis are affected by real-world time series data (e.g. non-stationary, data length size, sensor sources or noise). Methods are explored to determine embedding parameters, reconstructed state spaces, recurrence plots and recurrence quantification analysis. Additionally, this thesis presents three dimensional surface plots of recurrence quantification analysis with which to consider the variation of embedded parameters and recurrence thresholds. These show that three dimensional surface plots of Shannon entropy might be a suitable approach to understand the dynamics of real-world time series data. This thesis opens new avenues of applications in human-humanoid interaction where humanoid robots can be pre-programmed with nonlinear analysis algorithms to evaluate, for instance, the improvement of movement performances, to quantify and provide feedback of skill learning or to quantify movement adaptations and pathologies.

$$\min_G \max_X F(G, X)$$

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