Quantifying Movement Variability with Nonlinear Dynamics for Human-Humanoid Interaction

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Movement variability occurs in motor performance of multiple repetitions of a task in a certain environment. The challenge with quantifying movement variability is that traditional methods in time domain and frequency domain fail to detect tiny modulations in frequency or phase of time series. In this talk, methods of nonlinear dynamics (i.e., reconstructed state space, uniform time-delay embedding, recurrence plots and recurrence quantification analysis) are introduced with the aim of quantifying movement variability in human-humanoid interaction. Additionally, experiments are presented where twenty right-handed healthy participants imitated vertical and horizontal arm movements in normal and faster speed from an humanoid robot. From time series data collected with inertial measurements sensors, four window lengths and three levels of smoothed time series were analysed with nonlinear dynamics methods. Then weaknesses and robustness of nonlinear dynamics methods for raw data and post-processed data are presented and therefore concluded that Shannon entropy values from Recurrence Quantification Analysis were well distributed and showed variation in all the conditions of time series data. With that in mind, it is going to be highlighted the potential of nonlinear dynamics methods to enhance the development of better diagnostic tools for various applications in medical robotics or for new forms of human-humanoid interaction.

References

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