Abstract:

Objective: Modeling of human motor intention plays an essential role in predictively controlling a robotic system in human-robot interaction tasks. In most machine learning techniques, human motor behavior is modeled as a generic stochastic process. However, the integration of a priori knowledge about underlying system structures can provide insights on otherwise unobservable intrinsic states that yield superior prediction performance and increased generalization capabilities.

Methods: We present a novel method for modeling human motor behavior that explicitly includes a neuroscientifically supported model of human motor control, in which the dynamics of the human arm are modeled by a mechanical impedance that tracks a latent desired trajectory. We adopt a Bayesian setting by defining Gaussian process (GP) priors for the impedance elements and the latent desired trajectory. This enables exploitation of a priori human arm impedance knowledge for regression of interaction forces through inference of a latent desired human trajectory. Results: The method is validated using simulated data, with particular focus on effects of GP prior parameterization and intention estimation capabilities. Superior prediction performance is shown with respect to a naive GP prior.
An experiment with human participants evaluates generalization capabilities and effects of training data sparsity. Conclusion: We derive the correlations of an impedance-based GP model of human motor behavior that exploits a priori knowledge. Significance: The model effectively predicts interaction forces by inferring a latent desired human trajectory in previously observed as well as unobserved regions of the input space.

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