Using Penalized Spline Regression to calculate Mean Trajectories including Confidence Intervals of Human Motion Data

Abstract:
Research in motion planning for mobile robots increasingly focuses on modeling human-like motions and behaviors. Applied to robots, these models help generating motions that are intuitively comprehensible for a human interaction partner. However, identifying the underlying parameters of such human motion models is challenging. These parameters are commonly estimated by analyzing measured single trajectories or means of trajectory sets. Indeed, raw trajectories as well as the means are often not representative for the data, as measurements are noisy and the amount of generated data is limited. For a reasonable analysis it is necessary to smooth the data and estimate an according confidence interval for the mean. In this paper we apply penalized splines to smooth single trajectories and to estimate means of trajectory sets, which ensures little distortion of the original data. Based on that, a
method is presented that yields a confidence interval for the mean of human motion data. In order to cope with unknown distributions and small datasets our method employs bootstrapping. The analysis based on confidence intervals takes the variance of the data into account and allows for reasonable conclusions about underlying human motion parameters.