
Abstract

In research, training and entertainment industries, simulators are used to replicate human perception of vehicle motion in a safe and customizable environment. The perception of self-motion of the driver inside the simulator is improved by the presence of motion cues generated by a motion system. However, direct feedthrough of these vehicle cues require movements of the system that exceed the physical capabilities of its actuators. Therefore, a control process must be realized that translates these movements, this is typically the objective of a motion cueing algorithm.

In this thesis a Model Predictive Control (MPC) based cueing algorithm is developed which transforms simulated vehicle cues into motions exerted on a motion system, while maintaining a realistic driving experience. It balances a trade-off between the perception fidelity of the generated cues and the usage of workspace, where models of the vestibular system are used to simulate the driver's perceived motions. One of MPC's benefits is the use of a receding horizon principle, which is characterized by a repeated optimization of control actions over a future prediction interval. The algorithm uses a Single DOF Excursion (SDE) analysis to be aware of the available size of the workspace and adapts its generated cues accordingly. Hence, adaptive weights and constraints are applied in order to manage the motions within the changing workspace, where an adaptive converging constraints method finally matched the research objectives.

This method is verified with different case studies, the robustness to different input signals, the washout of the workspace and the influence of known future vehicle motions on the response are investigated. Furthermore, the method is compared to cueing algorithms from both literature and industry. It shows a workspace washout with minimized motion perception, an accurate reference tracking for different input signals and a full exploitation of the workspace. Moreover, knowledge about the future vehicle accelerations resulted in an improvement of the reference tracking, a reduction in false cues and it triggered the use of preposition techniques. Finally, comparisons with acknowledged cueing algorithms show a less smooth response with spurious jerks, however larger onsets, better reference tracking, longer sustained accelerations, and more efficient workspace exploitations are observed for the MPC based method.