Abstract

A Learning Model Predictive Control (LMPC) strategy for periodic tasks is presented. The proposed controller learns from previous iteration data to improve the performance of a closed loop system in each iteration. A sampled safe set and terminal cost function are used to guarantee recursive feasibility and non-decreasing performance cost in each iteration. The proposed control is tested on an autonomous racing example. Vehicle dynamics are identified online using Linear Regression. The control strategy is implemented on a 1:10 scale RC race car, sensor data from an ultrasound-based GPS and IMU are used to estimate the system state. Finally, experiments show the real-time feasibility of an optimal trajectory generation with online system identification.

Simulations illustrate the effectiveness of this approach and generate an optimal trajectory along a given race track. Furthermore,

A Learning Model Predictive Control (LMPC) for periodic tasks is presented. The proposed LMPC frameworks builds on \cite{Rosolia2016} and extends its range of applicability to systems subject to periodic cycles. The proposed controller learns from data to improve the performance of a closed-loop system at each iteration. A terminal cost and a sampled safe set that take into account the period of the system are used to guarantee recursive feasibility and non-decreasing performance cost at each iterations. The proposed control logic is tested on an autonomous racing example, where the vehicle dynamics are identified online. Simulation results illustrate the effectiveness of the proposed approach. These are bolstered by experimental results on a 1:10 scale RC car. Experimental results were possible thanks to an estimation technique proposed in this work, where indoor ultrasound based GPS, IMU and wheel encoders measurements are combined to estimate the system state.

A Learning Model Predictive Control (LMPC) strategy is extended to repetitive systems. The presented controller is able to improve its performance with every iteration by learning from previous iterations. It is applied to an autonomous race driving problem. Simulations on a kinematic and a dynamic bicycle model show the controller's performance. Additionally, the strategy is applied to a 1:10 scale RC car. An estimator using an indoor ultrasound based GPS as well as an IMU and wheel encoders is developed. The system's dynamics are identified online using Linear Regression.

%Experiments are performed on a small race track, reaching maximum velocities of $\SI{3}{\meter\per\second}$. \\