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Time-distributed optimization for Model Predictive Control

Abstract – **Model Predictive Control** (MPC) is a powerful control methodology that constructs a control law from the solution of a receding horizon optimal control problem (OCP). MPC can systemically handle nonlinearities, coupling, and constraints but can be difficult to implement in practice because of the need to solve non-linear OCPs online. In this talk, we introduce a unifying framework for **Time Distributed Optimization (TDO)** where, instead of computing high accuracy solutions of the OCP, the controller maintains a "guess" of the solution that is improved at each sampling instant using a finite number of iterations of an optimization algorithm. We show that any MPC formulation that is input-to-state stable (ISS) in the optimal case and any optimization algorithm whose convergence is at-least-q-linear can be used to construct a TDO MPC controller that inherits the stability and constraint handling properties of the optimal MPC controller. When applied to time-distributed sequential-quadratic programming (TD-SQP), also known as the real-time iteration (RTI) scheme, our framework significantly extends existing stability and robustness results. Finally, we illustrate our theoretical results with an experimental diesel engine emissions control example.

by Dominic Liao-McPherson

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Biographical Sketch – **Dominic Liao-McPherson** obtained his BASc (with High Honours) in Engineering Science, Aerospace Option, from the University of Toronto in 2015. Since 2015 he has been a doctorant at the University of Michigan, in the department of aerospace engineering. His research interests lie in model predictive control, reference governors, trajectory optimization, and numerical methods with applications in aerospace, robotics, and autonomous vehicles. He received the 2019 Prof. Kabamba award and a predoctoral fellowship from the University of Michigan and was a finalist in the 2019 ECC best student paper competition. He is currently visiting ONERA in Toulouse where he is working on parafoil guidance.

UNIVERSITY OF MICHIGAN

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