Data-driven MPC for Real-time Control of an Open-die Forging Problem

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Résumé

Model Predictive Control (MPC) is a traditional technique widely employed on the control of constrained non-linear systems. It offers several advantages over classical control techniques, as it can anticipate the system's behavior, naturally considering hard constraints on the optimization problem. Lately, data-driven MPC has emerged as an alternative to physics-based modeling when sufficient data is available. Nonetheless, there has been limited progress in mitigating the computational burden of MPC on real-time applications. Therefore, we use Imitation Learning to train a feed-forward neural network (NN) using data collected from an offline MPC simulation. The goal is to replace the constrained optimization problem by learning from an expert's behavior (Behavioral Cloning), alleviating the computation burden on real-time applications. In order to guarantee constraint satisfaction, we apply a Recursive Feasibility strategy to the prediction of the NN.

The network's performance is then compared to that of traditional MPC using the Van der Pol oscillator as toy example. Finally, we study the control of an open-die forging process to validate the proposed strategy on a more complex problem. Results show that both learning methods yield similar closed-loop performance while significantly reducing the computation burden of the controller.
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