Simulation of cutting stabilized by nonlinear model predictive control

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Abstract

Simulated application of nonlinear model predictive control (MPC) for stabilization of a cutting process is presented. The nonlinear MPC combines a neural-network model and a genetic-algorithm-based optimizer. The control scheme comprises a process, a model, an optimizer, a controller and a corrector. Neural-network-based nonlinear experimental model is applied to recursive prediction in MPC. A robust genetic-algorithm-based optimizer is applied for the optimization of control trajectories. A neural-network-based controller is included in the control scheme for enhanced optimizer initialization and for autonomous control after the learning period. The nonlinear MPC is applied to control the simulated chaotic cutting process. The dynamics of a cutting process are very complex due to the nonlinear effects of high order involved. The control objective is to construct an on-line control system capable of improving the quality of the manufactured surface by preventing tool oscillations which result in the rough surface of the workpiece. MPC strategy with tool support manipulation as a control variable is investigated. Simulated results show considerable improvement of the manufacturing quality obtained by the proposed nonlinear model predictive control.