HEAVY MACHINERY - HM 2011, 7-12
ISBN 978-86-82631-58-3
Paper accepted: 30.05.2011.

Switching Predictive Control: Controller Design and Simulations

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Abstract: *In this paper we will consider one class of switching controllers. Such control strategy is a mix of continuous dynamics and discrete events philosophy. Here we consider a finite set of the model predictive controllers (MPC) which are the only advanced control technique to have had a significant and wide spread impact on industrial process control. There are several advantages for wide acceptance of MPC: guaranteed stability, constraints handling and easy extension to multivariable and nonlinear systems. In this paper we add else one important property: significantly increasing of the transient performance using switching control strategy. Also, illustrative example is presented.*
Keywords: *Railway vehicle, independently rotating wheelset, active steering*

1 INTRODUCTION

The model predictive control (MPC) is the only advanced control methodology which has made a significant impact in industrial control engineering. We will mention that the main features of MPC are

(i) The extension to multivariable case is easy

(ii) It handles constraints. The higher performance levels are associated with pushing the limits. That frequently leads to more profitable operation

(iii) In industrial applications control update rate are relatively low and there is enough time for on-line computation.

Several important publications, in the form of survey papers and books, provide introduction to theoretical and practical issues associated with the MPC philosophy [1] and [2].

They noticed that most control laws, for example PID, do not explicitly consider the future implication of the current control actions. MPC, on the other hand, explicitly computes the predicted behavior over some horizon. One can therefore restrict the choice of current proposed input trajectories to those that do not lead to difficulties in the future.

Originally developed to meet the specialized control needs of the power plants and petroleum industry, MPC strategies can now be found in a wide variety of application areas such as discrete-event systems [3], cooperative control [4], digital electronic [5] and financial engineering [6].

For control of complex systems very important is the field of hybrid control. The hybrid systems describe the interaction of software, modeled by finite state systems such as finite state machines, with the physical world, described by differential or difference equations [7]. Specific problems in this field are presented in references [8] and [9]. The paper [10] presents a hybrid MPC. Authors propose frame for modeling and controlling models of the systems described by interacting physical laws, logical rules, and operating constraints.

As pointed out in [1] the consideration of hybrid systems opens up a rich area of research. Interesting application is presented in the field of power electronics (design of DC-DC converters). The application of hybrid model predictive control for step-down DC-DC converter is described in [11].

In this paper we introduce different strategy for switching predictive control in comparison with above mentioned papers. The controller is based on conventional optimal control that is obtained by minimization of some performance criteria. To be more specific, in the paper is considered the switching receding horizon control with the quadratic performance criterion. The performance criterion includes the prescribed degree of stability. The switching rule is based on the selection of the best performance from the finite set of the closed-loop systems. The main ingredient of the switching predictive controllers is the solution of the finite set of Riccati equations. Here is considered control of stable unconstrained systems.

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