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Review of the PhD thesis "***Numerical Aspects of Optimal Control Design for Nonlinear Systems***" submitted by **Ing. Matej Pčolka**

The thesis work focuses on nonlinear optimal control methods and provides a quite thorough analysis of some aspects of optimal control design for nonlinear systems, such as the choice of the step size of gradient algorithms and the horizon, as well as algorithms to improve on the efficiency of the solving methods and reduce the computational burden. Furthermore, innovative optimisation algorithms are also designed for quantized nonlinear predictive control, which seems to be tailored to building control (however a range of different applications can be envisaged), and in general for hybrid systems, systems that exhibit both continuous and discrete dynamics and are usually optimised through mixed integer nonlinear models. A three-stage optimisation algorithm is then proposed for production processes, in particular bioprocesses.
All the novel algorithms are motivated by practical problems and are then application-oriented.

The thesis work aims at discussing and illustrating numerical aspects of optimal control design for nonlinear systems, which is clearly fulfilled.
The methods employed to analyse some important features and parameters of solving algorithms of control problems for nonlinear systems, as well as to develop algorithms and optimisation frameworks for hybrid systems, production processes, are all adequate given the assumptions made and the goals to achieve.

The scope of the thesis work is relevant to the current needs of the scientific community because nonlinear systems, hybrid systems are common in real-life applications and design algorithms to optimise and control these systems with an eye on the practical implementation and the computational efficiency is valuable.

The analysis of nonlinear programming techniques and the design of tractable optimisation and control algorithms for nonlinear systems and systems with discontinuities, which are very common in real-world applications, are relevant topics and could bring significant control performance improvement. Deriving creative ways of reducing the computational and memory burden of a predictive control design, which can preserve closed-loop stability and suggest achieving considerable savings from the computational point of view, is a particularly interesting contribution of the thesis work.

It would help the readability of the thesis to better link the various contributions of the thesis work and also the algorithms to other possible case studies. Consider, for instance, the studies and algorithms focusing on hybrid systems and the framework for production processes; is there any aspect of the algorithms developed for hybrid systems, in particular considering the *robustification* approach, that can be utilised also for optimising production processes, can the framework for production processes be *robustified*, how can the framework for the production processes be modified for application to processes other than bioprocesses?

The candidate has clearly worked independently and could answer to many critical questions. The thesis work illustrates advanced optimisation models and algorithms to tackle nonlinear dynamics and generally hybrid systems, which are very common in the real-world applications. The novelty of these studies and designed algorithms are certainly original as demonstrated by the acceptance in several journals and conference proceedings.
The thesis certainly provides new insights that will be useful to future researchers in the field, as well as different stakeholders from the specific application areas.

The author of the thesis proved to have an ability to perform research and to achieve scientific results. I do recommend the thesis for presentation with the aim of receiving a Ph.D. degree.

Alessandra Parisio