The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Computationally efficient controller design for drilling automation using reduced order models

S. Naderi Lordejani[1], **W.H.A. Schilders**[2]

[1,2] Department of Mathematics and Computer Science, Eindhoven University of Technology, the Netherlands, {s.naderilordejani,w.h.a.schilders}@tue.nl

Keywords: *Model reduction, Controller design, Computational efficiency, Automation*

This abstract builds upon a novel model order reduction method and presents a computationally efficient procedure for designing a high-performance pressure controller for drilling automation. Hydraulics of a drilling process are typically described by models in terms of partial-differential equations (PDEs). Such models are, however, so complex that those complicate and may prohibit the design and analysis of model-based controllers in an efficient and timely manner. To address this complexity issue, we presented a model reduction technique for hyperbolic PDE models in [1]. This moment matching-type technique approximates the PDE model of a drilling process by a much simpler, yet highly accurate, low-order time delay model. This delay model is, as opposed to the PDE model, more amenable to established system theoretic analysis and controller design techniques. In the current work, we use this reduced-complexity model from [1] to design a high-performance controller which regulates the well pressure using only surface measurements. The designed pressure controller not only satisfies optimality conditions but also guarantees the closed-loop stability. In terms of computational efficiency, this technique is highly efficient. More specifically, computing the controller gains is the most demanding part of our technique. These gains are obtained by solving a set of linear matrix inequalities which are characterized by the reduced-complexity model. Thus, given the low order of the reduced model, these inequalities can be solved quickly and efficiently. Finally, we present simulation results, such as those in Figure 1, to confirm that this controller outperforms existing pressure controllers in realistic drilling scenarios.

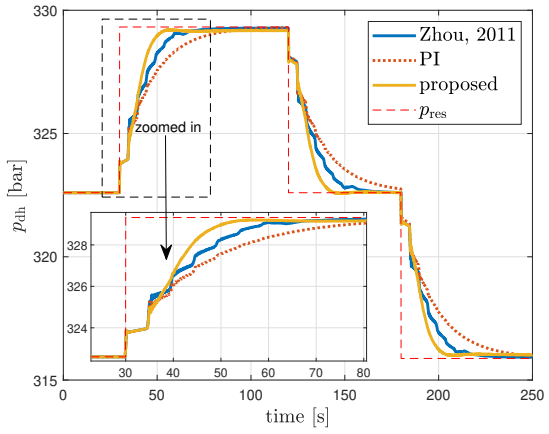

Figure 1: Comparison between the presented and existing pressure controller.

REFERENCES

[1] T. C. P. F. Leenen, S. Naderi Lordejani, B. Besselink, W. H. A. Schilders, N. van de Wouw, *Control-oriented model reduction for a class of hyperbolic systems with application to managed pressure drilling*, in: 21st IFAC world congress, Berlin, Germany, 2020.