

# Preface

This book provides insight into the model predictive control of lightly damped vibrating structures. Conclusions of ongoing research in the field, up-to-date experimental results and the doctoral dissertation thesis titled “Efficient Model Predictive Control Applied on Active Vibration Attenuation” by Gergely Takács have been summarized into a clearly presented and accessible form. The book is intended for use in undergraduate or graduate level university curricula or for industrial practitioners interested in computationally efficient predictive control utilized in active vibration attenuation. It is assumed the reader has a very basic understanding of linear control theory and vibration mechanics.

The control strategy discussed in this book is based on the idea of using a mathematical model to predict the future behavior of a vibrating system and selecting the best control moves based on an optimization procedure using this predicted information. This method is known as model predictive control (MPC) and due to its intense computational requirements has been so far used mainly to control processes with very slow dynamics. The control moves computed by MPC will not only be ideal in a sense of damping performance, but they will also respect process constraints arising from physical actuator limitations, safety or economic reasons. This title will introduce the current state and the theoretical particulars behind this advanced control strategy and show how it can be implemented using piezoelectric actuators to lightly damped vibrating structures, in order to eliminate or attenuate undesired vibrations.

Using more than 170 illustrations, photographs, diagrams and several tables, the book will take the reader through the necessary steps in understanding the fundamentals of active vibration control (AVC), give a thorough review of the current state of model predictive control and finally will also introduce the implementation of computationally efficient MPC algorithms and compare different predictive control strategies in simulation and experiment.

Both active vibration attenuation and model predictive control have been treated in numerous excellent books already. So why would we need another publication on these topics? Works discussing the field of (active) vibration control are generally limited to presenting traditional control methods ranging from

positive position feedback (PPF) to linear quadratic control (LQ). The progress of control theory has not stopped with providing us the tools to synthesize and implement simple controllers such as proportional integrating derivative (PID). Modern optimization-based control methods, such as model predictive control are generally not considered for active vibration control applications. This can be partly attributed to the fact that the results of control theory tend to be transferred to real-life applications very slowly. The other major reason is due to the obvious implementation limitations: the sampling speeds usually encountered in AVC are too fast for real-time deployment. Advantages of predictive controllers over traditional controllers are not limited to an increased performance, but these methods also handle process, actuator and safety-related constraints on an algorithmic level.

On the other hand, either the books published on the topic of model predictive control are focused exclusively on the theory in deep mathematical detail or, even if practical implementation examples are given, they are limited to processes with slow dynamics. The reason for this is that implementation of predictive controllers on petrochemical plants, heaters and other slow processes do not invoke the computational time issue. Applying predictive control in active vibration attenuation is therefore not a topic of these publications. This book is distinct from general works on AVC or MPC because it presents the multi-disciplinary area of predictive control applied in vibration control, treating the subject as one compound problem. We offer a specific cross-section of these two actual and attractive engineering fields and suggest solutions for the research and industrial community.

Gergely Takács is currently a research engineer at the Institute of Automation, Measurement and Applied Informatics of the Faculty of Mechanical Engineering of the Slovak University of Technology in Bratislava. He has received his PhD degree in Mechatronics from the Slovak University of Technology in 2009. His recent doctoral studies and commencing academic career have been fully devoted to the application of computationally efficient model predictive controllers in the active vibration control of lightly damped structures. His research interests include active vibration control, smart materials, advanced actuators, and computationally efficient model predictive control. Gergely Takács is a member of IEEE.

Boris Rohal'-Ilkiv has received his degrees from the Slovak University of Technology in Bratislava, the Faculty of Mechanical Engineering, in control engineering. Currently, he is a tenured professor at the Institute of Automation, Measurement and Applied Informatics at the Faculty of Mechanical Engineering, where he is an active lecturer and researcher in the area of dynamical systems modeling and control. He has devoted the majority of his academic career to model predictive control, with a special attention focused at practical real-time controller implementation issues. Boris Rohal'-Ilkiv is a member of IEEE.

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## Contact

Feel free to contact us with any matter related to this book or its general topic. Let us know what you think, if you have found mistakes, missing references or anything else. Your feedback is highly appreciated and we will do our best to rectify any insufficiencies for further editions. Unsolicited grant proposals and agencies are welcome as well:

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Damped Mechanical Structures

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