Department of Electrical and Computer Engineering

Title: *"Efficient Modeling and Simulation of Mechatronic Systems by Example of Wind Turbines"*

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Abstract: Control of advanced mechatronic systems requires adequate models reflecting the dynamics and the interaction of electrical, magnetic, and mechanical subsystems. For such strongly coupled systems the proper representation of domain interactions is crucial. This is achieved by a holistic approach modeling mechatronic systems by energetic state functions. Their dynamics is then governed by the Lagrangian motion equations in a unified manner. In this presentation the Lagrange model for electro-magneto-mechanical systems (EMMS), consisting of energetic state functions and a dissipation function, is briefly recalled. It automatically takes into account the nonlinear domain interactions, and is complemented by additional models for hysteresis in ferroelectric and ferromagnetic elements.

A contemporary example of controlled mechatronic systems are wind turbines. Wind turbines have become the sustainable backbone of green energy. This is not at least triggered by the availability of high-fidelity models enabling realistic numerical simulation of the turbine dynamics. Such simulation models, combining non-linear flexible and rigid substructures, wind field as well as converter and operational management, allow for detailed investigations of all parts of the turbine and its overall performance. However, such investigations require too long simulation times.

For a wind turbine design to get certified it must pass extensive simulation runs. The current standards require a few thousand different load case scenarios, which apparently poses a great challenge to the simulation tools. Even more, automatic mass simulation of predefined load cases requires capabilities that standard simulation tools are lacking, including parallel computation features that are indispensable for such applications.

In this talk an approach toward tailored software solutions for distributed batch simulation of wind turbines is discussed. The turbine model is described in detail and implementation issues are addressed. Special emphasis is given to the structure of the software. The reported simulation tool is validated and successfully applied in the industrial design and certification.

The talk is intended for anyone who is interested in dynamics simulation of mechatronic systems and in wind turbines in particular. The lecture can also be taken as crash course to the current state of technology in the wind turbine sector.

Biography: Andreas Müller joined the Institute of Mechatronics e.V., Chemnitz, an independent research institution, in 2011 as deputy manager. He concluded his study of mathematics and electrical engineering at the University of Applied Sciences Mittweida, Germany, and the University of Northumbria at Newcastle, UK, respectively in 1997. He also obtained a diploma degree in mechanical engineering from the Technical University Chemnitz, Germany, where he was 2004 awarded a PhD in theoretical mechanics. In 2011 he was granted the Habilitation degree from the University Duisburg-Essen, Germany. His research interests are centered on multibody dynamics, geometrical mechanics, non-linear electromechanical systems, and biomechanics. He is the author of more than 50 journal publications, 100 peer-reviewed conference papers, 4 book chapters, and the editor of five books in robotics and control. He serves as associate editor for Mech. Machine Theory, ASME J. Mechanisms and Robotics, Meccanica, Mechanical Sciences, Int. J. Mechanisms and Robotic Systems, Int. J. Advanced Robotic Systems.