2023 IEEE/ASME International Conference on
Advanced Intelligent Mechatronics (AIM)

Bridge State and Average Train Axle Mass Estimation for Adaptive Railway Bridges

Amelie Zeller, Spasena Dakova, Charlotte Stein, Michael Böhm, Gennaro Senatore, Arka P. Reksowardojo, Lucio Blandini, Oliver Sawodny, Cristina Tarín, *Institute for System Dynamics and Institute for Lightweight Structures and Conceptual Design, University of Stuttgart*

***Abstract*—Adaptive structures are equipped with sensors and actuators to counteract deformations caused by external loads. Concerning railway bridges, previous work has shown that active vibration damping allows to extend the service life. Trains as external loads represent the decisive influencing factor for bridge vibration and has to be taken into account when applying model-based control concepts. This paper proposes a state and disturbance estimator (SDE) for bridge structures based on a moving point load train model and estimating the average train axle mass. The model employed for state and disturbance estimation is linear time variant, which allows use of an augmented Kalman filter. Estimability is analyzed based on the Fisher information and the proposed SDE is systematically tested through simulations. A linear quadratic regulator is designed and combined with the proposed SDE to evaluate the closed-loop performance for damping the bridge vibrations during train crossing.**

***Index Terms*—Mechatronic systems, application, adaptive structures, railway bridges, state estimation, disturbance estimation.**

Funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation), Project-ID 279064222, SFB 1244. Subproject B02 in collaboration with C07 and B04.