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Robust control of multibody mechanical system: case study

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ABSTRACT

As it comes to real systems control, any model is a simplification. A question of how good is our controller and how well it performs in the case when the object differs from its model that we used in the design relates to the analysis of robustness.

We present the set of linear models of multibody dynamics of mechanical systems and demonstrate how the uncertainty can influence the control quality in different design schemes.

We demonstrate how the unmodelled higher modes of oscillations can result in the instability of closed-loop system. Based on the analytical and numerical study we deliver the recommendations for the control design as well as sensor location to ensure robust stability.

We generalise the uncertainties that are specific for rotating mechanical systems: higher modes of oscillations, gyroscopic forces, the neglecting of various relationships in elastic models of bending bodies, e.g. the difference between Timoshenko and Bernoulli elastic beam models, etc.

The mass-spring model is used for the benchmarking, while the real system is seen as a flexible rotor. The analysis is based on Nyquist plot representation, small gain theorem and H_∞ norm. The simulation results are presented with Matlab, Simulink and Wolfram Mathematica software.

Keywords: robustness, uncertainty, control, H_∞ norm.

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