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Modelling of torsional vibrations in a motorcycle steering system

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Abstract: Torsional vibrations of steering systems are significant problems for the active safety of motorcycles. These vibrations may occur even with slight disturbances of the steady state motion, and their causes result from the improper mechanical parameters and characteristics of the steering system affecting the dynamic properties of the vehicle. In many cases, full elimination of torsional vibrations requires the use of special dampers acting as mechatronic systems. They enable appropriate action of the steering systems in a wide range of changes of dynamic characteristics resulting from changes of operating parameters (load, speed, etc.). Identifying the causes of vibrations and finally the proper synthesis of the active damper requires research studies using mathematical modelling and computer simulation. Due to the complex nature of motorcycle dynamics, which prompts the creation of complex forms of the mathematical model, and at the same time the obvious paradigm of the relative simplicity of the model used in mechatronic systems, the synthesis of such a model requires a special approach. The paper presents a method of model synthesis including determination of nonlinear equations of motion in an extreme "expanded" version, then their linearisation, Laplace transformation and determination of the transfer functions, frequency analysis based on Bode plots, reduction of the transfer functions and finally calculation of state equations allowing a synthesis of the active damper algorithm.

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