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# Alleviation of the Response of Slender Bridges to Wind Action Using Different Types of Controlled Actuators

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Alleviation of the Response of Slender Bridges to Wind Action Using Different Types of Controlled Actuators

The theoretical work describes how the dynamic characteristics of slender bridges under wind action can be improved through the use of controlled actuators. First, models for the aerodynamic forces are introduced that are based on linear time-invariant transfer elements. Rational function approximations of the aerodynamic transfer functions allow for force representations with state-space models. Two matrix-based rational function approaches are applied. Their suitability is limited for bridge cross sections. For an evaluation of the approximation quality, several parameter studies are conducted. In the next step, a cable-stayed bridge is introduced as an example of a slender bridge structure. Two different spatial discretisations with element-wise and global shape functions are applied for modelling this bridge. The aeroelastic system as the combination of aerodynamic forces and the bridge structure is described in terms of a state-space model. Stability and transfer behaviour, the most important characteristics of the aeroelastic system, are theoretically investigated. Emphasis is laid on the effect of the rational function approximations on the quality of the results. Reaction wheels, control moment gyroscopes, and aerodynamically effective flaps are employed as actuators. The state-space model of the aeroelastic system is extended in order to incorporate these devices. When the actuator motions are controlled in a closed loop, the system response to disturbances can be attenuated. A particular focus of the work is on finding fundamental limits for the stabilisation of the actuator-extended aeroelastic systems. Furthermore, the performance of the controlled system in a turbulent wind field is compared for the different types of actuators. In the last steps, the effect of state observers is investigated, a disturbance feedforward is analysed, and the feasibility of an integral control is explored.