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Realistic High-Rise Tower Structural Control with a Hybrid Mass Damper

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Introduction

The field of structural control has received a lot of attention in recent decades with the goal of proposing solutions for reducing structural vibrations caused by earthquakes, wind, or human action. On bridges and buildings all over the world, both passive and active structural control systems are utilized effectively. One can anticipate a variety of design-related uncertainties when considering the actual control of civil structures. Since most simulation conditions are regarded as highly idealized, which is far from a realistic scenario in which randomness and uncertainty appear to prevail, the introduction of uncertainty into the simulations is crucial. mentioned that parameter uncertainties are likely to exist in even the most intricate models, and that robust control strategies are needed to deal with this phenomenon. In the literature on structural control, the most common types of uncertainty are parameter uncertainties caused by modeling mistakes, environmental effects, and structural damage, and input uncertainties caused by noisy feedback signals and unknown force parameters. Numerous studies in the literature examine the performance of passive, semi-active, and hybrid structural control systems as well as robust algorithms and methodologies. Examples of robust control from the literature are presented in this work, and they are arranged according to the type of uncertainty they address. All of the studies in this document are summarized in Figure 1 to show the algorithms used for each type of uncertainty.

Description

The Robust Model Predictive Control (RMPC) will be the subject of this investigation, and its performance will be evaluated by comparing it to a well-established robust controller benchmark in the field of structural control. Outside of structural control, numerous applications already used the RMPC. For instance, investigated how well a RMPC plan controlled urban road traffic networks. They implemented a RMPC for the rotor control of a wind turbine and came to the conclusion that the RMPC is an appropriate choice for the specific control application by developing an algorithm with the goal of minimizing queue lengths within an urban road network under uncertain conditions. The authors compared its performance to that of a standard proportional-integral (PI) controller to demonstrate its efficacy. developed a RMPC plan to control the airpath of a diesel engine because diesel engine control plans frequently encounter uncertainties and model-plant mismatches. They demonstrated that, given the uncertainties taken into account, their RMPC implementation can effectively control the diesel engine airpath. implemented a RMPC for unmanned aircraft flight control in uncertain conditions. Using two unmanned rotorcraft configurations, they experimentally evaluated their algorithm in real time to demonstrate its performance. They came to the conclusion that the proposed plan was robust because it effectively dealt with forcible disturbances and deviated as little as possible from the reference trajectory. developed a RMPC solution for box-constrained disturbance uncertainties for the robust control of an energy-efficient building. To determine their relative performance, the authors compared the RMPC to a nominal MPC and a Rule Based Controller (RBC). They came to the conclusion that the RMPC performed best overall when their model uncertainty was between 30% and 67%, while the nominal MPC performed better when uncertainty was lower and higher (67%) and the RBC performed best when uncertainty was higher. formulated their RMPC using linear matrix inequalities in order to control the temperature in a building with ambiguous model parameters. When the tracking performance of the RMPC was compared to that of a nominal MPC that had been synthesized without taking into account any model uncertainties, it was discovered that the RMPC performed better by 24% when taking into account a variation of 70% in the system parameters. Additionally, the RMPC outperformed the nominal MPC controller by 17% when faced with severe uncertainty and sinusoidal variations. The assessment of the spatial variability of HM concentrations in the bottom sediments of retention reservoirs was the goal of the paper. The example of 28 retention reservoirs in Poland served as the basis for the analysis. The purpose of the study was to ascertain the degree of HMs pollution of the bottom sediments, as well as the potential toxic effects of HMs on aquatic life and the health of dredging workers. Moreover, measurable strategies were utilized to decide the wellsprings of HMs. Due to activities that are carried out in catchments; the analyzed reservoirs differ in terms of the operation period, surface area, volume, location within the catchment, and human pressure. The following in-depth conclusions can be drawn from the analyses: the pollution load index values indicate that the bottom sediments of seven reservoirs were polluted. In addition, contamination factor values in the remaining twelve reservoirs indicate contamination with specific HMs, particularly Cr, Ni, Cu, and Pb. Due to high Cd and Pb concentrations in only two reservoirs, ecological risk (ER) index values revealed a potentially toxic effect on aquatic organisms.

Conclusion

A 2D reduced-order model was used in this study to investigate the robust control of the Rottweil tower, which is 245 meters tall. The well-known H control scheme, which is widely regarded as the benchmark value, was used to compare two robust model predictive controllers. A controller known as RMPC1 was made to give the tower the best possible displacement control, while a controller known as RMPC2 was made to use less power. Three distinct control scenarios were developed in accordance with comparable research in the literature in order to take into account parameter uncertainties. No aeroelastic or other intricate response amplitude effects were explicitly considered in the simulations, and the nominal design wind load—the sole force to take into account—was maintained in all scenarios. The controllers energy consumption was examined in detail in each case, with the addition and extraction of energy to the mass damper separated out.

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