Robust Control with IQC

Student

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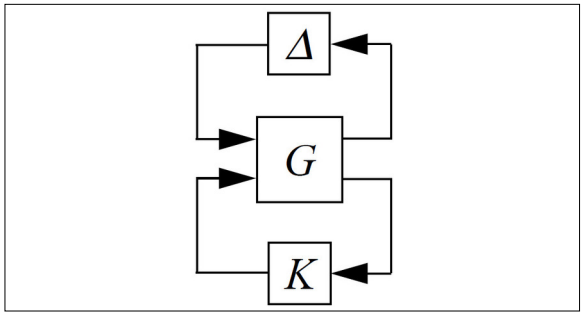
Introduction: A central question in control theory is whether a feedback stabilises the system or not. This is called nominal stability. However, in practice uncertainties and simplified mathematic models of the plant lead to a set of models for which the feedback must stabilise any possible plant. If the feedback stabilises the plant over a given set of models, we speak of robust stability. A simple method is the phase and gain margins in the Nyquist-plot. However, it guarantees only stability for either a phase or a gain variance. For simultaneous variances in phase and gain, more complex techniques are required, e.g: Linear quadratic regulator (LQR) together with loop recovery (LTR), H-infinity and mu-synthesis. Although these methods are advanced, they are not capable to include non-linearities. Integral quadratic constraints (IQC), however is a more general approach which is able to include non-linearities.
The objective of this project is to introduce the IQC-framework. Additionally, this paper investigates in the differences of the three controller-syntheses: LTR, H-infinity and IQC.

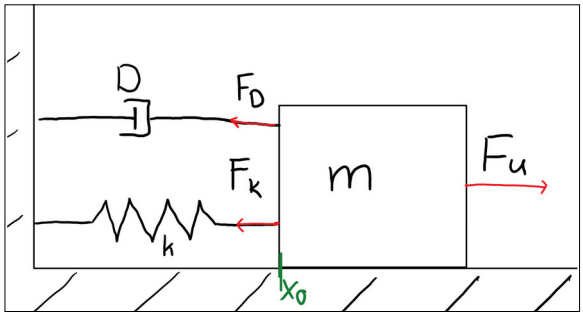
Approach: First, the LTR is introduced. Followed by a brief explanation of the H-infinity framework and the IQC synthesis. To compare the frameworks, they will be compared by a case study. The case study is a non-linear spring depending on its dilatation.

Conclusion: The effort to obtain controllers vary strongly with the method. From LTR being the simplest synthesis, the effort increases for the synthesis of a H-infinity controller. More effort is necessary to do the IQC-synthesis.
The IQC-framework is able to include various non-linearities and performances to the control problem. The cost, however, is increasing complexity.

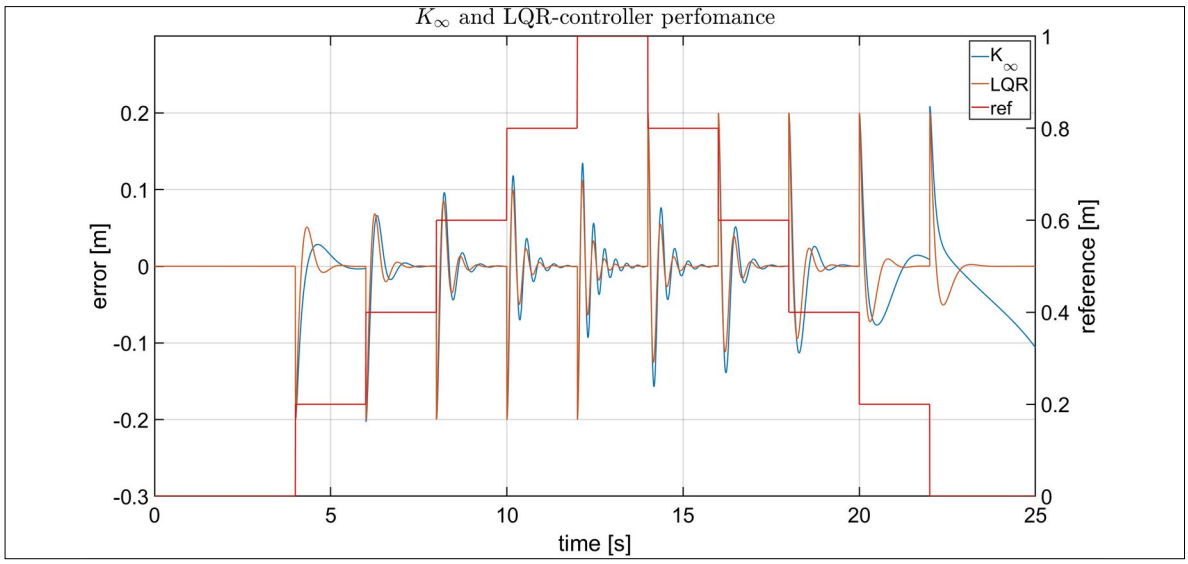
General plant (G) with uncertainties (Delta) and feedback(K).
U. Christen, Engineering aspects of H-inf control



Sketch of case study with non-linear spring constant
Own presentment



Results of the simulations.
Own presentment



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Subject Area
Electrical Engineering