

Accurate H-infinity-norm estimation via finite-frequency norms of local parametric models

Citation for published version (APA):

Tacx, P., & Oomen, T. (2021). *Accurate H-infinity-norm estimation via finite-frequency norms of local parametric models*. 43. Abstract from Benelux Workshop on Systems and Control 2021, Rotterdam, Netherlands.

Document status and date:

Published: 01/01/2021

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy

If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

Accurate \mathcal{H}_∞ -Norm Estimation via Finite-Frequency Norms of Local Parametric Models

Paul Tacx, Tom Oomen
Eindhoven University of Technology
Department of Mechanical Engineering
Control Systems Technology group

P.O. Box 513, 5600 MB Eindhoven, The Netherlands

Email: p.j.m.m.tacx@student.tue.nl & t.a.e.oomen@tue.nl

1 Background

Accurate \mathcal{H}_∞ -norm estimation is of critical importance for robust control design. Selecting an appropriate size of the uncertainty is crucial for the performance of the resulting robust controller. On the one hand, if the uncertainty is underestimated, there are no stability nor performance guarantees. On the other hand, if the uncertainty is overestimated, the system may become overly conservative.

2 Problem Formulation

Traditional algorithms to estimate the \mathcal{H}_∞ norm consider a discrete frequency grid. Hence, the \mathcal{H}_∞ -norm estimate is based solely on the at-grid frequencies which causes inter-grid errors. Consequently, potential resonances may be overlooked. This research aims to develop an algorithm to accurately and reliably determine the \mathcal{H}_∞ norm with a limited amount of data and limited user effort.

3 Approach

The key idea is to exploit the local smoothness over frequency by identifying local parametric models [1]. Since these local models are parametric, they can be evaluated continuously in their local frequency range, which enable the estimation of the inter-grid behavior [2]. The main idea is to estimate the global \mathcal{H}_∞ norm by estimating the finite-frequency L_∞ norm of the local models through the generalized KYP lemma [3].

4 Results

The developed approach is applied to a multivariable motion system. The resulting model uncertainty is shown in Fig. 1. In Fig. 2, the maximum singular values of the uncertainty and the resulting local models are depicted for a large frequency range. When studying the interpolation performance of the local models, it is clear that the true inter-grid behavior is accurately modeled. Moreover, the simulation

This work is part of the research programme VIDI with project number 15698, which is (partly) financed by the Netherlands Organisation for Scientific Research (NWO).

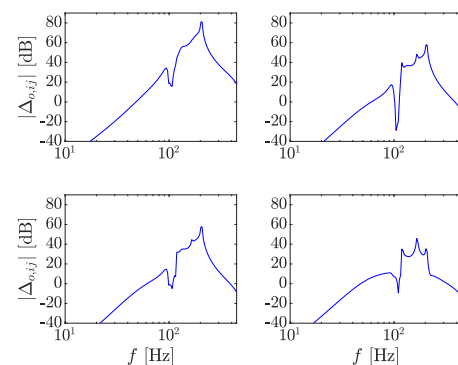


Figure 1: Bode magnitude diagram of the uncertainty Δ (—).

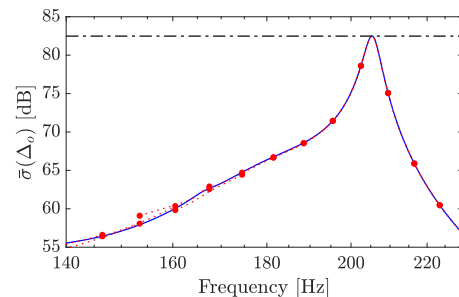


Figure 2: Bode magnitude diagram of the singular values: true uncertainty $\bar{\sigma}(\Delta)$ (—), local modeling estimate $\bar{\sigma}(\tilde{\Delta}_k)$ (••••).

shows that the \mathcal{H}_∞ norm is accurately estimated. Overall, the simulation example shows that the method proposed in this paper offers an accurate and reliable approach to estimate \mathcal{H}_∞ norm.

References

- [1] R. Pintelon, J. Schoukens, G. Vandersteen, and K. Barbé, "Estimation of nonparametric noise and fir models for multivariable systems—part i: Theory," *Mechanical Systems and Signal Processing*, 24(3):573–595, 2010.
- [2] E. Geerdyn, and T. Oomen, "local rational model approach for \mathcal{H}_∞ -norm estimation: With application to an active vibration isolation system," *Control Engineering Practice*, 68:63–70, 2017.
- [3] R. Iwasaki, and S. Hara, "Generalized KYP lemma: Unified frequency domain inequalities with design applications," *IEEE Transactions on Automatic Control*, 50(1):41–59, 2005.