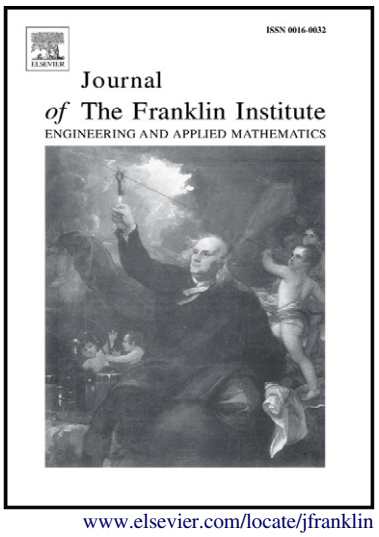

www.elsevier.com/locate/jfranklin

Bounded Real Lemmas for Positive Descriptor Systems

Qingling Zhang, Youmei Zhang, Tamaki Tanaka, Xinggang Yan

PII: S0016-0032(14)00299-3
DOI: http://dx.doi.org/10.1016/j.jfranklin.2014.10.019
Reference: FI2149

To appear in: *Journal of the Franklin Institute*

Received date: 28 February 2014
Revised date: 31 August 2014
Accepted date: 27 October 2014

Cite this article as: Qingling Zhang, Youmei Zhang, Tamaki Tanaka, Xinggang Yan, Bounded Real Lemmas for Positive Descriptor Systems, *Journal of the Franklin Institute,* http://dx.doi.org/10.1016/j.jfranklin.2014.10.019

Replies to Reviewers of Submission

Reply to Editor

We would like to express our sincere thanks to the Editor and the anonymous reviewers for their kind help and valuable comments which essentially improve the quality of our manuscript. In this revision, we have addressed all the comments raised by reviewers and amendments have been highlighted in blue accordingly. The detailed responses are stated as follows. Thank you very much for all your help.

Reply to Reviewer 1

We are really appreciated that the reviewer has been so conscientious during the reviewing process. During the revision, we have revised and improved the manuscript strictly based on your comments. In what follows, a list of changes with regard to your comments will be presented and we hope that it can be satisfactory.

Comments to the Author

This paper established a bounded real lemma for positive descriptor system. In addition, the authors considered the model reduction problem for positive singular system. This paper appears to me novel enough for this journal. In what follows please find some minor comments:

1. Lemma 1 also appears in Ref. [17], we suggest that the authors refer to this paper as well.

Reply. Thanks for your kind reminding and suggestion. In the revision, we have corrected this point.

2. The H-infinity model reduction techniques are different from classical definition. Therefore, one should compare with some recent papers on model reduction of positive systems (see, for example, H-infinity model reduction for discrete-time positive systems with inhomogeneous initial conditions, IJRNC, 2013). The advantage of "norm-preserving" proposed in this paper must be clarified.

Reply. Thank the reviewer for the insightful suggestion. Since our model reduction method is only applicable to positive descriptor systems in that the set $Z_d := \left\{ i \middle| (\hat{E}_c^D \hat{E}_c)_{ci} = 0 \right\}$ must be nonempty, and [27] treats positive standard systems, an numerical comparison with the method in [27] is difficult. However, from the observation of the numerical example section, we can also know that under the assumption that the initial condition of the original system and the reduced order system are different and the input vector are same, the output vector of the reduced order system asymptotically approaches that of the original system. On the other hand, by using our model reduction method, the norm of the transfer function matrix of the original system equals to that of the reduced order system, which means under the same input vector, the norms of the output vector of the two systems are equal. In the classical H_∞ model reduction setting, an additional performance index $\|y(t) - y_{ro}(t)\| < \gamma\|u(t)\|$ needs to be satisfied, while using our method, when $\|y(t)\| < \frac{1}{2}\gamma\|u(t)\|$ and $\|y_{ro}(t)\| < \frac{1}{2}\gamma\|u(t)\|$ hold, it suffices to prove $\|y(t) - y_{ro}(t)\| < \gamma\|u(t)\|$. In fact, based on the norm inequality $\|y(t) - y_{ro}(t)\| \leq \|y(t)\| + \|y_{ro}(t)\|$, we have $\|y(t) - y_{ro}(t)\| \leq \|y(t)\| + \|y_{ro}(t)\| < \gamma\|u(t)\|$ which is the classical performance index. To illustrate it clearly, we summarize this in Remark 7.

3. Some recent papers on positive singular systems are suggested to be included for better survey:
Positivity of discrete singular systems and their stability: An LP-based approach, Automatica, Volume 50, Issue 1, January 2014, Pages 84-91.
L-infinity-gain analysis for positive systems with distributed delays, Automatica, Volume 50, Issue 1, January 2014, Pages 175-179.

Reply. Thanks for your kind mentioning. Some recent papers including above papers have been cited in this revision as you suggested.