KYBERNETIKA — VOLUME 44 (2008), NUMBER 1, PAGES 17-34

Overlapping Controllers for Uncertain Delay Continuous-Time Systems

Lubomír Bakule; Josep M. Rossell

Abstract: This papers extends the Inclusion Principle to a class of linear continuous-time uncertain systems with state as well as control delays. The derived expansion-contraction relations include norm bounded arbitrarily time-varying real uncertainties and a point delay. They are easily applicable also to polytopic uncertainties. These structural conditions are further specialized on closed-loop systems with arbitrarily time-varying parameters, a point delay, and guaranteed quadratic costs. A linear matrix inequality (LMI) delay independent procedure is used for control design in the expanded space. The results are specialized on the overlapping decentralized control design. A numerical illustrative example is supplied.

Keywords: decentralized control; large-scale complex systems; overlapping decompositions; continuous-time systems; uncertainty; delay; LMI;

AMS Subject Classification: 93A14; 93A15; 93B51; 93B52; 93C41;

References

[1] L. Bakule, J. Rodellar, and J. Rossell: Generalized selection of complementary matrices in the inclusion principle. IEEE Trans. Automat. Control 45 (2000), 6, 1237–1243.

[2] L. Bakule, J. Rodellar, and J. Rossell: Structure of expansion-contraction matrices in the inclusion principle for dynamic systems. SIAM J. Matrix Analysis and Appl. 21 (2000), 4, 1136–1155.

[3] L. Bakule, J. Rodellar, and J. Rossell: Controllability-observability of expanded composite systems. Linear Algebra Appl. 332–334 (2001), 381–400.

[4] L. Bakule, J. Rodellar, and J. Rossell: Overlapping quadratic optimal control of linear time-varying commutative systems. SIAM J. Control Optim. 40 (2002), 5, 1611–1627.

[5] L. Bakule, J. Rodellar, and J. Rossell: Overlapping resilient H_∞ control for uncertain time-delayed systems. In: Proc. 44th IEEE Conference on Decision and Control and European Control Conference (CDC-ECC'05), Sevilla 2005, pp. 2290–2295.

[6] L. Bakule, J. Rodellar, and J. Rossell: Overlapping guaranteed cost control for uncertain continuous-time delayed systems. In: Proc. 16th IFAC World Congress, Prague 2005.

[7] L. Bakule, J. Rodellar, and J. Rossell: Robust overlapping guaranteed cost control of uncertain state-delay discrete-time systems. IEEE Trans. Automat. Control 51 (2006), 12, 1943–1950.

[8] S. Esfahani and I. Petersen: An LMI approach to output-feedback-guaranteed cost control for uncertain time-delay systems. Internat. J. Robust and Nonlinear Control 10 (2000), 157–174.

[9] E. Fridman and U. Shaked: Parameter dependent stability and stabilization of uncertain time-delay systems. IEEE Trans. Automat. Control 48 (2003), 861–866.

[10] P. Gahinet, A. Nemirovski, A. Laub, and M. Chilali: The LMI Control Toolbox. The MathWorks, Inc., 1995.

[11] M. Ikeda and D. Šiljak: Overlapping decompositions, expansions and contractions of dynamic systems. Large Scale Systems 1 (1980), 1, 29–38.

[12] M. Ikeda and D. Šiljak: Overlapping decentralized control with input, state, and output inclusion. Control Theory and Advanced Technology 2 (1986), 2, 155–172.

[13] M. Ikeda, D. Šiljak, and D. White: Decentralized control with overlapping information sets. J. Optim. Theory Appl. 34 (1981), 2, 279–310.

[14] V. Kapila and W. Haddad: Robust stabilization with parametric uncertainty and time delay. J. Franklin Institute 336 (1999), 473–480.

[15] V. Kapila, W. Haddad, R. Erwin, and D. Bernstein: Robust controller synthesis via shifted parameter-dependent quadratic cost bounds. IEEE Trans. Automat. Control 43 (1998), 1003–1007.

[16] O. Moheimani and I. Petersen: Optimal quadratic guaranteed cost control of a class of uncertain time-delay systems. IEE Proc. Control Theory Appl. 44 (1997), 2, 183–188.

[17] H. Mukaidani: An LMI approach to guaranteed cost control for uncertain delay systems. IEEE Trans. Circuits and Systems – I: Fundamental Theory Appl. 50 (2003), 6, 795–800.

[18] W. Rugh: Linear System Theory. Second edition. Prentice Hall, Upper Saddle River, N. J. 1996.

[19] S. Stanković and D. Šiljak: Inclusion principle for linear time-varying systems. SIAM J. Control Optim. 42 (2003), 1, 321–341.

[20] D. Šiljak: Decentralized Control of Complex Systems. Academie Press, New York 1991.

[21] D. Šiljak and A. Zečević: Control of large-scale systems: Beyond decentralized feedback. Annual Reviews of Control 29 (2005), 169–179.

[22] A. Zečević and D. Šiljak: Design of robust static output feedback for large-scale systems. IEEE Trans. Automat. Control 49 (2004), 11, 2040–2044.