Operators and Matrices
Volume 18, Number 2 (2024), 389–407
doi:10.7153/oam-2024-18-24

STABILITY ANALYSIS OF TIME—INVARIANT PERTURBED SINGULAR SYSTEMS

EZZINE FATEN, MOHAMED ALI HAMMAMI AND WALID HDIDI

Abstract. This paper considers a class of linear time–invariant perturbed singular systems. The main aim of this paper is to develop the practical exponential stability of this class of systems based on Lyapunov techniques. Finally, to illustrate our results more clearly, we introduce a numerical example.

Mathematics subject classification (2020): Primary 37B55; Secondary 34D20.
Keywords and phrases: Linear time–invariant singular systems, consistent initial conditions, Lyapunov techniques, Gamidov's inequality, exponential stability, practical exponential stability.

REFERENCES

[1] A. BENABDALLAH, W. HDIDI, *Improving the performance of semiglobal output controllers for nonlinear systems*, Kybernetika, **53** (2017), 296–330.
[2] A. BENABDALLAH, W. HDIDI, *Uniting two local output controllers for linear system subject to input saturation: LMI approach*, Journal of the Franklin Institute, **355** (2018), 6969–6991.
[3] S. L. CAMPBELL, C. D. MEYER, N. J. ROSE, *Applications of the Drazin inverse to linear systems of differential equations with singular constant coefficients*, SIAM Journal on Applied Mathematics, **31** (1976), 411–425.
[4] S. L. CAMPBELL, *Singular systems of differential equations*, Pitman, Marshfield, Mass, 1980.
[5] S. L. CAMPBELL, *Singular systems of differential equations II*, Pitman, Marshfield, Mass, 1982.
[6] D. CONG HUONG, N. HUU SAU, *Finite-time stability and stabilisation of singular discrete-time linear positive systems with time-varying delay*, International Journal of Systems Science, **50** (2019), 1–15.
[7] T. CARABALLO, F. EZZINE, M. A. HAMMAMI, *On the exponential stability of stochastic perturbed singular systems in mean square*, Applied Mathematics and Optimization, **3** (2021), 1–23.
[8] T. CARABALLO, F. EZZINE, M. A. HAMMAMI, *New stability criteria for stochastic perturbed singular systems in mean square*, Nonlinear Dynamics, **1** (2021), 241–256.
[9] T. CARABALLO, F. EZZINE, M. A. HAMMAMI, *A new result on stabilization analysis for stochastic nonlinear affine systems via Gamidov's inequality*, Revista de la Real Academia de Ciencias Exactas, Físicas y Naturales. Serie A, Matemáticas, **4** (2022), 116–177.
[10] R. J. CAVERLYL, J. R. FORBES, *LMI Properties and Applications in Systems, Stability, and Control Theory*, arXiv:1903.08599, 2021.
[11] L. DAI, *Singular Control systems*, Springer, New York, 1989.
[12] D. LJ. DEBELJKOVIC, B. JOVANOVIĆ, V. DRAKULIĆ, *Singular system theory in chemical engineering theory: Stability in the sense of Lyapunov: A survey*, Hemijska Industrija, **6** (2001), 260–272.
[13] D. LJ. DEBELJKOVIC, I. BUZUROVIC, *Lyapunov stability of linear continuous singular systems: An overview*, International Journal of Information and System Sciences, **1** (2011), 247–268.
[14] F. EZZINE, M. A. HAMMAMI, *Growth conditions for the stability of a class of time–varying perturbed singular systems*, Kybernetika, **58** (2022), 1–24.
[15] H. K. KHALIL, *Nonlinear Systems*, Mac–Millan, 2nd edition, 1996.
[16] D. G. LUENBERGER, *Dynamic equation in descriptor form*, IEEE Transactions on Automatic Control, **22** (1977), 310–319.
[17] D. G. LUENBERGER, *Time–invariant descriptor systems*, Automatica, **14** (1978), 473–480.

Paper OaM-18-24

[18] A. M. LYAPUNOV, *The general problem of the stability of motion*, International Journal of Control, **55** (1992), 521–790.
[19] J. MIN JIAO, *Robust stability and stabilization of discrete singular systems with interval time-varying delay and linear fractional uncertainty*, International Journal of Automation and Computing, **9** (2012), 1–8.
[20] D. H. OWNES, D. LJ. DEBELJKOVIĆ, *Stability of linear descriptor systems: A geometric analysis*, IMA Journal of Mathematical Control and Information, **2** (1985), 139–151.
[21] Q. C. PHAM, N. TABAREAU, J. E. SLOTINE, *A contraction theory approach to stochastic Incremental stability*, IEEE transcactions on Automatic Control, **54** (2009), 1285–1290.
[22] H. H. ROSENBROCK, *Structure properties of linear dynamical systems*, International Journal of Control, **20** (1974), 191–202.
[23] H. WANG, A. XUE, R. LU, *New stability criteria for singular systems with time–varying delay and nonlinear perturbations*, International Journal of Systems Science, **45** (2014), 1–15.