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Practical h-stability behavior of time-varying nonlinear systems

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Abstract: We deal with the problem of practical uniform h-stability for nonlinear time-varying perturbed differential equations. The main aim is to give sufficient conditions on the linear and perturbed terms to guarantee the global existence and the practical uniform h-stability of the solutions based on Gronwall's type integral inequalities. Several numerical examples and an application to control systems with simulations are presented to illustrate the applicability of the obtained results.

Keywords: Gronwall's inequality; perturbed system; practical h-stability
AMS Subject Classification: 34A30, 34A34, 34D10

References

[1] Aeyels D., Peuteman J., *A new asymptotic stability criterion for nonlinear time-varying differential equations*, IEEE Trans. Automat. Control **43** (1998), no. 7, 968–971.
[2] Bay N. S., Phat V. N., *Stability of nonlinear difference time-varying systems with delays*, Vietnam J. Math. **4** (1999), 129–136.
[3] Bellman R., *Stability Theory of Differential Equations*, McGraw-Hill Book Co., New York, 1953.
[4] Ben Hamed B., *On the robust practical global stability of nonlinear time-varying system*, Mediterr. J. Math. **10** (2013), no. 3, 1591–1608.
[5] Ben Hamed B., Ellouze I., Hammami M. A., *Practical uniform stability of nonlinear differential delay equations*, Mediterr. J. Math. **8** (2011), no. 4, 603–616.
[6] Ben Hamed B., Haj Salem Z., Hammami M. A., *Stability of nonlinear time-varying perturbed differential equations*, Nonlinear Dynam. **73** (2013), no. 3, 1353–1365.
[7] Ben Makhlouf A., Hammami M. A., *A nonlinear inequality and application to global asymptotic stability of perturbed systems*, Math. Methods Appl. Sci. **38** (2015), no. 12, 2496–2505.
[8] Damak H., *On the practical output h-stabilization of nonlinear uncertain systems*, J. Appl. Nonlinear Dyn. **10** (2021), no. 4, 659–669.
[9] Damak H., Hadj Taieb N., Hammami M. A., *A practical separation principle for nonlinear non-autonomous systems*, Internat. J. Control **96** (2023), no. 1, 214–222.
[10] Damak H., Hammami M. A., Kalitine B., *On the global uniform asymptotic stability of time-varying systems*, Differ. Equ. Dyn. Syst. **22** (2014), no. 2, 113–124.
[11] Damak H., Hammami M. A., Kicha A., *A converse theorem for practical h-stability of time-varying nonlinear systems*, New Zealand J. Math. **50** (2020), 109–123.
[12] Damak H., Hammami M. A., Kicha A., *A converse theorem on practical h-stability of nonlinear systems*, Mediterr. J. Math. **17** (2020), no. 3, Paper No. 88, 18 pages.
[13] Damak H., Hammami M. A., Kicha A., *Growth conditions for asymptotic behavior of solutions for certain time-varying differential equations*, Differ. Uravn. Protsessy. Upr. (2021), no. 1, 423–447.
[14] Damak H., Hammami M. A., Kicha A., *On the practical h-stabilization of nonlinear time-varying systems: application to separately excited DC motor*, COMPEL-Int. J. Comput. Math. Electr. Electron Eng. **40** (2021), no. 4, 888–904.
[15] Dragomir S. S., *Some Gronwall Type Inequalities and Applications*, School of Communications and Informatics, Victoria University of Technology, Melbourne City, 2002.
[16] Ellouze I., Hammami M. A., *Practical stability of impulsive control systems with multiple time delays*, Dyn. Contin. Discrete Impuls. Syst. Ser. A Math. Anal. **20** (2013), no. 3, 341–356.
[17] Ghanmi B., *On the practical h-stability of nonlinear systems of differential equations*, J. Dyn. Control Syst. **25** (2019), no. 4, 691–713.
[18] Hammi M., Hammami M. A., *Gronwall–Bellman type integral inequalities and applications to global uniform asymptotic stability*, Cubo **17** (2015), no. 3, 53–70.
[19] Khalil H. K., *Nonlinear Systems*, Prentice-Hall, New York, 2002.
[20] Medina R., *Perturbations of nonlinear systems of difference equations*, J. Math. Anal. Appl. **204** (1996), no. 2, 545–553.

[21] Pinto M., *Perturbations of asymptotically stable differential systems*, Analysis **4** (1984), no. 1–2, 161–175.
[22] Pinto M., *Stability of nonlinear differential systems*, Appl. Anal. **43** (1992), no. 1–2, 1–20.