Lectures on Control Using Logic and Switching

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Abstract

The overall objective of these lectures is to overview a variety of methods for synthesizing and analyzing logic-based switching control systems. By a logic-based switching controller is meant a controller whose subsystems include not only familiar dynamical components {integrators, summers, gains, etc.} but logic-driven elements as well. The overall models of systems composed of such logics together with the processes they are intended to control, are concrete examples of what might be called "hybrid dynamical systems." An important category of such systems are those consisting of a process to be controlled, a family of fixed-gain or variable-gain candidate controllers, and an "event-driven switching logic" called a supervisor whose job is to determine in real time which controller should be applied to the process. Examples of supervisory control systems include re-configurable systems, fault correction systems, and certain types of parameter-adaptive systems.

Major reasons for introducing logic and switching are to deal with communication, actuator and sensor constraints, with model uncertainty, with unforeseen events or to avoid performing difficult tasks e.g., precise equipment calibration which might otherwise be necessary were one to consider only conventional controls. The aim of these lectures in is to provide an overview of algorithms with these capabilities, as well as to discuss various techniques for analyzing the types of switched systems which result.

References

[1] A. S. Morse, D. Q. Mayne and G. C. Goodwin. Applications of hysteresis switching in parameter adaptive control. *IEEE Transactions on Automatic Control*, 37(9):1343–1354, September 1992.

[2] F. M. Pait and A. S. Morse. A cyclic switching strategy for parameter-adaptive control. *IEEE Transactions on Automatic Control*, 39(6):1172–1183, June 1994.

[3] A. S. Morse. Control using logic-based swtching In A. Isidori, editor, *Trends in Control*, pages 69 – 113. Springer-Verlag, 1995.

[4] A. S. Morse. A bound for the disturbance-to-tracking error gain of a supervised set-point control system. In D. Normand Cyrot, editor, *Perspectives in Control – Theory and Applications*, pages 23 – 41. Springer-Verlag, 1998.

[5] J. P. Hespanha and A. S. Morse. Stabilization of nonholonomic integrators via logic-based switching. *Automatica*, pages 385–394, mar 1999. see also Proc. 13th World Congress, IFAC, pp. 467-473.

[6] D. Liberzon, J. P. Hespanha, and A. S. Morse. Stability of switched systems: a Lie-algebraic condition. *Systems and Control Letters*, 37:117–122, June 1999.

[7] D. Liberzon and A. S. Morse. Basic problems in stability and design of switched systems. *IEEE Control Systems Magazine*, pages 59 – 70, oct 1999.

[8] C. De Persis, R. De Santis, and A. S. Morse. Further results on switched control of linear systems with constraints. In *Proceedings of the 2002 IEEE Conference on Decision and Control*, pages 2810–2815, dec 2002.

[9] J. P. Hespanha, D. Liberzon, and A. S. Morse. Overcoming the limitations of adaptive control by means of logic-based switching. *Systems and Control Letters*, 2002. to appear.

[10] A. Jadbabaie, J. Lin, and A. S. Morse. Coordination of groups of mobile autonomous agents using nearest neighbor rules. *IEEE Transactions on Automatic Control*, mar 2002. to appear;also in Proc. 2002 IEEE CDC, pages 2953 - 2958.