Practical Adaptive Control

Adaptive Control is viewed as a game changer in many application domains where real-time feedback control is essential to ensure the desired performance. Adaptive controllers, whose distinguishing feature is a parameter estimator that prescribes the rule for changing the control parameters in real-time, have been studied extensively over the past forty years, with fundamental properties of stability and robustness well understood. Guidelines for analysis and synthesis for adaptive controllers have been laid out for linear and (specific classes of) nonlinear systems, continuous and discrete-time systems, single-input and multi-input systems, and deterministic and stochastic systems. So what’s missing? There are glaring gaps in adaptive control theory that remain to be closed for adaptive control to be a viable, practical, and easily implementable methodology. Guarantees have to be provided that ensure robustness to a wide variety of non-parametric perturbations. Guidelines have to be in place for a systematic design of all free parameters in the controller. Bounds have to be derived, not only for steady-state behavior, but also for transient characteristics. Implementation issues will have to be satisfactorily addressed. The ability to accommodate actuator constraints in terms of bandwidth, magnitude limits, and rate limits has to be precisely characterized. Design of semi-autonomous adaptive systems that integrates humans either in-the-loop or on-the-loop has to be explored. Recently, there have been breakthroughs in Adaptive Control that have led to reducing the above gaps. This talk will outline the basic principles of the now classical adaptive control theory, but also highlight these recent results and show how they contribute towards making adaptive control practical.

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