ABSTRACT

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This dissertation addresses the design and analysis of fast Newton-based extremum seeking feedback for scalar and vectorial static maps in cascade with partial differential equation (PDE) dynamics in its actuation path. Although more general classes of PDE-based systems could be envisaged, we concentrated our efforts in handling diffusion PDEs. The proposed adaptive control scheme for real-time optimization follows two basic steps: first, it cancels out the effects of the actuation dynamics in the dither signals, and second, it applies a boundary control for the diffusion process via backstepping transformation. In particular, the diffusion compensator employs perturbation-based (averaging-based) estimates for gradient and Hessian's inverse of the nonlinear-scalar static map to be optimized. The complete stability analysis of the closed-loop system is carried out using Lyapunov's method and applying averaging for infinite-dimensional systems in order to capture the infinite-dimensional state of the actuator model. Local exponential convergence to a small neighborhood of the unknown extremum is guaranteed and verified by means of a numerical example.

Keywords: Extremum seeking. Adaptive control. Backstepping. Averaging theory. Infinite-dimensional systems. Partial differential equations.