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Original article

Extremum seeking control and its application to process and reaction systems: A survey

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Abstract

The objective of this paper is to present a survey on extremum seeking control methods and their applications to process and reaction systems. Two important classes of extremum seeking control approaches are considered: perturbation-based and model-based methods.

Keywords: Extremum seeking control; Adaptive control; Reaction systems; Nonlinear systems; On-line optimisation

1. Introduction

Most adaptive control schemes documented in the literature [14–16,19] are developed for regulation to known set-points or tracking known reference trajectories. Yet in some applications the control objective could be to optimize an objective function which can be a function of unknown parameters, or to select the desired states to keep a performance function at its extremum value. Self-optimizing control and extremum seeking control are two methods to handle these kinds of optimization problems. The goal of self-optimizing control is to find a set of controller variables which, when kept at constant set points, indirectly lead to near-optimal operation with acceptable loss [23,26]. The task of extremum seeking is to find the operating set-points that maximize or minimize an objective function. Since the early research work on extremum control in the 1920s [20], many successful applications of extremum control approaches have been reported, for example, fuel flow control to achieve maximum pressure [29], combustion process control for IC engines and gas furnaces [1,25], and anti-lock braking system control [6].

Real-time optimization has seen a resurgence of interest in the recent years. The traditional approach is the model-based repeated optimization where the model is adapted using the available measurements and numerical optimization is performed on the updated model [34]. An alternative approach is known as extremum seeking. Extremum seeking control allows the solution of the optimization problem as a *control problem* with the advantages related to sensitivity reduction and disturbance rejection.

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