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SYNTHESISING FEEDBACK CONTROL FOR TIME–DELAYED SYSTEMS

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Abstract. In this paper, we use a convolution kernel to construct an optimal feedback controller for classes of linear and nonlinear time–delayed systems. Novel error bounds on the state variable and the objective functional with respect to the disturbances of the tail functions as well as the initial conditions are derived. Numerical examples are provided to illustrate the efficiency of the method.
Keywords. Convolution kernel, feedback control, time–delayed system.

1 Introduction

There are many efficient schemes in the literature for computing open–loop optimal control problems with general nonlinear dynamics. For example, one can refer to the control parametrisation method (see [8] and [10]), the methods based on the maximum principle presented in [1], and the relevant references cited therein. However, it is known that feedback controllers are much more desirable in practice because of their robustness properties. Due to a lack of computational power in the past, not much attention has been given to the computation of feedback controllers for such general problems until recently.

In [9], a perturbation feedback control method for a class of nonlinear optimal control regulator problems is considered. This method forces the system to track a previously computed open–loop optimal trajectory by adding robustness and error tolerance properties into the closed–loop system, and the feedback controller is assumed to take a special structure. The required feedback control law is then obtained by solving an optimal parameter selection problem. Clearly, the control effort spent in forcing the system to return to the optimal trajectory may not be the best strategy, thus, the resulting feedback control law is unlikely to be optimal. Nevertheless, it does suggest an approach for solving feedback control problems using open–loop optimal control techniques.

Using neural networks in synthesising feedback control laws for general nonlinear dynamical systems has been investigated, (see [2] and [6], and the references cited therein). However, it is not easy to decide the number of