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Exponential Stabilization of Cascade ODE-Linearized KdV System by Boundary Dirichlet Actuation

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Abstract

In this paper, we solve the problem of exponential stabilization for a class of cascade ODE-PDE systems governed by a linear ordinary differential equation and the $1-d$ linearized Korteweg-de Vries equation (KdV) posed on a bounded interval. The control for the whole system acts in the left boundary with Dirichlet condition of the KdV equation whereas the KdV acts in the linear ODE by a Dirichlet connection. We use the so-called backstepping method in infinite dimension to convert system under consideration to an exponentially stable cascade ODE-PDE system. Then, we use the invertibility of such design to achieve the exponential stability for the original ODE-PDE cascade system by using Lyapunov analysis.

Keywords: Cascade ODE-PDE, Linearized-KdV, Backstepping, Exponential stability

1. Introduction

It is well known that the Korteweg-de Vries (KdV) equation in bounded domain models the dynamics of various types of extreme waves in shallow water, more particularly tsunami waves and freak waves (see [27]). For better understanding of KdV, one can see [28], in which different mathematical models of water wave are deduced. From theoretical point of view, the KdV controlled equation has some interesting control properties depending on where the controls are located and on the type of boundary conditions [8], [20]. In the past decades, stabilization of coupled ODE-PDE systems was

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