Decoupling Control using Limiting Properties of Linear Optimal Regulator and State Estimator and Its Applications to Mechanical Systems

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Abstract

The purpose of this paper is to discuss an explicit relationship between decoupling control and limiting properties of a linear optimal regulator and a state estimator.

First, decoupling control for minimum/nonminimum phase systems are considered by using a limiting form of LQ control point of view. It is shown that the closed-loop system with a limiting feedback can be decoupled by letting only the weighting matrix tend to infinity without getting the canonically decoupled system. Moreover, using an appropriate performance index, it deals with a new method on decoupling control to keep out an effect of fixed poles by pole-zero cancellation. Stability and sensitivity of the decoupled system are improved by the proposed method. It gives also experimental applications to mechanical systems to illustrate effectiveness on the proposed decoupling control with the limiting properties.

Secondly, when states of a system are not available, there is a need for state estimators that yield estimates of the states. Decoupling control based on a full-order observer and a reduced-order observer for a minimum phase system are considered by using limiting properties of a state estimator. Furthermore, an application to a servo problem with decoupling is shown in this paper. Of particular interest is the case where the desired trajectory is a step function. The effects of the limiting properties are confirmed by some numerical examples on the observer-based decoupling control.

Thirdly, this paper deals with robustness and a fragility of the H_∞ control of a nonlinear magnetic suspension system using the feedback linearization, from an experimental point of view. The feedback linearization is one of a control method which can be obtained a decoupled system for a nonlinear system. The usefulness of the detailed nonlinear model, an effect of the feedback linearization, and robustness and a fragility of the feedback linearization-based control are evaluated from comparative experiments.

Key Words: **Multivariable systems, Linear optimal regulator, State estimator, Decoupling control, Mechanical systems**