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ROBUSTNESS OF MULTIRATE CONTROL SYSTEMS UNDER UNUNIFORM AND UNIFORM MODEL PERTURBATIONS

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Abstract. This paper is concerned with robustness stability of multirate control systems employing different sampling rates at the plant input and output terminals. It examines the multirate control mechanism in the frequency domain in comparison with the single rate control scheme. It is shown that the multirate control mechanism is characterized by manipulation of the system frequency response in high frequency subbands and folding the high frequency subband response to the base frequency band. This multirate control scheme is capable of achieving some performance specifications and can make the system robust under the uniform plant model perturbation, which cannot be achieved by single rate controllers. However, the multirate control scheme amplifies the the system loop gain in high frequency subbands leading to deterioration of system robustness stability under the ununiform plant model perturbation.

Keywords. Frequency transfer function, Gain margin, Model perturbation, Multirate control, Robustness stability.

1 Introduction

A multirate control system is a closed loop feedback control system in which more than one sampling rates are involved in the system loop. This models digital control of processes in practical applications where technological and hardware constraints require the sensor measurements and control actuator updates be performed at different rates. The research on multirate control systems have been active in recent years and several results on the design and analysis of multirate control system have been presented. See, for example, [5, 14, 1, 11, 2, 12, 6, 10].

It is shown that multirate controllers can be used to achieve some design specifications which cannot be achieved by controllers using a single sampling rate. These specifications include equivalent state feedback without observers [5], model matching without involving unstable pole-zero cancellations [14, 6] simultaneous stabilization and regulation of a number of plants [15, 10] and gain margin improvement [4].

In this paper, we study stability robustness of multirate control systems which are designed to achieve some performance specifications that cannot be