NEW ROBUST STABILITY CRITERION AND ROBUST CONTROLLER SYNTHESIS

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SUMMARY

In this paper, a new robust stability criterion for linear systems is proposed by combining the passivity and small gain theorems in different frequency bands. A controller synthesis method based on the new criterion is also developed. The controller can achieve both good performance and robustness in the same frequency band, if the uncertainty in that frequency band is passive or near passive. For processes with near passive lumped uncertainties with large gain in the frequency region in which good performance is required, the proposed controller can have better performance than that of $H_\infty$ control for the same robustness specification. © 1998 John Wiley & Sons, Ltd.

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1. INTRODUCTION

Most of the current robust control methods, such as $H_\infty$ control, are based on the small gain theorem. 1 The uncertainties of the systems are bounded by their norms and the controllers are designed to make the systems seen by the uncertainties to have small gains to achieve the required robustness.

The passivity theorem provides another sufficient condition for robust stability: if the system seen by the uncertainty is strictly passive and the negative feedback uncertainty is passive, then the closed-loop system will be stable 2 (as shown in Figure 1). A linear system is passive if and only if its transfer function matrix is positive real 3 and positive real systems are phase-bounded. 4 Some robust control design methods have been proposed based on the passivity theorem. 5–7 As this closed-loop stability does not require the small gain condition, these control designs can be less conservative than that of $H_\infty$ design if the phase information of the uncertainty is known.

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