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التوثيق الإلكتروني والميكروفيلم

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لم ترد بالأصل

CAIRO UNIVERSITY FACULTY OF ENGINEERING

Robust Controller Design for Large-Scale Uncertain Dynamical Systems

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Master of Science

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Abstract

The growing dimensions and complexity of nowadays technological development and societal processes are one of the foremost challenges to system theory. Determining a solution for the problems arising in large-scale systems (L.S.S.) may become either very uneconomical or even impossible using the classical mathematical tools developed for system analysis and control.

Due to environmental conditions, aging, ...etc., the closed loop stability requirements of many L.S.S. can not satisfied when facing large variations as well as perturbations in various system parameters. Although a lot of work had appeared in this field, almost all of them represent variations in certain domain or subsets, which may not be satisfied in life applications and under natural variations. Furthermore, the issue of global stability of large-scale systems has been previously investigated considering only static interconnections between subsystems. The issue of dynamic interconnections were not usually addressed. Also there is no accepted methodology for the determination of expected performance which account for changes in performance characteristics, due to reconfiguration of system functions, in the presence of dynamic interconnections. Recently new definition was introduced, this is stability robustness. Different view points, different definition also different procedures in modeling, analysis, and control had been introduced, to satisfy the global system stability.

In this work, a new proposed technique for designing a robust decentralized controller for large-scale interconnected dynamical

systems is developed taking into consideration parameter variations in the structure of large-scale systems. These variations are very interesting in practical applications, where not only uncertainty or perturbations may be introduced in the real system but also function or parameter failure that may occur in the worst case as well. The problem of dynamic interconnections between subsystems is fully addressed by this approach.

A quadratic cost criteria is introduced, for designing an optimal controller based on the Markov chain technique. This technique assumes that the system may suffer from a usual type of parameter uncertainty or parameter failure, due to component redundancy. A number of configuration is introduced and a corresponding number of controllers is designed for each case. According to the observable changes in the system configuration, the controller gain is automatically switched to a new value that maintain the overall system performance within acceptable range of values.

A robust state feedback controller has been designed considering variable actuator changes in one case, and variable observer changes in another. The technique was extended to deal with the general case of variations in both the input and system matrices.

The overall system is decomposed into a group of dynamically interconnected subsystems, then a problem formulation using system augmentation is used for designing such a robust controller. Computational reduction in finding the control law is used, this made the programming easier and reduce the order of the solved equations. The case of output feedback was considered. It is useful to be used when only output is presented instead of complete information about the system *states. The computational complexity increases but a computational reduction method simplifies the problem.*

A numerical example was introduced to discuss the new methodology. The results shows that the proposed controller achieves robustness requirements. Also it capture the actual system behaviour under different modes of uncertainty in the input and system matrix, or in both matrices.

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