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PRACTICAL STABILITY CRITERIA FOR LARGE-SCALE NONLINEAR STOCHASTIC SYSTEMS BY DECOMPOSITION AND AGGREGATION

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Abstract. In this paper, the concept of practical stability is extended for the large-scale stochastic systems of the Ito-Doob type. The concept of vector Lyapunov-like functions coupled with the decomposition-aggregation techniques are utilized to develop a comparison principle and, sufficient conditions are established for various types of practical stability criteria in the p-th mean and in probability of the equilibrium state of the system under the stochastic structural perturbations. This framework of decomposition and aggregation is ideally suited for reducing the dimensionality problem arising in testing large-scale systems for the concepts of convergence and stability. The results provide new stability tests for stochastic processes arising in various decentralized control, extremal regulation, adaptation, and parameter estimation schemes.

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1 INTRODUCTION

One of the foremost challenges to system theory in the present-day advanced technological world is to overcome the increasing size and complexity of the corresponding mathematical models[7,8]. Since the amount of computational effort is enormous, it is simpler and more economical to decompose a large scale complex system into a number of interconnected subsystems at least for the purpose of studying system reliability in the context of stability analysis. These subsystems can be considered independent to some extent, so that some of the qualitative behavior of the corresponding subsystems can be combined with interconnection constraints to come up with the qualitative behavior of the overall large scale systems. Besides the computational aspects of large scale dynamic systems it is equally important to determine to what extent the complexity effects the system behavior and the role it plays in the system with large interconnected structures.
Stability analysis of both deterministic and stochastic systems in the Lyapunov sense is well known and is widely used in the real world problems [1,2,3,6,7,8]. However, sometimes for a practical system, the desired state may be unstable in the Lyapunov sense, but still good enough in the sense