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Modeling and Analysis for Multi-State Systems with Discrete-Time Markov Regime-Switching

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Abstract

The main focus of this paper is on the development of reliability measures for a repairable multi-state system which operates under dynamic regimes under the discrete-time hypothesis. The switching process of regimes is governed by a Markov chain, and the functioning process of the system follows another Markov chain with different transition probability matrices under different regimes. In terms of two chains as above, a new Markov chain is constructed to depict the evolution process of the dynamic system. For the regime consideration, some novel reliability indices are essential and firstly introduced in this paper. By means of hierarchical partitions for the new state space, Ion-Channel modeling theory and discrete-time Markov chain, the traditional and novel reliability and availability functions for the system under random regimes are easily obtained with the closed form solutions, such as two types of system reliabilities, two types of system point availabilities, two types of system multiple-point availabilities and the associated system multi-interval availabilities and so on. In addition, some probability distributions of sojourn times we are interested in are discussed and computed here. Finally, a numerical example is given to illustrate the results obtained in the paper.

Keywords: Reliability, availability, Markov chain, multi-point availability, sojourn time

1. Introduction

Multi-state system operating under random regimes and dynamic reliability modeling, which are two hot issues in reliability field nowadays, are of considerable research interest. The binary coherent system is a fundamental and frequently used concept for reliability modeling [1], in which both the system and its components are considered to be in one of two states: work or failed. Unfortunately (for such a model), in many practical systems, the system and its components are