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基于Markov链互模拟的航天器发射任务可靠度模型

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Mission reliability model of spacecraft launch based on bisimulation of continuous-time Markov processes

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- 摘要
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摘要 状态空间复杂、多过程并发执行和子过程反复迭代的特点, 使航天器发射工程实施全过程的任务可靠性评估难以量化. 通过构建多个并发执行的时间连续的Markov链对航天器发射工程状态转移约束关系进行描述, 采用互模拟时间等价关系简化航天器发射工程实施过程的状态空间, 利用连续时间Markov链的概率转移特性进行建模与分析, 得到了全系统、全过程的航天器发射任务可靠度模型. 数值验证表明该模型可用于航天器发射任务工期推演、可靠度评估以及薄弱环节分析.

关键词: 航天器发射 互模拟 Markov链 任务可靠度 状态转移概率

Abstract: Characteristics of complex state space, multi-process concurrent execution and sub-processes iterative make mission reliability assessment for the whole process of spacecraft launch engineering implementation is difficult to quantify. Multiple concurrently executing continuous time Markov chain is constructed to describe state transition constraint relations of spacecraft launch engineering. The state space of the whole process of spacecraft launch engineering implementation is simplified by bisimulation equivalence relation. The model of mission reliability for spacecraft launch engineering is builded by continuous time Markov chain transfer probability characteristics. In this paper, the example applied results shows that the model is a feasible for decision-making demonstration of spacecraft launch project, evaluation of mission reliability and analysis of weak link.

Key words: spacecraft launch bisimulation Markov chains mission reliability the state transition probabilities

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