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Joint redundancy and imperfect preventive maintenance optimization for series – parallel multi-state degraded systems

Mustapha Nourelfath[a], Eric Châtelet[b], Nabil Nahas[a]

[a] Interuniversity Research Center on Enterprise Networks, Logistics and Transportation (CIRRELT), Mechanical Engineering Department, Laval University, Quebec, Canada G1K7P4

[b] Charles Delaunay Institute (ICD-LM2S), Sciences and Technologies for Risk Management (STMR), Troyes University of Technology, CNRS, 12 rue Marie Curie, BP 2060, 10010 Troyes, France

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Abstract

This paper formulates a joint redundancy and imperfect preventive maintenance planning optimization model for series – parallel multi-state degraded systems. Non identical multi-state components can be used in parallel to improve the system availability by providing redundancy in subsystems. Multiple component choices are available in the market for each subsystem. The status of each component is considered to degrade with use. The objective is to determine jointly the maximal-availability series – parallel system structure and the appropriate preventive maintenance actions, subject to a budget constraint. System availability is defined as the ability to satisfy consumer demand that is represented as a piecewise cumulative load curve. A procedure is used, based on Markov processes and universal moment generating function, to evaluate the multi-state system availability and the cost function. A heuristic approach is also proposed to solve the formulated problem. This heuristic is based on a combination of space partitioning, genetic algorithms (GA) and tabu search (TS). After dividing the search space into a set of disjoint subsets, this approach uses GA to select the subspaces, and applies TS to each selected sub-space.

Abbreviations (the singular and plural of an acronym are always spelled the same)

GA, genetic algorithms; TS, tabu search; PM, preventive maintenance; RAP, redundancy allocation problem; MSS, multi-state system; UMGF, universal moment generating function; SP, space partitioning

Keywords

Multi-state systems; Degradation; Maintenance optimization; Redundancy optimization; Series – parallel systems; Meta-heuristics

Figures and tables from this article:

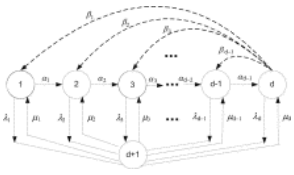

Fig. 1. State transition diagram for one component.

Figure options

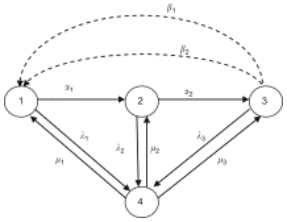

Fig. 2. Illustrative component state transition diagram.

Figure options

Table 1. Data for the example.

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Table 2. Parameters of the cumulative load _ demand curve.

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Table 3. Transition rates for the illustrative example.

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Table 4. Performance rates for each component state.

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Table 5. Preventive maintenance and repair costs.

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Table 6. SP/TG best solutions.

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Corresponding author. Tel.: +1 418 6562131x12355; fax: +1 418 6567415.