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Adaptive Spare Parts Inventory Control under Stochastic Degradation

Efficient control of spare parts inventory is essential for maintaining the availability of engineering systems operating under progressive degradation. This paper proposes an adaptive decision-support framework that integrates stochastic degradation modeling with data-driven control policies for inventory management. By continuously updating the risk of failure and its implications for future demand, the approach enables dynamic assessment of stockout risk in the presence of supply lead times. The problem is formulated as a sequential decision-making task under uncertainty, in which replenishment actions are guided by the evolving condition of the system and the current inventory status. A reinforcement learning approach is employed to learn effective inventory policies that balance availability and cost considerations in a stochastic environment. The proposed framework provides a flexible and scalable solution for condition-informed inventory control, highlighting the potential of combining degradation modeling and artificial intelligence to improve decision-making in maintenance-intensive systems.

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