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航天长寿命产品可靠性建模与评估的Bayes信息融合方法

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A Bayes information fusion approach for reliability modeling and assessment of spaceflight longlife product

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摘要 针对航天长寿命产品在研制、生产、试验和使用过程中, 存在大量的性能退化数据和少量寿命数据的特点, 给出了融合性能退化数据和寿命数据获取其寿命分布的一种Bayes方法, 以及利用其性能退化参数来进行可靠性评估的方法. 首先, 根据Fisher信息量确定维纳过程漂移参数和扩散参数的无信息验前分布; 然后, 利用性能退化数据结合其性能退化的独立高斯增量特点, 获取参数的第一次验后分布, 利用寿命数据结合其寿命的逆高斯分布获取参数的第二次验后分布; 最后, 利用漂移参数和扩散参数的验后分布, 对产品进行了可靠性评估. 本文模型充分利用了性能数据和寿命数据, 在很大程度上提高了评估的精度.

关键词: 可靠性评估 Bayes方法 Wiener过程 性能退化数据 寿命数据

Abstract: Due to the fact that there are more performance degradation data and less life data during development, producing, test and running, this paper provides a Bayes method to obtain the life distribution through fusing the two kinds of data, and the reliability assessment method based on performance parameters. At first, we obtain the noninformative prior distribution of the drift and volatity parameters of the Wiener process by using fisher information. And then, by using the degradation data, this paper gives the first posterior distribution based on the independent Gaussian increment, and the second posterior distribution based on the inverse life distribution by using the life data. The proposed approach is used to assess the reliability of spaceflight longlife product in the end. The results show that the new approach can improve the precision of assessment greatly.

Key words: reliability assessment Bayes method Wiener process performance degradation data life data

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