REPLACEMENT POLICY FOR SPARE PARTS BASED ON A BIVARIATE WIENER PROCESS

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ABSTRACT

Condition monitoring, defined as the process of collecting real-time sensor information in order to observe the health of a functioning device, is increasingly being used in maintenance decision-making. During condition monitoring, degradation signal, which captures the current state of device, is computed from condition information. In this paper, a threshold-based replacement policy using real-time information obtained by condition monitoring is proposed. This replacement policy is based on a bivariate Wiener process, in which one component represents the observed information obtained by condition monitoring, while another one represents the unobserved degradation process. The two processes are assumed to be correlated to each other. Compared to the degradation models considered in previous research, this model concerns a more realistic and more difficult situation, where the observed signal can not perfectly represent the degradation of the functioning device. In our replacement policy, failure occurs when the unobserved process reaches a fixed failure threshold and replacement is performed when the observed process reaches a predetermined replacement threshold. We use probabilistic methods and the properties of Wiener processes to show that the average replacement cost can be minimized by choosing an optimal replacement threshold. In addition, numerical experiments and sensitivity analysis will be conducted to develop insights into the behavior of the optimal threshold. Moreover, we use Bayesian updating approach to estimate the parameters in the proposed model based on the condition monitoring information. By implementing this approach, the characteristics of both the individual and population device can be reflected in our model. Finally, in order to evaluate the Bayesian updating approach and the bivariate Wiener process model, two comparison studies based on the simulations of the replacement process are conducted.