Bayesian Approach for Fatigue Life Prediction from Field Inspection

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Abstract

In the design considering fatigue life of mechanical components, uncertainties arising from the materials and manufacturing processes should be taken into account for ensuring reliability. Common practice in the design is to apply safety factor in conjunction with the numerical codes for evaluating the lifetime. This approach, however, most likely relies on the designer's experience. Besides, the predictions often are not in agreement with the real observations during the actual use.

In this paper, a more dependable approach based on the Bayesian technique is proposed, which incorporates the field failure data with the prior knowledge to obtain the posterior distribution of the unknown parameters of the fatigue life. (Gelman et al., 2004) Posterior predictive distributions and associated values are estimated afterwards, which represents the degree of our belief of the life conditional on the observed data. As more data are provided, the values will be updated to more confident information. The results can be used in various needs such as a risk analysis, reliability based design optimization, maintenance scheduling, or validation of reliability analysis codes.

In order to obtain the posterior distribution, Markov Chain Monte Carlo (MCMC) technique is employed, which is a modern statistical computational method which draws effectively the samples of the given distribution. (Andrieu et al., 2003) Field data of turbine components are exploited to illustrate our approach, which counts as a regular inspection the number of failed blades in a turbine disk. (Kim et al., 2009)

References

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