Nonparametric reliability analysis for design of a mechanical system working on an inaccessible area

Tae Hee Lee,[a,*] Jong-Su Choi,[b] Woo Chul Lim,[a] Su-gil Cho[a], and Sup Hong[b]

a. Department of automotive engineering, Hanyang University, 222 Wangsimni-ro, Seongdong-gu, Seoul 133-791, Republic of Korea

b. Ocean System Engineering Research Division, Maritime and Ocean Engineering Research Institute, Korea Institute of Ocean Science & Technology, 32 1312 beon-gil, Yuseong-daero, Yuseong-gu, Daejeon 305-343, Republic of Korea

* Corresponding author: Phone +82-2-2220-0449, fax. +82-2-2220-2299, E-mail address: thlee@hanyang.ac.kr

Abstract

Nonparametric (distribution-free) reliability analysis (RA) is suggested as an alternative for RA of a mechanical system working on an inaccessible area, for instance, vehicle traveling on deep-seabed. Generally, it is not easy to estimate the appropriate statistical distribution function on the base of sample data, especially noise or environmental variables. Since the probability distributions of noise random variables are not often known and only a few sample data is given for design of a mechanical system working on the inaccessible area, the usage of nonparametric estimation is an emerging method to estimate the reliability of the system. Nonparametric RA is defined as reliability estimation of performance function from nonparametrically estimated distribution of noise random variables. Two mathematical examples are illustrated to compare the characteristics of nonparametric RA with those of parametric RA. Test statistic for estimated distribution of a noise random variable and reliability accuracy at an optimum design are used for evaluation of the performance and robustness of each RA. A reliability-based design optimization (RBDO) of a system working on the inaccessible area is formulated and RBDO based on nonparametric RA is performed. It is concluded that the nonparametric RA is more robust then the parametric RA for few sample data of stochastic variables.