Estimating Time-To-Failure Distribution of Degradation Models Using Kernel Density Method

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ABSTRACT


For some reliability studies, there are few failures that are observed by the end of the life test. Consequently, there is a growing interest in studying the degradation of a product over time, because it provides enough information to estimate the time-to-failure distribution. The time-to-failure is defined as the time when the degradation of a unit reaches a critical level that characterizes the failure. In this thesis, we introduce the idea of the nonparametric estimation of the time-to-failure distribution and its percentiles through using the method of the kernel density estimation method. The selection of the bandwidth parameter is the most important aspect of the kernel estimation. Therefore, some methods of choosing the bandwidth parameter are introduced and compared. On the other hand, we discuss some of the well known parametric methods used to estimate the time-to-failure distribution and its percentile including ordinary least squares method, two stage method, and maximum likelihood method. The different existing methods were compared with the proposed method through simulation technique using the mean squares error and the length of the bootstrap confidence interval as the basis criteria of the comparisons. In general, when the distributional assumption is available, the maximum likelihood estimator performs better than the kernel estimator, while the kernel estimator with the interquartile range method performs better than the other estimators when the distributional assumption is not available. In addition, a comparison among the different estimators is achieved using real data.

Keywords: Bandwidth selection; Degradation; Kernel density estimation; Maximum likelihood; Ordinary least squares; Reliability; Two stage method.