SPACE SYSTEMS SYMPOSIUM (D1)
Poster Session (P)

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IMPORTANCE RANKING AND CORRECTION OF ERROR FACTORS FOR MULTI-STAGE MANUFACTURING PROCESS OF AEROSPACE ELECTRONIC APPARATUS USING MSA METHODS AND SVM

Abstract

The error analysis and correction topics are a difficult issue for the multidisciplinary design and manufacture of complex aerospace electronic apparatus definitely. The handicaps consist not only on their various indecisive physical models, including optical, mechanical or electronical prototypes, but on the complicated mathematical description of multi-stage manufacturing process. To conquer these problems to some extents, an error analysis and correction technique, which utilizes both the Multivariate Statistical Analysis (MSA) methods and the Support Vector Machine (SVM) technique, is proposed in this paper. The MSA methods, including Principal Components Analysis (PCA), k-means and multivariate Monte Carlo simulation, are employed to search and correct the multiple errors; while the SVM is utilized to forecast and classify the quality level of product. The quality level forecast of SVM and the parameter errors tuning of MSA constitute a close-loop computation process of the error correction. The processing steps are: 1) we select typical Quality Control Parameters (QCP) and Quality Level Parameters (QLP) of an aerospace electronic apparatus for error analysis purpose. The QCP can be collected in any manufacturing stages and be any types of quality data, such as the mechanics or the electrics parameters etc. The QLP is an integrated quality evaluation result of product. For example, it can be classified as first-class level or second-class level. 2) We use QCP as the training dataset and QLP as the supervising dataset to train SVM until a steady classification precision is gotten. 3) When a new QCP dataset is inputted, if its forecasted QLP is low we will use Monte Carlo method to generate random data to correct the error of multiple QCP dataset. Both k-means and PCA methods are used to estimate and verdict the distribution space of error dataset. 4) This tuning processing above will be repeated until the classification level of SVM is improved. To test the validity of this method, the quality data of a kind of fiber optic gyro are employed: seventeen quality data, such as the cutting angle, splicing loss and extinction ratio are organized to train the SVM. More than 200 data samples are utilized to estimate the distribution. Experimental results show us that we can achieve at least 3 targets by using this method: 1) forecasting the product quality level; 2) learning the importance rank of error factors; 3) estimating the error correction results of multivariate quality parameters.