Abstract

Process capability is a measure of repeatability and consistency of a manufacturing process relative to the customer requirements in terms of specification limits of a product parameter. This measure is used to objectively measure the degree to which the process is or is not meeting the specification requirements. Capability indices have been developed to graphically portray that measure. Capability indices help to place the distribution of the process in relation to the product specification limits. It is used to determine whether the process, given its natural variation, is capable of meeting established specifications. It is also a measure of the manufacturability of the product with the given processes. Some of the mostly used univariate process capability indices are C_p, C_{pk} and C_{pm}. It is a fact of life that most data are naturally multivariate in a manufacturing process. In these days because of the use of computers in online process monitoring, huge amount of data are collected. Hence study of multivariate process capability is very essential. There exists some multivariate process capability indices like MC_{pm}, $\left[C_{pM}, PV, LI\right]$ and MC_f based on the assumption of normality of the production process. Some of them have limitations to lower dimension of dataset. Few indices like MC_f and S_{pk}^T are which are based on the yield and non confirming product of the process. They do not deal with the geometrical representation of the tolerance and process region. They use standard values of yield and non confirming product hence it is difficult to acces those indices. The indices can not be used for nonparametric cases. Index like MC_{PC} which is non parametric in nature can not work for all sort of dataset.

The objective of this thesis is to formulate a Multivariate Process Capability Index to calculate the capability index for any parametric or nonparametric distributed process of higher dimension after removing outliers in the dataset,. This work is to demonstrate that the Classical (CPCA) and Robust (ROBPCA) Principal Component Analysis can help to reduce the number of variables to lower dimension and use the univariate indices to calculate the processes capability index. Robust principal component analysis can remove the noisy data to get a more precise index. Support vector data description (SVDD) has a good ability of data expression in higher dimension eliminating the outliers. Computational geometry (CG) with fast Quick hull

algorithm can better estimate the volume of the tolerance and process region by finding the convex hull of the dataset of the two regions and representing the nonparametric data in two and three dimensions. This helps in calculating the capability index of the high dimensional nonparametric and parametric process. Different practical datasets and different generated datasets are used to validate the two proposed indices. Computer codes are developed in MATLAB using Statistical and Optimization Toolbox.

Keywords: Multivariate process capability index, Classical principal component analysis, Robust principal component analysis, Support vector data description and Computational geometry.