Statistical performance of tests for mean shape difference with application in manufacturing

Hussam Alshraideh   and   Enrique del Castillo

Dept. of Industrial and Manufacturing Engineering

The Pennsylvania State University, University Park, PA 16802, USA

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Abstract

This paper considers experiments in manufacturing where the response of interest is the geometrical shape of a part and the goal is to determine whether and how the experimental factors affect the resulting shape of the part. The usual approach in practice is to estimate the form error of the part and conduct an ANOVA on the form errors. Instead, we study the performance of several Statistical Shape Analysis techniques to analyze this class of experiments. Real data sets as well as simulated shape data of interest in manufacturing were used to perform power comparisons for 2 and 3 dimensional shapes. The ANOVA on the form errors was found to have poor performance in detecting mean shape differences in circular and cylindrical parts. An ANOVA test due to Goodall and a recently proposed ANOVA Permutation test provide highest power to detect differences in the mean shape. It is shown how these tests can also be applied to general "free form" shapes where no standard definition of form error exists.

Keywords: Statistical Shape Analysis, Form error, Permutation Tests, EDMA, Cylindricity, Circularity.