Statistical Shape Analysis of Experiments for Manufacturing Processes

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Abstract

We review existing and develop new statistical techniques for the analysis of experiments where the response is the geometric shape of a manufactured part. The analysis of variance for shapes is discussed. An F test and a permutation test for detecting differences in shape are presented. It is shown how the permutation test provides higher power for 2D circular profiles than the traditional methods used in manufacturing practice, which are based on the circularity form error. The proposed permutation test does not require the error assumptions needed in the F test, which may be restrictive in practice. New visualization tools, including main effect and interaction plots for shapes and deviation from nominal plots are presented to aid in the interpretation of the experimental results. The proposed methods are illustrated with a real manufacturing application in titanium lathe turning.

Keywords: Profile data, Procrustes Methods, Geometric Specifications, Registration, Morphometrics, Signal Response Systems.