Statistical process monitoring approaches for high-density point cloud data

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Motivation: The introduction to 3D laser scanners and the need for processing high-density data cloud



(a) a CAD model of a manufactured part

(b) Traditional measurement systems only measures a set of specified points

(c) 3D laserscannerseliminate blindspots

The general approach



Partial profile of a product under other measurement systems which may give false negative signal

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Full profile made up of millions of data points generated by a 3D laser scanner

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Standard profile under in-control manufacturing Λ

Calculate deviation from the nominal distribution

The general approach



Some non-parametric statistical method for calculating deviations from the reference distribution



EWMA control chart for visualizing the deviation statistics

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Comparing non-parametric methods



Need control charts for changes in slope and y-intercept

Set the In-control Average Run Length equal to 200 metric: consistently low ARL for out-of –control scenarios

Extensions

What out-of-control scenarios to look at:

Scenario	Size of shift	Shift Introduced
l I	Global	$\delta_{\mu\prime}$
II	Global	$1 + \delta_{\sigma'}$
Ш	Localized (10 points)	$\delta_{\mu\prime}$
IV	Localized (10 points)	$1 + \delta_{\sigma'}$
V	Localized (50 points)	$\delta_{\mu\prime}$
VI	Localized (50 points)	$1 + \delta_{\sigma'}$

Extensions (Cont.)

- What statistic to use for plotting control chart:
 - -max deviation
 -sum of absolute deviations
 -mean absolute deviation
 -sum of squared differences
 -Q-Q plot statistics



Extensions (Cont.)

- What distributions to look at:
 - normal distributionLaplace distributionuniform distribution







Extensions (Cont.)

1.normal 2.Laplace 3.uniform 1.max deviation
2.sum of absolute deviations
3.mean absolute deviation
4.sum of squared differences
5.Q-Q plot statistics

6 out-ofcontrol scenarios

Comparison of results

Total # of sample points = 50000 SAD = Sum Absolute Deviation MAD = Mean Absolute Deviation



Comparison of results (Cont.)

Total # of sample points = 50000 SAD = Sum Absolute Deviation MAD = Mean Absolute Deviation



Scenario 5: Local (50 points) shift on μ

Scenario 6: Local (50 points) shift on σ

Future work

- Non-normal distributions for Q-Q method
- UK research (2012 Ross and Adams JQT) presents new frameworks
 - CvM (Cramer-von-Mises) CPM
 (performs better and simpler to implement)
 KS CPM

Reflection