Machining Centre Monitoring with Calibrated Artefact Probing

T Rooker
Integrated Metrology for Precision Manufacturing Conference
January 2019
NC-Checker – hardware

Calibrated spherical artefact [1]

Touch trigger probe [2]

NC-Checker – benchmark report

Fault identification

Pivot point correction

Trend analysis
Performance monitoring with NC-Checker

• Current trend analysis
  – 1-dimensional, overlaid onto benchmark wheel
  – Must be reset after significant machine event

• Objectives
  – Track long-term trends and generate user display
  – Data analytics for intelligent maintenance decision system
Long term trend tracking

$CI_{95}(GP, tol) = 1.96 \sigma_{GP} \left( \frac{\mu_{GP}}{tol} \right)$
Threshold sense checker

- Data-driven tolerance threshold – normal operating condition
- Identify unexpected tolerance changes
Trend stability – outlier detection

Outlier detection in a 2D linear correlation

- Regression fit
- Correlated measurements with Gaussian noise
- Non-correlated outliers

Multivariate input GPR on C, evidence: 38.369094485155486
Trend stability – outlier detection

Five-axis geometric performance drift
absolute error values

Z-score outlier detection on multivariate
Gaussian Process regression errors

Measured error /mm

Discrepancy measure /g

Outlier threshold from 95% confidence interval
Error predicting C
Error predicting 8-va
Error predicting 8+ve
Conclusions and further research

- NC-Checker as an interactive maintenance logger and monitoring system

- Unexpected tolerance changes can be identified and challenged where necessary

- Trend stability monitoring needs further dataset for verification

- Collect alternative operational data to predict errors and inform the benchmark interval
Acknowledgements

- EPSRC
- metrology software products ltd.
- The University of Sheffield:
  - Industrial Doctorate Centre for Machining Science
  - Dynamics Research Group
  - Advanced Manufacturing Research Centre

Thank you
tjrooker1@sheffield.ac.uk