Real-Time Measurement for an Internal Grinding System

Precision Machining Research Consortium
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Measurement Head Background

- Two diamond-tipped tactile probes
- Two LVDTs wired in series
- Small DC positioning motor
Experimental Setup Diagram

LabView Data Acquisition System

- Software Interface
- Digital I/O
  - Digital Interface Circuits
  - Optical Isolators
  - DC Motor
  - Probe 1 LVDT
  - Probe 2 LVDT
- Analog I/O
  - Anti-Aliasing Filter
  - LVDT Voltage Module
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Work Piece Rotation

- Lathe simulated rotation at 519 RPM
- X, Y, and Z positioning capability
Data Acquisition System

- LabView virtual instrument software
- Real-time analysis
- Assumed maximum of 50 UPR
- Anti-Aliasing filters
- Two analog inputs
- Probe positioning
Spindle Error

- Low frequency undulations distort results
- Evaluated with Donaldson Reversal Technique

Radial Error Motion
**Spindle Error**

- Significant low frequency error motion
- Two signals $180^\circ$ out-of-phase
Spindle Errors

- Frequency analysis
- Low frequency 1 and 3 UPR error motion
Deviation from Target Diameter

- Minimized measurement normal deviations
- Diameters of master parts verified on CMM

![Optimal Line Determination](image.png)
Deviation from Target Diameter

- Diameter measurement with line definition
- Small statistical variation
Out-of-Roundness

- Visualization of surface profile
- Least Squares Circle method
Out-of-Roundness Visualization

- Low and high frequency undulations
- Lower frequencies distort higher frequencies
Out-of-Roundness Visualization

- Minimized distortion of high frequency information
Surface Profile Waviness Analysis

- Large low frequency spindle error
- Peak visible at 31 UPR
Surface Profile Verification

- Verification on Pneumo-Centric 5500
Future Work

- Minimize radial deviations of spindle
- Implement interface to machine controller
- Determine frequency response of gauge
- Develop portable experimental setup