Non-Contact Measurement of Cylindricity

Research Objectives
- Extend the MDRL's current roundness measurement capabilities to three dimensions
- Automate instrumentation and motion control for ease of data collection
- Incorporate some measures of cylindricity in addition to roundness

Hardware
- 4-Axis Professional Instruments positioning system, including two linear air bearing stages and one BLOCK-HEAD ® 4R spindle
- Lion Precision Capacitance Gages
- National Instruments data acquisition
- Aerotech amplifiers and U500 PC based motion controller

Software
- Aerotech U500 motion control software
- National Instruments CVI used for data acquisition and processing and custom user interface

Experimental Setup

Results
- Professional Instruments linear air bearing stages make it possible to accommodate parts from 1 inch in diameter to 12 inches, and up to 8 inches in height that are electrically conductive
- Spindle speed, vertical step size, and number of cross sections programmed by user
- After proper setup, CNC positioning system and data acquisition system automatically run test and analyze results
- Roundness measurement and harmonic analysis available for for up to 100 cross sections with digital low-pass filtering ability
- 3-D wireframe model of highly magnified part surface

Conclusions
- Cylindrical form of single point diamond turned cylinders measured with high repeatability
- The stiffness of the machine’s structural loop keeps asynchronous error between 1 and 2 μin permitting highly accurate measurements
- Inspection possible for optical-quality parts that would be damaged by contact measurement instruments
- As an inspection tool, the C2M2 can quickly and automatically scan the surface of a cylinder and assess the roundness and locate flaws

Future Work
- Integration of motion control and data acquisition software will allow for seamless automation and faster setup
- Expand flexibility to accommodate cylindroids with non-constant diameters

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In a more practical application, it can be seen how part inspection is possible. In this case, the peak in the polar plot represents a flaw in this artifact. The same flaw can also be seen jutting out from the lower right-hand corner of the 3-D model.