Non-Contact Measurement of Turbine Blades

Technion Seminar
Nov. 2006
Topics

• Metrology Trends
• Current Technology
• The Desired Solution
• The WIZprobe
• The WIZblade
Metrology Trends
Blade Metrology Trends

- Complex geometry parts
- Global quality control standards
- Dimensional verification with CAD model
- Higher measuring speed and accuracy
- In line inspection
Current Technology
Current Technology

• **Jigs and Templates**
  - Tailored and expensive
  - Subjective decisions
  - Labor Intensive

• **Mechanical Touch Trigger Probes**
  - Repeatable but slow
  - Zero dynamic range - precision jigs
  - Programming requires high expertise

• **Mechanical Scanning Probes**
  - Faster (Analog)
  - Limited in fine details (Edges)
Current Non-Contact Technology

• Triangulation Laser Sensors
  - Fast but not Accurate and not Reliable, generate Noise
  - Sensitive to Color, Surface finish, Material and Glare

• Vision sensors
  - Fast
  - 2D Applications
  - Not Accurate in 3D
Current CMM Platforms

- Using Mechanical Touch Probes
- Accurate and Repeatable
- Slow
- Programming requires high expertise
- Programming takes a long time
- High Precision high cost fixtures
- Alignment takes a long time
The Desired Solution
The Desired Probe

- High precision - Accuracy and Resolution
- High speed clean data acquiring - Time saving
- Wide dynamic range - Simple scanning programs
- Quick set-up time - without costly jigs
- Measure any material, color and surface finish - No need to paint, spray or treat the surface
- Solid State - High reliability and minimum down time
- Easy integration to conventional CMMs
The Desired Motion Platform

- Highly Accurate
- Measure while in motion
- Real time tracking on freeform parts
- Easy setup of the part
- No expensive Jigs
The Sensor Technology

Conventional Triangulation Sensor

Circumferential Triangulation Sensor
The WIZprobe Patent

- Circumferential triangulation
- Special toroidal optics generates 2D image on the CCD
- Sub-pixel image processing algorithms
- Real time adaptive control for every point
The WIZprobe

- Small
- No Cable
- Full PH-10 Auto Joint Connection
## WIZprobe Spec.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single point accuracy</td>
<td>6 microns @ 1 Sigma</td>
</tr>
<tr>
<td>Best fit accuracy (100 points)</td>
<td>2 micron @ 2 Sigma</td>
</tr>
<tr>
<td>Operating range</td>
<td>10 mm</td>
</tr>
<tr>
<td>Stand off distance</td>
<td>50 mm</td>
</tr>
<tr>
<td>Max. scanning rate</td>
<td>50 points per sec.</td>
</tr>
<tr>
<td>Laser Power</td>
<td>20 - 300 micro watt</td>
</tr>
<tr>
<td>CCD exposure time</td>
<td>64 - 4000 micro sec</td>
</tr>
</tbody>
</table>

Real Time Adaptive Control
Real Time Adaptive Control

- Any material, color and surface finish
- Wide range of angles

- Laser Power
  - 20 - 300 microwatt

- Exposure Time
  - 64 - 4000 microsecond
Competitive Edge

✓ Over mechanical touch probes
  - Speed, Feature accuracy, Setup, High resolution geometry

✓ Over existing laser sensors
  - Accuracy, Adaptivity
  - Real data output

✓ Over vision systems
  - Accuracy
  - 3D capability
WIZprobe vs. Touch Probe

WIZprobe

- CAD Normal
- Laser Beam
- CAD Point
- Measured Point
- Actual surface

Reported Point = Projection of the measured point on the CAD Normal

Touch Probe

- Reported Point
- Actual surface
WIZblade Highlights

- Full range of blade sizes
- Automatic part Alignment
- No precision jigs required
- Simple and easy setup
- Rapid scanning
- High quality data
- Fine detail verification
- Real time data display
- Automatic CAD comparison
- Simple new Blade introduction
WIZblade Movie
Alignment procedure

- 3-2-1 alignment
- 6 Points alignment
WIZblade Software
## Typical Cycle Time

<table>
<thead>
<tr>
<th>Task</th>
<th>Conventional CMM</th>
<th>WIZblade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment</td>
<td>2 minutes</td>
<td>30 sec</td>
</tr>
<tr>
<td>One section side (40 mm length)</td>
<td>30 sec</td>
<td>5 sec</td>
</tr>
<tr>
<td>5 cross sections (4 orientations)</td>
<td>18 minutes</td>
<td>3 minutes</td>
</tr>
<tr>
<td>10 sections</td>
<td>24 minutes</td>
<td>4 minutes</td>
</tr>
</tbody>
</table>

The table above shows the typical cycle time for different tasks using conventional CMM and WIZblade technologies. The tasks include alignment, measuring one section side, and measuring cross sections.
WIZblade
Typical MRO Dimensions
Effective Chord

Compressor blades
WIZblade
Typical MRO Dimensions
Blade Length

Compressor blades
WIZblade

Typical MRO Dimensions

Cross Notch

Turbine blades

"Alignment Surfaces"
The WIZblade Kit

- WIZprobe Kit
- High Speed Motion Controller
- WIZblade Software
- Joystick Panel
The WIZblade Kit

- WIZprobe
- WIZcard
- Joystick Pendant
- Interface Box
- Controller
- PC
- Platform
Switch Box

CMM Controller

Switch Box

CMM

WIZblade

Nextec Controller
• The growing demand for high speed, simple setup and high quality control standards require new innovative blade scanning solutions

• The WIZblade provides the leading solution for fast and accurate Measuring and QC of turbine blades