Low-Cost Cobot Integrated 3D Scanning

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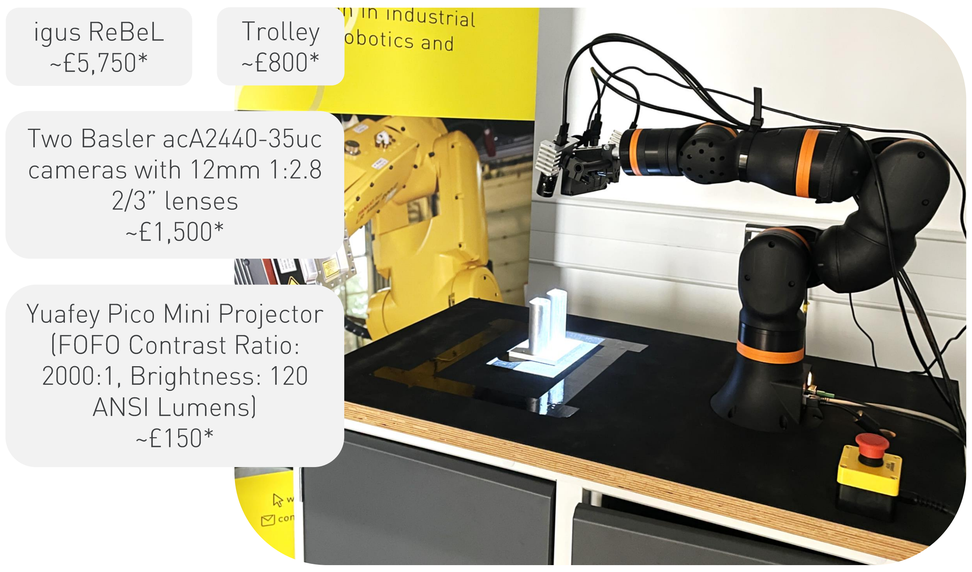
The high cost of both 3D scanning and collaborative robots (cobots) has been a barrier of entry for manufacturers, particularly to those who are small to medium sized where the precision of typical 3D scanning systems often exceeds their requirements. The increase in the number of affordable cobots has allowed for a low-cost automated scanning system to become more accessible and financially viable. The aim of the project was to integrate a low-cost, lightweight fringe projection system attached to a six-degrees-of-freedom robotic arm and PC to create a portable scanning system.



Six DOF Cobot + Fringe Projection 3D Scanner → Program to Control Cobot and Scanner Simultaneously → Low-Cost Cobot *Integrated* 3D Scanning

* Estimated prices only, excluding time, labour, machinery costs, PC and software.

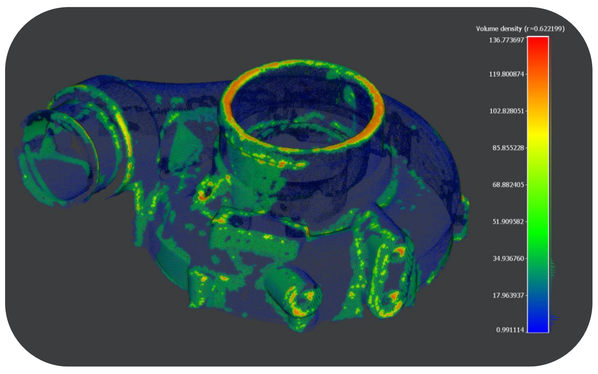
- Non-specialist engineers (undergraduate student interns) were able to set-up, operate and program the solutions.
- Specialist engineers aided in integrating the solutions together.

Software used for both solutions included Polyga's FlexScan3D and CloudCompare:

- FlexScan3D generates the projection, interprets the fringe distortion and generates a point cloud.
- CloudCompare enables point cloud analysis and comparison.

Point Cloud Examples of Scanned Objects:

- Total Number of Points: 898,682
- Number of Scans: 45
- Individual Scan Time: ~0.3 seconds

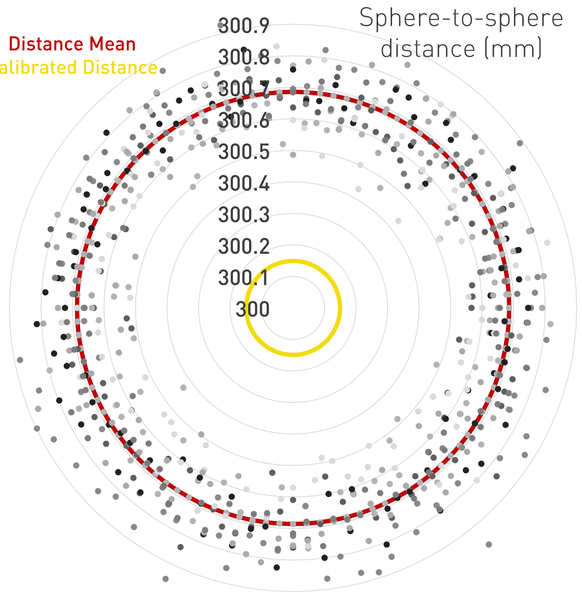


Average Point-to-Point Distance: 0.622mm

VDI/VDE 2634 Evaluation:

Experiment 1: Polyga V1 Scanner

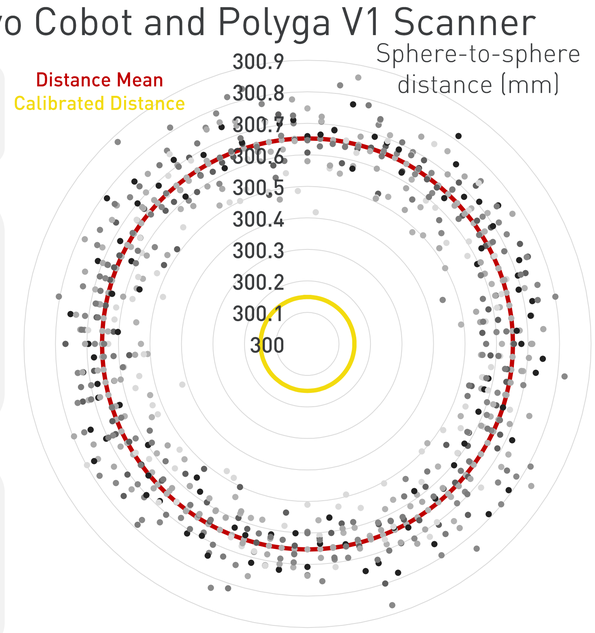
Scanner takes 100 scans consecutively. → Cobot moves scanner to new position and scanner takes 100 scans consecutively. → Process repeated until 7 positions are reached.



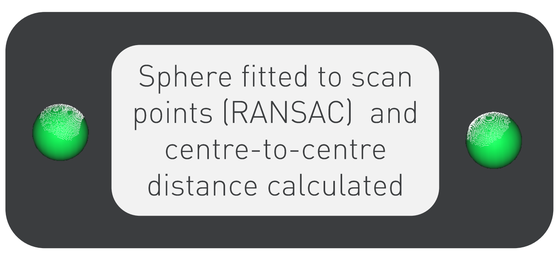
Sphere-to-Sphere Distance Mean	300.686 mm
Sphere Spacing Error	0.537 mm
Sphere-to-Sphere Distance Standard Deviation	0.084 mm

Experiment 2: Inovo Cobot and Polyga V1 Scanner

Scanner takes 1 scan. → Cobot moves to scanner to new position and scanner takes 1 scan. → Cobot moves to 7 total positions before returning to initial. → Process repeated until 100 scans are taken at each position.



Sphere-to-Sphere Distance Mean	300.652 mm
Sphere Spacing Error	0.503 mm
Sphere-to-Sphere Distance Standard Deviation	0.076 mm



Calibrated Ball Bar Sphere-to-Sphere Distance: 300.149mm

Conclusions:

- Non-specialist engineers are able to set-up a system but may need specialist help to ingrate the system.
- Software was successfully written for the integration and can be adapted for the size of the object being scanned and detail required.
- The Inovo and Polyga V1 Scanner solution is relatively precise, with a standard deviation < 85 µm but not as accurate, with a sphere spacing error of ~500 µm.

Next Steps:

- Experiment with more off-the-shelf low-cost hardware.
- Expand parameter testing.
- Automatic scanner calibration using computer vision.

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