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Scalable Low-Cost Photogrammetry for Enhanced In-the-Loop Robotic Deployment - Experimental Snapshot and Future Potential

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Abstract

On-line metrology systems capable of rapid 6DoF computation are proven enablers for increasing accuracy and metric performance of robotic control systems. Applications range from improved tool path delivery to the accurate placement and alignment of sensors used for inspection of as-manufactured components. However, present solutions are hard to adapt to new robotic cell configurations easily, making them difficult to use across the range of application use cases. This presentation explores novel options for the flexible deployment of low-cost off-the-shelf camera systems in photogrammetric networks capable of on-line deployment across small, medium, and large volumes matching state-of-the-art industrial tools.

Starting at small scales with a KR6 robot system with a working volume of 1.36m^3, the development of a highly adaptive multi-camera system is detailed through experimental data gained from over 1 million cycles of 6DoF robot tracking that start to represent the challenges presented by a wide range of manufacturing and inspection tasks. Emphasis is on avoiding large scale stable structures and tooling, keeping systems flexible and rapid to deploy, calibrate and operate. Validation against simultaneously acquired laser tracker end effector localisation connects estimated 6DoF solutions with achievable accuracy.

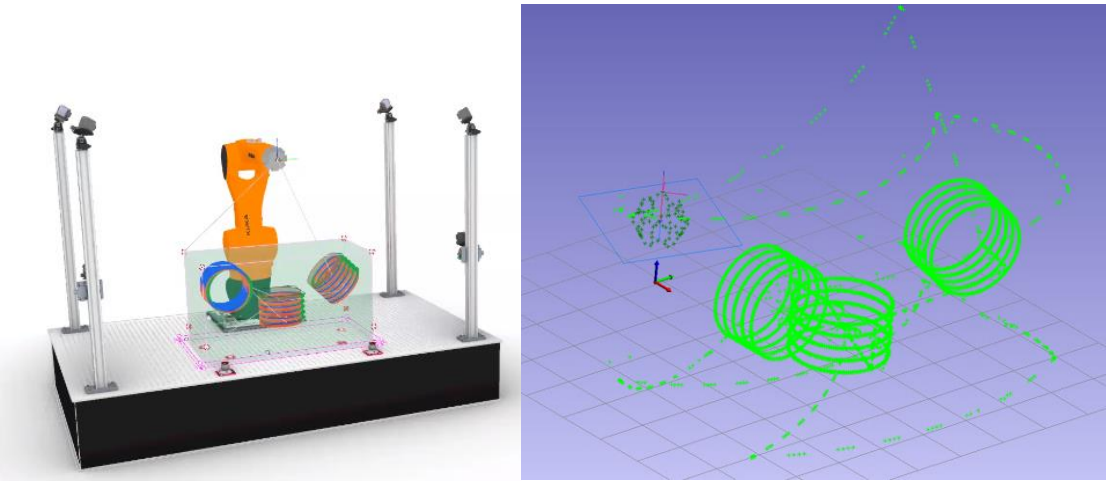


Fig 1. Left: KR6 experimental setup with path planned “donuts” Right: low-cost photogrammetrically tracked “real donuts” running into industry standard SA software.

This presentation extends to utilisation of the same systems for sub-mm robotic tracking at larger volumes demonstrated with a highly unique KR500 mounted OCRobotics snake robot inspection system with an 8m reach and a multitude of degrees of freedom. Here small-scale solutions achieved with the KR6 bench level tests are expanded into low-cost imaging solutions that can be deployed for inspection of large scale manufactured assemblies where networks of close-range

robot mounted sensors can be brought into and tracked in close proximity for wide area surface inspection tasks. In doing so, this work demonstrates the flexibility of the presented solution to maintain state-of-the-art accuracy and metric performance deployed against highly different robotic scenarios.



Fig 2. Tracking camera view of “sleeping” 8m reach snake inspection robot. One of a network of 9 convergent views acquired from roof mounted low-cost photogrammetric cameras at a “safe” 12m range.