Identifying the gaps in the standards use to quantify large volume metrology (LVM) systems performance for industrial robot applications

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External 6DOF systems can enhance flexibility of automation

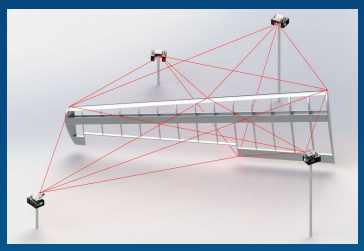
Robots are used in industry because of their[1]:

- High repeatability.
- Versatility.

However they also have low absolute accuracy thereby hindering their operational flexibility, and limiting their uses to repetitive tasks[1].

Why using external 6DOF system in industry[2]:

- To flexibly track robots, parts and fixtures over a large working volume.



Advantages[3]:

- To improve positional accuracy.
- To enhance in-process control.
- To increased operational flexibility.

The latest multi-target, multi-nodal 6DOF systems overcome line of sight limitations through the integration of multiple measurement nodes.

Do current standards quantify the performance of complex multi-nodal systems?

Performance Quantification → Standards

	ASTM E3064-16	ASTM E2919-14	ASME B89.4.19	ISO 10360-10	VDI/VDE 2617 Parts 1-3
Aim	Evaluation of the performance of optical tracking systems that measure 6DOF pose	Measuring the 6DOF pose of a rigid object	Performance evaluation of laser-based spherical CMM	Verification of the performance of a laser tracker	Practical acceptance and reverification methods for the evaluation
System tested	Optical tracking system	All systems	Laser	Laser	Optical 3D measuring imaging
Artefact	Ball bar 300 mm length	Any measurable rigid objects	Length bar with SMR/ SRC/ODR*	Spheres/ SMR/ SRC/ ODR/ length bar	Gauge blocks, spheres, planes
Tests	Dynamic volumetric measurements	Measure poses for N > 32 poses + comparison to a Ref Sys	Point-to-point/ Two face test/ Ranging tests + comparison to a Ref Sys	Probing and form test/ Two face test/ Length test	Point-by-point/ single and multiple view for probing, sphere-spacing and flatness tests
Measurands	Position (relative) Orientation (relative)	Position and Orientation + pose errors (absolute and relative)	Length (absolute) Target coordinate measurements	Length (absolute) Sphere diameter (absolute) Target coordinate Size and form errors	Length (absolute) Sphere diameter (absolute) Plane form (absolute)
Static/ Dynamic	Dynamic (at constant speed)	Static	Static	Static	Static

*Retroreflective targets

Gaps:

- No, current standard do not fully characterise multi-nodal, multi-target LVM 6DOF technologies.
- Inconsistent definition of criteria used to measure the performance of the system under test.
  - Requirement for concurrent measurement reference system.
  - No universally applicable test methodology suitable for all 6DOF technologies.
- Lack of dynamic test that is independent of volumetric errors introduced by the reference system and measures for velocity.

Addressing the Gaps

An approach has been taken to adapt existing methods described in current standards to include dynamic (speed, velocity) measurement in a series of scalable, volumetric tests. These tests are not reliant on concurrent measurement of a reference system and will accommodate multiple LVM technologies.

Elements of the test include a rotating calibrated length gauge, interchangeable target constellations, integrated environmental sensors, and the option to include an external reference system. Additionally, the tests can be arrayed throughout a volume to provide volumetric data. The test measurands are the absolute and relative pose of the constellations and their velocities.

References

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3. Moeller, C., Schmidt, H.C., Koch, P., Boehlmann, C., Kothe, S., Wollnack, J. and Hintze, W., 2017. Real time pose control of an industrial robotic system for machining of large scale components in aerospace industry using laser tracker system. SAE International journal of aerospace, 10(2), pp.100-108.

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