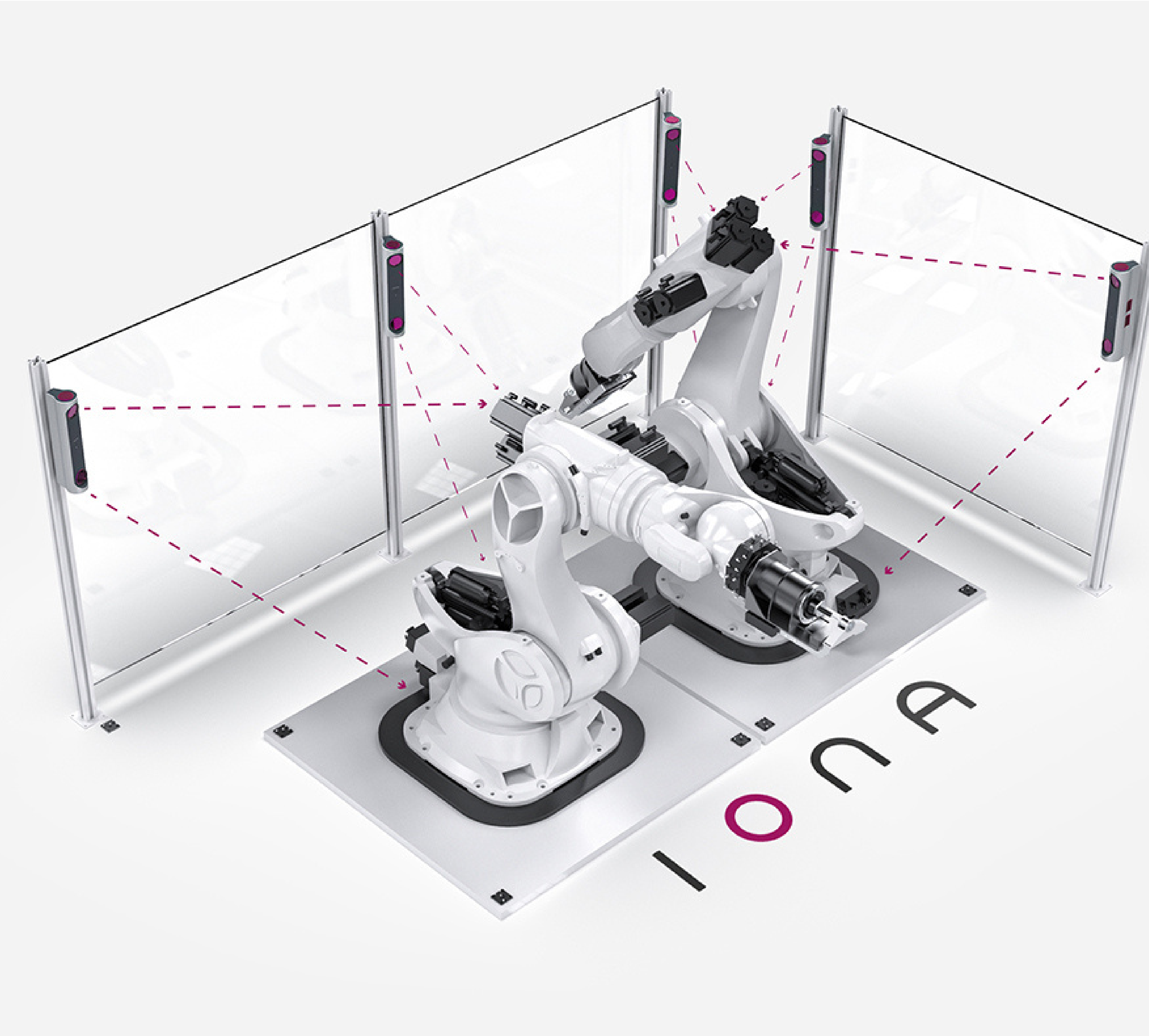
INSPHERE

3 Steps to Improving Robot Accuracy



Robot process isn't performing as expected?

We all know that robots are a great technology for carrying out repetitive tasks over and over. However, robots are increasingly being used in challenging applications that tend to expose their weaknesses rather than leveraging their strengths. The use of robots is often based on several assumptions, which are worth considering in a little more detail.

High Repeatability ≠ High Accuracy

As a robot can repeatably return to the same position time after time, it may be assumed that it is globally accurate – but this is rarely true. Repeatability for an industrial serial axis robot may be around 50µm, but if the same robot were programmed to move nominally one metre, it would likely have inaccuracies at the millimetre level.

High Payload ≠ High Stiffness.

Another assumption is the interplay between robot payload and stiffness. The payload rating is the robot's ability to lift and manipulate mass, whereas the stiffness is concerned with the robot's rigidity under load, usually manifesting as end-effector stability during an operation. We have encountered numerous examples where larger payload robots have been down-selected with the assumption that the robot will be more rigid when exposed to external forces.

However, the stiffness is more than just a function of the lifting power of the motors. Stiffness of the robot end-effector can be heavily influenced by load orientation, backlash in gear boxes, and robot linkage stiffness. These elements are not inherently improved just by using a larger robot. Poor stiffness typically manifests as positional inaccuracy and process variation.

High Flexibility ≠ In-process Adaptability.

Lastly, robots are highly flexible both in terms of how you deploy them and how they can manipulate an end-effector in space. It is understandable that for a continually changing set of tasks or parts that robot flexibility is seen as an advantage – however, given that robots have poor global accuracy, their ability to adapt in-process to absorb variation is also poor.

How can a robot's performance be improved?

Understanding and accepting the limitations of industrial robots should not preclude them from adoption in difficult applications, but it should change our approach as to how best to deploy them.

MEASURE

Measuring your current process is a logical first step and yet is rarely carried out in practice as it is difficult to do accurately. We need to establish what is actually happening during the manufacturing operation. This is subtly different from a more common approach, which is to measure the process outcome, i.e. the manufactured part or assembly, from which conclusions are inferred.

Measurement of the produced outcome can only ever give part of the story. If the part/assembly/process is good – that's great! – but if you need to dive deeper then measuring of the outcome will have many conflated signals as to where the error may be arising. For example, your problem may be fixture/part location relative to the robot, but this could be mistaken for robot positioning inaccuracy.

Another approach is to measure the robot path as a "dry run", without any external loads. This is not always easy as measurement systems capable of such tasks often require specialist resource, expensive software, and even modification of the process to ensure targeting and line of sight are maintained. Although a useful diagnostic step, this kind of measurement can provide a false sense of security as it is often the case that payloads and external forces have a significant impact on performance. Want to measure in-process? Read on!

TEACH

The ability to teach a robot is a very useful function, updating a position from the pendant and relying on good repeatability to ensure the robot returns to the 'taught' position. This can be used to generate a program from scratch or to 'touch-up' an existing program to achieve the original intent. This typically occurs when an offline program (OLP) is being brought online, but there are of course other times you would touch-up a program, perhaps to negate some drift, or accommodate a new fixture.

Traditionally, touching-up a robot program is carried out by a skilled operator relying on visual markers. Touching-up a program can be a good way to wash-out some of the tolerance stacks in your manufacturing process, for example inaccuracies in the tool centre point (TCP) offsets or positioning of the fixture relative to the robot. However, it is a lengthy process and only valid for the one-operation. This can be extremely arduous in complex robotic applications and can become impractical or even impossible for dynamic paths. Could leveraging robot repeatability unlock you process?

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MONITOR

If the purpose of the process measurement and robot teach was to ensure a baseline performance could be achieved, then the next question to ask should be: is the process performance maintained over time?

Although robots have good repeatability from one run to the next, they are still mechanical systems and as such, they have limitations when faced with:

- Variation in the fixture/tooling/part location.
- Temperature variation.
- Variation in the static and dynamic loads.
- Wear and tear of gearboxes/moving parts.

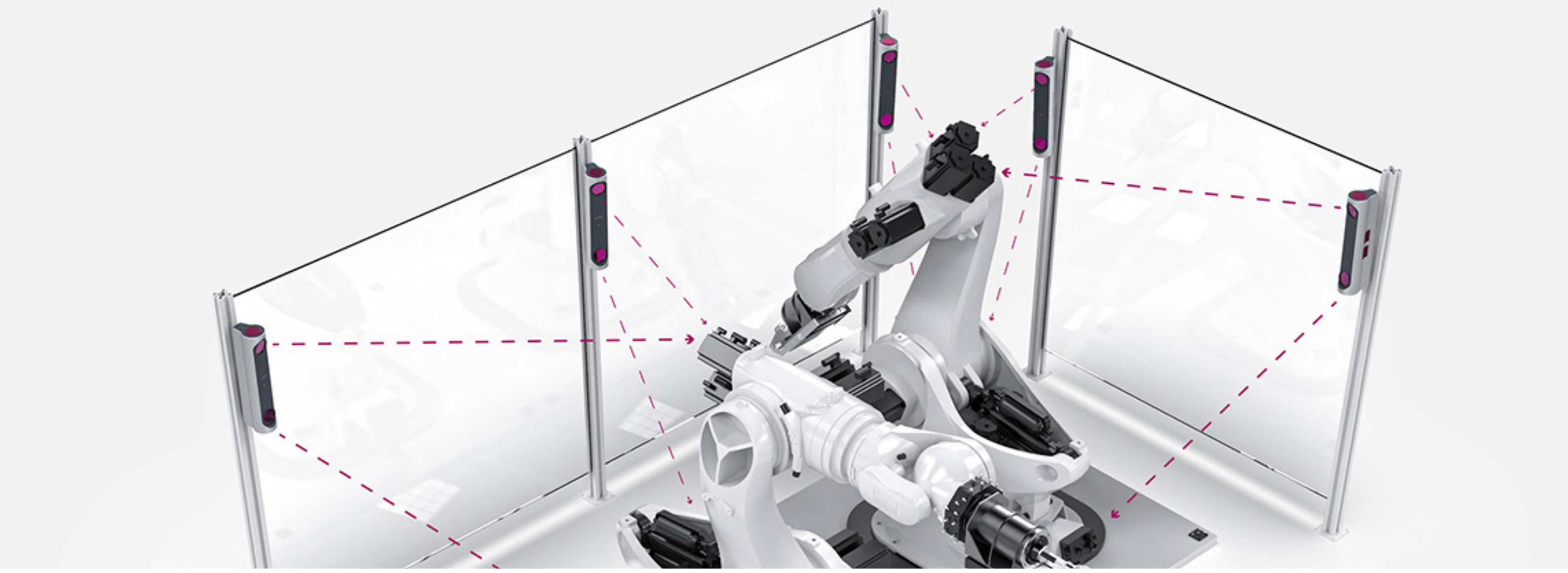
The same measurement principles should be applied as before – can I measure my process as a whole, whilst it is being carried out?
Monitoring the process provides confidence that a robot process is consistent, and your process is controlled. This can – as confidence grows – provide a proxy for process control, reducing the part inspection requirement. Additionally, monitoring the process can work as an early warning system for maintenance teams, catching and scheduling down-time before scrap is produced.

What are the challenges with taking this approach?

Carrying out these three steps is straightforward in principle, however, in practice, there are a number of hurdles to overcome. Until now, measurement and sensors systems have not been designed to allow operators to capture this data easily.
Portable metrology equipment typically requires a specialist to operate the equipment and software.

Even with specialist resource on hand, inherent limitations with the metrology system remain, typically:

x Only able to measure a single point of interest.
x Only able to measure in 3D, without angular information.
x Must maintain a limited line of sight.
x Requires a stable mount.
x Not built to remain in-situ within the robot environment.
x Requires third party software.



What's unique about IONA System?

IONA is the culmination of INSPHERE's experience in tackling these challenging applications. The hardware and software have been developed by us from the ground-up to monitor and improve robot processes. Enabling simple in-process measurement of the end-effectors and fixtures, we have created a system for production engineers, not metrologists.

As consequence, IONA:

- Is designed to remain in-situ, in industrial environments and continually monitor 24/7/365.
- Can simultaneously measure multiple points of interest (in 6D).
- Overcomes line-of-sight issues by virtue of numerous vantage points and built-in redundancy.
- Does not require stable mounting.
- Has a non-specialist, easy-to-use software for collecting data and improving robot accuracy.

Our measure module can provide true position of robot end-effectors relative to the cell datum, fixture datum or any other reference (all of which can move!). Data is readily available in real time to import back into your OLP environment or integrate directly into a digital twin. The engine works best when combined with teach, our module for improving robot performance. Analogous to the manual method of touching up programs (but much quicker and simpler) teach takes the measured data and updates the robot program to reflect the design intent. It negates operator-to-operator variation, reduces the potential for mistakes, and provides an external reference to buy-off. In most applications, this enables a cell to be commissioned without the requirement for parts. Once the program is optimised, the software switches over to monitor, giving continuous assurance that in-process accuracy is maintained.

The ability to monitor a process 24/7 is often not given the value it deserves, simply because it has not previously been viable with available technologies. The costs of bad parts and process interruptions are known to be very high. IONA can shift the mind-set of manufacturing from one that tolerates scrap, waste and stoppages, to one that is constantly vigilant, is able to learn from historic data, and therefore delivers far greater productivity than has previously been possible. This shift is a key part of the move towards Smart Manufacturing Industry 4.0 philosophies, and makes possible a major uplift in manufacturing quality and productivity for a wide range of complex automation processes.

IONA directly improves the accuracy of robotic applications, giving you:

- More process confidence
- Right-first-time programs
- Significant time and cost savings
- Improved part quality
- Early detection of process drift (reducing scrap!)
- Increased uptime and better planning of preventive maintenance
- Higher productivity

Find out more about the IONA System:
https://inspereltd.com/iona