A study of the accuracy and repeatability of mobile collaborative robots for non-destructive evaluations

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The demand for Non-Destructive Testing and Evaluation (NDT&E) of high-value manufactured products, such as aircraft wing panels, is rising quickly. Due to the reach limitations, inspection with fixed robotics is challenging because wing panels are frequently large and often include a variety of geometrical features. New and more efficient inspection delivery techniques must be created to meet this demand. The use of collaborative mobile robotic platforms is one such development. Advances in mobile robotic platform localization, path planning, and sensor technology have made it possible to bring the inspection process to the part. The mobile systems introduce a much greater flexibility and an independence from infrastructures, such as Gantry-based systems. Additionally, there is a decrease in the amount of capital equipment needed to accommodate the various geometries, weights, and sizes of the parts.

In addition to these attractive features, mobility introduces additional variables into the inspection process, increasing the possibility of errors. Positional uncertainty of mobile platforms is inherently higher than for fixed robot systems leading to potential errors in registering NDT scans to part geometries.

Because most commercial mobile platforms are used for pick-and-place operations, a stable base capable of withstanding the forces generated by the arm is often not a design requirement. In our application utilising wheel probe ultrasonic inspection, the requirement for force control of the probe necessitates a stable base with inertia sufficient to resist the measurement forces of the wheel probe. For this reason, a KUKA KMR iiwa was chosen as a result of providing high inertia on the KMR base unit. This robot also incorporates SICK S3000 laser scanners for environment mapping and maintaining safety around humans and obstacles.

The KMR platform's accuracy and repeatability were measured by moving in a square path with the same start and end points. The platform measurements were validated using a Leica Absolute Laser Tracker with a 10µm accuracy.

Different kinematic and dynamic accuracies were investigated including multiple linear and rotational speeds, as well as assessing strafing capabilities (omnidirectional motion without rotation enabled by the use of Mecanum wheels on the KMR robot).