Being safe around collaborative and versatile robots in shared spaces

Case story: Creating a Metamodel for Determining Safe Cobot Speeds

Domain: Manufacturing

From award project: Risk Assessment Metamodel for Cobot Operating Speed Determination (RACOS)

Project beneficiary: YASKAWA

From open call: 2

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Supplementary materials (click to download): full reports Milestone 1, Milestone 2, and appendix

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1 Overview

The RACOS project provides a tool that enables the system integrator or end-user to approximate the maximum allowed collaborative speed of a cobot based on workpiece characteristics. This approach is focused on lathe machine tending applications but can be transferred to all kinds of rotary workpieces. Based on an empirical study, the main influencing factors on the collaborative speed and the robot's behavior have been identified. The concluded approximation equations provide a sound basis to execute simulations in order to determine cycle times and the economic feasibility of a collaborative work cell in advance. This study has been exemplarily executed with a Yaskawa HC10DT IP67 collaborative robot for in-depth behavior analysis. For other robot models, the applied measurement procedure can be transferred.

2 Challenges

Over the last years, collaborative machine tending has become a common cobot application, especially for small and medium-sized companies. One major obstacle occurs when facing the safety requirements regarding ISO/TS 15066, particularly in terms of force and pressure measurements. Preliminary economic considerations of the targeted solution are impaired due to lacking methods to approximate the achieved cycle times in advance. In fact, economic comparisons to fenceless industrial robots are not possible. Currently, end-users and system integrators have no database of influencing factors on the force and pressure distribution of a workpiece. Therefore, the suitability of a specific product for collaborative applications cannot be described.

3 Solution

Yaskawa developed a suitable measurement setup to execute force and pressure measurements with various influencing factors. A broad empirical study was executed with more than 3000 datasets on the behavior of the collaborative robot Yaskawa HC10DT IP67 regarding robot pose, sensor sensitivity, and workpiece-specific factors, such as diameter or weight. Besides this valuable knowledge basis, statistical analysis delivered multi-dimensional approximation equations to calculate the maximum allowed collaborative speed. Therefore, the risk assessment and certification process's efforts can be drastically reduced, leading to higher efficiency in collaborative cell planning. Furthermore, higher accuracy in preliminary economic evaluation for potential automation projects provides higher investment reliability to end customers. This improved planning security adds value regarding the acceptance and trust in cobot applications.

4 Considerations

The RACOS project contributes to fundamental research in terms of influencing factors on the force and pressure distribution in collaborative applications for quasi-static and transient contact cases. The proposed test setup can be replicated and used with other collaborative robots and/ or workpieces to supplement the existing database for a broader application field. In the future, this database can drastically decrease the efforts in risk assessment procedures for collaborative applications.

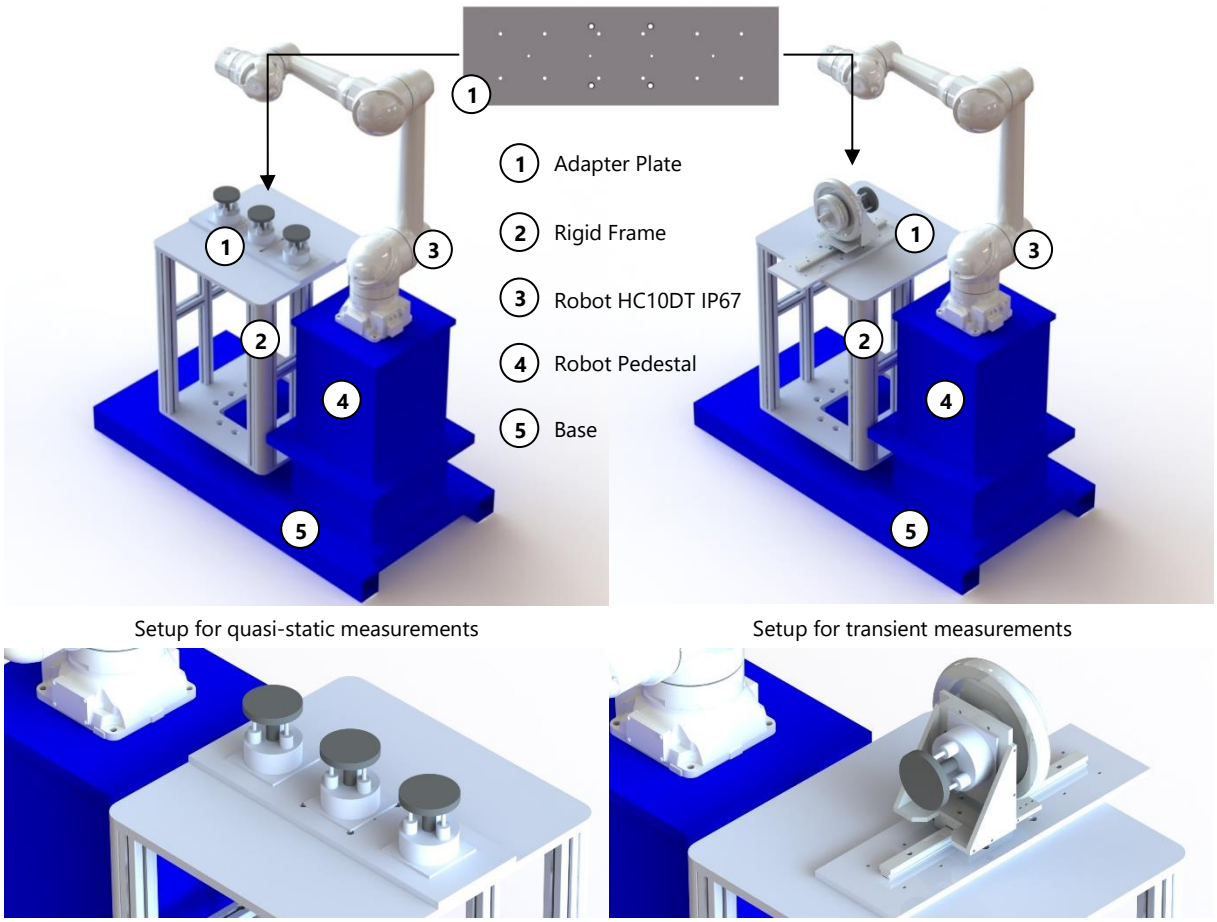

Figure 1: Proposed Test Setup

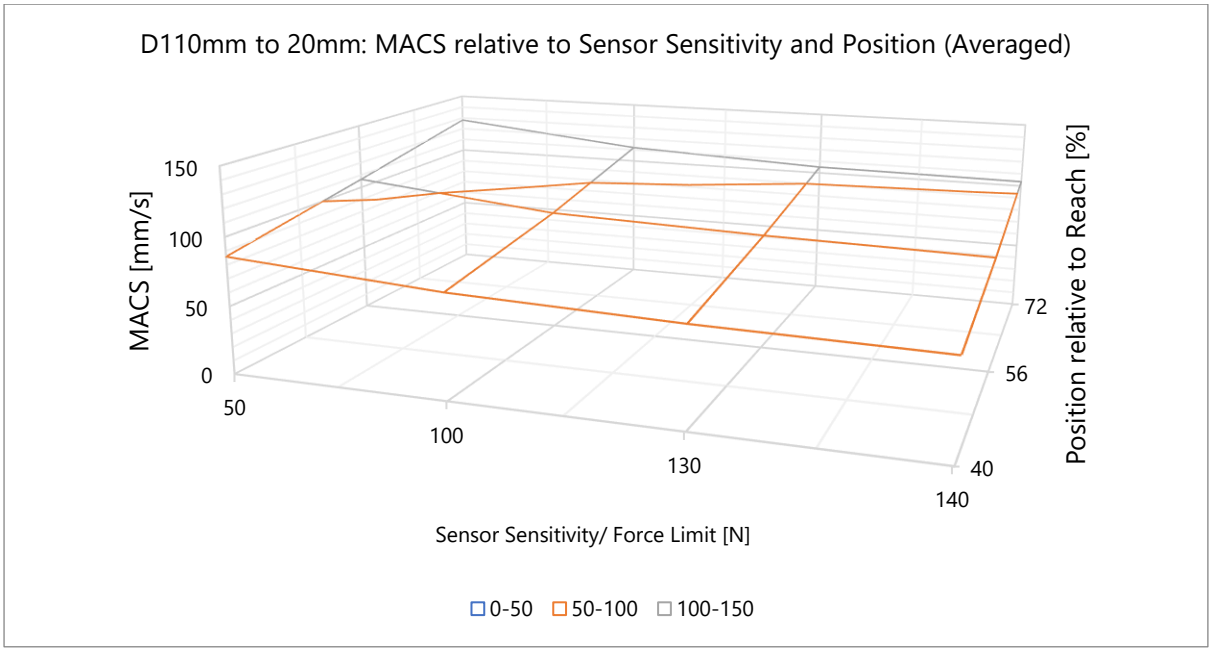

Figure 2: Maximum Allowed Collaborative Speed (MACS) relative to Sensor Sensitivity Setting and Robot Pose for Workpiece Diameters 110mm to 20mm