2 Problems

2.1 Uncertainties in Robot Machine Dynamics Characterisation

Presenting Institution: Manufacturing Technology Centre

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Abstract (Technical Topics and Desired Outcomes): A computer assisted system modelling deterministic approach has been recently implemented at the MTC for estimating the dynamic stiffness of an industrial parallel robot machine, the Exechon Parallel Kinematic Machine (PKM) - shown in Figure 1. For modeling purposes, it is treated as a multi-body system externally excited at the tooltip position.

Objectives: The ultimate objective of this modelling work is to identify the dynamic stiffness of the machine to improve its accuracy via real-time feedback control design. The aim of this use case is to increase the maturity of the model by quantifying the effects of known sources of uncertainty

Time domain measurement data was used to estimate a model for the robot drives. Experimental acceleration data of vibration transmissibility at certain locations on the machine whilst exciting it with random forces was recorded. Forces were applied through a shaker table via the tooltip and the recorded data corresponds to only two machine positions along the X-axis.

Apart from sensor location, there are other sources of uncertainty associated to the model simplification. The model does not account for body flexibility or frictional effects in the machine joints. Additionally, internal mechanisms and drives control are represented via mathematical deterministic models The assessment of the machine vibrations focused on the dynamic response of the machine to a force excitation with a burst random frequency characteristic and a pre-set power value. This should suffice for designing advanced dynamic control algorithms, with no need for modelling the machining process, which reduces the number of uncertainties of the model for

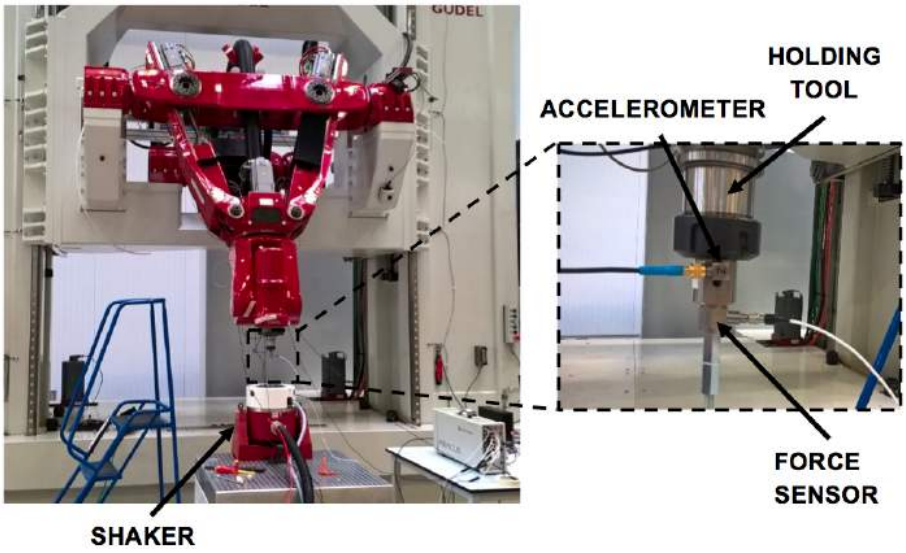

Figure 1: Image of the Exechon Parallel Kinematic Machine (PKM) and experimental set up.

control design purposes.

UQ&M Aspirations:

- The ambition is to obtain an estimation of uncertainties on the parameters described above. It is expected that the results will provide a better understanding on how the variations of these parameters may modify the frequency response of the machines model and increase its predictive capabilities.
- An UQ&M analysis could help to increase the Readiness Level of the machine dynamics by providing some characterisation of either the parameter uncertainty and / or directly in the robot dynamic stiffness mathematical model. This would also raise the confidence levels of the model and its usability for control design purposes and allow a more robust frequency-based control design in the future based on a more accurate estimation of the dynamic stiffness of the machine.

Resources Available for this Problem:

- Experts from the MTC
- Access to the multibody modelling approach

References:

1. Full problem details can be found here: Uncertainties in Robot Machine Dynamics Characterisation. A presentation will be given on the first morning of the Study Group
2. The Manufacturing Technology Centre. Simulation and Systems Integration Readiness Scale Development report for WP4. Use Case 2 - PKM Dynamics Model Validation (Internal Report). UK (2016)
3. The Manufacturing Technology Centre. SimReady (white paper in preparation). UK (2017)