Contribution ID: **89** Type: **not specified**

Towards Traceable and Trustworthy Digital Twins for Quality Control

Monday, 11 September 2023 13:50 (20 minutes)

DTs are simulation models that replicate physical systems in a virtual environment, dynamically updating the virtual model according to the observed state of its real counterpart to achieve physical control of the latter. DTs consist of a Physical to Virtual (P2V) and a Virtual to Physical (V2P) connection. DTs require complex modelling, often resorting to data-driven approaches. DTs allow for defects and systems fault prediction, enabling reliable predictive maintenance and process adjustment and control to be implemented: DTs are essential for sustainability and digitalization.
The creation of DTs often neglects quality control measurements, resulting in their lack of traceability and inability to associate them with a confidence level in the prediction. The evaluation of the measurement uncertainty will allow DTs'application in the industrial context for quality control, defects and system faults prediction, statistical predictive defect correction and system maintenance within a traceable application framework.
Available methods for DT's uncertainty evaluation neglect coupling with the different parts of the DT, especially the closed-loop feedback control and the V2P connection. Bayesian approaches will allow for rigorous management of such coupling effect also by non-parametric approaches. A rigorous definition of DT's metrological characteristics is unavailable, and both accuracy and precision shall be defined, catering for the V2P closed-loop feedback control.
This is being developed by the Trustworthy virtual experiments and digital twins (ViDiT) project, funded by the European Partnership on Metrology, tackling four complex applications: robot and machine tools, nanoindentation, primary electrical and cylindricity measurements.

Keywords

Digital Twin, Uncertainty, Cobot

Classification

Both methodology and application

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Session Classification: CONTRIBUTED Special Session: Measurement Uncertainty