SMR-DISP-2024F

Position of master internship

Digital twin calibration using an industrial vision system

Encadrement :
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Etablissement : Lyon 1
Laboratoire : laboratoire DISP

Profil recherché :
M1 Industrial Engineering / Computer Science

Financement: 600 € per month

Période de stage : spring semester

Compétences souhaitées :
Discret Event System

Mots-clés:
Digital twin, Manufacturing system, Chronicles, industrial vision

Summary
A recent industrial concept, the Digital Twin offers companies new uses to optimize their performance. In the latest report from the Alliance for the Industry of the Future (AIF), a Digital Twin is characterized as: an organized set of digital models, updated in relation to reality, equipped with advanced operating tools. For production equipment, the calibration of the Digital Twin in relation to its Physical Twin is a major difficulty during commissioning and remains a real challenge during the operating phase. The current strategy is to use industrial IoT to increase observation. This strategy requires "excessively" instrumenting the physical system, leading to cost and reliability issues. At the same time, industrial vision is today very widespread and increasingly efficient, leading to 3D solutions integrating machine learning tools for recognition. However, usage today is very focused on product observation. The proposed project therefore aims to use an industrial vision solution for the calibration and synchronization of a digital twin of production equipment through the automatic construction of behavioral models based on discrete event systems.

Detailed subject
Although the notion of CPS (Cyber-Physical Systems) appeared in 2006 in [1] with the work of the American National Science Foundation (NSF), it is very often the definition of [2] which is retained. As part of this definition, the author defines different characteristics including the fact that a CPS is (i) adapted to multiple temporal and spatial scales, (ii) highly automated and connected, and above all (iii) capable of dynamically reconfigure following a failure or a request for a functional change in production.
We delimit the framework of the work to Cyber-Physical Production Systems (CPPS) of the Reconfigurable Manufacturing Systems (RMS) type. Consequently, the chosen definition of the Digital Twin (DT) will correspond to the vision of the industrial engineer. Indeed, there are a multitude of definitions of a Digital Twin depending on the use cases and the associated value creation. As such, the AIF (Alliance Industrie du Futur) recently published the report [3] "Digital Twin, Major Lever of the Digital Transformation of Industry". The DT is defined there as being:

(i) an organized set of digital models representing a real-world entity to respond to specific issues and uses,
(ii) updated in relation to reality, at a frequency and precision adapted to its issues and uses,
(iii) equipped with advanced operating tools making it possible to understand, analyze, predict and optimize the operation and management of the real entity.

The project aims more particularly to deal with the problem of updating, that is to say the calibration and synchronization of the digital twin with respect to its physical twin.

In order to automatically calibrate and synchronize a digital twin, the current strategy consists on the one hand of using the states observable via the control system and on the other hand of augmenting this observation via industrial IoT. This strategy requires "excessively" instrumenting the physical system, leading to cost and reliability issues.

At the same time, industrial vision is today very widespread on the one hand to monitor the quality of products and on the other hand to provide an industrial robot with the data necessary for handling products. Industrial vision solutions (Cognex, Sensopart, Keyence, etc.) are today increasingly efficient, up to 3D solutions integrating machine learning tools for recognition. However, usage today is very focused on product observation. The proposed project therefore aims, ultimately, to use an industrial vision solution for the calibration and synchronization of a digital twin. Initially, the objective is to identify particular events from image analysis (arrival of a product in a particular position, characteristic state of an actuator, etc.). The analysis of these events, both from the point of view of the sequence of appearance and time, will make it possible to identify the behavior of the physical system and thus calibrate the digital twin via a modeling step using a discrete event system (DES).

Expected deliverables

- State of the art on temporal model of a discrete event system (Chronicles for instance).
- Method to identify the behavior of the physical twin from observed events, automatic generation of a DES model.
- Development of a demonstrator based on a Cognex industrial camera to identify specific events on a production machine (bottle packaging line).

Bibliographie

[1] E. A. Lee, “Cyber-Physical Systems - Are Computing Foundations Adequate ?,” in Position Paper for NSF Workshop On Cyber-Physical Systems, 2006, vol. 2, pp. 1–9.

[2] L. Monostori, “Cyber-physical production systems: Roots, expectations and R\&D challenges,” Procedia CIRP, vol. 17, pp. 9–13, 2014, doi: 10.1016/j.procir.2014.03.115.

[3] http://www.industrie-dufutur.org/content/uploads/2023/05/AIF_JumeauNumerique_FR-version-Web.pdf

[4] Guyet, Thomas, et Philippe Besnard. Chronicles: Formalization of a Temporal Model. SpringerBriefs in Computer Science. Cham: Springer International Publishing, 2023. https://doi.org/10.1007/978-3-031-33693-5.

[5] Alexandre Sahuguède, Euriell Le Corronc, Marie-Véronique V Le Lann. Chronicle Discovery for Diagnosis from Raw Data: A Clustering Approach. 10th IFAC Symposium on Fault Detection, Supervision and Safety for Technical Processes, SAFEPROCESS 2018, Aug 2018, Varsaw, Poland. 8p. ⟨hal-01817529⟩

Recruitment conditions

Candidates must hold a doctorate or a recognized qualification at least equivalent to the national diploma required.

- The missions will be carried out in the Villeurbanne (69) Campus of Lyon Tech la Doua, DISP Lab, Bât. Léonard de Vinci, 21 av. Jean Capelle.
- The duration of the internship is 6 months
- Desired start date: 01/03/2024

Application procedure

The application file includes the following:

- Application cover letter
- Curriculum vitae
- Transcript of master grades

Further information

For further information concerning the position and application procedure, contact:

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