PhD thesis Offer

Hybrid data and soft model-based process monitoring and prognostics applied to composite material forming in industry 4.0

- Duration: 3 years, starting from October 2022
- Employer: IRT Jules Verne, Bouguenais, France
- Funding: IRT Perform Program
- Host laboratory: GeM, Ecole Centrale Nantes, Nantes, France

Context and Motivation

Recently, the concept of hybrid method (combining data and models) has known increased popularity in process monitoring and control [2-4]. The fundamental idea is to use a simulation model to supervise the learning process. The principal challenge is fitting the quality prediction model on the available experimental data.

Composite manufacturing processes such as preforming and thermoforming are subject to variability related to equipment as well as materials. Defects appear despite upstream control efforts on the supply of raw materials and monitoring (PHM) of processing equipment (ovens, presses, tools). These defects are the consequence of a coupling of several factors related to the material and the physical phenomena involved in the process [1]. Traditional numerical simulations based on finite element type methods of processes is expensive and time-consuming. Thanks to recent learning methods, the data collected becomes a potentially valuable source of information that can be used to monitor processes, detect production defects and identify the causes at the origin of the same in order to reduce non-quality in production.

Objectives

The objectives of this thesis are to scientifically propose:

- an original methodological framework (data collection and algorithmic)
- the development of a hybrid modeling based on limited data and the construction of a soft model, and industrially:
- the monitoring of a process and predictive quality analytics for the parts produced (defect or not defect).

Candidate Profile and Qualifications

- Holding a Master's Degree or Engineering Diploma

- Major in Computational mechanics or Applied mathematics with a strong interest in programming
- Knowledge of artificial intelligence or deep learning numerical techniques, TensorFlow or Pytorch is a plus.
- English proficiency, team-work and good technical writing are basic requirements.

References

[1] Azzouz, R., Allaoui, S., & Moulart, R. (2021). Composite preforming defects: a review and a classification. International Journal of Material Forming, 1-20.

[2] Khayyam, H., Jamali, A., Bab-Hadiashar, A., Esch, T., Ramakrishna, S., Jalili, M., & Naebe, M. (2020). A novel hybrid machine learning algorithm for limited and big data modeling with application in industry 4.0. IEEE Access, 8, 111381-111393.

[3] Tatipala, S., Wall, J., Johansson, C., & Larsson, T. (2020). A Hybrid Data-Based and Model-Based Approach to Process Monitoring and Control in Sheet Metal Forming. Processes, 8(1), 89

[4] Tidriri, K., Chatti, N., Verron, S., & Tiplica, T. (2016). Bridging data-driven and model-based approaches for process fault diagnosis and health monitoring: A review of researches and future challenges. Annual Reviews in Control, 42, 63-81.

Advisement and contact for application

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- your CV
- the grade transcripts of the last 2 years of higher education
- a reference letter