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DATA-BASED LEAKAGE DETECTION AND UNCERTAINTY QUANTIFICATION IN THE MANUFACTURING OF LARGE-SCALE CFRP COMPONENTS

– Specialisation Project –

Description of the Project

The production of CFRP (carbon fiber reinforced polymer) components requires that material preforms of an application-specific geometry are consolidated by means of heat and pressure. In that process the pressure is applied through a vaccum setup where the workpiece is covered by vacuum film and which is made airtight by sealant tape along the boundary. In practice it occurs that the vacuum bag contains leakages which are in most cases invisible to the human eye. Nevertheless, leakages need to be localized and patched as they can cause porosities and voids which can constitute serious defects that render the final product unusable. The overall goal of this specialisation project is to develop a machine learning based methodology that leverages flow rates measured at vacuum ports during the process time to localize leakages in industrial-scale vacuum setups.

Goals

1. Literature review: Provide a literature review on leakage detection. Consider at least [1, 2, 3, 4].
2. Data acquisition: Describe the experimental setup, the data acquisition process, the assumed connection between leakage positions and sensor data, and potential sources of uncertainty in the setup.
3. Data preparation: Explore the data , identify suitable preprocessing steps and, if possible, find ways to augment the data synthetically.
4. Model training: Design a neural network architecture to predict a single pair of leakage coordinates. Train candidate models, adapt your design if necessary, and use hyperparameter tuning to identify a final configuration. Evaluate your final model on test data.
5. Uncertainty quantification: Implement at least one existing method to quantify and visualize the uncertainty of your model's predictions. You can for example consider [5, 6] as candidate approaches.
6. (Optional) Multi-leakage detection: Discuss how your neural network architecture could be adapted so as to detect multiple leakages in one shot. Implement and test your ideas if possible.

References

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[5] Y. Gal and Z. Ghahramani, "Dropout as a bayesian approximation: Representing model uncertainty in deep learning," in *international conference on machine learning*, pp. 1050–1059, PMLR, 2016.

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