SP4

Automated data-driven damage detection

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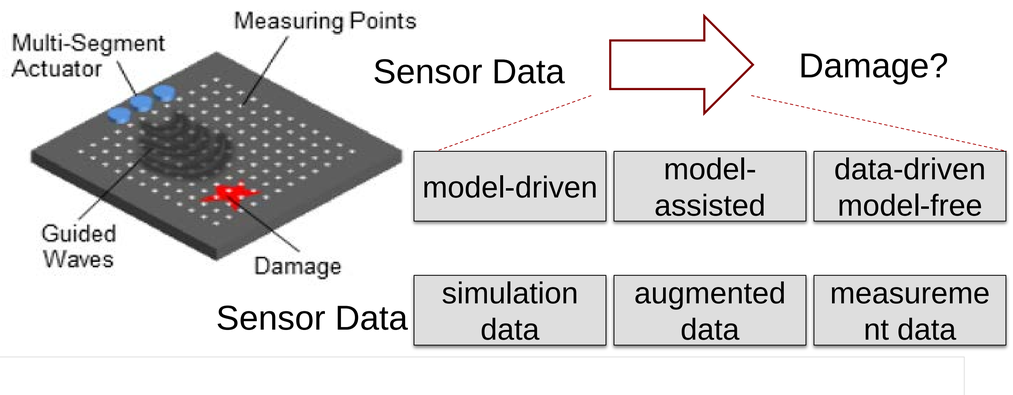
Objectives

Starting point:

- Simulation of GUW in FML can be achieved with MOR, but 3D models are complex and synthetic sensor data is oversimplified
- Detection of damages with data-driven Machine Learning (ML) and Bayesian Inversion (BI) possible with enough data variance and computing power
- Detection methods based purely on experimental data lack generalisation and independence from environmental change

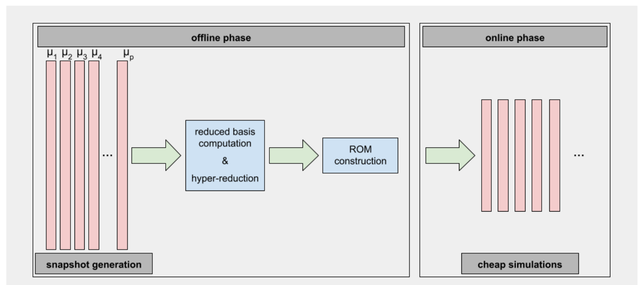


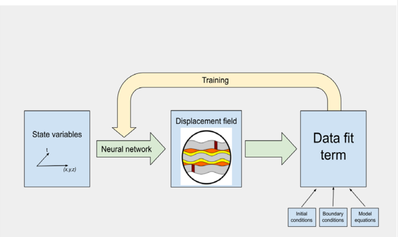
Research hypothesis:

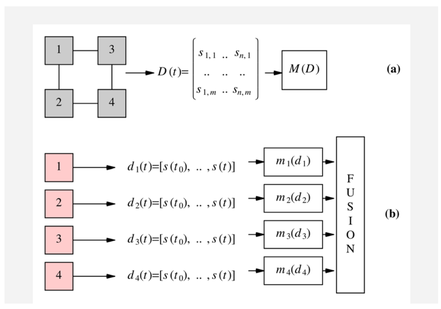
- Real-world measurements contain noise, errors, uncertainties, and have limited variance (sparse state space), but can be augmented with numerically generated and simulated data.
- Three different methodical approaches: model-driven, model-assisted, and model-free; using three different types of data: simulation, augmented and measured data → broader perspective for damage detection
- A joint framework shall fuse the methods to exploit the respective advantages and this allows to detect damages more accurately than utilising only one approach.”

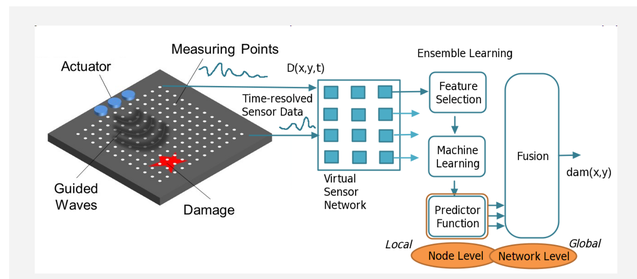
Methods

- Data assimilation
  - damage parameter estimation using Bayesian inversion and data assimilation approaches for nonlinear, 3D problems
- PINNs
  - compact solution of model equations and later joint damage parameter identification using PINN
- Hybrid Data-driven Methods ML
  - investigate methods to distribute and partition damage diagnostics, fuse local weak indicators globally or in spatial regions to strong indicators, emphasize embedded systems
  - damage detection, characterisation, and classification in 3D X-ray tomography and US scan data: automated damage characterization in CT data, optimization of CT measuring processes



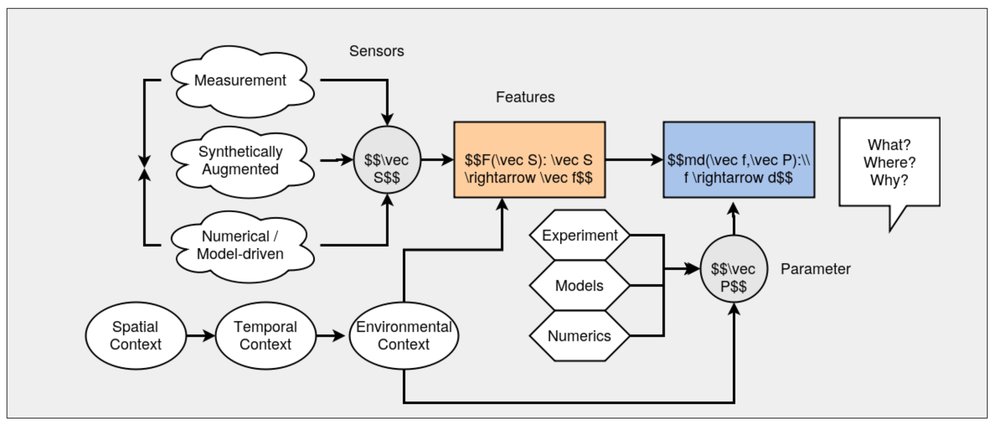






Expected results

- Data assimilation for damage detection using MOR
- Damage detection using PINNs posing low computational complexity
- Synthetic sensor data augmentation using model-driven support
- Low-resource distributed damage prediction in sensor networks (hierarchical and hybrid multi-model methods)
- Fused framework for accurate, generalised, and robust damage detection independent from environmental changes



Added value for the research unit

- Analysis of possibilities and limitations of damage identification using data-driven computational and mathematical methods
- Analyse trade-off between practicability and accuracy
- Implementation of the methods in embedded systems
- Perspective: indications for suitable sensor locations
- Automated model and damage parameter space exploration

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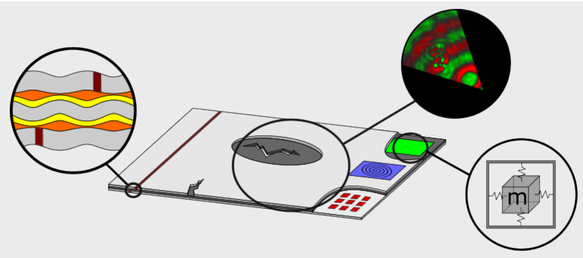

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