How can we detect and characterize hidden defects in materials low-cost and high-quality?

Reducing defects in materials improves robustness, ecology, and economics.

**OBJECTIVES**

Robust detection and characterisation of hidden defects, e.g., pores or cracks, is still a challenge.

Knowledge about defects enables improvement of design, production, and life-time.

- Common Measuring Techniques: X-ray Radiography/CT, US Sonography
- Visual inspection and characterization is error prone and time-consuming
- Automated damage and defect diagnosis is required
- But data-driven models require ground truth data set and advanced work flow

**METHODS**

- X-ray Radiography (LowQ, MidQ)
- X-ray Computer Tomography
  - Reconstruction (Reference, HighQ)
- X-ray Image Simulation
- CAD Modeling of defects using Monte Carlo Simulation
- Semantic CNN Pixel Classifier and DBSCAN for Feature Marking

**Creating!**

**Missing!**

**Using…**

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The Reality Gap: Noise, Bias, and Artifacts

Good and Bad News

Do not trust data-driven models!

RESULTS

A simple data-driven feature marking detector is suitable to detect pores in low-contrast and low-cost X-ray radiography images.

Simulation of X-ray image data sets for the training of the detector is valid and suitable.

- A data-driven image feature detector trained using synthetic data only can be applied to real measured images
- But noise, simulation bias, and computational artifacts decrease the feature marking accuracy (too much FP)
- Missing Ground truth problem solved by simulation

CONCLUSION

- Semantic pixel classifier is robust against Gaussian detector noise, but highly sensitive to non-Gaussian spatially correlated X-ray noise
- Due to the missing ground truth in real world images, the feature marking model must be trained with synthetic images derived from CAD models
- Artifacts (FP) were observed in feature maps of synthetic X-ray images independent of the CAD model and of defect-free materials!