Defect Detection in Additive Manufacturing Using a Feature-Enhanced Random Forest Classifier

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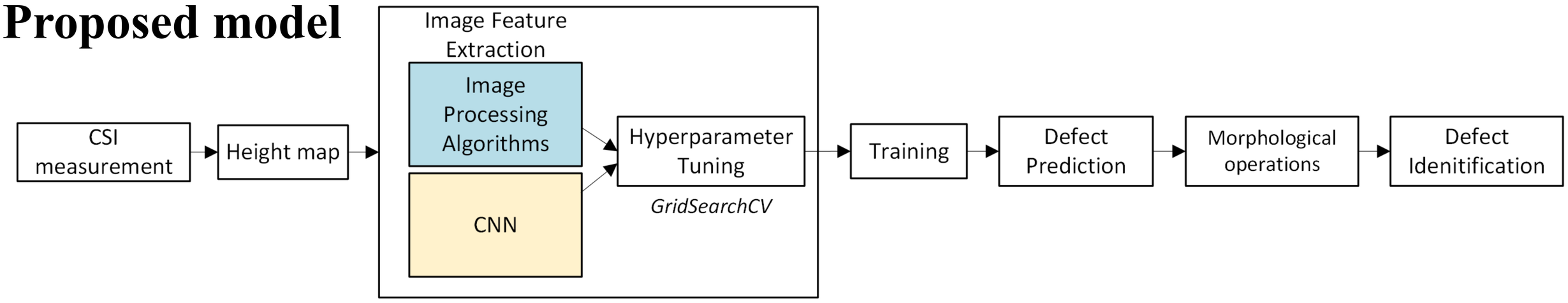
Introduction:

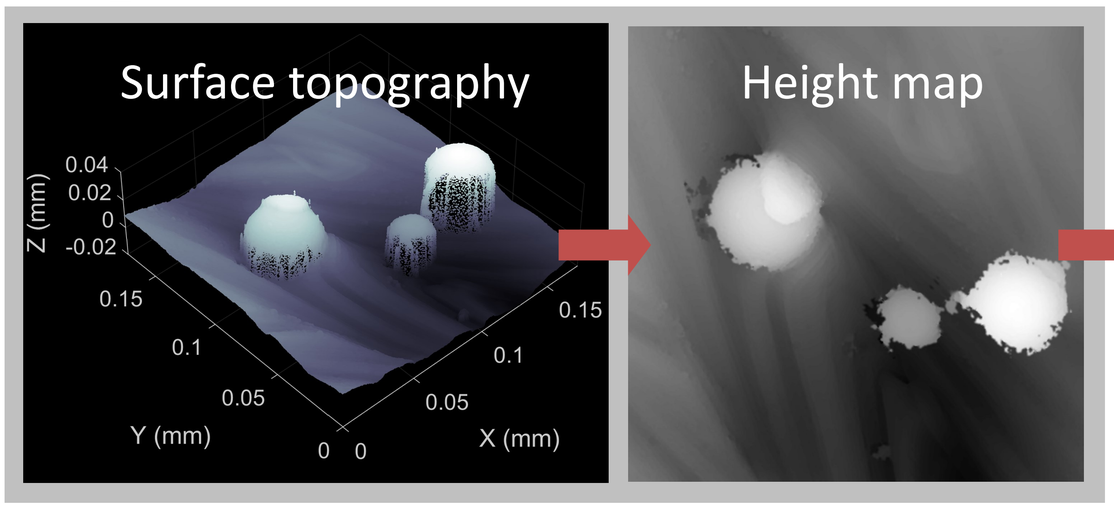
Accurate defect detection in the Additive Manufacturing (AM) process is crucial, as it directly impacts both product quality and overall production reliability. Traditional image-based techniques, such as thresholding, edge detection, and manual inspection, often face significant challenges due to image variability and complexity. These methods are highly sensitive to noise, lighting conditions, and texture variations, leading to inconsistent defect detection across different image sets. To overcome these limitations, this study proposes an effective approach that integrates random forest classifiers with advanced image feature extraction techniques, including both **traditional image processing algorithms** and **convolutional neural networks** (CNNs).

Proposed model



The methodology involves extracting relevant features from height maps generated from surface topography using Coherence Scanning Interferometry (CSI). **A fine-tuning process** is applied to optimize the random forest hyperparameters, thereby enhancing model performance during training. The effectiveness of the proposed approach is validated through **experimental verification**, where prediction results obtained from both image processing and CNN-based feature extraction are compared and analysed.

Experiments

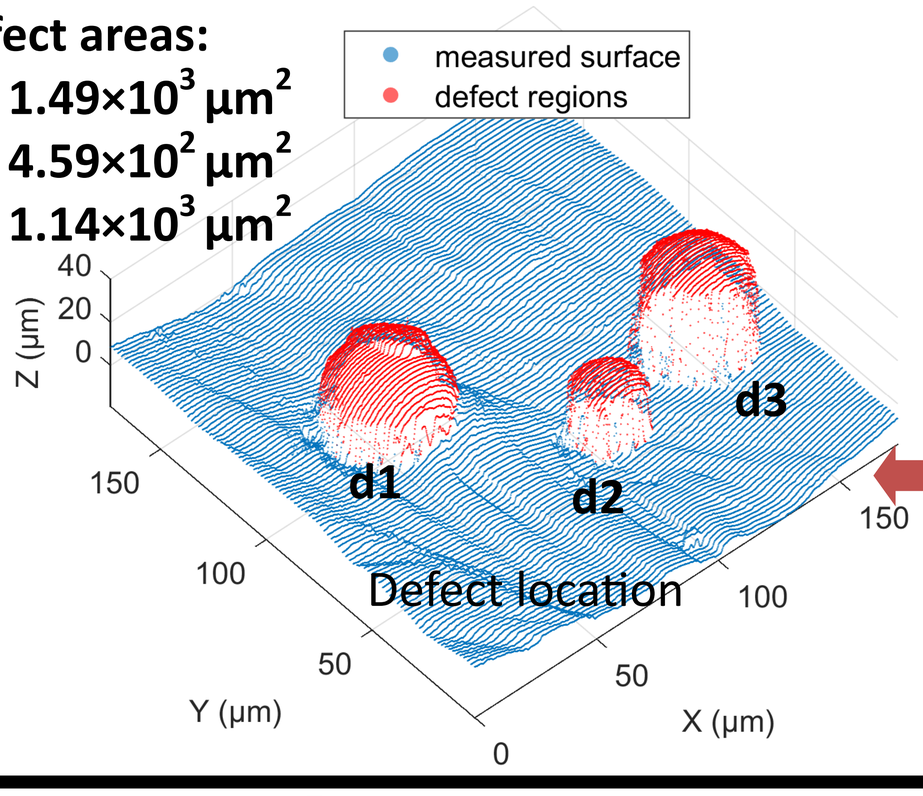


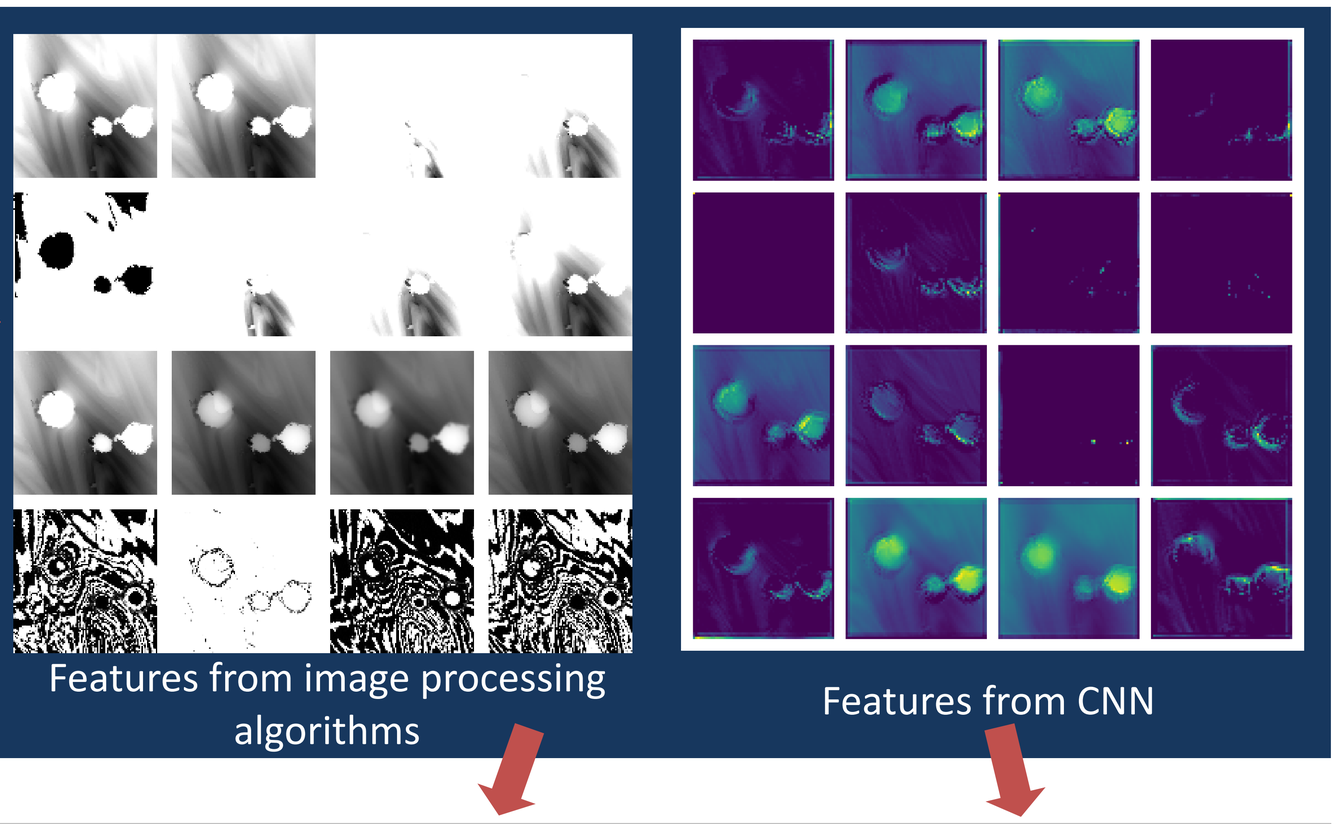
Defect areas:

d1: 1.49×10^3 µm^2

d2: 4.59×10^2 µm^2

d3: 1.14×10^3 µm^2





Future work

- Apply diverse image processing algorithms
- Optimize CNN layer structures

Acknowledgements

The authors would like to thank the UKRI Research England Development (RED) Fund for funding this work via the Midlands Centre for Data-Driven Metrology and project EPSRC EP/X010929/1.