

# Defect Detection Approaches Based on Simulated Reference Image

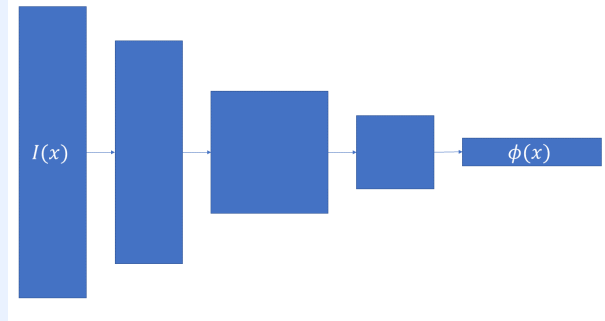
Nati Ofir<sup>1</sup> Yotam Ben Shoshan<sup>2</sup> Ran Badanes<sup>2</sup> Boris Sherman<sup>2</sup>

<sup>1</sup>Weizmann Institute and The Open University of Israel <sup>2</sup>Applied Materials

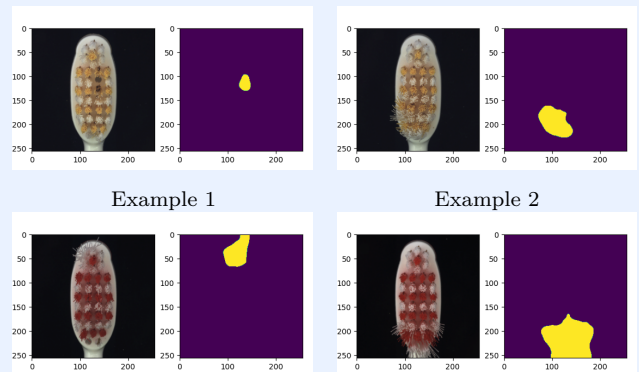
We study defect and anomaly detection using simulated clean references for SEM defects and natural images. Integrating them into classical, supervised, and unsupervised methods improves accuracy versus real references due to reduced noise, better alignment, and closer background matching.

Defect Detection; Anomaly Detection; Semi-Supervised Learning

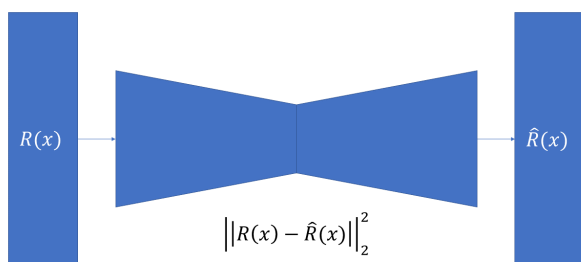
- Generate a **simulated clean reference**  $\hat{R}(x)$  from a candidate defect image  $I(x)$ .
- Use  $\hat{R}(x)$  to improve:
  - Classical difference / probabilistic detection,
  - Supervised segmentation (human labels),
  - Unsupervised detection (PatchCore-like memory bank).
- Simulated references often beat real references: **less noise, less geometric variation, better background match.**



**Figure:** ResNet-18 feature extractor used to build a memory bank for anomaly detection.



Example 1 Example 2  
Example 3 Example 4  
PatchCore predictions when trained using simulated reference images (MVTec toothbrush).



**Figure:** CNN (U-Net) used to generate a simulated reference image.

**Nati Ofir**  
nati.ofir@weizmann.ac.il / natiofir.github.io