Attention Modules Improve Image-Level Anomaly Detection: A DifferNet Case Study

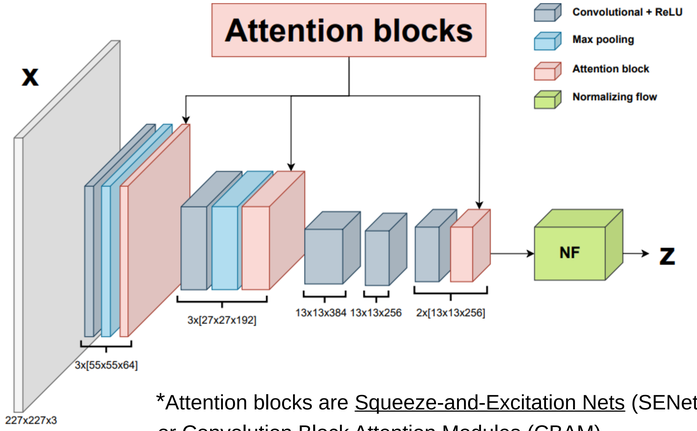
André Vieira-e-Silva, Francisco Simões, Danny Kowerko, Tobias Schlosser, Felipe Battisti and Veronica Teichrieb

Universidade Federal de Pernambuco · Universidade Federal Rural de Pernambuco · Technische Universität Chemnitz · voxar labs

JUNE 18-22, 2023 CVPR VANCOUVER, CANADA

Introduction & Methodology:

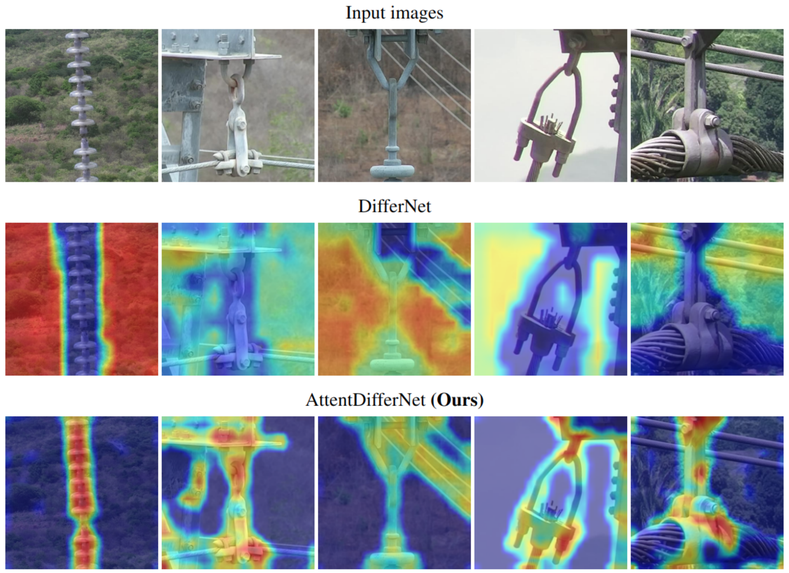
- MVTec AD dataset has fomented many new classes of Anomaly Detection (AD) models
  - A popular approach to benefit from feature-embedding extraction:
    - Distribution maps — DifferNet, CFLOW-AD, FastFlow, CS-Flow
    - Patch memory-bank — PatchCore, PaDiM, SPADE
- Those methods could overcome most challenges imposed by MVTec AD. However, industrial inspection **in the wild** still holds great challenges, such as:
  - Images varying illumination, angulation, orientation, background, resolution, defect size, etc.
  - Many defects are unpredictable
  - Almost no relevant public datasets available
- **Hypothesis: Attention modules can improve the performance of unsupervised anomaly detection in the wild**
- We propose AttentDifferNet: an attention-based DifferNet



*Attention blocks are Squeeze-and-Excitation Nets (SENets) or Convolution Block Attention Modules (CBAM)

Experiments:

- Three tested datasets: One **in-the-wild** (InsPLAD-fault), and two **controlled-environment** (MVTec AD and Semiconductor Wafers)
- To prove the hypothesis, attention usage should improve performance in InsPLAD-fault and not present deteriorated performance on controlled-environment datasets
- Grad-CAM-based gradient activation maps comparison
  - On InsPLAD-fault (**figure below**) AttentDifferNet is able to focus on more significant features in the image, such as the object that was supposed to be analyzed located on the foreground
  - On MVTec AD data, AttentDifferNet was more specific, focusing on the anomaly itself, in both objects and textures



Results:

- On InsPLAD-fault (**table below**) AttentDifferNet with SENet blocks achieves superior results in all categories, not only compared to the DifferNet variations, but to all other state-of-the-art methods
- On MVTec AD dataset, despite AttentDifferNet not being able to achieve the best results, it exceeds our expectations (which was to keep similar performance to DifferNet), by outperforming DifferNet in every single category
- Similarly to MVTec AD, on Semiconductor Wafers, AttentDifferNet also improves overall performance related to the standard DifferNet

InsPLAD-fault (**in-the-wild dataset**) AUROC results

Category	DifferNet	AttentDifferNet (SENet)	AttentDifferNet (CBAM)	CS-Flow	PatchCore	Fastflow	CFLOW-AD
Glass Insulator	82.81%	**86.57%**	81.03%	85.73%	78.44%	80.82%	82.22%
Lightning Rod Sus.	99.08%	**99.62%**	99.33%	96.60%	85.11%	87.98%	95.52%
Insulator Up. Shackle	92.42%	**94.62%**	92.10%	88.40%	81.02%	87.57%	86.60%
Vari-grip	91.20%	**93.52%**	88.99%	91.53%	91.92%	81.89%	90.37%
Yoke Suspension	96.77%	**97.38%**	96.86%	90.70%	58.06%	80.40%	83.87%
Average AUROC	92.46%	**94.34%**	91.66%	90.59%	78.91%	83.73%	87.72%

[1]**Bold** font indicates the best category (row) result.

[2]Underlined values show the best result between DifferNet variations (only three first columns).

Contributions

- **AttentDifferNet**, an attention-based DifferNet
  - Quali-quantitatively superior to DifferNet on all classes of three image-level anomaly detection datasets from multiple domains
- **AttentDifferNet** achieves state-of-the-art performance on InsPLAD-fault, a dataset for anomaly detection in the wild
- An average 1.77 ± 0.25 percentage point improvement in all three datasets in their overall AUROC