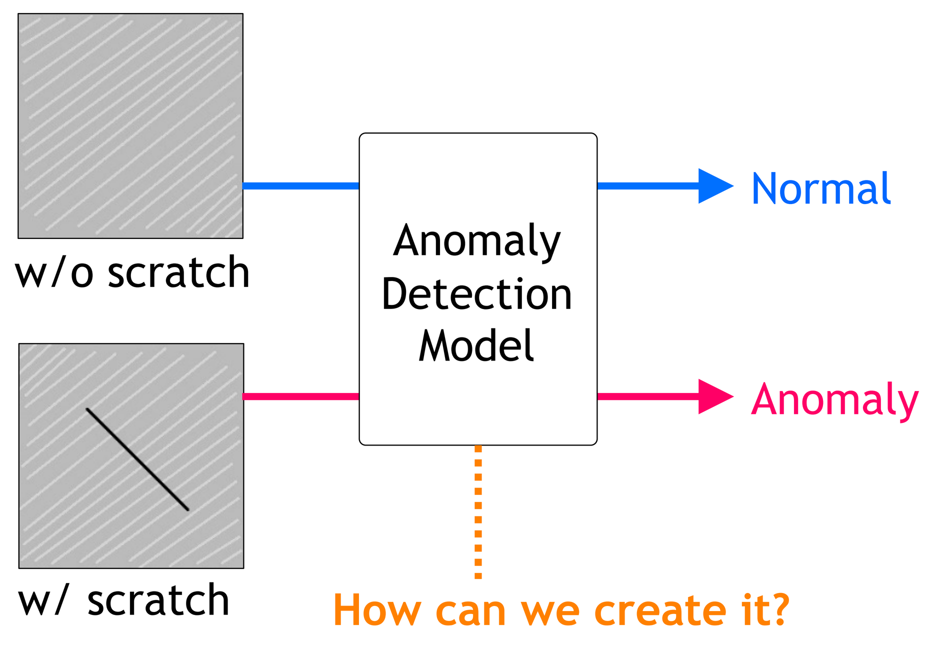
The 35th British Machine Vision Conference (BMVC 2024)
Paper ID: 833

Anomaly Detection Based on Semi-Formula Driven Pre-training Dataset to Represent Subtle Difference and Anomaly Score

Hiroki Kobayashi, Naoki Murakami, Naoto Hiramatsu, Takahiro Suzuki, Manabu Hashimoto (Chukyo University)

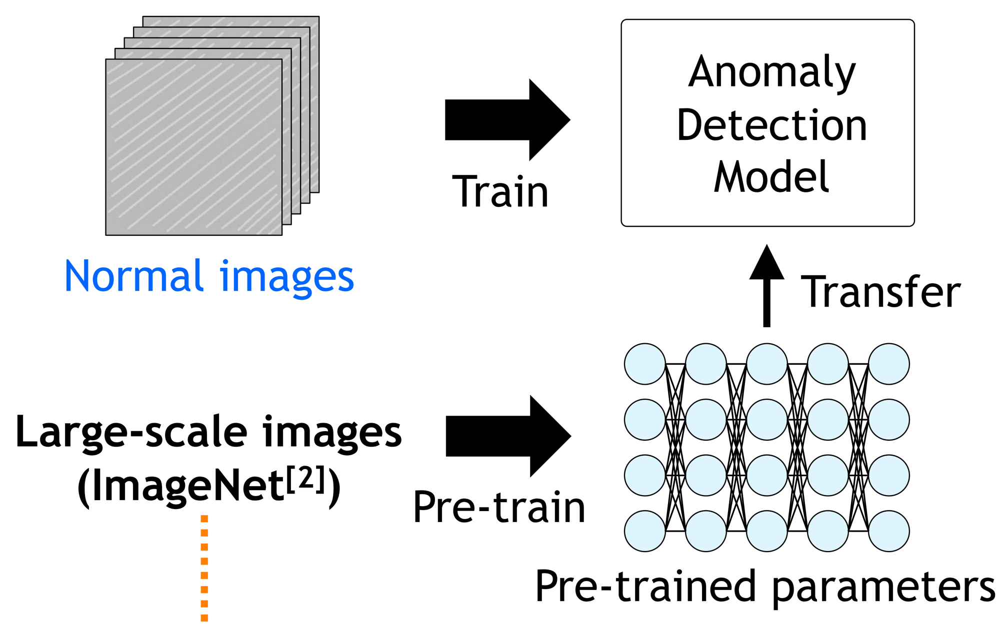
1. Task

- Normal/Anomaly classification
- No anomaly images for training



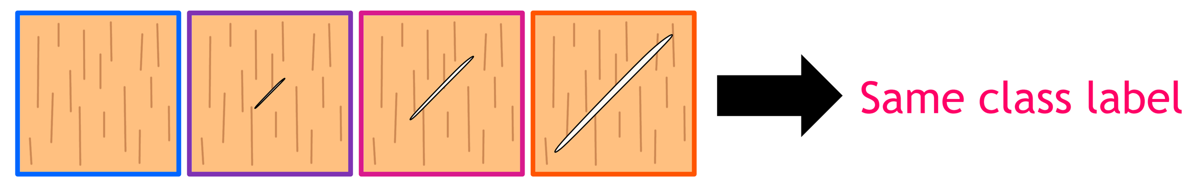
2. Related Works (PaDiM[1])

- Training with only normal images
- Using pre-training model

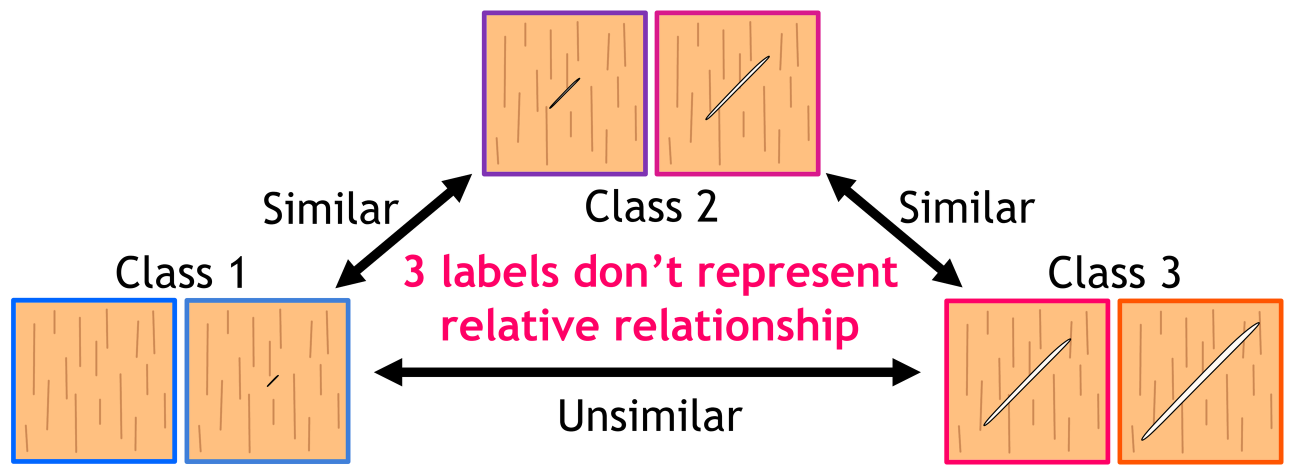


3. Problem of ImageNet[2]

1. No separation of subtle difference



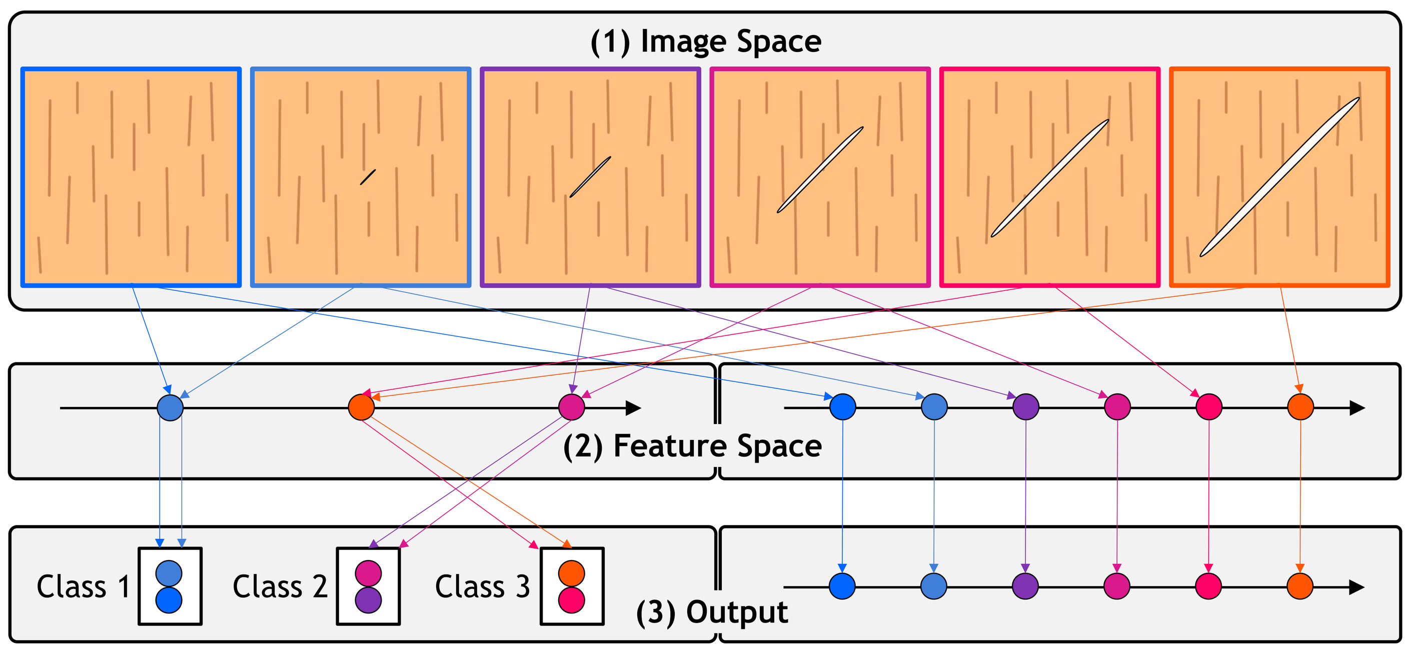
2. No relative relationship of label



4. Basic Idea and Proposed Method

- Basic idea

Representing subtle difference and anomaly score



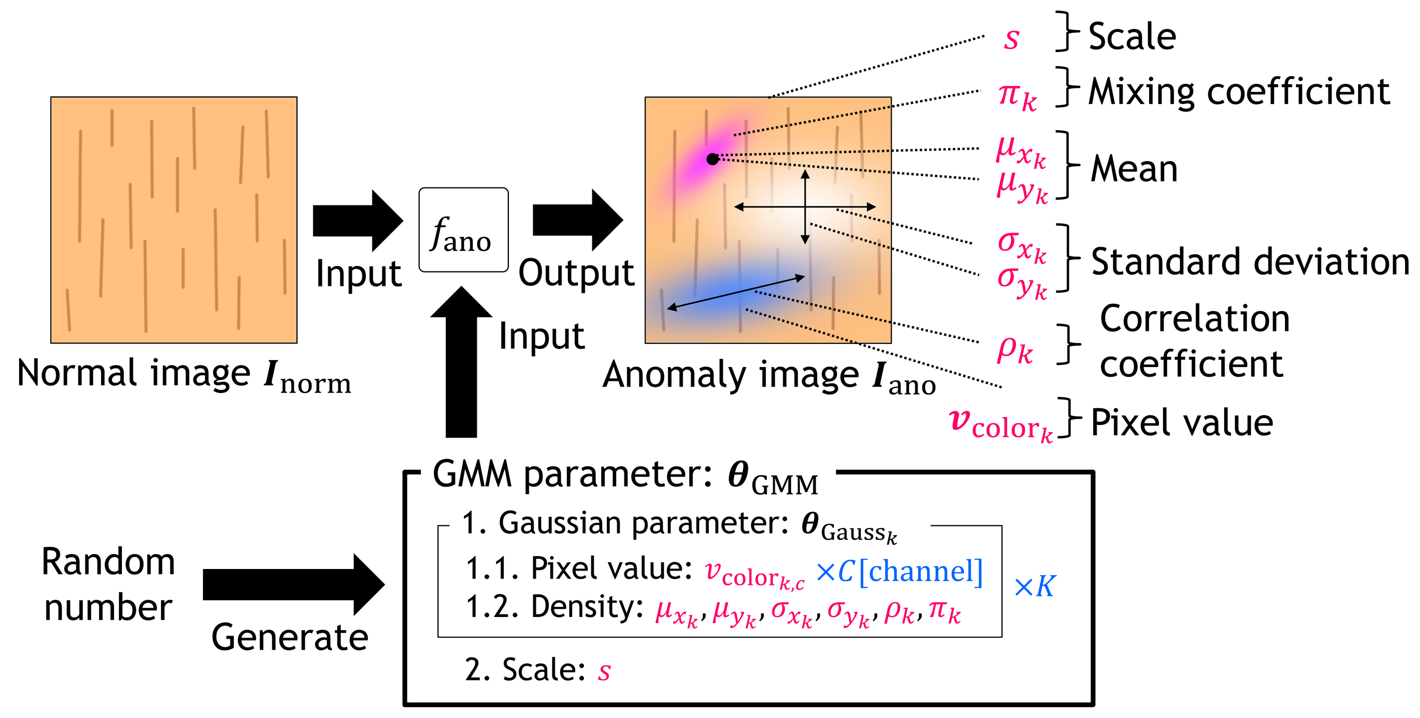
ImageNet has
(a) No separation of subtle difference
(b) No relative relationship of label
=> It will make poor feature space

Proposed idea has
(a) Separation of subtle difference
(b) Relative relationship of label based on anomaly score
=> It will make good feature space

- Proposed method

1. Create large-scale dataset

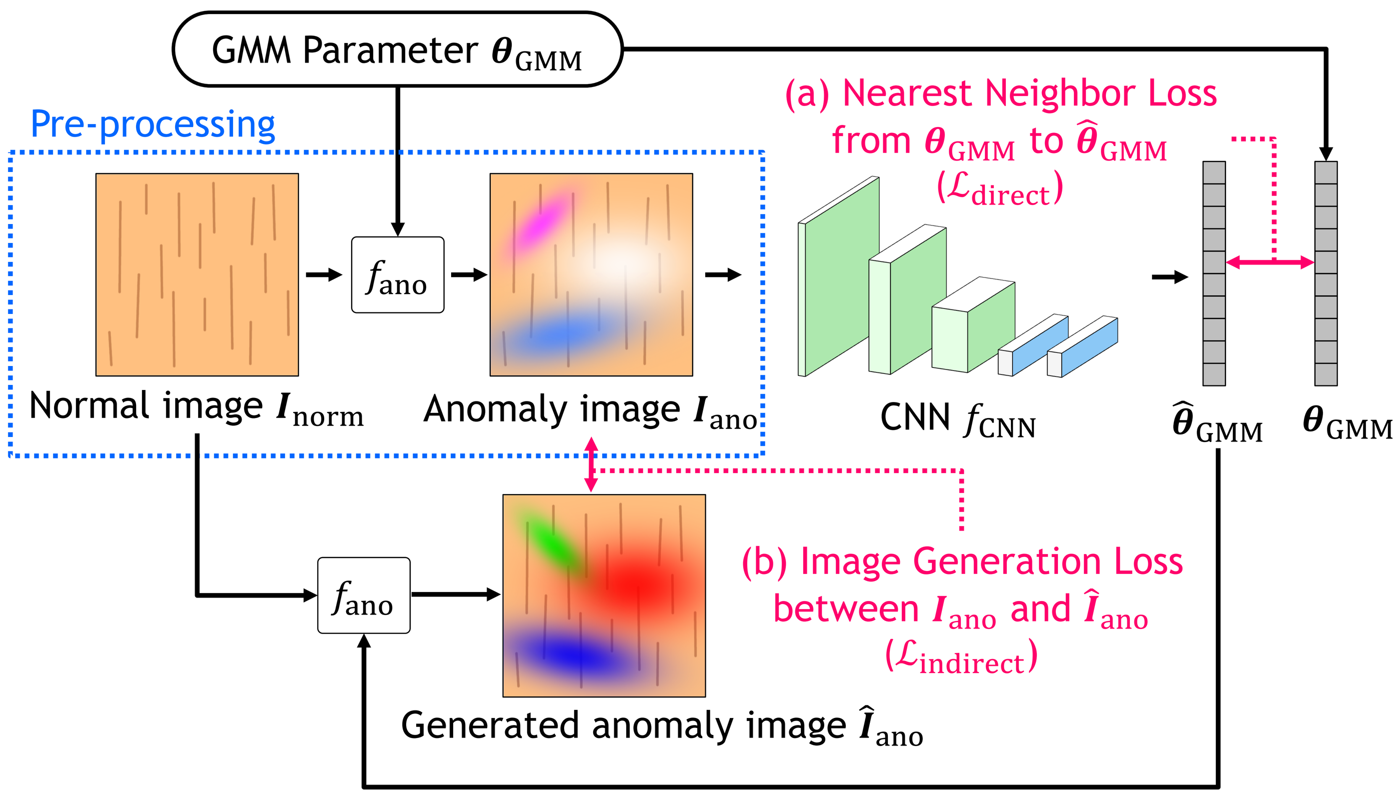
Random GMM parameter is added to 1-normal image, and 1-anomaly image is generated.



Note: Total number of parameters = $K(C+6)+1$

2. Pre-train with large-scale dataset

CNN is pre-trained by minimizing of each loss.

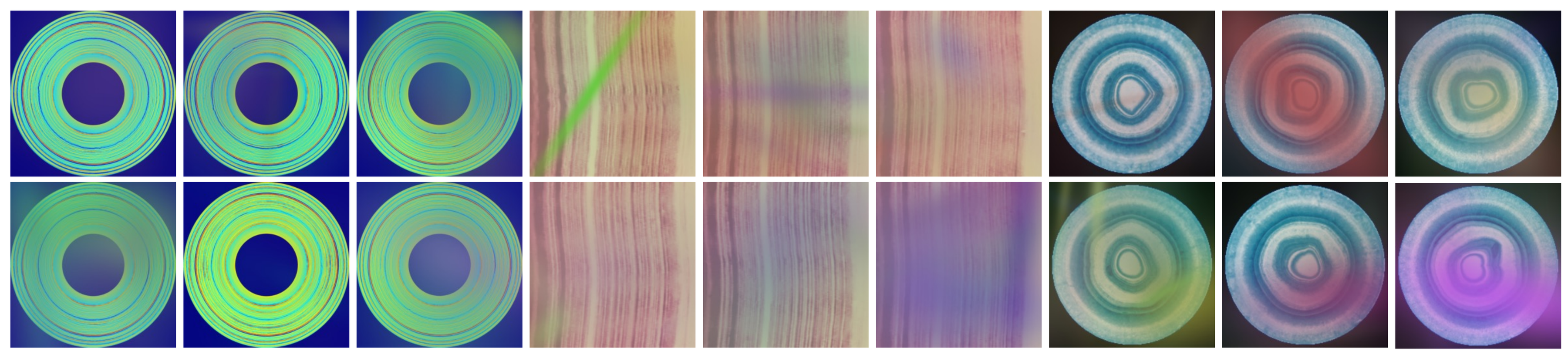


3. Apply PaDiM-algorithm[1]

5. Experiments

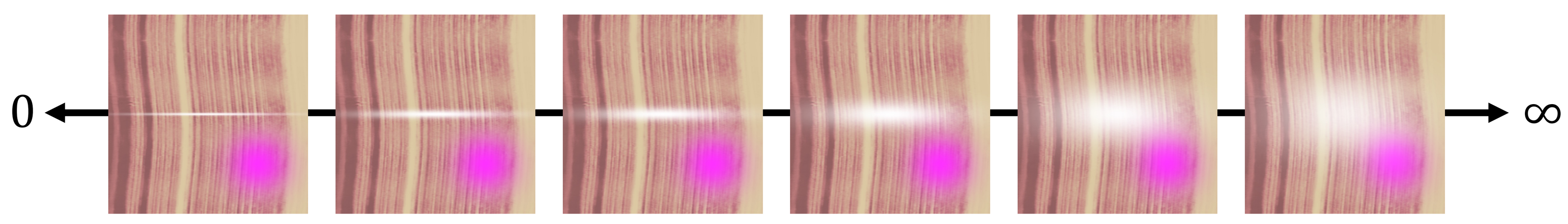
1. Proposed semi-formula driven dataset with BTAD[3]

   1. Examples of generated anomaly images (18 out of 1,000,000 images)

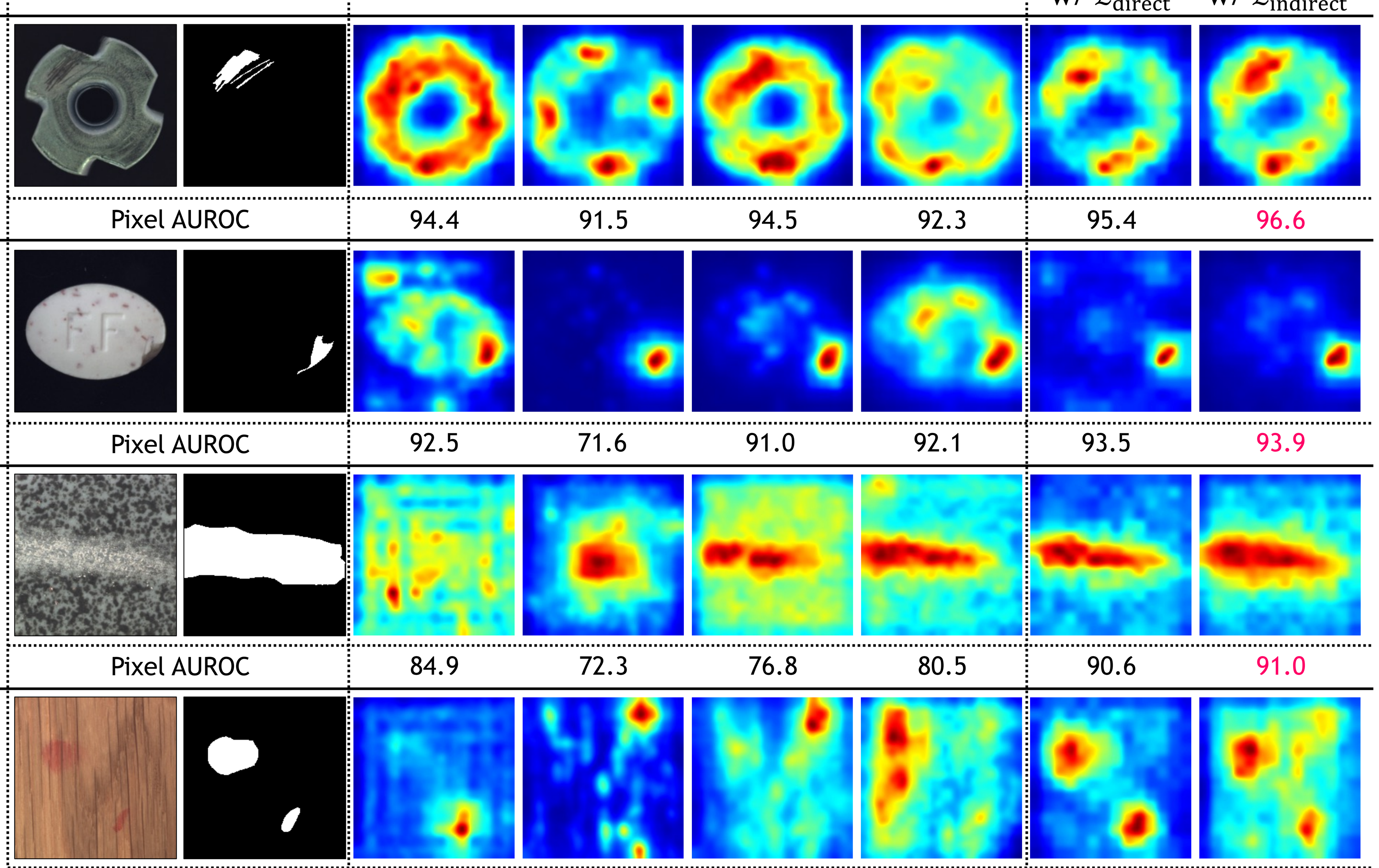


   2. Results of changing each parameter

E.g., y-standard deviation indicates vertical size



2. Anomaly detection performance (4 categories of MVTec AD[4])



	Input Image Ground Truth	ImageNet[2]	FractalDB[5]	DAGM[6]	BTAD[3]	BTAD+GMM w/ $\mathcal{L}_{\text{direct}}$	BTAD+GMM w/ $\mathcal{L}_{\text{indirect}}$
		Previous methods				Proposed methods	
Metal Nut	Pixel AUROC	94.4	91.5	94.5	92.3	95.4	96.6
Pill	Pixel AUROC	92.5	71.6	91.0	92.1	93.5	93.9
Tile	Pixel AUROC	84.9	72.3	76.8	80.5	90.6	91.0
Wood	Pixel AUROC	90.3	69.5	85.6	73.7	90.2	89.2
	Mean	90.5	76.2	87.0	84.7	92.4	92.7

Proposed method can detect defects with high precision.

6. Conclusion

Pre-training to represent subtle difference and anomaly score

- Characteristic

Pre-trained feature space represents

- Subtle difference
- Anomaly score

- Result

High performance for categories where ImageNet performed poorly.

<Reference>
[1] T. Defard, et al., PaDiM: A Patch Distribution Modeling Framework for Anomaly Detection and Localization, ICPR, 2021.
[2] J. Deng, et al., ImageNet: A Large-Scale Hierarchical Image Database, CVPR, 2009.
[3] P. Mishra, et al., VT-ADL: A Vision Transformer Network for Image Anomaly Detection and Localization, ISIE, 2021.
[4] P. Bergmann, et al., The MVTec Anomaly Detection Dataset: A Comprehensive Real-World Dataset for Unsupervised Anomaly Detection, IJCV, 2021.
[5] H. Kataoka, et al., Pre-Training Without Natural Images, IJCV, 2022.
[6] M. Wieler and T. Hahn, Weakly Supervised Learning for Industrial Optical Inspection, DAGM, 2007.

Contact : ASMI Lab., Graduate School of Engineering, Chukyo University. Email: {kobayashi, mana}@isl.sist.chukyo-u.ac.jp
Advanced Sensing and Machine Intelligence Group, Chukyo University