Yunkang CAO

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Education

Huazhong University of Science and Technology (Top 10 in P.R. China) *Wuhan, China*
Ph.D. in Mechanical Engineering (Supervisor: Prof. Weiming Shen) Sep. 2010 - Jun. 2025 (expected)
Politecnico di Milano *Milan, Italy*
Visiting Ph.D. in Computer Science (Supervisor: Giacomo Boracchi) Oct. 2023 - Sep. 2024 (expected)
Huazhong University of Science and Technology (Top 10 in P.R. China) *Wuhan, China*
B.E. in Mechanical Engineering **GPA**: 91.55/100 (Top 3%) Sep. 2016 - Jun. 2020

Research Interest

Visual Anomaly Detection, Vision-Language Model, Unsupervised/Zero-shot Learning, Computer Vision

Publications

#co-first author, *corresponding author

First-Authored Peer-Reviewed Publications

1. **Y. Cao**, J. Zhang, L. Frittoli, Y. Cheng, W. Shen*, G. Boracchi. AdaCLIP: Adapting CLIP with Hybrid Learnable Prompts for Zero-Shot Anomaly Detection. ***European Conference on Computer Vision (ECCV)***.
2. **Y. Cao**, X. Xu, W. Shen*. Complementary pseudo multimodal feature for point cloud anomaly detection. ***Pattern Recognition, 2024***. Arxiv: 2303.13194. [CODE]
3. **Y. Cao**, X. Xu, C. Sun, L. Gao, W. Shen*. BiaS: Incorporating Biased Knowledge to Boost Unsupervised Image Anomaly Localization. ***IEEE Transactions on Systems, Man, and Cybernetics: Systems, 2024***. DOI: 10.1109/TSMC.2023.3344383.
4. **Y. Cao**, X. Xu, Z. Liu, W. Shen*. Collaborative discrepancy optimization for reliable image anomaly localization. ***IEEE Transactions on Industrial Informatics, 2023***. DOI: 10.1109/TII.2023.3241579.[CODE]
5. **Y. Cao**, Y. Zhang, W. Shen*. High-Resolution Image Anomaly Detection via Spatiotemporal Consistency Incorporated Knowledge Distillation. ***International Conference on Automation Science and Engineering (CASE), 2023***. DOI: 10.1109/CASE56687.2023.10260338.
6. **Y. Cao**, Q. Wan, W. Shen*, L. Gao. Informative knowledge distillation for image anomaly segmentation. ***Knowledge-Based Systems, 2022***. DOI: 10.1016/J.KNOSYS.2022.108846. [CODE]

Other Peer-Reviewed Publications

1. H. Yao, **Y. Cao**, W. Luo, W. Zhang, W. Yu*, W. Shen. Prior Normality Prompt Transformer for Multiclass Industrial Image Anomaly Detection. ***IEEE Transactions on Industrial Informatics, 2024***. DOI: 10.1109/TII.2024.3413322.
2. Q. Wan, **Y. Cao**, L. Gao, X. Li*, Y. Gao. Deep Feature Contrasting for Industrial Image Anomaly Segmentation. ***IEEE Transactions on Instrumentation and Measurement, 2024***. DOI: 10.1109/TIM.2023.3348901.
3. Y. Bai, J. Zhang, Y. Dong, G. Tian*, **Y. Cao**. Dual-path Frequency Discriminators for Few-shot Anomaly Detection. ***Knowledge-Based Systems, 2024***, *conditionally accepted*. Arxiv: 2403.04151.
4. Z. Liu, X. Xu, **Y. Cao**, W. Shen*. Generative Denoise Distillation: Simple Stochastic Noises Induce Efficient Knowledge Transfer for Dense Prediction. ***Knowledge-Based Systems, 2024***, *conditionally accepted*. Arxiv: 2401.08332.
5. Y. Cheng, **Y. Cao**, C. Rui, W. Shen*. RAD: A Comprehensive Dataset for Benchmarking the Robustness of Image Anomaly Detection. ***International Conference on Automation Science and Engineering (CASE), 2024***. Arxiv: 2406.07176.
6. Y. Zhang, **Y. Cao**, T. Zhang, W. Shen*. Attention Fusion Reverse Distillation for Multi-Lighting Image Anomaly Detection. ***International Conference on Automation Science and Engineering (CASE), 2024***. Arxiv: 2406.04573.

7. Y. Jiang, **Y. Cao**, W. Shen*. A masked reverse knowledge distillation method incorporating global and local information for image anomaly detection. ***Knowledge-Based Systems, 2023***. DOI: 10.1016/J.KNOSYS.2023.110982.
8. Q. Wan, **Y. Cao**, L. Gao, W. Shen, X. Li*. Position encoding enhanced feature mapping for image anomaly detection. ***International Conference on Automation Science and Engineering (CASE), 2022***. DOI: 10.1109/CASE49997.2022.9926547. [CODE]

First-Authored Manuscripts under Review

1. **Y. Cao**, X. Xu, C. Sun, Y. Cheng, Z. Du, L. Gao, W. Shen*. Segment any anomaly without training via hybrid prompt regularization. ***IEEE Transactions on Cybernetics***, *reject and resubmit.* Arxiv: 2305.10724. [CODE]
2. **Y. Cao**, H. Yao, W. Luo, W. Shen*. VarAD: Lightweight High-Resolution Image Anomaly Detection via Visual Autoregressive Modeling. ***IEEE Transactions on Industrial Informatics***, *under review.*
3. **Y. Cao**, X. Xu, J. Zhang, Y. Cheng, X. Huang, G. Pang, W. Shen*. A Survey on Visual Anomaly Detection: Challenge, Approach, and Prospect. *pending to submit.* Arxiv: 2401.16402.
4. **Y. Cao**, X. Xu, C. Sun, X. Huang, W. Shen*. Towards generic anomaly detection and understanding: Large-scale visual-linguistic model (gpt-4v) takes the lead. *pending to submit.* Arxiv: 2311.02782. [CODE] [Press Coverage (CN)]
5. Y. Cheng[#], **Y. Cao**[#], G. Xie, Z. Lu, W. Shen*. Towards Zero-shot Point Cloud Anomaly Detection: A Multi-View Projection Framework. ***IEEE Transactions on Systems, Man, and Cybernetics: Systems***, *under review.*

Other Manuscripts under Review

1. Y. Jiang, **Y. Cao**, W. Shen*. Prototypical Learning Guided Context-Aware Segmentation Network for Few-Shot Anomaly Detection. ***IEEE Transactions on Neural Networks and Learning Systems***, *reject and resubmit.*
2. S. Han, **Y. Cao**, O. Fink*. CUT: A Controllable, Universal, and Training-Free Visual Anomaly Generation Framework. ***Neural Information Processing Systems (NeurIPS)***, *under review.* Arxiv: 2406.01078.
3. Y. Zhang, **Y. Cao**, X. Xu, W. Shen*. LogiCode: an LLM-Driven Framework for Logical Anomaly Detection. ***IEEE Transactions on Automation Science and Engineering***, *major revision.* Arxiv: 2406.04687. [CODE]
4. Y. Jiang, **Y. Cao**, Y. Cheng, Y. Zhang, W. Shen*. VTFusion: A Vision-Text Multimodal Fusion Network for Few-Shot Anomaly Detection. ***IEEE Transactions on Cybernetics***, *under review.*
5. H. Yao, W. Luo, **Y. Cao**, Y. Zhang, W. Yu*, W. Shen. Global-Regularized Neighborhood Regression for Efficient Zero-Shot Texture Anomaly Detection. ***IEEE Transactions on Systems, Man, and Cybernetics: Systems***, *under review.* Arxiv: 2406.07333.
6. W. Luo, P. Xing, **Y. Cao**, H. Yao, W. Shen, Z. Li*. URA-Net: Uncertainty-Integrated Anomaly Perception and Restoration Attention Network for Unsupervised Anomaly Detection. ***IEEE Transactions on Neural Networks and Learning Systems***, *under review.*

Research Project

Mobile E-Ink Screen Surface Defect Detection Equipment Jun. 2023 - Present

- constructed a *high-resolution* defect inspection prototype for mobile e-ink screens.
- collected a comprehensive dataset of high-resolution images for mobile e-ink screen inspection.
- translated image anomaly detection into token prediction, and introduced state space models to predict the future tokens based on previous tokens
- achieved high detection efficiency with great global information capture capacity for high-resolution images.

Complex Surface Part Inspection Equipment Jun. 2020 - Jun. 2024

- constructed a *multi-view and multi-illumination* defect inspection prototype equipment for curved surface parts.
- collected an automotive part inspection dataset featuring multi-illumination images.
- proposed a multi-illumination visual anomaly detection task and extended reverse knowledge distillation for this task.
- improved 6.5% detection AUROC with minimal additional overhead in comparison to anomaly detection under

single illumination.

Selected Awards & Honors

- **2nd place** in Visual Anomaly and Novelty Detection 2023 Challenge by CVPR. [Paper] [CODE] Jun. 2023
- Mathematical Modeling Stars Nomination (**Top2**) of China Mathematical Modeling Contest. May 2022
- **National Scholarship (the highest scholarship for B.E.)** Sep. 2017 & Sep. 2019

Academic Service

- **Peer-reviewer of journals**: ◇ *IEEE Trans. Syst. Man Cybern. -Syst.*, ◇ *IEEE Trans. Neural Netw. Learn. Syst.*, ◇ *IEEE Trans. Ind. Inform.*, ◇ *IEEE Trans. Circuits Syst. Video Technol.*, *etc.*
- **Peer-reviewer of conferences**: ◇ *CVPR*, ◇ *NeurIPS*, ◇ *AAAI*, ◇ *IJCAI*, ◇ *ICRA*, *etc.*
- **Co-organizer of special sessions**: *Industrial Foundation Models and Applications in Smart Manufacturing* at the IEEE International Conference on Automation Science and Engineering (2024).

Invited Presentations

- EPFL, ***Application-Oriented Industrial Visual Anomaly Detection***. [Slides] July 2024
- National University of Defense Technology, ***Overview of Visual Anomaly Detection—Review, Applications, and Future Prospects***. [Slides] Nov. 2023