

Ruiyang Hao

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EMPLOYMENT AND EDUCATION

Institute for AI Industry Research, Tsinghua University, Beijing, China | 2023.7-now

Research Assistant | Supervisor: Prof. Zaiqing Nie
Research Topic: Vision Perception & Planning (Autonomous Driving)



Emerging Innovation Group, SenseTime Research, Beijing, China | 2022.6-2022.10

Research Intern | Supervisor: Dr. Jiang Wu
Research Topic: Vision Perception (UAV Remote Sensing)



Department of Automation, Tsinghua University, Beijing, China | 2020.9-2023.7

Electronic Engineering (MPhil) | GPA 4.00 | ranking 1/159 | Supervisor: Prof. Biqing Huang
Research Topic: Vision Perception (Industrial Defect Inspection)



Shenyuan Honors Collage, Beihang University, Beijing, China | 2016.9-2020.6

Electronic Engineering (BEng) | GPA 3.83 | ranking 1/51 | Supervisor: Prof. Fei Tao
Research Topic: Evolutionary Computation (Industry Management)



RESEARCH EXPERIENCE

Big Data Intelligence Lab, Institute for AI Industry Research, Tsinghua | Supervisor: Prof. Zaiqing Nie

- **Research Topic:** Vision Perception & Planning for Autonomous Driving
- **Specific Research Projects:**

- ✓ **Roadside Cooperative Perception (RCooper) Datasets and Benchmark**

Objective: Towards high-level autonomous driving, **Roadside Cooperative Perception (RCooper)** task is proposed to realize more practical area-coverage roadside perception for restricted traffic areas, which can extend sensing range and reduce blind spots.

Contributions: Construct the **first real-world, large-scale RCooper dataset** to bloom the research on practical roadside cooperative perception, including detection and tracking. The dataset comprises 50k images and 30k point clouds, including two representative traffic scenes (i.e., intersection and corridor). Construct the roadside cooperative perception **benchmark** with SOTA cooperative methods, which proves the **effectiveness of roadside cooperation perception** and demonstrate the direction of further research.

- ✓ **More Powerful End-to-End Autonomous Driving**

Overview: I'm trying to incorporate end-to-end autonomous driving with LLM. Employing LLM as an intelligent driving decider could be an interesting and exciting thing.

Institute of Industrial Intelligence System, Department of Automation, Tsinghua | Supervisor: Prof. Biqing Huang

- **Research Topic:** Vision Perception for Industrial Defect Inspection
- **Research Overview:** Visual detection and recognition for surface defects of industrial products plays a vital role in product quality control. Deep learning techniques have become powerful tools for this task, but there are still some challenges for actual industrial scenarios: 1) **the long-tail data distribution**; 2) **the lack of high-quality labeled data**; 3) **feature extraction for complex industrial defect**. Specific projects below show how I address mentioned issues.

- **Specific Research Projects:**

- ✓ **Glass defect identification project towards Fuyao Group**

Objective: To realize automatic detection and identification of glass surface defects.

Methodology: The **adaptive threshold segmentation** method was used to carry out high-recall and high-efficiency preliminary screening of glass defects, and a **metric learning task** was designed to extract robust embedding features of glass defects under the condition of limited samples. An ensemble learning framework is constructed for glass defect recognition, where **multi-expert classifiers with diversified loss functions** are constructed to train to solve the accuracy loss caused by long-tail data distribution.

Effect: Glass recognition accuracy reached 94% on the real data set (SOTA).

- ✓ **Unsupervised defect segmentation project**

Objective: To achieve accurate segmentation of industrial surface defects in an unsupervised way.

Methodology: A **lightweight network structure** based on depth-wise convolution is designed for industrial environment deployment. Spatial-level and channel-level **attention modules and multi-task strategies** are employed to improve the segmentation performance of defect edges. A **self-supervised learning strategy with homologous enhancement** is proposed to solve the defect segmentation problem without annotated information.

Effect: Two typical industrial defect datasets with a pixel-level AUC of 98.40% (SOTA).

- ✓ **Steel surface defect detection project**

Objective: To achieve accurate detection of steel surface defects.

Methodology: Based on the classical object detection framework Faster R-CNN, a novel architecture is proposed to address the issue of the diversity in defect shapes and scales: **deformable and atrous convolution** was adopted to improve the feature extraction towards multi-shape defects, and a **balanced feature pyramid with richer feature fusion** was designed to achieve better detection performance for multi-scale defects.

Effect: 80.5% AP on steel surface defect datasets NEU-DET (SOTA).

Emerging Innovation Group, SenseTime Research | Supervisor: Dr. Jiang Wu

- **Research Topic:** Vision Perception for UAV Remote Sensing (semantic segmentation for narrow objects)
- **Research Summary:** To address the segmentation challenges posed by narrow features of targets (e.g., roof parapet) from UAV view, the **parallel multi-resolution branch and multi-level feature fusion** capabilities of HRNet are leveraged, which effectively improves the segmentation performance of small targets. Additionally, A **multi-head multi-task decoder** is constructed to enhance the edge segmentation and direction perception. Furthermore, **multi-modality integration** is employed, incorporating gradient information from the depth map to refine the perception of depth information. Finally, a **post-processing method considering continuity** is implemented, where the detected orientation of the principal normal vector is utilized to fix discontinuous targets. These modifications perform a significant increase of over 30% in foreground pixel recall for UAV segmentation.

Service-oriented Intelligent Manufacturing Research Group, Beihang University | Supervisor: Prof. Fei Tao

- **Research Topic:** Evolutionary Computation for Industry (Industrial service supply-demand optimization)
- **Research Summary:** The modern manufacturing industry realizes effective resource sharing and close cooperation among manufacturing enterprises in the form of manufacturing services. Towards the type diversity and quantity variation diversity of manufacturing service supply and demand, a **classification hypernetwork model** is established to describe the matching relationship between supply and demand of manufacturing services and their quantity relationship, and a **utility optimization model** considering the type diversity and quantity diversity of supply and demand is proposed. The **knowledge-guided NSGA-II multi-objective optimization** algorithm is proposed to solve the above optimization model, and the effectiveness of the model and algorithm are demonstrated by experiments, and suggestions are put forward for the management of manufacturing enterprise clustering.

PUBLICATIONS

- **Ruiyang Hao**, Bingyu Lu, Ying Cheng, Xiu Li, & Biqing Huang[†] (2021). A Steel Surface Defect Inspection Approach towards Smart Industrial Monitoring. *Journal of Intelligent Manufacturing*, 32: 1833-1843. ([Link](#), IF: 8.3, 92 citations)
- Rongge Xu*, **Ruiyang Hao***, & Biqing Huang[†] (2022). Efficient surface defect detection using self-supervised learning strategy and segmentation. *Advanced Engineering Informatics*, 52: 101566. (*co-first author, [Link](#), IF: 8.8, 37 citations)
- **Ruiyang Hao**, Ying Cheng[†], Yongping Zhang, & Fei Tao (2021). Manufacturing Service Supply-Demand Optimization with Dual Diversities for Industrial Internet Platforms. *Computers & Industrial Engineering*, 156: 107237. ([Link](#), IF: 7.9, 26 citations)
- **Ruiyang Hao***, Siqi Fan*, Yingru Dai, Zhenlin Zhang, Chenxi Li, Yuntian Wang, Haibao Yu, Wenxian Yang, Jirui Yuan, & Zaiqing Nie[†] (2024). RCooper: A Real-world Large-scale Dataset for Roadside Cooperative Perception. *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR 2024)*. ([Link](#))
- Jiaxun Wang, Xiang Wang, **Ruiyang Hao**, Haonan Yin, Biqing Huang[†], Xiao Xu, & Jingxian Liu (2024). Incremental Template Neighborhood Matching for 3D Anomaly Detection. *Neurocomputing*, 581: 127483. ([Link](#), IF: 6.0)
- Yani Wang, Xiang Wang, **Ruiyang Hao**, Bingyu Lu, & Biqing Huang[†] (2024). Metal surface defect detection method based on improved cascade R-CNN. *Journal of Computing & Information Science in Engineering*, 24(4): 041002. ([Link](#), IF: 3.1)

Notes: * denotes equal contribution and [†] denotes corresponding author. Reported citations are recorded in Mar. 2024.

PROFESSIONAL SERVICES

- Journal Reviewer of *Advanced Engineering Informatics*, *Journal of Industrial Information Integration*, *Journal of Real-Time Image Processing*, *The Visual Computer*, etc. Since 2023.
- Secretary, Graduate Thesis Review Committee, Tsinghua University, 2023.
- Member, Computer Vision Foundation (CVF), since 2024.

SELECTED AWARDS

- **National Scholarship**, the Top Scholarship in China, in 2018, **top 1%** of undergraduates
- First-class Excellence Scholarship, awarded by Tsinghua University, in 2022, **top 2.5%** of graduate students
- First-class Excellence Scholarship, awarded by Tsinghua University, in 2021, **top 2.5%** of graduate students
- Outstanding graduate and the honored degree, awarded by Beihang University, in 2020, **top 5%** of undergraduates
- Meritorious Prize of Interdisciplinary Contest in Modeling, awarded by the American Consortium for Mathematics and Its Applications, in 2019, **top 8%** of contestants
- Meritorious Prize of Interdisciplinary Contest in Modeling, awarded by the American Consortium for Mathematics and Its Applications, in 2018, **top 8%** of contestants

RESEARCH Interests

The autonomous system is an exciting and popular topic. My research interests involve the **vision perception algorithms and decision-making in autonomous systems**. It is exhilarating to be able to contribute to this field.