Wei DAI

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Education

City University of Hong Kong, Hong Kong, China   *Sep. 2021 - Aug. 2025*
Ph.D. in Robotics and Automation
Supervisor: Prof. Jun Liu & Prof. Steven Wang

South China University of Technology, Guangzhou, China   *Sep. 2017 - Jun. 2021*
B.Eng. in Mechanical Engineering
Supervisor: Prof. Zhenping Wan

Selected Awards

- **Research Tuition Grant**, CityU   *2021-2025*
- **Postgraduate Studentship**, CityU   *2021-2025*
- **Research Activities Fund**, CityU   *2024-2025*
- **Outstanding Academic Performance Award**, CityU   *2024*
- **Institutional Research Tuition Scholarship**, CityU   *2024*
- **ISBI Student Travel Grant** (3 recipients in Hong Kong), ISBI   *2024*
- **Conference Grant**, CityU   *2024*
- **Outstanding Undergradutate Thesis Award** (Top 1%), SCUT   *2021*
- **The First Prize Scholarship** (Top 2%), SCUT   *2019-2020*
- **National Stellar Volunteer Award** (121 volunteer hours), CVSF   *2020*
- **Honorable Mention**, National University Student Mechanics Competition *2019*
- **Honorable Mention**, Mathematical Contest in Modeling (MCM)   *2019*
- **Zhangtao-Lifen Dengyun Scholarship** (Top 1%), SCUT   *2018*

Research Experience

Enrich Data Through Mixing Samples:

I developed a binary mixing mask approach to adapt data mixture methods from classifcation to segmentation tasks, providing hard labels for each mingled image. Additionally, I introduced two mixed sample data augmentation techniques: rotary-cutting mixture (RotMix) and saliency mixture (SaliencyMix), aimed at improving model generalisation. RotMix incorporates relative rotation between two images, while SaliencyMix uses the minimum barrier distance algorithm and raster scan scheme to focus on underrepresented areas by emphasising salient features.

Analyse Small-scale Medical Objects:

I developed SvANet, a scale-variant attention-based architecture for segmenting small medical objects. SvANet employs a scale-variant attention (SvAttn) method and a cross-scale guidance module to track feature changes and reuse attention maps from progressively compressed stages, leveraging

high-resolution features from early learning stages to reduce compression artefacts. Additionally, SvANet integrates Monte Carlo attention and convolution with vision transformer to capture multi-scale information within a single feature map by generating attention maps at various scales.

Construct Light-weight Neural Networks:

I developed a hierarchical attention-based network (HierAttn), a lightweight architecture designed to efficiently differentiate multi-class skin lesions with minimal computational cost and memory use. HierAttn combines branch attention and convolution-transformer hybrid module to capture hierarchical features and multi-scale representations.

Despite considerable research on 2D image analysis using mobile neural networks, 3D medical image analysis with lightweight architectures remains underexplored. I proposed Mobile Vision Mamba (MobileViM), designed for efficient and precise 3D medical image segmentation across modalities, achieving over 90 FPS on a single RTX 4090 with fewer than 6.5 million parameters. MobileViM employs a dimension-independent mechanism, dual-direction traversing, and scale bridging, significantly enhancing feature learning and processing speed.

Diagnose Sperm Health for IVF Robotics:

I developed a sperm feature-correlated network (SFCNet) to assist IVF robotics by differentiating and characterising multiple sperms. SFCNet combines SaliencyMix, lightweight architecture design, and cross-scale guidance with SvAttn for enhanced segmentation and morphology analysis, while tracking sperm motility with lateral attention and a multi-scale tracking system. It achieves superior performance at over 70 FPS on a single RTX 3090.

Develop Foundation Model for Medical Image Analysis:

Recently, I have been focused on creating a foundation model system that aids in the analysis of reproductive cell instances. This project aims to establish a dynamic, interactive environment that facilitates seamless human interaction with medical robotics.

Publications (Google Scholar)

Journal Papers

1. **W. Dai**, R. Liu, T. Wu, M. Wang, J. Yin and J. Liu, "Deeply Supervised Skin Lesions Diagnosis with Stage and Branch Attention," in *IEEE Journal of Biomedical and Health Informatics*, vol. 28, no. 2, pp. 719-729, Feb. 2024. (**JBHI, IF: 7.7**)

2. **W. Dai**, T. Wu, R. Liu, M. Wang, J. Yin, and J. Liu, "Any Region Can Be Perceived Equally and Effectively on Rotation Pretext Task Using Full Rotation and Weighted-region Mixture," in *Neural Networks*, 2024. (**NN, IF: 7.8**)

3. **W. Dai**, Z. Wu, R. Liu, T. Wu, M. Wang, J. Zhou, Z. Zhang, and J. Liu, "Automated Non-invasive Analysis of Motile Sperms Using Sperm Feature-correlated Network," in *IEEE Transactions on Automation Science and Engineering*, pp. 1-11, 2024. (**TASE, IF: 5.9**)

4. R. Liu, **W. Dai**, C. Wu, T. Wu, M. Wang, J. Zhou, X. Zhang, W. Li, and J. Liu, "Deep Learning-based Microscopic Cell Detection Using Inverse Distance Transform and Auxiliary Counting," in *IEEE Journal of Biomedical and Health Informatics*, pp. 1-13, 2024. (**JBHI, IF: 7.7**)

5. R. Liu, **W. Dai**, T. Wu, M. Wang, S. Wan, and J. Liu, "AIMIC: Deep Learning for Microscopic Image Classification," Computer Methods and Programs in Biomedicine, vol. 226, p. 107162, 2022. (**CMPB, IF: 6.1**)

6. T. Wu, K. Shang, **W. Dai**, M. Wang, R. Liu, J. Zhou, and J. Liu, "High-resolution Cross-scale Transformer: A Deep Learning Model for Bolt Loosening Detection Based on Monocular Vision Measurement", in *Engineering Applications of Artificial Intelligence*, vol. 133, pp. 108574, Feb. 2024. (**EAAI, IF: 8.0**)

7. R. Liu, Y. Zhu, C. Wu, H. Guo, **W. Dai**, T. Wu, M. Wang, W. J. Li, and J. Liu, "Interactive Dual Network with Adaptive Density Map for Automatic Cell Counting," *IEEE Transactions on Automation Science and Engineering*, 2023. (**TASE, IF: 5.6**)

8. K. Shang, T. Wu, X. Jin, Z. Zhang, C. Li, R. Liu, M. Wang, **W. Dai**, and J. Liu, "Coaxiality Prediction for Aeroengines Precision Assembly Based on Geometric Distribution Error Model and Point Cloud Deep Learning," *Journal of Manufacturing Systems*, vol. 71, pp. 681–694, 2023. (**JMS, IF: 12.1**)

9. M. Wang, J. Zhang, R. Liu, T. Wu, **W. Dai**, R. Liu, J. Zhang, and J. Liu, "Liquid Metal-based Flexible Sensor for Perception of Force Magnitude, Location, and Contacting Orientation," *IEEE Transactions on Instrumentation and Measurement*, 2023. (**TIM, IF: 5.6**)

Conference Papers

1. **W. Dai**, Z. Wu, J. Wang, R. Liu, M. Wang, T. Wu, J. Zhou, Z. Zhang, and J. Liu, "Automated Non-invasive Analysis of Motile Sperms Using Cross-scale Guidance Network," in *IEEE International Conference on Robotics and Automation*. pp. 17708-17714, IEEE, 2024. (**ICRA 2024**)

2. **W. Dai**, Z. Wu, R. Liu, J. Zhou, M. Wang, T. Wu, and J. Liu, "SoSegFormer: A Cross-scale Feature Correlated Network for Small Medical Object Segmentation," in *IEEE International Symposium on Biomedical Imaging*. pp. 1-4, IEEE, 2024. (**ISBI 2024**)

3. J. Zhou, R. Liu, M. Wang, T. Wu, **W. Dai**, X. Zhang, and J. Liu, "Sonicplex: Simultaneous Arrangement of Massive Particles Through a Simple Acoustic Micromanipulation Platform," in *International Conference on Manipulation, Automation and Robotics at Small Scales*. IEEE, 2023, pp. 1–6. (**MARSS 2023**)

4. M. Wang, Z. Li, **W. Dai**, R. Liu, S. Yuan, and J. Liu, "On-chip Transportation and Mixing of Microsample Using Electrohydrodynamic Flow," in *International Conference on Manipulation, Automation and Robotics at Small Scales*. IEEE, 2022, pp. 1–6. (**MARSS 2022**)

Preprints

1. **W. Dai**, R. Liu, Z. Wu, T. Wu, M. Wang, J. Zhou, Y. Yuan, and J. Liu, "Exploiting Scale-Variant Attention for Segmenting Small Medical Objects ," in *arXiv*. 2024. First revision.

2. **W. Dai**, J. Yin, Z. Zhang, and J. Liu, "Saliency-assisted Scale-bridge Network for Small Medical Object Segmentation." 2024. Under review.

3. **W. Dai**, and J. Liu, "MobileViM: A Light-weight and Dimension-independent Vision Mamba for 3D Medical Image Analysis," in *arXiv*. 2025. Under review.

Professional Activities

Journal Reviewers

- IEEE Transactions on Circuits and Systems for Video Technology (IEEE TCSVT)

- IEEE Journal of Biomedical and Health Informatics (IEEE JBHI)

- IEEE Transactions on Biomedical Engineering (IEEE TBME)

- Computer Methods and Programs in Biomedicine (CMPB)
- IEEE Transactions on Robotics (IEEE TRO)
- IEEE Transactions on Automation Science and Engineering (IEEE TASE)
- IEEE Robotics and Automation Letters (IEEE RAL)
- Engineering Applications of Artificial Intelligence (EAAI)
- Lab on a Chip
- Advanced Intelligent Systems
- International Journal of Computing and Digital Systems
- BMC Medical Informatics and Decision Making

Conference Reviewers

- IEEE International Symposium on Biomedical Imaging
- IEEE International Conference on Robotics and Automation
- IEEE International Conference on Intelligent Robots and Systems
- IEEE International Conference on Advanced Robotics and Its Social Impacts
- IEEE International Conference on Nano/Micro Engineered and Molecular Systems
- IEEE International Conference on Manipulation, Automation and Robotics at Small Scales

Conference Presentations

- ISBI 2024, Athens, Greece *May 2024*
- ICRA 2024, Yokohama, Japan *May 2024*

Teaching Assistant

- MNE4032 Robotics and Machine Vision *Spring 2024*
- MNE8116 Computer Controlled Systems *Spring 2023*
- MNE6005/MNE8113 Micro Systems Technology *Fall 2022-2024*

Experience

University of St Andrews, St Andrews, United Kingdom *Jul. 2019 - Aug. 2019*
University of Dundee, Dundee, United Kingdom
Visiting student in School of Science and Engineering

- Applying a deep learning architecture U-Net to extract traffic lanes.
- Detecting ArUco markers and distinguishing the colour of the traffic light.

Extracurricular Activities

- 25th & 26th Standard Chartered Hong Kong Marathon (10 km), Hong Kong *2023 - 2024*
- 7th & 8th Nike Relay Race, Guangzhou *2018 - 2019*