

# Xiaohua Wu

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## Reference:

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|-----------------------------|-------------------|--|
| • Prof. Yingxi Xie (SCUT)   | Ph. D. Supervisor | <a href="mailto:xieyingxi@scut.edu.cn">xieyingxi@scut.edu.cn</a> |
| • Prof. Longsheng Lu (SCUT) | Ph. D. Advisor    | <a href="mailto:meluls@scut.edu.cn">meluls@scut.edu.cn</a>       |
| • Prof. Shu Yang (SCUT)     | Ph. D. Advisor    | <a href="mailto:yangshme@scut.edu.cn">yangshme@scut.edu.cn</a>   |
| • Prof. Di Xing (SCUT)      | Ph. D. Advisor    | <a href="mailto:xingmech@scut.edu.cn">xingmech@scut.edu.cn</a>   |

## Education:

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| <b>South China University of Technology</b><br>Ph. D in Mechanical Engineering                      | Sept. 2022 – Jun. 2026 (Expected) |
| <b>South China University of Technology</b><br>Master-PhD Track in Mechanical Design and Automation | Sept. 2021 – Jun. 2022            |
| <b>South China University of Technology</b><br>B. Eng. in Mechanical Engineering (Innovation Class) | Sept. 2017 – Jun. 2021            |

## Research Interest:

- Tactile sensing arrays & Super-resolution techniques
- Multimodal flexible sensors & Signal processing
- Micro/Nano Functional Structure Engineering

## Research Experience:

### A. Ph. D. Phase (2022-2026)

**Thesis Topic:** Bioinspired Tactile Super-Resolution Sensing Devices: Design, Mechanism and Implementation

**Supervisor:** Yingxi Xie

**Description:** Flexible pressure sensor arrays, as key sensing components, are limited in practical applications due to the massive number of units and wiring complexity required for large-area high-resolution layouts. We propose a super-resolution method for tactile sensor arrays based on physical-electrical receptive field co-enhancement, achieving actual positioning accuracy up to 10,000 times beyond the physical resolution. Thanks to the extensive receptive field, the proposed method maintains robust performance even with over 60% damaged area, and its effectiveness has been validated in human-machine interaction and embodied intelligence scenarios.

### B. Undergraduate Phase (2020-2021)

**Thesis Topic:** Neural-Network-Modeled Woven Carbon-Fiber Supercapacitor Electrodes with Genetic-Algorithm Parameter Optimization

**Supervisor:** Yingxi Xie

**Description:** Flexible woven-structured solid-state supercapacitors, as novel energy storage devices, are constrained by complex process parameters and challenging performance optimization, making it difficult to simultaneously achieve high areal capacitance and mechanical flexibility. In this work, we propose a data-driven process optimization approach based on neural networks, combined with genetic algorithms for parameter tuning, to synergistically optimize the effects of laser power, scanning speed, electrolyte concentration, and electrode width on device capacitance. The resulting devices exhibit significantly enhanced areal and volumetric capacitance compared with the unoptimized group.

## Research Skills:

### A. Mechanical Design & Fabrication

- 3D Modeling & CAD: SolidWorks, Inventor, AutoCAD
- Multiphysics Simulation & Analysis: COMSOL, ANSYS, ICEPAK
- Mechanical Machining & Tooling: CNC, Lathes, Milling Machines
- Precision Instruments & Measurement Techniques
- Flexible Sensor Fabrication & Integration Processes

### B. Embedded Systems & Software Development

- Microcontrollers & IoT Platforms: STM32, ESP8266, Arduino
- PCB Design & EDA Tools: JLCEDA, Altium Designer
- Software & Web Development: Python, Flask, Docker, WeChat Mini Programs, WeChat Cloud Hosting
- Operating Systems & Middleware: Ubuntu, ROS, Linux Environment
- Hardware-Software Integration & System Debugging

### C. AI & Algorithm Development

- Machine Learning & Deep Learning Frameworks: PyTorch, PaddlePaddle, Scikit-learn
- Computer Vision & Active Learning: OpenCV, ModAL
- Programming & Scripting: Python, C, C++, MATLAB, WeChat App Development
- Data Processing, Analysis & Visualization Techniques
- Model Training, Hyperparameter Optimization & Performance Evaluation

## Publications:

### A. First author, and Corresponding author (\*) publications:

- [1] Wu, X., Wu, Z., Feng, Y., Liang, Y., Lu, L., Yang S., Xie, Y.\*. (2025). A bio-inspired proximity-tactile sensor array with tunable detection depth for embodied intelligence. **International Journal of Extreme Manufacturing**, Accept.
- [2] Wu, X., Huang, X., Liang, Y., Lu, L., Yang, S., Liao, J., ... Xie, Y\*. (2025). Deep Learning-Assisted Fingerprint-Inspired Flexible Pressure Sensor for Tension Monitoring in Carbon Fiber Production. **Advance Science**, e13680.
- [3] Wu, X., Liang, Y., Lu L., Yang S., Liang Z., Liu F., ... Xie Y\*. (2025). Fabric-Based Flexible Pressure Sensor Arrays with Ultra-Wide Pressure Range for Lower Limb Motion Capture System. **Research**, 8.
- [4] Xie, Y., Bian, S., Lu, L., Chen, H., Liao, J., Liang, Y., & Wu, X.\*. (2025). Airbag-like Comb Flexible Pressure Sensor and Its Wearable Applications. **ACS Applied Materials & Interfaces**, 17(23), 34230–34240.
- [5] Wu, X., Lu, L., Liang, L., Mei, X., Liang, Q., Zhong, Y., ...Xie, Y\*. (2024). Quick Prediction of Complex Temperature Fields Using Conditional Generative Adversarial Networks. **ASME Journal of Heat and Mass Transfer**, 146(11).
- [6] Xie, Y. (Supervisor), Wu, X., Huang, X., Liang, Q., Deng, S., Wu, Z., ...Lu, L\*. (2023). A Deep Learning-Enabled Skin-Inspired Pressure Sensor for Complicated Recognition Tasks with Ultralong Life. **Research**, 6.
- [7] Wu, X.†, Xie, Y. †\*, Chen, W., Huang, X., Wu, Z., Bian, S., ...Lu, L.\*. A Damage Ultra-Tolerant Super-Resolution Piezoresistive Tactile Sensor Array Mimicking Human Skin. (manuscript completed)

### B. Other cooperative publications:

- [1] Xie, Y., Zhang, H., Yang, S., Zhong, Y., Tao, B., Wu, X., Chai, S., & Lu, L. (2026). Fabrication and heat transfer performance study of aluminum-based grooved composite porous enhanced boiling structure. **International Journal of Thermal Sciences**, 220, 110385.
- [2] Xie, Y., Liu, F., Luo, Y., Lin, N., Wu, X., Wu, Z., & Lu, L. (2025). Hair-like flexible airflow sensor for large-area airflow sensing. **Advanced Science**, 12(44), e10741.
- [3] Yang, W., Xie, Y., Wu, X., Yang, R., Lu, L., Li, J., & Chen, H. (2025). A novel perspective on laser-induced graphene in electronic skin for sensing and distinguishing of strain and temperature. **Sensors and Actuators A: Physical**, 382, 116132.
- [4] Zhong, Y., Xie, Y., Chen, H., Wu, X., Chai, S., Li, J., ...Yang, S. (2024). Study on the design and application of liquid-cooling plate for vehicle integrated domain controller based on planar DNA-type flow channel. **International Communications Heat Mass Transfer**, 159, 108193.
- [5] Xie, Y., Chen, W., Lin, N., Ding, X., Zhang, B., & Wu, X. (2024). Cost-Effective Tunable Iontronic Pressure Sensors Based on a Performance Prediction Model. **IEEE Sensor Journal**, 24(20), 31796–31805.
- [6] Mei, X., Xie, Y., Chai, S., Wu, X., & Lu, L. (2023). Analysis of Liquid Film Evaporation in Porous Particles: Toward Optimal Wick Parameters for Heat Transfer in Heat Pipes. **ASME Journal of Heat and Mass Transfer**, 145(11).
- [7] Ding, X., Xu, X., He, Z., Liang, Y., Wu, X., & Li, Z. (2023). Selective laser carving-induced patterned electrodes for high-performance binder-free and substrate-free all-carbon-based micro-supercapacitors. **Carbon**, 213, 118177.
- [8] Wang, W., Lu, L., Lu, X., Liang, Z., Lin, H., Li, Z., Wu, X., Lin, L., & Xie, Y. (2023). Scorpion-inspired dual-bionic, microcrack-assisted wrinkle based laser induced graphene-silver strain sensor with high sensitivity and broad working range for wireless health monitoring system. **Nano Research**, 16(1), 1228–1241.

## Patents & Software:

- [1] Xie, Y. (Supervisor), Wu, X., Lu, L., Li, Z., Liu, Z., & Zheng, B. (2022). **Rope Skipping Action Recognition System, Method, and Jump Rope.** **China Patent** CN113856132B. Granted April 22, 2022.
- [2] Xie, Y. (Supervisor), Wu, X., Lu, L., Liang, Q., Liang, L., & Zhong, Y. (2025). **Method, System, Device, and Medium for Calculating PCB Temperature Field Inside a Radiator.** **China Patent** CN114781201B. Granted March 7, 2025.
- [3] Xie, Y. (Supervisor), Wu, X., Lu, L., Liang, Y., Liang, Z., Liu, F., & Lu, X. (2025). **Lower Limb Motion Capture Method, Device, System, and Medium Based on Flexible Pressure Sensor Arrays.** **China Patent** CN120360532A. Published July 25, 2025.
- [4] Xie, Y. (Supervisor), Wu, X., Lu, L., Li, Z., Lu, X., & Zhang, H. (2025). **Three-Dimensional Breathable Electrode Sheet and Its Fabrication Method and Applications.** **China Patent** CN119587036A. Published March 11, 2025.
- [5] Xie, Y. (Supervisor), Wu, X., Lu, L., Huang, X., Wu, Z., & Liu, F. (2024). **Skin-Inspired Flexible Tactile Sensor Array, Method, and Device.** **China Patent** CN117405265A. Published January 16, 2024.
- [6] Xie, Y. (Supervisor), Wu, X., Lu, L., Yao, Y., Wu, Z., & Deng, S. (2023). **Intelligent Detection System and Method Based on Flexible Pressure Sensors.** **China Patent** CN116919389A. Published October 24, 2023.
- [7] Xie, Y. (Supervisor), Wu, X., Lu, L., Deng, S., Li, Z., Lu, X., & Zhang, H. (2023). **System for Collecting Multi-Lead Electrocardiogram Signals.** **China Patent** CN116919406A. Published October 24, 2023.
- [8] **Scupha: Vehicle Domain Controller Heat Management Fast Computation Software.** **Software Copyright** Version 1.0.0. Registered February 21, 2022.
- [9] Lu, L., Yang, R., Xie, Y., Wu, X., Wu, Z., Tao, B., Lu, X., & Huang, X. (2024). **Resistive Strain Sensor Array, Manufacturing Method, and Acquisition System.** **China Patent** CN118442912A. Published August 6, 2024.
- [10] Xie, Y., Yang, R., Lu, L., Wu, X., Lu, X., Liao, J., Wu, Z., Huang, X., & Li, Z. (2024). **Three-Lead Smart ECG Garment.** **China Patent** CN308568816S. Published April 9, 2024.
- [11] Xie, Y., Deng, S., Lu, L., Wu, X., Lu, X., Liao, J., Wu, Z., Huang, X., & Li, Z. (2024). **Physiological Electrode Performance Testing System and Method Simulating Different Human Motion States.** **China Patent** CN117398102A. Published January 16, 2024.

- [12] Xie, Y., Yang, R., Lu, L., Wu, X., Lu, X., Liao, J., Wu, Z., Huang, X., & Li, Z. (2024). **Three-Lead Smart ECG Garment.** [China Patent](#) CN308568816S. Published April 9, 2024.
- [13] Xie, Y., Deng, S., Lu, L., Wu, X., Lu, X., Liao, J., Wu, Z., Huang, X., & Li, Z. (2024). **Physiological Electrode Performance Testing System and Method Simulating Different Human Motion States.** [China Patent](#) CN117398102A. Published January 16, 2024.
- [14] Xie, Y., Huang, X., Lu, L., Wu, X., Deng, S., & Liang, Q. (2023). **Flexible Pressure Sensor and Its Fabrication Method and Applications.** [China Patent](#) CN116929608A. Published October 24, 2023.
- [15] Lu, X., Xie, Y., Li, Z., Lu, L., Wu, X., Liang, Z., & Yang, S. (2023). **PCBA Component for Implementing Three-Lead Electrocardiogram.** [China Patent](#) CN116671926A. Published September 1, 2023.
- [16] Lu, X., Liang, Z., Xie, Y., Lu, L., Wu, X., Li, Z., & Yang, S. (2023). **Multi-Sensor ECG Monitoring Hardware System Based on 12 Leads.** [China Patent](#) CN116671925A. Published September 1, 2023.
- [17] Lu, L., Li, Z., Xie, Y., Wang, W., & Wu, X. (2025). **Flexible Bioelectric Dry Electrode and Its Fabrication Method and Applications.** [China Patent](#) CN114947865B. Granted May 6, 2025.
- [18] Chen, Q., Xie, Y., Liao, J., Lu, L., & Wu, X. (2024). **ECG Detection Electrode and Its Fabrication Method.** [China Patent](#) CN119174612A. Published December 24, 2024.
- [19] Xie, Y., Wu, Z., Lu, L., Lu, X., Liao, J., Wu, X., Deng, S., & Li, Z. (2024). **Method and Device for Classifying Abnormal ECG Signals Based on Explainable Techniques.** [China Patent](#) CN118526207A. Published August 23, 2024.
- [20] Cai, X., Zhang, S., Long, F., Xie, Y., Zhang, C., Lin, Y., Chen, Q., Liao, J., Feng, Y., Chen, W., Wu, X., Liang, Y., & Gao, Z. (2025). **Tuning Device, Control Method, and Musical Instrument.** [China Patent](#) CN118692424B. Granted April 15, 2025.

## Conference Presentations & Posters:

- **Skin-Inspired, Ultra-Long-Lifetime Fully Textile Flexible Pressure Sensors for Complex Recognition Applications.** [Oral Presentation](#), PhD Academic Salon on Microsystems and Nanoengineering, 2024.
- **Deep Learning-Assisted Fingerprint-Inspired Flexible Pressure Sensor for Tension Monitoring in Carbon Fiber Production.** [Poster Presentation](#), The 9th Symposium of Flexible & Stretchable Electronics (ISFSE), 2025.
- **High-Precision Lower-Limb Motion Capture System Based on Flexible Pressure Sensor Array Insoles.** [Poster Presentation](#), The 2nd Exhibition of Sensor Technology and Application Achievements, Chinese Society for Optical Engineering.

## Awards:

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| • Nomination Award, 2nd Sensor Technology & Applications Exhibition (CSOE), 2025                  | (1/5) |
| • Gold Award, Foshan High-Value Patent Commercialization Competition (University Division), 2024  | (1/4) |
| • First Prize, "Brightstone Cup" Mechanical Engineering Innovation Competition (Provincial), 2024 | (1/5) |
| • Grand Prize (University) & Third Prize (National), Esquel Cup Innovation Competition, 2023      | (1/3) |
| • First Prize, "Brightstone Cup" Mechanical Engineering Innovation Competition (Provincial), 2023 | (1/5) |
| • First Prize, "Brightstone Cup" Mechanical Engineering Innovation Competition (Provincial), 2021 | (2/5) |
| • Gold Award (Provincial) & Bronze Award (National), "Internet+" Innovation Competition, 2021     | (4/9) |
| • Grand Prize (University) & Second Prize (National), Esquel Cup Innovation Competition, 2021     | (2/3) |

## Teaching Experience:

Spring 2025	Teaching Assistant	Technological Innovation: Methods and Practice	SCUT
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