Shijiang Li (李仕江), Ph.D. Student

E-mail: lsjxmu@stu.xmu.edu.cn Phone: (+86) 18523218277

Google Scholar: Shijiang Li - Google Scholar Address: Xiamen City, Fujian Province, China

Research Interests

- **Multi-Sensor Fusion and Environmental Perception**

Leveraging multi-sensor data to enhance the robot's perception and navigation capabilities in complex environments.

- **Physics-Informed and Data-Driven Robotic Autonomy**

Developing learning frameworks that integrate physical modeling, multi-sensor fusion, and uncertainty reasoning to enable safe, efficient, and explainable decision-making for embodied robotic systems.

Education

- **Ph.D. in Mechanical Manufacturing and Automation, Xiamen University** **2021.09 – present**

Dissertation: Research and Application of Data-Driven Modeling of the Coupling Relationship Between Excavation Robot Buckets and Materials

- **B.Eng. in Mechanical Design & Manufacturing and Automation, Xiamen University** **2017.09 - 2021.06**

GPA: 3.6/4; Rank: 3/61

Selected Project Experience

Research and Application of Data-Driven Modeling of the Coupling Relationship Between Excavation Robot Buckets and Materials **2023.03 – present**

Developed a physics-informed data-driven framework for modeling bucket-material interactions in excavation robots.

- Built an excavator operation state perception system by fusing multi-source sensor data
- Applied deep learning with physics mechanism to predict excavation resistance and bucket fill rate.
- Used the model for trajectory optimization, balancing energy efficiency, bucket fill rate and operational time.

Development of an Electric Micro-Excavator and Its Digital Twin System **2021.09 - 2023.07**

Developed an electric mini excavator and its digital twin system, enabling remote control and data-driven intelligence for enhanced operational performance.

- Optimized the mechanical structure and designed the electro-hydraulic control system.
- Developed the digital model and remote control interface using Unity3D for system synchronization.
- Built kinematic and dynamic models, and implemented PID-based trajectory tracking control.

Additional Projects and Research Contributions

- Automated Electrostatic Discharge (ESD) Testing Systems: Contributed to the development of automated ESD testing systems, improving efficiency and accuracy in industrial applications.
- Inverse Design for Product Customization: Contributed to inverse design theories, enabling product customization based on operational data to meet specific user requirements.
- Project Completion Reports: Drafted detailed project completion reports, summarizing key results and outcomes.
- Preparation of Project Reports and Funding Proposals: Experienced in preparing comprehensive project reports and funding proposals.

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Skill and Abilities

- **Research & Analysis:** Experienced in applying physics-informed modeling, intelligent control, and machine learning for construction machinery optimization.
- **System Development:** Participated in the design and integration of mechanical, hydraulic, and electrical systems for robotic and mechatronic applications, including electric micro-excavators.
- **Simulation & Modeling:** Developed and applied dynamic system simulations, 3D kinematic models, and digital twin systems for monitoring, diagnosis, and performance assessment.
- **Programming & Tools:** Python, MATLAB, C++; familiar with ROS, PyTorch, SolidWorks, AutoCAD.
- **Teamwork & Communication:** Strong in collaborating with interdisciplinary teams and presenting research effectively.
- **Adaptability & Problem-Solving:** Skilled at quickly adapting to new challenges and finding practical solutions.

Selected Publications

1. **S. Li**, X. Zhou, S. Wang, Y. Pan, T. Guo, L. Hou, Excavation trajectory planning based on feedforward neural network and physics-encoded optimization, Automation in Construction 181 (2026), https://doi.org/10.1016/j.autcon.2025.106634.
2. **S. Li**, G. Zhou, S. Wang, X. Jia, L. Hou, Multi-sensor data fusion and deep learning-based prediction of excavator bucket fill rates, Automation in Construction 171 (2025), https://doi.org/10.1016/j.autcon.2025.106008.
3. **S. Li**, S. Wang, X. Chen, G. Zhou, B. Wu, L. Hou, Application of physics-informed machine learning for excavator working resistance modeling, Mechanical Systems and Signal Processing 209 (2024) 111117, https://doi.org/10.1016/j.ymssp.2024.111117.
4. **S. Li**, S. Wang, X. Chen, G. Zhou, L. Hou, Identification of material excavation difficulty and uncertainty analysis based on Bayesian deep learning, Journal of Industrial Information Integration 42 (2024) 100728, https://doi.org/10.1016/j.jii.2024.100728.
5. **S. L**i, L. Hou, Z. Chen, S. Wang, X. Bu, Uncertainty modeling and applications for operating data-driven inverse design, Journal of Engineering Design 34 (2) (2023) 81-110, https://doi.org/10.1080/09544828.2023.2180846.
6. **S. Li**, X. Zhou, Y. Liu, J. Chen, T. Guo, W. Yang, L. Hou, Agile conceptual design and validation based on multi-source product data and large language models: a review, framework, and outlook, Journal of Engineering Design (2025) 1-31. https://doi.org/10.1080/09544828.2025.2476879.
7. **S. Li**, G. Zhou, Y. Dang, X. Jia, S. Wang, Y. Pan, L. Hou, Modeling of Excavator Bucket-Material Interaction Based on Multi-Task Learning. (Under Review)

Awards

- Xiamen University Nanqiang Outstanding PhD Student Scholarship, Xiamen University, 2023.09
- China Association for Science and Technology (CAST) Young Talent Support Program, PhD Student Plan, Association for Science and Technology, 2025.01
- Merit Student, Xiamen University, 2025.08
- National Scholarship, Ministry of Education of China 2025.10