Lingkai Hu

Phone: +86 13229883028 Email: 2112107060@e.gzhu.edu.cn Personal Website: Lingkai-Hu.github.io/Research/

EDUCATION

Guangzhou University **09/2021 – Present**

- **Major:** Mechanical Engineering (ME)
- **GPA:** 82.7/100
- **Major Research Direction:** *Deep learning algorithm, Natural Language Processing, Large Language Models, Computer Vision, Industrial Defect Detection, Digital Signal Processing, Few-Shot Learning*

RESEARCH INTERESTS

My research expertise lies in the field of artificial intelligence technology. I have a strong background in designing and implementing algorithms for artificial intelligence, computer vision, and digital signal processing. In addition to producing numerous theoretical contributions to artificial intelligence, I have also collaborated with diverse individuals and teams across various domains, such as medicine, soft robotics, civil engineering, industrial defect detection, and more. I am also open to exploring new research areas if given the opportunity.

PUBLICATION

1. Wenkai Huang, **Lingkai Hu**, "Using a Noisy U-Net for Detecting Lung Nodule Candidates", IEEE Access, 2019. (Accepted [First Student Author])
2. Zefeng Xu, Liqi Yang, Wenkai Huang, **Lingkai Hu**, "Dynamics Analysis of a Novel 3-PSS Parallel Robot Based on Linear Motor", IEEE Access, 2020. (Accepted [Third Student Author])
3. Wenkai Huang, Yihao Xue, **Lingkai Hu**, Hantang Liuli, "S-EEGNet: Electroencephalogram Signal Classification Based on a Separable Convolution Neural Network With Bilinear Interpolation", IEEE Access, 2020. (Accepted [Second Student Author])
4. Wenkai Huang, Yihao Xue, Zefeng Xu, **Lingkai Hu**, "Successive Over Relaxation Recurrent Confidence Inference Network Based on Linear Extrapolation", IEEE Access, 2021, (Accepted [Third Student Author])
5. Zefeng Xu, **Lingkai Hu**, Yitong Zhou, "A soft gripper integrated with mechanically-prestressed soft actuators", SDPC 2022, 2022. (Accepted [Second Author])
6. Zefeng Xu, **Lingkai Hu**, Yitong Zhou, "Pneumatic Soft Robotic Crawler Integrated With a Precurved Actuator Enables Fast Locomotion", ROBIO 2022, 2022. (Accepted [Second Author])
7. Zhuangcheng Fang, **Lingkai Hu**, Haibo Jiang, Shu Fang, Guifeng Zhao, Yuhong Ma, "Shear performance of high-strength friction-grip bolted shear connector in prefabricated steel-UHPC composite beams: Finite element modelling and parametric study", CASE STUD CONSTR MAT, 2023. (Accepted [First Student Author])
8. Wenkai Huang, Jiafu Wen, Weiming Gan, **Lingkai Hu**, Bingjun Luo, "Neighborhood Correlation Enhancement Network for PCB Defect Classification", TIM, 2023. (Accepted [Third Student Author])
9. **Lingkai Hu**, Wenkai Huang, Feng Zhan, Weiming Gan, "Moss: Adaptive Inductive Bias Attention for Efficient and Robust Sequence Processing", IEEE Transactions on Neural Networks and Learning Systems, (Under Review [First Author])
10. **Lingkai Hu**, Wenkai Huang, Weiming Gan, Feng Zhan, Kunbo Han, "Cuneate Recurrent Neural Network", IEEE Transactions on Artificial Intelligence. (Under Review [First Author])
11. **Lingkai Hu**, Feng Zhan, Wenkai Huang, Yikai Dong, Kunbo Han, "Category Knowledge-Guided Few-Shot Bearing Fault Diagnosis", Reliability Engineering & System Safety. (Under Review [Co-First Author])
12. **Lingkai Hu**, Feng Zhan, Wenkai Huang, Weiming Gan, "Ultron: A High-Performance Sequence-Processing Model Based on the Composite Mapping Layer", Neural Networks. (Under Review [First Author])
13. Collaborative Network of Multi-view Graph Disentanglement for PCB Defect Classification (Preparing [Second Author])

RESEARCH EXPERIENCE

Project: Research on High-Performance Large Language Model (Ultron) **06/2023 – 09/2023**

Research leader

- I designed and implemented Ultron, a novel sequence-processing model that efficiently handles long-range dependencies by using a composite mapping function with $O(L \log_2 L)$ complexity. I conducted experiments on four datasets to compare Ultron with other Transformer-based models and demonstrate its advantages in terms of accuracy, generalization, efficiency, and memory consumption. I also prepared and wrote a research paper that reported the project's methods, results, and conclusions.

Project: Research on Knowledge-Guided Few-Shot Bearing Fault Diagnosis **02/2023-Present**

Project Leader

- I proposed a novel framework, Category Knowledge as a Guide (CKG), for cross-domain fault diagnosis and early fault detection of rotating machinery. The CKG framework can extract category features from few-shot data and classify them into different domains. I designed and evaluated an algorithm based on the CKG framework and verified its performance experimentally.

Project: Research on the Optimization Efficiency of Long-Sequence Tasks (CRNN) **10/2022 – 08/2023**

Research leader

- I proposed and developed the Cuneate Recurrent Neural Network (CRNN), a novel model that adds a cuneate layer to the Recurrent Neural Network (RNN) to enhance information extraction and reduce memory decay. I demonstrated that CRNN can handle long signal sequence lengths better than other RNN models, by conducting experiments on various datasets involving music, image, text, and bearing classification.

Project: Research on the Generalized Attention Model (Moss) **03/2023-06/2023**

Research leader

- I examined self-attention mechanisms and the challenges they face in terms of complexity and robustness. To address these challenges, I proposed and designed an Adaptive Inductive Bias Attention (AIB) algorithm and a Moss model that can capture positional inductive relationships with lower complexity and higher robustness than Transformer-based models. I evaluated the performance of Moss on five datasets and demonstrated its superiority over Transformer-based models in accuracy, complexity, and robustness.

Project: Research on Printed Circuit Board Defect Detection **09/2021–Present**

Project Leader

- The project aimed to identify and classify defects in printed circuit boards (PCBs) using computer vision techniques and neural networks. I developed a visual matching algorithm that aligned defect maps and standard maps of PCBs with pixel accuracy. I proposed a Collaborative Network of Multi-view Graph Disentanglement (AMTCN) for PCB Defect Classification, which was designed to reduce computational complexity and improve the detection of similarities between functional and non-functional defect textures, as well as small defects. Our experimental comparison concluded that AMTCN achieved superior defect identification accuracy, minimal FLOPs, and Params with HRIPCB compared to 13 advanced models.

Project: Research on High-Strength Friction-Grip Bolt **04/2022-01/2023**

Project Leader

- I performed finite element analysis on the mechanical behavior and performance of high-strength friction-grip bolts (HSFGBs) and prefabricated ultra-high performance concrete (UHPC) slabs. I applied data analysis techniques to assess the outcomes and contrast them with existing methods.

Project: Research on Soft Crawler Robot **12/2021-Present**

Project Leader

- I developed a 3D surface fitting algorithm to measure the curvature of a soft robotic crawler on various surfaces. I also visualized the data and authored a research paper on the project's methodology, findings, and implications.

Project: Research on Soft Robotic Gripper **09/2021-Present**

Project Leader

- I developed a computer vision algorithm to measure the radius of the robot gripper and examined how it varied under different pressures. I also visualized the data and authored a research paper on the methods, results, and implications of the project.

Project: Research on Complex Mathematical Relationship Reasoning **01/2020 – 09/2021**

Research Leader

- I developed a neural network model that applied the successive over relaxation method and the principle of current confidence to solve mathematical problems. The model could eliminate incorrect answers and prevent training collapse by using customized loss functions. I evaluated the model performance on Sudoku puzzles, which I collected and preprocessed. I designed and implemented the entire neural network and validated it experimentally.

Project: Research on Medical Signal Analysis **08/2019 – 07/2020**

Principal Researcher

- I developed and implemented a novel method for medical signal analysis, named S-EEGNet, which combines empirical mode decomposition (EMD) and deformable convolution. I also conducted data visualization and contributed to experimental design. The method outperformed existing methods in terms of accuracy and robustness.

Project: Research on 3-PSS Three-DOF Space Parallel Robot **08/2018 – 02/2020**

Principal Researcher

- I contributed to the design and simulation of the robot motion algorithm using MATLAB and Simulink.

Project: Research on Medical Image Segmentation and Detection of Lung Cancer **05/2018 – 08/2019**

Project Leader

- I proposed a novel noise-based regularization technique for U-Net, which can enhance the detection of small early nodules in lung cancer images. I designed and evaluated the Noisy U-Net for Image Segmentation of Lung Cancer Candidate Boundaries on two public datasets and compared it with the original U-Net. The results showed that Noisy U-Net had higher sensitivity to low-level features and better performance in detecting small lung cancer nodules.

SOFTWARE & LANGUAGE SKILLS

- Python, C, Matlab, LaTeX, Markdown
- PyTorch, Tensorflow, Opencv