Zirui Liu

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ResearchGate·ORCID·Google Scholar·Github.io

Ph.D. Candidate in Electrical Engineering specializing in power electronics, electrical machines, and drives, seeking a postdoctoral or research assistant position.

SKILLS

Programming: C, MATLAB, Python, LaTeX

Tools: Simulink, Embedded Coder, Altium Designer, JMAG, Pspice

EDUCATION

Ph.D. in Electrical Engineering, Huazhong University of Sci. and Tech. Sept. 2019 – Exp. Jun. 2025

- Project: The National Natural Science Foundation of China (Grant 52377050)
- Thesis: "Nonlinear Electro-Thermal Parameters Real-Time Estimation for VSI Driven Electrical Machine System"
- Advisor: Professor **Ronghai Qu**
- Main Subjects: PMSM, Power Electronic, Modern Control & Observe Theory, Artificial Intelligence, Data & Model Fusion, Nonlinear Electrical Machine & Controller Model

B.Sc. in Electrical Engineering and Automation, Hunan University Sept. 2015 – Jun. 2019

- GPA**: 3.77/4.00** RANK: **2/263**
- Thesis: "Design of Modulation Method for High-speed PMSM"
- Advisor: Professor **Keyuan Huang**
- Main Subjects: PMSM, Nonlinear system, Sensorless Control, SiC MOSFET

PROJECTS

Grants Proposals Development 2022 – Present

- The project of the National Natural Science Foundation of China for power controller & electrical machine real-time monitoring in both electrical and thermal states
- The key project of the National Natural Science Foundation of China for fault-tolerant and high-power density integrated motor in more electrical aircraft application
- Contributed to the preparation of grant applications

100kW High Temperature Integrated Two-level VSI & PMSM System 2019 – 2023

- Power device, capacitor and other controller components early selection and design
- Design of SiC MOSFET module gate drive for high temperature operation (up to 175℃)
- Self-sensing and auto-tuning algorithm for dual three-phase PMSM with Embedded Coder
- Prototype testing in different operation condition with environmental simulation chamber (including high temperature, full load operation)

1200 V Cascaded Multilevel Converter 2019 – 2021

- Led early device selection and system modeling simulation
- Designed a gate driver for SiC MOSFET discrete devices and developed a 4-level single-phase

prototype
- Developed a capacitor voltage balancing and pre-charge strategy

1kW 28V Low Voltage High-speed Electrical Pump System 2020 – 2021
- Design of control chip, inverter and EMC in one PCB
- Low cost resistor-based phase current sampling with full-closed-loop position sensorless control
- Development of harmonic current injection for low electrolytic capacitance design
- Prototype testing in different operation condition

12kVA interleave DC/DC & Three Phase DC/AC Controller 2020 – 2022
- Schematic design of the control board and power board
- Testing of the integrated interleave Bidirectional DC/DC & Three Phase DC/AC
- Design of the three-layer controller & Power electronic drive & Power loop PCB structure.
- Control strategy for engine starter & generator integration using synchronous reluctance machine

All-In-One Thermal Controller for EV Application 2020 – 2022
- Design and testing of IGBT drive and EMC for integrated controller
- Loss calculation for thermal Finite element analysis
- PCB schematic and layout review
- Simulation design for PMSM and BLDC sensorless control

IPMSM Test Platform for EV application 2022 – 2024
- FEA for nonlinear flux characteristic analysis for IPMSM
- Up to 20 temperature sensors installed inside different positions
- Developing model & data fusion framework for real-time thermal modelling and temperature estimation
- Open sourced project on thermal modelling: LPTN-informed-LSTM

AWARDS

Three times National Scholarship 2016, 2017, 2024
Four times The first prize Scholarship 2018, 2022, 2023, 2024
Three times Merit Student 2016, 2017, 2018
Meritorious Winner in The Mathematical Contest in Modeling (MCM) Mar. 2017
Second Prize of Mid China Area in The National Undergraduate Electronic Design Contest Nov. 2017
Outstanding Winner in the Huawei Future Smart Car Competition Nov. 2021

PUBLICATIONS

Part I: Nonlinear Parameter Identification & Control
- **Z. Liu,** X. Fan, W. Kong, L. Cao and R. Qu, “Improved Small-Signal Injection-Based Online Multi-parameter Identification Method for IPM Machines Considering Cross-Coupling Magnetic Saturation”.
  IEEE Transactions on Power Electronics, vol. 37, no. 12, pp. 14362-14374, Dec. 2022
- **Z. Liu**, W. Kong, X. Fan and R. Qu, “Online Multi-Parameter Observation of IPM Machine with Reconstructed Nonlinear Small-Signal Model Based on Dual EKF”.
  IEEE Transactions on Industrial Electronics, vol. 71, no. 2, pp. 1234-1245, Feb. 2024

Part II: AC Machine Position Sensorless Control

- **Z. Liu,** B. Shen, W. Kong, X. Fan, K. Peng and R. Qu, "Analytical Approach for Position Observation Error Correction in IPMSM Sensorless Drives Using Online Multi-Parameter Estimation".
  IEEE Transactions on Power Electronics, 2024, Early Access, doi: 10.1109/TPEL.2024.3390809.
- **Z. Liu,** W. Kong, X. Fan, F. Wang and R. Qu, "Online Multiparameter Estimation with Position Error Correction for Unified Synchronous Machine Sensorless Drives".
  IEEE Energy Conversion Congress and Exposition (ECCE) , 2023, pp. 4882-4888
- **Z. Liu,** W. Kong, H. Liu, K. Peng, F. Wang, X. Fan, R. Qu. "Online Multiparameter Estimation with Position Error Correction for Unified Synchronous Machine Sensorless Drives."
  IEEE Transactions on Industry Applications, 2024, Early Access, doi: 10.1109/TIA.2024.3473898.

Part III: Real-time Thermal Modelling and Temperature Estimation

- **Z. Liu**, W. Kong, X. Fan, Z. Li, P. Kai, R. Qu, "Hybrid Thermal Modeling with LPTN-Informed Neural Network for Multi-Node Temperature Estimation in PMSM"
  IEEE Transactions on Power Electronics, 2024, vol. 39, no. 9, pp. 10897-10909, Sept. 2024.
- **Z. Liu**, W. Kong, X. Fan, Z. Li, P. Kai, R. Qu, "Hybrid Thermal Modeling with LPTN-Informed Neural Network for Multi-Node Temperature Estimation in PMSM"
  IEEE Dataport, doi: https://dx.doi.org/10.21227/sbwe-k671
- **Z. Liu**, W. Kong, X. Fan, H. Guo, K. Peng, R. Qu, "Electro-Thermal Fusion in Physics-Informed Neural ODEs for Noninvasive Stator and Rotor Temperature Estimation of PMSM" (In progress)

Others

- **Z. Liu,** W. Yu, H. Guo, W. Kong, C. Gan and R. Qu, "A Capacitor Voltage Sorting Algorithm for Modular Multilevel Converters (MMC) under Low-Frequency Carrier Modulation".
  International Conference on Electrical Machines and Systems (ICEMS), Harbin, China, 2019, pp. 1-4
- L. Li, X. Fan, **Z. Liu**, D. Li, T. Zou, X. Chen, R. Qu, "A Computationally Efficient Semi-Analytical Method for Circulating Current Loss of High-Speed Permanent Magnet Machines".
  IEEE Transactions on Energy Conversion, vol. 39, no. 1, pp. 675-687, March 2024
- Z. Li, W. Kong, **Z. Liu**, B. Shen and R. Qu, "A Novel Adaptive Nonlinear Reaching Law for DC-link Voltage Control of DC-biased Vernier Reluctance Generator".
  IEEE Transactions on Transportation Electrification, 2024, doi: 10.1109/TTE.2024.3398082
- Y. Shao, W. Kong, **Z. Liu**, H. Guo, L. Wang, D. Li and R. Qu, "Active zero-sequence voltage injection modulation strategy for capacitor current suppression in dual sector PMSM systems".
  Journal of Power Electronics, 2024, doi: 10.1007/s43236-024-00896-0
- H. Guo, Y. Shao, W. Kong, **Z. Liu**, L. Li and R. Qu, "A multi-frequency equivalent harmonic modeling method for digital discontinuous PWM".
  IEEE Journal of Emerging and Selected Topics in Power Electronics, 2024, doi: 10.1109/JESTPE.2024.3443278.
- H. Liu, X. Wu, W. Kong, G. Long, H. Lou, **Z. Liu**, D. Li, "Dead-Time Compensation Based on Current Phase Estimation for High-Frequency Cascaded Transformer Multilevel Inverter"
  IEEE Journal of Emerging and Selected Topics in Power Electronics, doi: 10.1109/JESTPE.2024.3407762. Early Access.
- H. Liu, W. Kong, G. Long, H. Lou, W. Long, D. Li, **Z. Liu**, M. Dong, Z. Zhao, Y. Wen. "Modeling and Optimization Algorithm of Coupling Noise for SiC MOSFET Active Gate Driver Considering Common-Source Inductance,"

IEEE Transactions on Power Electronics doi: 10.1109/TPEL.2024.3440267 Early Access.

- H. Zheng, J. Hao, M. Zha, **Z. Liu** and W. Kong, "Sensorless Control and Inductance Parameter Identification of PMSM Based on Two-Orientation High-Frequency Square Wave Injection". *IEEE 6th International Electrical and Energy Conference (CIEEC)*, Hefei, China, 2023, pp. 585-590
- L. Cao, X. Fan, D. Li, W. Kong, R. Qu and **Z. Liu**, "Improved LPTN-Based Online Temperature Prediction of Permanent Magnet Machines by Global Parameter Identification". *IEEE Transactions on Industrial Electronics*, vol. 70, no. 9, pp. 8830-8841, Sept. 2023
- R. Wang, X. Fan, D. Li, R. Qu, **Z. Liu** and L. Li, "Comparison of Heat Transfer Characteristics of the Hollow-Shaft Oil Cooling System for High-Speed Permanent Magnet Synchronous Machines". *IEEE Transactions on Industry Applications*, vol. 58, no. 5, pp. 6081-6092, Sept.-Oct. 2022
- S. Yang, W. Kong, Z. Li, **Z. Liu**, "Parameter Identification for DC-biased Vernier Reluctance Motor Considering Harmonic Current and Inverter Nonlinearity". *International Conference on Smart Energy and Electrical Engineering (SEEE)*, Wuhan, China, 2022

SERVICES

Reviewer:

- IEEE Transactions on Power Electronics
- IEEE Transactions on Transportation Electrification
- IEEE Journal of Emerging and Selected Topics in Power Electronics
- IEEE Transactions on Industrial Informatics

Conference

- Reviewer of the 7th International Electrical and Energy Conference 2024 (CIEEC 2024)
- Reviewer of the 26th international Conference on Electrical Machines and Systems 2023 (ICEMS 2023)
- Reviewer & Volunteer of the 6th International Electrical and Energy Conference 2024 (CIEEC 2023)
- Section Chair of the 3rd China International Youth Conference on Electrical Engineering (CIYCEE 2022)

Open Sourced Project on Real-Electrical Machine Temperature Prediction

- LPTN-informed-LSTM: The implementation and results of a LPTN-informed LSTM for multi-node temperature estimation in PMSMs.

Open Sourced Project on Embedded Code for Electrical Machine Drive

- SynMotor_FSO_ParamEst: Simulations and code for model-based sensorless control of synchronous machines, integrating a full state observer.

Open Sourced Project on System Estimation under Electrical Machine Sensorless Control

- AdaptParamOb_ACMotorSensorlessControl: Model-based adaptive observer for unified synchronous machine sensorless drives in full speed region, including code, simulation in both Matlab and python.

INTERNSHIPS

Hardware Developer, Huawei Intelligent Vehicle Solutions BU, Shanghai, China Feb. 2021 – Apr. 2021
Project: All-In-One Integrated Thermal Management Controller Design for EV Application

- Power electronics loss calculation for thermal analysis
- PCB schematic and layout review
- Final report editing