

Wentao Zhang

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Education

Southeast University

2021/09 - 2025/09 (Expected)

Ph. D. in Electrical Engineering

Nanjing, Jiangsu, China

- Dissertation Title: “Multi-physics Analysis and Design of Flat Wire Winding PM machines in Electric Vehicles”

Southeast University

2018/09 - 2021/06

Master in Electrical Engineering

Nanjing, Jiangsu, China

- Dissertation Title: “Analysis and Design of High-Performance Wound-Excited Magnetic Field Modulation-based Brushless Machines”

Southeast University

2014/09 - 2018/06

B.Eng in Electrical Engineering

Nanjing, Jiangsu, China

- Dissertation Title: “Comparative Study of Control Systems for PM Machine in Electric Vehicles”

Research Experience

My research focuses on the multi-physics design, analysis and control of the high power/torque density electric machine system applied in electric vehicles (EVs), including the flat wire PM machines and wound field excited machines. Twenty one IEEE Transaction papers have been published and two more are under review. In general, my research can be divided into three parts.

The first part is the design methods for the high-performance electric machines in EVs, including the novel n-layer flat wire winding design and performance evaluation, DC winding induced voltage analysis and suppression for the wound excited electric machines and mechanism driven multi-objective optimization methods. **The second part is the advanced cooling system design and analysis for the electric machines in EVs**, both high resolution lumped parameter thermal model and the fluid-solid strong coupled oil cooling system are developed for the EV used electric machines. **The third part is the control and dynamic modeling for the electric machine system in EVs**, in which the control strategy, converter characteristics and the spatial harmonic electric machine model have been applied.

Research Publication

Transaction/Journal Paper

- [J1] **W. Zhang**, W. Hua, Z. Wu, G. Zhao, Y. Wang and W. Xia, “Analysis of DC Winding Induced Voltage in Wound-Field Flux-Switching Machine With Air-Gap Field Modulation Principle,” **IEEE Trans. Ind. Electron.**, vol. 69, no. 3, pp. 2300-2311, March 2022.
- [J2] **W. Zhang** et al., “Reduction of Open-Circuit DC Winding Induced Voltage and Torque Pulsation in the Wound Field Switched Flux Machine by Stator Axial Pairing of Tooth Tips,” **IEEE Trans. Ind. Appl.**, vol. 58, no. 2, pp. 1976-1990, March-April 2022.
- [J3] **W. Zhang**, Z. Wu, Y. Fan, W. Hua and M. Cheng, “A Stable and Computationally Efficient Spatial Harmonic Model for Predicting the DC Winding Induced Voltage in WFSF Machine,” **IEEE Trans. Ind. Appl.**, vol. 59, no. 4, pp. 3966-3977, July-Aug. 2023.
- [J4] **W. Zhang**, Z. Wu, L. Jin, Y. Fan, W. Hua and M. Cheng, “Analysis and Multi-Objective Optimization of the Hybrid Excitation Switched Flux Machine,” **IEEE Trans. Ind. Appl.**, vol. 61, no. 2, pp. 2996-3006, March-April 2025.
- [J5] **W. Zhang**, Z. Wu, Y. Fan, W. Hua and M. Cheng, “Analysis and Improvement of DC Winding Current Dynamics in Wound Field Switched Flux Machine,” **IEEE Trans. Ind. Appl.**, vol. 60, no. 4, pp. 6023-6032, July-Aug. 2024.
- [J6] **W. Zhang**, Z. Wu and W. Hua, “Design of n-Layer Flat Wire Winding in Permanent Magnet Machine for Electric Vehicles,” **IEEE Trans. Transport. Electrific.**, doi: 10.1109/TTE.2025.3532407. (early access)
- [J7] **W. Zhang**, Z. Wu, L. Jin, Y. Fan, W. Hua and M. Cheng, “Analysis and Multi-Objective Optimization of the Hybrid Excitation Switched Flux Machine,” **IEEE Trans. Ind. Appl.**, vol. 61, no. 2, pp. 2996-3006, March-April 2025.
- [J8] **W. Zhang**, Z. Wu, L. Jin, Y. Fan, W. Hua and M. Cheng, “Design Tradeoff between Flux Regulation Capability and DC Winding Induced Voltage in Hybrid Excitation Switched Flux Machine,” **IEEE Trans. Ind. Appl.** (accepted).
- [J9] **W. Zhang**; Y. Fan.; Z. Q. Zhu; Z. Wu; W. Hua; M. Cheng. “Analysis of DC Winding Induced Voltage in Wound-Rotor Synchronous Machines by Using the Air-Gap Field Modulation Principle.” **World Electr. Veh. J.** 2022, 13, 215.

- [J10] **W. Zhang**, Z. Wu and W. Hua, "Space-Resolved Lumped Parameter Thermal Model for Oil-Cooling Flat Wire Winding PM Machines," **IEEE Trans. Ind Appl.** (under review)
- [J11] Z. Wu, **W. Zhang**, and W. Hua, "Performance Evaluation of Flat Wire Windings for Permanent Magnet Machines in Electric Vehicles," **IEEE Trans. Ind. Electron.** (under review)
- [J12] Z. Wu, **W. Zhang**, Y. Fan, W. Hua and M. Cheng, "A Transient-State Lumped Parameter Thermal Model for Brushless Wound Field Switched Flux Machines," **IEEE Trans. Transport. Electrific.**, vol. 10, no. 1, pp. 224-238, March 2024.
- [J13] Z. Wu, Z. Q. Zhu, C. Wang, W. Hua, K. Wang and **W. Zhang**, "Influence of rotor iron bridge position on DC-winding-induced voltage in wound field switched flux machine having partitioned stators," **Chinese Journal of Electrical Engineering**, vol. 7, no. 3, pp. 20-28, Sept. 2021.
- [J14] Z. Wu, Z. Q. Zhu, S. Cai, W. Hua and **W. Zhang**, "Enhancement of torque density in wound field switched flux machines with partitioned stators using assisted ferrites," **Chinese Journal of Electrical Engineering**, vol. 7, no. 3, pp. 42-51, Sept. 2021.
- [J15] Z. Wu, L. Jin, W. Hua, **W. Zhang** and M. Cheng, "Harmonics Orders Modelling of DC Winding Induced Voltage Pulsation in Wound Field Switched Flux Machines under PWM Excitation," **IEEE Trans. Transport. Electrific.**, vol. 10, no. 3, pp. 7040-7050, Sept. 2024.
- [J16] Z. Wu, L. Jin, **W. Zhang**, Y. Fan, W. Hua and M. Cheng, "Influence of PWM Excitation on DC Winding Induced Voltage Pulsation in Wound Field Switched Flux Machines," **IEEE Trans. Ind Appl.**, vol. 60, no. 1, pp. 460-476, Jan.-Feb. 2024.
- [J17] Zhongze Wu, Z. Q. Zhu, Wei Hua, Sam Akehurst, Xiaofeng Zhu, **Wentao Zhang**, Jie Hu, Haoyang Li, Junming Zhu, "Analysis and Suppression of Induced Voltage Pulsation in DC Winding of Five-Phase Wound-Field Switched Flux Machines," **IEEE Transactions on Energy Conversion**, vol. 34, no. 4, pp. 1890-1905, Dec. 2019.
- [J18] Z. Wu, L. Jin, W. Hua, **W. Zhang** and M. Cheng, "Harmonics Orders Modeling of DC Winding Induced Voltage Pulsation in Wound Field Switched Flux Machines Under PWM Excitation," **IEEE Trans. Transport. Electrific.**, vol. 10, no. 3, pp. 7040-7050, Sept. 2024.
- [J19] Z. Wu, L. Jin, **W. Zhang**, Y. Fan, W. Hua and M. Cheng, "Influence of PWM Excitation on DC Winding Induced Voltage Pulsation in Wound Field Switched Flux Machines," **IEEE Trans. Ind Appl.**, vol. 60, no. 1, pp. 460-476, Jan.-Feb. 2024.
- [J20] L. Jin, W. Hua, U. Akuru, Z. Wu, **W. Zhang** and M. Cheng, "Comparative Study on DC Winding Induced Voltage Pulsation of Wound Field Flux Modulation Machines Having Different Iron Core Structures," **IEEE Trans. Ind Appl.**, doi: 10.1109/TIA.2023.3327033 (early access).
- [J21] X. Yan, Z. Wu, W. Hua, **W. Zhang** and M. Cheng, "A Mathematical Model for Wound Field Switched Flux Machine Considering Inductance Harmonics of Field and Armature Windings," **IEEE Trans. Ind Appl.**, vol. 60, no. 5, pp. 6811-6822, Sept.-Oct. 2024.
- [J22] H. Hua, X. Chen, D. Li, **W. Zhang**, Z. Wu and W. Hua, "Investigation of Torque Improvement of Modular Stator Surface-Mounted Permanent Magnet Machines With Flux Gaps," **IEEE Trans. Ind Appl.**, vol. 60, no. 5, pp. 6787-6798, Sept.-Oct. 2024.
- [J23] Jixuan Chen, Wei Hua, Lingyun Shao, Zhongze Wu, Xueyi Yan, and **Wentao Zhang**, "Modified magnetic equivalent circuit of double-stator single-rotor axial flux permanent magnet machine considering stator radial-end flux-leakage," **IET Electric Power Applications**, vol. 18, no. 2, pp. 195-207, Feb. 2024.

Conference Paper

- [C1] **W. Zhang**, Z. Wu, W. Hua, Y. Fan, Z. Xu and M. Cheng, "Design Tradeoff between Flux Regulation Capability and DC Winding Induced Voltage in Hybrid Excitation Switched Flux Machine," in Proc. IEEE Energy Convers. Congr. Expo., Nashville, TN, USA, 2023, pp. 5060-5066.
- [C2] **W. Zhang**, Z. Wu, L. Jin, Y. Fan, W. Hua and M. Cheng, "Analysis and Multi-Objective Optimization of the Hybrid Excitation Switched Flux Machine," in Proc. Int. Elect. Energy Conf. , Hefei, China, 2023, pp. 3371-3376. (**Best Paper Award**)
- [C3] **W. Zhang**, Z. Wu, W. Hua, Y. Fan and M. Cheng, "Influence of the End-Effect in Wound Field Switched Flux Machine," in Proc. Int. Conf. Elect. Mach. Syst., Zhuhai, China, 2023, pp. 1223-1227.
- [C4] **W. Zhang**, Z. Wu, Y. Fan, W. Hua and M. Cheng, "Analysis and Improvement of DC Winding Current Dynamics in Wound Field Switched Flux Machine," in Proc. Int. Conf. Energy Technol. Future Grids, Wollongong, Australia, 2023, pp. 1-6.

- [C5] **W. Zhang**, Z. Wu, Y. Fan, W. Hua and M. Cheng, “A Stable and Computationally Efficient Spatial Harmonic Model for Predicting the DC Winding Induced Voltage in WFSF Machine,” in Proc. Energy Convers. Congr. Expo., Detroit, MI, USA, 2022, pp. 1-7.
- [C6] **W. Zhang**, Z. Wu, W. Hua and Z. Q. Zhu, “Reduction of Open-Circuit DC Winding Induced Voltage and Torque Pulsation in the Wound Field Switched Flux Machine by Stator Axial Pairing of Tooth-Tips,” in Proc. IEEE Int. Elect. Mach. Drives Conf., Gothenburg, Sweden, 2020, pp. 522-528.
- [C7] L. Jin, W. Hua, U. Akuru, Z. Wu, **W. Zhang** and M. Cheng, “Comparative Study on DC Winding Induced Voltage Pulsation of Wound Field Flux Modulation Machines Having Different Iron Core Structures,” in Proc. Int. Conf. Elect. Mach. Syst., Zhuhai, China, 2023, pp. 442-447.
- [C8] M. P. Koroma, W. Hua, Z. Wu, L. Jin and **W. Zhang**, “Influence of Magnet Layer Numbers on Electromagnetic Performance of Interior Permanent Magnet Machines,” in Proc. Int. Conf. Elect. Mach. Syst., Zhuhai, China, 2023, pp. 696-700.
- [C9] X. Yan, Z. Wu, W. Hua, **W. Zhang** and M. Cheng, “A Mathematical Model for Wound Field Switched Flux Machine Considering Inductance Harmonics of Field and Armature Windings,” in Proc. IEEE Int. Elect. Mach. Drives Conf., San Francisco, CA, USA, 2023, pp. 1-6.
- [C10] Z. Wu, Lai Jin, **Wentao Zhang**, Xueyi Yan, Haorui Ge, Hao Hua, “A Lumped Parameter Thermal Model for Variable Flux Reluctance Machine Considering Relative Position of DC and AC Windings,” in Proc. Int. Conf. Elect. Mach., Torino, Italy, 2024, pp. 1-7.

Patent

- Wu Zhongze; **Zhang Wentao**; Mao Xixuan; Hua Wei, Method, Device, Storage Medium, and Flat Wire Winding for Generating Windings of Flat Wire Permanent Magnet Motors with Arbitrary Layers, CN119298577A, 2025.01.10.
- Wu Zhongze; **Zhang Wentao**; Hua Wei; Zou Zhixiang, Temperature Calculation Method for Drive Motors Using Temperature-Fluid Weak Coupling Technology, CN119294277A, 2025.01.10.
- Wu Zhongze; **Zhang Wentao**; Fu Erfang; Hua Wei; Liu Kai, General Modeling Method for Magnet Slot to Reduce Stress Concentration in Embedded Permanent Magnet Motor Rotors, CN119004896A, 2024.11.22.
- Wu Zhongze; **Zhang Wentao**; Hua Wei, Mechanism-Driven Optimization Method for Hybrid Excitation Motors with Multiple Operating Modes, CN118886378A, 2024.11.01.
- Wu Zhongze; **Zhang Wentao**; Hua Wei, Optimization Design Method for Embedded Permanent Magnet Motor Rotors with Low Torque Ripple and Low Noise, CN118826334A, 2024.10.22.
- Wu Zhongze; **Zhang Wentao**; Jin Lai; Hua Wei, Disc-Type Brushless Electric Excitation Field Modulation Motor with Double-Row Stator Structure, CN118100572A, 2024.05.28.
- Wu Zhongze; **Zhang Wentao**; Hua Wei; Zou Zhixiang, Establishment Method of General Lumped Parameter Thermal Network Model for Motors, CN117094088A, 2023.11.21.
- Wu Zhongze; **Zhang Wentao**; Liao Junxiang; Fan Ying; Hua Wei; Cheng Ming, Method for Suppressing Pulsating Induced Voltage in Excitation Windings Based on Harmonic Current Injection, CN115208245A, 2022.10.18.
- Wu Zhongze; **Zhang Wentao**; Fan Ying; Hua Wei; Cheng Ming, High-Precision Field-Circuit Coupling Design Method for Brushless Electric Excitation Field Modulation Motors, CN114781227A, 2022.07.22.
- Hua Wei; **Zhang Wentao**; Wu Zhongze; Ding Shichuan, Method for Reducing Torque Ripple and Induced Voltage in Electric Excitation Flux Switching Motors, CN111769697A, 2020.10.13.

Awards

- 2024 2nd Prize in 11th Energy Equipment Innovative Design Competition for China Postgraduate
- 2023 **Wiscom System Scholarship**
- 2023 1st Prize Academic Scholarship
- 2023 CIEEC Best Paper Award
- 2023 **1st Prize in IEEE IAS CMD Thesis Contest (non-Ph. D)**
- 2022 Outstanding Master Degree Thesis in Jiangsu Province
- 2017 2nd Prize in Southeast University Smart Car Competition

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