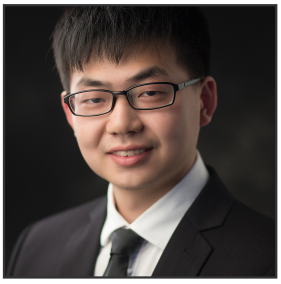

Zhao **FENG**

Mechatronic Engineering · Ph.D. candidate

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"What doesn't kill you makes you stronger."

Summary

I received the PH.D. degree of Mechatronic Engineering from the School of Power and Mechanical Engineering, Wuhan University, China in June, 2020. I also studied at the Department of Electrical and Computer Engineering, National University of Singapore (NUS), Singapore, for one year as a joint PhD student. My research interests include iteration learning control, sliding mode and adaptive control, impedance control for precision position or force tracking with applications to piezoelectric-actuated devices, such as nanopositioning stages and ear surgical device. In the future, I will continue to devote myself to developing practical and significant control methods for robotic systems, smart or soft materials as well as surgical devices.

Education

Wuhan University (Supervisor: Prof. Xiaohui XIAO) — *No.299, Bayi Road, Wuhan, Hubei Province, P.R. China 430072*

PhD in Mechatronic Engineering — *2014.09 - 2020.06*

B.Eng. in Mechanical Design, Manufacturing and Automation — *2010.09 - 2014.06*

National University of Singapore (Supervisor: Prof. Tong Heng LEE and Prof. Kok Kiong TAN) — *3 Engineering Drive 3, Singapore 117582*

Joint PhD student (Sponsored by China Scholarship Council) — *2019.01 - 2020.01*

Research

Research Interests

Controller Design

- Mechatronics, robotics
- Damping controller design for high-bandwidth position tracking
- Iterative learning and repetitive control, disturbance/state observer technology
- Sliding mode control, adaptive control, force and impedance control

Research Applications

Experimental Test

- 3-DoF piezoelectric actuator-driven nanopositioner for high-speed and precision motion or positioning for image scanning of scanning probe microscopes
- Piezoelectric actuator-based ear surgical device with application to office-based myringotomy and grommet insertion for patients with otitis media with effusion

Projects

Fast and Precise Control of Micro-Manipulators Based on Error Compensation Strategy in Frequency Domain — *Wuhan University*

Natural Science Foundation of China (Grant No. 51375349), Participant — *2014.09 - 2017.12*

- Set up experimental platform based on Simulink Real-Time with data acquisition card (PCI 6289, National Instrument) and a 3-DoF piezoelectric actuator-driven nanopositioner (P-561.3CD, Physik Instrumente)
- Design a data-based feedforward controller for a coupled parallel nanopositioning stage to eliminate the cross-coupling effects and hysteresis nonlinearity without any modeling process for fast repetitive motion
- Propose the bandwidth-enhanced damping controller to make the closed-loop bandwidth exceeds the dominating resonant frequency in order to improve motion speed
- Linear time-varying Q-filter design for high-bandwidth and flexible tracking via discrete wavelet transform to make iterative learning control track varying references

Rapid and Precise Motion Control of Micro-manipulators for Multi-axis and Multi-Task Applications *Wuhan University*

Shenzhen Science and Technology Program (Grant No. JCYJ20170306171514468), Participant *2017.05 - 2019.05*

- Set up experimental platform based on a real-time controller (MicroLabBox, dSPACE) and a linear motor motion stage (LMAC-ES17065-4, AEROTECH)
- Flexible tracking for multi-task applications based on model-data iterative learning control
- Design of disturbance rejection method through repetitive control and disturbance or extend state observer to improve the robustness of the system
- Multi-axis linear and nonlinear contour tracking based on position domain iterative learning control algorithm
- Design a novel signal-transformation based repetitive controller dedicated to accurate and fast tracking of spiral trajectory with simple structure and less parameters

Office-based Ventilation Tube Applicator for Patients with Otitis Media with Effusion *National University of Singapore*

Science and Engineering Research Council (SERC), Singapore (SERC Grant No. 103 149 0002), Participant *2019.01 - 2020.01*

- Develop an adaptive integral terminal sliding mode force control scheme for the piezoelectric actuator-based ear surgical device to achieves desired force tracking without modeling the complex soft interaction
- Formulate the integral terminal sliding mode based adaptive integral backstepping control to accommodate friction, hysteresis nonlinearity, model uncertainties as well as external disturbance and retain high tacking precision for the ear surgical device
- Propose an integral backstepping impedance force control for precision interaction force tracking on soft environment based on nonlinear Hunt-Crossley model with experimental verification
- Develop an adaptive integral terminal sliding-mode-based impedance control for the piezoelectric actuator-based ear surgical device with soft interaction to regulate position and force simultaneously with experiments on a mock membrane

Skills

Language

Communication

Native in Chinese; Fluent in English (IELTS: 6.5)

Software

Programming

MATLAB/Simulink, LabVIEW, dSPACE, LaTeX, Microsoft Office

Honors & Awards

International

2016.08 **Best Student Paper Award,** International Conference on Intelligent Robotics and Applications *Tokyo, Japan*

2018.07 **Finalist,** IEEE International Conference on Advanced Robotics and Mechatronics (ICARM) *Singapore*

Domestic

2012.12 **3rd Prize Scholarship,** Semester year of 2011 as undergraduate (top 15%) *Wuhan University*

2013.12 **1st Prize Scholarship,** Semester year of 2012 as undergraduate (top 5%) *Wuhan University*

2013.12 **National Encouragement Scholarship,** Semester year of 2012 as undergraduate (top 2%) *Wuhan University*

2014.06 **Outstanding Graduate,** Undergraduate students in Wuhan University *Wuhan University*

2017.09 **2nd Prize Scholarship,** Semester year of 2016 as graduate *Wuhan University*

2018.06 **State Scholarship,** As a Joint PH.D. student supported by China Scholarship Council(CSC) *CSC*

2020.06 **Outstanding Graduate,** Graduate students in Wuhan University *Wuhan University*

Publications

Journal Papers (First Author)

[1] **Feng, Z.**, Ling, J.,Ming, M., Liang, W.Y., Tan, K.K., & Xiao, X.H. Signal-transformation-based repetitive control of spiral trajectory for piezoelectric nanopositioning stages, *IEEE/ASME Transactions on Mechatronics*, 25(3), 1643-1645. (IF=5.673, Q1)

[2] **Feng, Z.**, Liang, W.Y., Ling, J., Xiao, X.H., Tan, K.K.& Lee, T.H. Integral terminal sliding mode based adaptive integral backstepping control for precision motion of a piezoelectric ultrasonic motor. *Mechanical Systems and Signal Processing*, 144C 106856, 2020. (IF=6.471, Q1)

[3] **Feng, Z.**, Liang, W.Y., Ling, J., Xiao, X.H., Tan, K.K.& Lee, T.H. Adaptive integral terminal sliding mode control for precision force tracking of a piezoelectric actuator-based ear surgical device. *IEEE Transactions on Industrial Electronics* , Under Review. (IF=7.515, Q1)

[4] **Feng, Z.**, Liang, W.Y., Ling, J., Xiao, X.H., Tan, K.K.& Lee, T.H. Adaptive robust impedance control for a piezo-actuated ear surgical device with soft interaction. *IEEE/ASME Transactions on Mechatronics*, Under Review. (IF=5.673, Q1)
[5] **Feng, Z.**, Ling, J., Ming, M., & Xiao, X.H. (2019). Integrated modified repetitive control with disturbance observer of piezoelectric nanopositioning stages for high-speed and precision motion. *Journal of Dynamic Systems, Measurement, and Control*, 141(8), 081006. (IF=1.304, Q3)
[6] **Feng, Z.**, Ling, J., Ming, M., & Xiao, X.H. (2018). A model-data integrated iterative learning controller for flexible tracking with application to a piezo nanopositioner. *Transactions of the Institute of Measurement and Control*, 40(10), 3201-3210.(IF=1.649, Q3)
[7] **Feng, Z.**, Ling, J., Ming, M., &Xiao, X.H. (2017). Data-based double-feedforward controller design for a coupled parallel piezo nanopositioning stage. *Proceedings of the Institution of Mechanical Engineers, Part I: Journal of Systems and Control Engineering*, 231(10), 881-892. (IF=1.386, Q4)
[8] **Feng, Z.**, Ling, J., Ming, M., & Xiao, X. H. (2017). High-bandwidth and flexible tracking control for precision motion with application to a piezo nanopositioner. *Review of Scientific Instruments*, 88(8), 085107. (IF=1.48, Q3)

Journal Papers (Co-author)

[1] Ling, J., **Feng, Z.**, Zheng, D.D., Yang, J., Yu, H.Y., & Xiao, X.H. Robust adaptive motion tracking of piezoelectric actuated stages using online neural-network-based sliding mode control. *Mechanical Systems and Signal Processing*, 150, 107235. (IF=6.471, Q1)
[2] Ye, T.T., Ling, J., Kang, X., **Feng, Z.**, & Xiao, X.H. (2020). A Novel Two-stage Constant Force Compliant Microgripper. *Journal of Mechanical Design*, 1-14. (IF=2.652, Q2)
[3] Ling, J., **Feng, Z.**, Kang, X., & Xiao, X.H. (2020). Bandwidth enhancement in damping control for piezoelectric nanopositioning stages with load uncertainty: Design and implementation. *Journal of Vibration and Control*, 1077546320941705.(IF=2.169, Q2)
[4] Ling, J., Rakotondrabe, M., **Feng, Z.**, Ming, M., & Xiao, X.H. (2019). A robust resonant controller for high-speed scanning of nanopositioners: design and implementation. IEEE Transactions on Control Systems Technology, 28(3), 1116-1123. (IF=5.312, Q1)
[5] Ling, J., **Feng, Z.**, Ming, M., Guo, Z., & Xiao, X.H. (2020). Signal transformed internal model control for non-raster scanning of piezo-actuated nanopositioning stages. *International Journal of Control, Automation and Systems*, 18, pages1915–1925. (IF=2.733, Q3)
[6] Ling, J., **Feng, Z.**, Ming, M., & Xiao, X.HX. (2019). Model reference adaptive damping control for a nanopositioning stage with load uncertainties. *Review of Scientific Instruments*, 90(4), 045101.(IF=1.48, Q3)
[7] Ling, J., **Feng, Z.**, Ming, M., & Xiao, X.H. (2018). Damping controller design for nanopositioners: A hybrid reference model matching and virtual reference feedback tuning approach. International Journal of Precision Engineering and Manufacturing, 19(1), 13-22. (IF=1.378, Q3)
[8] Ming, M., **Feng, Z.**,Ling, J., & Xiao, X.H. (2020). Disturbance observer-based model prediction control with real-time modified reference for a piezo-actuated nanopositioning stage. Transactions of the Institute of Measurement and Control, 42(4), 813-822. (IF=1.956, Q3)
[9] Ming, M., Ling, J., **Feng, Z.**, & Xiao, X.H. (2018). A model prediction control design for inverse multiplicative structure based feedforward hysteresis compensation of a piezo nanopositioning stage. *International Journal of Precision Engineering and Manufacturing*, 19(11), 1699-1708. (IF=1.779, Q3)
[10] Ling, J., **Feng, Z.**, Yao, D., & Xiao, X.H. (2018). Non- linear contour tracking using feedback PID and feedforward position domain cross-coupled iterative learning control. *Transactions of the Institute of Measurement and Control*, 40(6), 1970-1982.(IF=1.649, Q3)
[11] Ling, J., **Feng, Z**., Ming, M., & Xiao, X.H. (2018). Precision contour tracking using feedback-feedforward integrated control for a 2-DoF manipulation system. *International Journal of Robotics and Automation*, 33(3).(IF= 0.987, Q4)
[12] Ling, J., Zheng, D.D., **Feng, Z.**, Pan, Y.P., Yu, H.Y., & Xiao, X.H. Model-inversion-like Iterative Learning Control of Uncertain Nonlinear Systems using Neural Networks, *ISA Transactions*, Major Revision. (IF=4.343, Q1)

Conference Papers (First Author)

[1] **Feng, Z.**, Ling, J., Ming, M., & Xiao, X.H. (2016, August). Data-driven feedforward decoupling filter design for parallel nanopositioning stages. In International Conference on Intelligent Robotics and Applications (pp. 709-720). Springer, Cham.
[2] **Feng, Z.**, Ling, J., Ming, M., & Xiao, X.H. (2019, July). Model-Assisted Extended State Observer based Repetitive Control for High Precision Tracking of Piezoelectric Nanopositioning Stages. In 2019 Chinese Control Conference (CCC) (pp. 6900-6905). IEEE.

Co-author papers

[1] Liang, W.Y., **Feng, Z.**, Wu, Y., Ren, Q.Y., Lee, T.H. Robust Force Tracking Impedance Control of an Ultrasonic Motor-actuated End-effector in a Soft Environment. 2020 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2020), Accept.
[2] Ling, J.,**Feng, Z**, Yao, D., & Xiao, X.H. (2016, July). A position domain iteration learning control for contour tracking with application to a multi-axis motion testbed. In 2016 American Control Conference (ACC) (pp. 1247-1252). IEEE.
[3] Ling, J., **Feng, Z.**, Ming, M., Guo, Z., & Xiao, X.H. (2018, July). Integrating Damping Control with Iterative Learning Control for Fast and Precise Scanning of Nanopositioners: A TITO Design. In 2018 3rd International Conference on Advanced Robotics and Mechatronics (ICARM) (pp. 183-188). IEEE.
[4] Ming, M., **Feng, Z.**, Ling, J., & Xiao, X.H. (2019, October). Disturbance Observer Based Model Prediction Control for a 2-DOF Nanopositioning Stage. In IECON 2019-45th Annual Conference of the IEEE Industrial Electronics Society (Vol. 1, pp. 5211-5216). IEEE.
[5]Ling, J., Ye, T.T, **Feng, Z.**, Ming, M., & Xiao, X.H. (2019). Damping Controller Design for Triangular Scanning of a Third-Order Nanopositioning Stage. The International Conference on Control, Automation, and Systems (ICCAS), 412-417.