Zhen Zhu

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EDUCATION

Tsinghua University (#**16** in 2024 US NEWS) ***09/2022 – 06/2025***
MSc in Mechanical Engineering
GPA: 3.86/4.0 Rank: **21/118**
Master thesis: "Real-time chatter detection and suppression in robotic milling"

Tianjin University (#**195** in 2024 US NEWS) ***09/2018 – 06/2022***
BSc in Mechanical Engineering
GPA: 3.72/4.0 Rank: **8/194**
Bachelor thesis: "Design and performance study of ultrasonic scalpel for vertebra cutting"

PUBLICATIONS

- F. Feng, **Z. Zhu**, M. Yuan, K. Zhou, J. Blumberg, E.L. Jiang, E. Uhlmann, P.F. Feng*, Functionalization and prediction of end milling surface topography based on a quantitative indicator of chatter and forced vibration. ***International Journal of Machine Tools and Manufacture***, (2024) in press. (IF=14, JCR-Q1, first author is supervisor)
- **Z. Zhu**, F. Feng*, H. Wu, C.M. Wu, J. Blumberg, E.L. Jiang, P.F. Feng, Real-time chatter suppression in robotic milling via continuous spindle speed variation. ***Journal of Sound and Vibration***, (2024) in press. (IF=4.3, JCR-Q1)
- F. Feng*, X.G. Song, Y. Zhang, **Z. Zhu**, H. Wu, P.F. Feng*, A rapid method to quantify high-frequency-domain signals based on fixed-interval fractal dimension. ***Fractal and Fractional***, 8 (2024) 455. (IF=3.6, JCR-Q1), see here via publisher.

PROJECTS

Project 1: Real-time vibration suppression in robotic milling ***09/2023 – 10/2024***
Supported by Sino-German Mobility Program, directed by Dr. Feng Feng

Part 1-Robotic milling system construction

Foundational "donkeywork" for robotic milling on metals and polymers, lab's first robotic milling system.

- Constructed from scratch, integrating an ABB IRB6700 robot, high-speed spindle, Siemens PLC, pneumatic and cooling systems, and cutting tools. Calibrated with a maximum error of 0.75 mm and an average error of 0.3 mm—enough for common milling tasks.
- Developed a LabVIEW-based control system on PC for managing the robot, spindle, and auxiliary subsystems. Achieved motion delays under 10 ms for routine tasks and around 150 ms for complex operations like tool changes and path clearing, enhancing automation and remote control.
- Integrating a KUKA KR-60 robot for large-sized (3 m×1.5 m) polymer milling , targeting a 330 ms communication delay for collaborative milling between two robots.
- Half-month academic exchange to Technical University Berlin, Germany.

Part 2-Real time chatter detection and suppression

- Developed a LabVIEW-based real-time chatter detection and suppression system using accelerometers, reducing detection-to-suppression delay to the millisecond level, down from second level in previous work. Quantitatively analyzed surface quality across different delay levels (10 ms, 100 ms, 1 s, 5 s).

- Investigated self-excited vibration mechanisms, robotic and cutting dynamics, and integrated effective detection and suppression strategies, focusing on fast implementation and response while minimizing complexity, advancing the practical application of digital twin technology.
- Produced a paper, now in press with ***Journal of Sound and Vibration***

Project 2: Real-time surface reconstruction and vibration quantification ***10/2023 – 10/2024***
Supported by Shenzhen Natural Science Foundation, directed by Dr. Feng Feng

- Proposed a quantitative indicator that quantifies self-excited and forced vibrations during end milling, surpassing the binary "vibration or not" approach while incorporating surface quality evaluation. The indicator achieves a strong correlation with surface roughness Ra^2 ($r = 0.98$) and enables targeted vibration control, improving operational efficiency by up to 20%.
- Developed a real-time surface reconstruction and quality evaluation method using acceleration signals and a pre-trained 1D CNN, trained on 1,160 sets of real milled surface topography images. The method achieved up to 84% surface reconstruction accuracy, with predicted *Ra* values showing less than 0.5 μm error compared to actual *Ra* values, supporting its integration into digital twin systems for manufacturing.
- Produced a paper, now in press with ***International Journal of Machine Tools and Manufacture***

Project 3: Design and performance study of ultrasonic scalpel ***12/2021 – 06/2022***
Undergraduate Thesis, directed by Prof. Fujun Wang

- Designed and optimized an ultrasonic scalpel for vertebra cutting using titanium alloy TC4, targeting a resonance frequency of 40$\pm$5 kHz and a tool tip amplitude $\geq$100 μm. Finite element simulations achieved a resonance frequency of 40,188 Hz, a 120 μm maximum amplitude, and a 721 MPa maximum stress, within material limits.
- Fabricated and tested on bone cement at 5%–100% power, with 35%–55% power identified as optimal for balancing cutting efficiency and heat. The cooling system effectively reduced heat, and blade tip amplitudes of 110–130 μm matched simulation results, confirming the scalpel's effectiveness for vertebra cutting.

TECHNICAL SKILLS

Programming language: Matlab, Python, LabVIEW, C++ **2D/3D modelling:** AutoCAD, Solidworks
Finite element analysis: Abaqus, ANSYS, Adams **Deep learning framework:** Tensorflow, Pytorch
English proficiency: TOEFL 101 IELTS 7.5

AWARDS and HORNORS

- First-class Scholarship for Comprehensive Performance, Tsinghua University *12/2023*
- Academic Newcomer, Tsinghua University *04/2023*
- Graduation with Honor, Tianjin University *06/2022*
- National Scholarship for Undergraduate *10/2021*
- Second Prize in the 4th China University Intelligent Robot Creative Competition (Designed the fastest robotic gripper to solve Rubik's Cube) *08/2021*
- China Aerospace Science and Technology Corporation Scholarship *10/2020*