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: **17/118**
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 & MANUSCRIPTS

- 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). (IF=14, JCR-Q1, first author is supervisor)
  Under review, Second submit
- 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.
- **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.
  In preparation

PROJECTS

Project 1: Real-time vibration suppression in robotic milling ***11/2023 – Present***
Supported by Sino-German Mobility Program, directed by Dr. Feng Feng

Part 1-Robotic machining system construction

- Lab's first robotic machining 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 absolute error of 0.72 mm and an average absolute error of 0.29 mm, enough for common machining tasks, like milling and drilling.
- Developed a C# application using the ABB PC SDK to remotely control the robot, spindle, and auxiliary subsystems. Routine robot motion tasks and spindle speed adjustment achieved delays under 10 ms.
- Integrating a KUKA KR-60 robot for large-sized (3 m×1.5 m) polymer milling , targeting a 100 ms communication delay for collaborative machining between two robots.
- Half-month academic exchange to Technische Universität Berlin, Germany.

Part 2-Real time chatter detection and suppression

- Developed a LabVIEW-based real-time self-excited vibration (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 suppression effect and surface

quality across different delay levels (10 ms, 100 ms, 500 ms, 1 s).

- Work completed and drafting the paper.

Project 2: Real-time surface reconstruction and vibration quantification ***06/2023 – 10/2024***

Supported by Shenzhen Natural Science Foundation, directed by Dr. Feng Feng

- Developed a real-time surface reconstruction method that combines surface topography generation mechanism with a 1D CNN, trained on 1,160 machined surface height maps scanned by white-light interferometer. Achieved 84% prediction accuracy, with an absolute surface roughness *Ra* error within 0.5 μm, offering potential online surface reconstruction method for digital twin systems.
- Proposed a vibration energy-based indicator integrating *Ra* evaluation with vibration source analysis, addressing limitations of using *Ra* alone or linking chatter to poor quality without guidance on vibration suppression. Achieved strong Ra^2 correlation ($r = 0.98$) and enabled targeted vibration control, enhancing efficiency by up to 20%.
- Produced a paper, now under review by ***International Journal of Machine Tools and Manufacture***

Project 3: Fabrication of blazed grating by ultrasonic machining ***11/2022 – 04/2023***

Supported by Shenzhen Natural Science Foundation, directed by Dr. Feng Feng

- Designed a graded blazed grating on metallic glass for infrared (1–5 μm) with ∼50–70% diffraction efficiency. Conducted diffraction efficiency simulation. Set up micro-nano ultrasonic machining equipment with laser displacement sensor for feature machining and measurement from 500 nm to 10 μm.
- Optimized cutting parameters by testing different feed speeds (0.333–2.667 mm/s) and depths of cut (3.2–4 μm) to improve surface quality.

Project 4: 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±5 kHz and a tool tip amplitude ≥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, C++, LabVIEW **2D/3D modelling:** AutoCAD, Solidworks
Simulation: Abaqus, ANSYS, COMSOL, FDTD **Deep learning framework:** Tensorflow, Pytorch
English proficiency: TOEFL 101 IELTS 7.5

AWARDS and HORNORS

- Second-class Scholarship for Comprehensive Performance, Tsinghua University, *2024*
- First-class Scholarship for Comprehensive Performance, Tsinghua University, *2023*
- Outstanding Graduate, Tianjin Ministry of Education, *2022*
- National Scholarship for Undergraduate, Ministry of Education, *2021*
- Second Prize in the 4th China University Intelligent Robot Creative Competition (Designed fastest robotic gripper to solve Rubik's Cube, solved time: 27.717s), *2021*
- CASC Scholarship, Tianjin University, *2020*