

Tian Xu

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Education

Program	Institution/Board	Year
<i>Ph.D.</i> (Mechatronic Engineering)	Zhejiang University, China	2017 - 2023 (Expected)
<i>B.Eng.</i> (Mechatronic Engineering)	Zhejiang University, China	2013 - 2017

Research Experience

- Inverse Problem of FEM-based Soft Tissue Models*** **Jun 2019 - Present**
Zhejiang University
(*Ph.D. / Guide: Prof. Yong Lei*)
 - Supported by the National Key Scientific Instrument Research and Development Projects (Grant No. 81827804).
 - This research includes developing two iterative algorithms and one direct method to identify unknown elastic parameters and boundary conditions of linear and nonlinear hyperelastic materials under locally noisy observation.
 - Developed an effective algorithm for solving complex boundary conditions in elasticity problems, utilizing equivalent elastic constraint boundary conditions and incorporating L1 regularization term to accurately estimate unknown boundary stiffness with a relative error of less than 5%.
 - Proposed a direct method to accurately identify unknown Young's modulus and boundary conditions of the linear elastic model without iterations, achieving relative error of estimated elastic parameters within 5% and mean error of estimated displacement within 0.5 mm.
 - Published 3 SCI journal papers & 2 conference papers.
- Surgical Virtual Training System*** **Oct 2021 - Oct 2022**
Zhejiang University
(*Ph.D. / Guide: Prof. Yong Lei*)
 - Supported by the Zhejiang Provincial Natural Science Foundation of China (Grant No. LSD19H180004).
 - Participated the design of a 3-DOF force feedback interaction device with a 30-frame update frequency to simulate surgical cutting in a surgical scenario set up using Sofa/SofaUnity.
- Robot-assisted Lung Puncture Navigation System*** **Jun 2019 - Jun 2022**
Zhejiang University
(*Ph.D. / Guide: Prof. Yong Lei*)
 - Supported by the Zhejiang Provincial Natural Science Foundation of China (Grant No. LSD19H180004).
 - Designed a 4-DOF positioning robot and achieved position accuracy within 1 mm and orientation accuracy within 1 degree through PID robot motion control using an AVR micro-controller.
 - Proposed a lung puncture robot positioning algorithm and calibration template based on NDI optical tracking, achieving a mean navigation error of less than 2.5 mm.
 - Realized CT image 3D reconstruction based on VTK, and achieved real-time communication with NDI optical system for navigation.
 - Published 1 conference paper.
- Interactive Biomechanical Finite Element Model of Liver*** **Jun 2018 - Jun 2019**
Zhejiang University
(*Ph.D. / Guide: Prof. Yong Lei*)
 - Supported by the National Key Scientific Instrument Development and Development Projects (Grant No. 81827804).
 - Developed an interactive liver-blood vessel finite element model based on the Sofa platform.
 - Published 1 conference paper.
- Registration of Ultrasound Images and CT Images*** **Jun 2018 - Jun 2019**
Zhejiang University
(*Ph.D. / Guide: Prof. Yong Lei*)
 - Supported by the Science Fund for Creative Group of NSFC (Grant No. 51821903).
 - Designed a Freehand ultrasound acquisition platform by the video capture card and the NDI magnetic positioning system.
 - Proposed a 3D ultrasound reconstruction algorithm based on morphological processing and B-spline fitting, and achieved CT image registration through feature-weighted optimization of the ICP algorithm.

Publications

Journal Publications:

- **Tian Xu**, Zhen Wang, Yingda Hu, Shilun Du, Ao Du, Zhenyang Yu, Yong Lei. "A FEM-based direct method for identification of Young's modulus and boundary conditions in three-dimensional linear elasticity from local observation." *International Journal of Mechanical Sciences*, 2023. doi: 10.1016/j.ijmecsci.2022.107797
- **Tian Xu**, Murong Li, ZhenWang, Yingda Hu, Shilun Du, Yong Lei. "A method for determining elastic constants and boundary conditions of three-dimensional hyperelastic materials." *International Journal of Mechanical Sciences*, 2022. doi: 10.1016/j.ijmecsci.2022.107329
- **Tian Xu**, Yong Lei, XiaoLiang Cheng, Murong Li. "Identification of Young's modulus and equivalent spring constraint boundary conditions of the soft tissue with locally observed displacements for endoscopic liver surgery." *Computer Methods in Biomechanics and Biomedical Engineering*, 2022. doi: 10.1080/10255842.2021.1959556
- Murong Li, Yong Lei, Yingda Hu, Shilun Du, Dedong Gao, Zhen Wang, **Tian Xu**. "A Novel Semiempirical Friction Coefficient Model Between Needle and Polyvinyl Alcohol Tissue Phantom and Its Validation by Using Computational Inverse Technique." *Journal of Tribology*, 2022. doi: 10.1115/1.4053788
- Murong Li, Yong Lei, **Tian Xu**. "Sensitivity of Influential Factors on Needle Insertion Experiments: A Quantitative Analysis on Phantom Deformations and Needle Deflections." *Chinese Journal of Mechanical Engineering*, 2020. doi: 10.1186/s10033-020-00515-6
- **Tian Xu**, Yong Lei. "A multiple-data-based direct (MD) method to identify Young's modulus and boundary conditions in three-dimensional linear elasticity." *International Journal of Mechanical Sciences*, 2023. (minor revision)
- **Tian Xu**, Yong Lei. "A direct method to estimate Young's moduli and boundary conditions of a 3D nonhomogeneous material based on partial observation." *International Journal of Mechanical Sciences*, 2023. (in preparation)

Conference Publications:

- **Tian Xu**, Shilun Du, Murong Li, Yingda Hu, Zhen Wang, Yong Lei. "A Novel Objective Function for the Inverse Problem of Simultaneous Identification of Unknown Youngs Modulus and Boundary Conditions With Noisy and Partial Observation." *Proceedings of the ASME 2022 17th International Manufacturing Science and Engineering Conference*, 2022. doi: 10.1115/MSEC2022-85516
- **Tian Xu**, Yong Lei. "Identification of Young's Modulus and Equivalent Spring Constraint Boundary Conditions of the Object With Incomplete Displacement Boundary Conditions." *Proceedings of the ASME 2020 15th International Manufacturing Science and Engineering Conference*, 2020. doi: 10.1115/MSEC2020-839
- **Tian Xu**, Yong Lei. "A Novel Composit Vascularized FEM Model for Liver Surgery Simulation and Guidance." *2019 IEEE 9th Annual International Conference on CYBER Technology in Automation, Control, and Intelligent Systems (CYBER)*, 2019. doi: 10.1109/CYBER46603.2019.9066698
- Shilun Du, Murong Li, **Tian Xu**, Yingda Hu, Zhen Wang, Yong Lei. "Design and Analysis of a Novel Experiment Platform for 3D Needle Insertion Based on Orthogonally Arranged Dual Camera." *Proceedings of the ASME 2022 17th International Manufacturing Science and Engineering Conference*, 2022. doi: 10.1115/MSEC2022-85764
- Zhen Wang, Yong Dong, Yong Fang, Murong Li, **Tian Xu**, Yong Lei. "A Light-weight High-accuracy 4-DOF Robot for CT-image Guided Percutaneous Interventions." *2022 International Symposium on Medical Robotics (ISMR)*, 2022. doi: 10.1109/ISMR48347.2022.9807576
- Zhen Wang, **Tian Xu**, Yong Lei. "A force sensor-less method for identifying the Young's modulus of soft tissue." *Proceedings of the ASME 2023 18th International Manufacturing Science and Engineering Conference*, 2023. (Accepted)

Achievements/Awards

- *Zhejiang University FESTO Scholarship* (2021 - 2022).
- *Zhejiang University FESTO Scholarship* (2020 - 2021).
- *Zhejiang University Outstanding Graduate Scholarship* (2018 - 2019).
- *Third Prize in the Zhou Peiyuan Mechanics Competition* (2015 - 2016).
- *Second Prize in the National College Physics Competition* (2014 - 2015).
- *Zhejiang University Academic Scholarship* (2014 - 2015).
- *Zhejiang University Academic Scholarship* (2013 - 2014).
- *Zhejiang University Outstanding Undergraduate Scholarship* (2013 - 2014).

Technical Skills

- Programming: C, C++, Python, MATLAB
- MCU: Arduino, AVR, STM32
- Simulation Platforms: Simulink, Abaqus, Unity, Solidworks, Sofa/SofaUnity
- Tools: Solidworks, UG, Labview, Latex, Photoshop, Adobe Dreamweaver

Others

- Hobbies: Jogging, Reading
- Languages: Chinese (Native), English (Fluent)