Ruoyi Hao

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Education

The Chinese University of Hong Kong (CUHK)   **HK, China**
Ph.D. in Electronic Engineering (Medical Robotics & AI) | Supervisor: Prof. Hongliang REN
GPA: 3.83/4.0   *August 2021– Prospective 2026*

East China University of Science and Technology (ECUST)   **Shanghai, China**
B.E. in Process Equipment and Control Engineering   *September 2016–June 2020*
GPA: 3.79/4.0   **Ranking:** 1st/118

Work Experience

The Chinese University of Hong Kong (CUHK)   **HK, China**
Research Assistant | Supervisor: Prof. Hongliang REN   *May 2021– July 2021*

National University of Singapore (Suzhou) Research Institute (NUSRI)   **Suzhou, China**
Assistant Investigator | Supervisor: Prof. Hongliang REN   *January 2021–April 2021*

Research Projects

Dec. 2021–now   **Nasotracheal Intubation Robot**   **(HK RGC CRF Project, Student Lead)**
1. Developed modular robotic platform for nasotracheal intubation featuring: variable-stiffness bronchoscope control module, compact bronchoscope feeding mechanism, 8-DoF integrated feeding module with multi-modal hybrid sensing. Implemented SolidWorks mechanical design and STM32-based motor control, with high-level autonomous decision-making using hybrid visual/force perception. Validated design through kinematic modeling, MATLAB simulation, and path-tracking experiments
2. Proposed RACCT (Recurrent Action-Confidence Chunking with Transformer) model for low-contact intubation: designed data filtering protocol for high-quality training data, developed nasal prosthesis with force feedback for evaluation, achieved 34% reduction in peak insertion force vs. manual operations.
3. Published open-source upper airway anatomical landmark dataset with instance segmentation. Contains clinical images from 82 patients and human phantom images, with instance segmentation and annotation of the main anatomical structures of the upper airway.
4. Created GlottisNet for real-time glottis segmentation: lightweight multi-receptive field module with redefined sample strategy, surpassing SOTA accuracy at 19MB model size (>170 FPS inference).

April 2021–now   **Telescoping Deployable Linkages for Keyhole Procedures**
1. Proposed a series of deployable manipulators integrating the principles of concentric tube structures with rigid linkage mechanisms. Achieved record-breaking 1.8 mm diameter manipulator with 4-DoF (base configuration), and 8 mm diameter manipulator with 12-DoF (extended configuration) with DoF density 1.5 (SOTA for single-port manipulators).
2. Conducted kinematic analysis of the functional performance based on the basic configuration, focusing on the workspace, dexterity, singularity, and optimization of fixed positions for task-specific performance with MATLAB simulation. Demonstrated superior performance and task adaptability.

Jan 2021 – May 2022 **Gastrointestinal Endoscopic Surgical Robot (CN National Key R&D Program)**
1. Developed modular variable-stiffness manipulator for Endoscopic Submucosal Dissection (ESD). Achieved 3.5mm outer diameter with 6-DoF dexterity.
2. Implemented Galil-based motor control with Prandtl-Ishlinskii hysteresis compensation. Enhanced positioning precision by resolving variable-stiffness control latency.

Selected Publications & Patents

- **Hao, R.,** et al. Upper Airway Anatomical Landmark Dataset for Automated Bronchoscopy and Intubation. Scientific Data 12.1 (2025): 1907.
- **Hao, R.**, et al. Variable-Stiffness Nasotracheal Intubation Robot with Passive Buffering: A Modular Platform in Mannequin Studies. IEEE International Conference on Robotics and Automation (ICRA) 2025.
- Tian, Y.†, **Hao, R.** †, et al. Learning to Perform Low-Contact Autonomous Nasotracheal Tube Intubation by Recurrent Action-Confidence Chunking with Transformer. IEEE International Conference on Intelligent Robots and Systems (IROS) 2025.
- H. Ren, **R. Hao**. (2022). A vision-guided fiberoptic nasotracheal intubation robot. U.S. Provisional Patent application No. 63,303,270. Washington, DC: U.S. Patent and Trademark Office.
- Gao, H., **Hao, R.**, et al. Modeling and compensation of stiffness-dependent hysteresis for stiffness-tunable tendon-sheath mechanism in flexible endoscopic robots. IEEE Transactions on Industrial Electronics (2023).
- Fang, Y., **Hao, R.**, et al. Asymmetric Trajectory Optimization for Vibration Control in Flexible Motion Systems. IEEE Transactions on Industrial Electronics (2025).
- Gao, H., …, **Hao, R**., et al. GESRsim: Gastrointestinal endoscopic surgical robot simulator. IEEE International Conference on Intelligent Robots and Systems (IROS) 2022.
- Li, C., Qian C., **Hao, R.**, et al. Telescoping Deployable Linkages for Keyhole Procedures. Science Robotics (Under review).
- Zhou, Y. †, Zhang, Y. †, **Hao, R.**, et al. A Real-time Scale-robust Network for Glottis Segmentation in Nasal Transnasal Intubation. IEEE Transactions on Medical Imaging (Under review).
- **Hao, R**., et al. A Holistic Endotracheal Tube Feeding Module for Intubation Robots Imitating In-Finger Manipulations. IEEE/ASME Transactions on Mechatronics (waiting for submission).

Selected Awards & Honors

- Solomon Systech Scholarship — May. 2023
- Geneva International Exhibition of Inventions: Silver Award — Apr. 2023
- EMedIC Global 2021: Silver Award & Best Presentation Award — Nov. 2021
- Outstanding College Graduates of Shanghai — Mar. 2020
- National Scholarship (Top 0.2% Chinese undergraduate, three times) — Dec. 2019 &2018 &2017
- Baosteel Outstanding Student Special Prize (Top 0.001% Chinese undergraduate) — Nov. 2019
- The 16th "Challenge Cup" National Undergraduate Curricular Academic Science and Technology Works Competition in Shanghai (Outstanding Winner, top 0.25% participating group) — May. 2019

Skills & Tools

Programming: Matlab & Simulink, Python
Robotic Software: AutoCAD, SolidWorks, ROS, Coppeliasim (previously V-rep)