Rongkai Liu

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Aim: HRI and Robotic Researcher http://EricRongkai.github.io (Homepage)

PERSONAL INTRODUCTION

- **Research Background**: Artificial intelligence and human intelligence should be complementary and coexist, rather than simply replacing humans with robots.
- **Personal Advantages**: Good independent scientific research ability and comprehensive engineering realization ability; ability to work on the whole chain of tasks from demand research and analysis, scientific problem mining, innovative human-machine system and robot system prototype hardware and algorithm design and development; good organization and coordination ability and teamwork ability.

EDUCATION

- **University of Science and Technology of China** 2020.09 – 2024.06 Ph.D.
  - **Major**: Pattern Recognition and Intelligent Systems
  - **Research Interest**: HRI, Human robot collaboration, Rehabilitation robotics
- **China University of Mining and Technology-Beijing** 2017.09 – 2020.06 M.S.
  - **Major**: Control Theory and Control Engineering
- **China University of Mining and Technology-Beijing** 2013.09 – 2017.06 B.S.
  - **Major**: Electrical engineering and automation

WORK EXPERIENCES

- **Hefei Institute of Physical Sciences, CAS** *Full-time graduate student* 2020.09 – 2024.06
- **Institute of Automation, CAS** *Research Assistant* 2017.06 – 2020.08
- **Beijing Zhongke Hongtai Medical Robotics Co.** *Internship* 2019.05 – 2019.08

PUBLICATIONS

- **R. Liu**, Q. Song, T. Ma, and H. Pan, "Toward Remapping Residual Movement of Shoulder: A Soft Body-Machine Interface," *IEEE Transaction on Neural System and Rehabilitation (T-NSRE).*, Under Review. (IF:4.9)
- **R. Liu**, T. Ma, and N. Yao et al., "Adaptive Symmetry Reference Trajectory Generation in Shared Autonomy for Active Knee Orthosis," *IEEE Robotics and Automation Letters (RA-L) with IROS 2023*, vol. 8, no. 6, pp. 3118–3125, Jun. 2023. (IF:5.2)
- L. Tong, **R. Liu**, and L. Peng, "LSTM-Based Lower Limbs Motion Reconstruction Using Low-Dimensional Input of Inertial Motion Capture System," *IEEE Sensors Journal*, vol. 20, no. 7, pp. 3667–3677, Apr. 2020.(IF:4.3)
- X. Zhao, **R. Liu**, and T. Ma et al, "Real-time Gait Phase Estimation Based on Multi-source Flexible Sensors Fusion," in 2023 3rd International Conference on Robotics and Control Engineering(RobCE2023), Nanjing, China: ACM, May. 2023, in production.
- **R. Liu**, L. Peng, and L. Tong et al, "A Novel Method for Parkinson' s Disease Classification and Dyskinesia Quantification Using Wearable Inertial Sensors," in 2019 IEEE 9th Annual International Conference on CYBER Technology in Automation, Control, and Intelligent Systems (CYBER), Suzhou, China: IEEE, Jul. 2019, pp. 1022–1026.

- **R. Liu**, L. Peng, and L. Tong et al., "The Design of Wearable Wireless Inertial Measurement Unit for Body motion Capture System," in 2018 IEEE International Conference on Intelligence and Safety for Robotics (ISR), Shenyang: IEEE, Aug. 2018, pp. 557–562.

PATENTS

- L. Peng, Z. Hou, **R. Liu** "Wearable devices for quantifying and recognizing dyskinesia in Parkinson's patients"
- L. Peng, Z. Hou, **R. Liu** "Quantification and identification of dyskinesia in Parkinson's patients based on support vector machine"
- Q. Song, **R. Liu**, T. Ma "A non-invasive flexible body-machine interaction interface" (Under Review)

RESEARCH PROJECTS

- **Big Data-based Intent Understanding and Intelligent Input for Natural Interaction**
  National Key Research and Development Program
  - Devised a non-invasive body-machine interaction interface (SoftBoMI) utilizing soft strain sensors and an inertial measurement unit. This interface captures shoulder movements to generate control commands for assisting devices.
  - Designed the online parsing, calibration and data visualization software, and built a virtual simulation environment for wheelchair manipulation based on Unity3D;
  - Designed a data decoding framework for user intent inference intervention with shared autonomy, which improves the manipulation accuracy and the dynamic performance of the interface.
- **Stroke Rehabilitation Robot**
  National Key Research and Development Program for Intelligent Robots
  - Built a knee exoskeleton robotic system that maps real-time captured gait motion trajectories from the patient's healthy side to the affected side's actuator, aiming to perform induced gait symmetry restoration;
  - Designed an encoder-decoder algorithmic framework for online learning and reproduction of gait trajectory time series based on robot imitation learning algorithms.
  - Constructed a probabilistic form of robot gait skill library by collecting standard gait data, aimed at providing machine strategies.
  - Designed an online validation, disambiguation, and fine-tuning process for user inputs, realized through a shared autonomy framework, aimed at enhancing the safety of the robotic system.
- **Key technology of brain injury rehabilitation robot system and function evaluation**
  National Natural Science Foundation of China
  - Responsible for the design and development of a wireless inertial motion capture system for the human body;
  - Completed the software and hardware design of human motion capture system based on MEMS inertial sensors and the development of virtual human real-time mapping program based on Unity3D;
  - Proposed a human lower limb motion reconstruction method based on sparse inertial sensor nodes based on LSTM neural network.
- **Wearable devices in Parkinson's chronic disease management**
  Beijing Natural Science Foundation Key Program
  - Designed a wearable synchronous data acquisition system that record multiple IMU, EMG and video signals;
  - Realized wireless uploading of collected data locally or in the cloud based on BLE and NB-IoT;
  - Collected movement data from 70 typical Parkinson's patients in the Department of Neurology of Peking Union Medical College Hospital;
  - Designed a quantitative assessment method of gait impairment in Parkinson's patients based on RBF-SVM.
- **Research on adaptive control for upper limb rehabilitation robot based on sEMG and FES**
  National Natural Science Foundation of China Youth Fund

  - Responsible for the development and debugging of the communication and motion control embedded system for a five-degree-of-freedom exoskeleton upper limb rehabilitation robot;
  - Developed virtual reality rehabilitation training systems based on Unity3D for 6-DOF and 2-DOF upper limb rehabilitation robots.

- **Research, development and industrialization of intelligent wheelchair**
  University of Science and Technology of China "Innovation and Entrepreneurship Fund"
  - Responsible for overall project planning and reporting;
  - Carried out preliminary market demand research.

RESEARCHES IN PROGESS

- **Human-in-the-loop assistive strategy optimization for gait symmetry rehabilitation**
  - Using Bayesian optimization to optimize the joint moment assisting strategy to improve the gait symmetry performance of hemiplegic patients;
  - Design of hybrid force-position control strategies for robot joints in conjunction with a developed symmetric gait trajectory generation algorithm.
- **Assisted robotic arm teleoperation under shared control**
  - Design of an assisted robotic arm teleoperation task space based on the Pybullet robot physics simulation environment;
  - By collecting manipulation data from skilled users, we are designing a hybrid shared autonomy model to reduce the manipulation difficulty and learning cost of multi-degree-of-freedom assistive robots.

SKILLS

- **Programming Language**: Python, C/C++, C#, Matlab, LaTex
- **Software Development**: QT, Unity3D, Pybind11, RabbitMQ, ROS, PyBullet, WinForm, Simulink
- **Data Analysis and Visualization**: Proficiency with data analysis libraries such as Numpy, Scipy, Pandas, and static and dynamic scientific research plotting libraries such as Matplotlib, Seaborn, and Pyqtgraph.
- **Agorithm Research**:
  - Proficiency in machine learning algorithm development frameworks such as SK-Learn, Pytorch, Tsfresh, etc.;
  - Familiar with the theory of time series analysis and modeling of stochastic systems under the Bayesian school such as HMM, KF, EKF, MDP, etc.;
  - Familiar with robot imitation learning algorithms such as DMP, pDMP, GP, GMM, BC, nonlinear oscillator, etc.;
  - Understanding of the theory of optimal control algorithms such as LQR, MPC, and reinforcement learning;
  - Understanding of generative modeling theories such as AE, VAE, GAIL, etc.
- **Hardware Development**:
  - Mastering the design and commissioning of robot electrical drive systems;
  - Familiar with the overall architecture of robotic systems, proficient in the development of embedded systems based on Linux and RTOS platforms;
  - Familiar with software and hardware development of wireless communication protocols such as BLE, 2.4G.

HONORS

- **2021**: First Class Academic Scholarship of USTC
- **2020**: Outstanding Graduates of CUMTB
- **2016**: Second Prize of Beijing University Students Electronic Design Competition
- **2016**: Champion of "China Music Power" National School Band Competition Beijing Region
- **2015**: Outstanding Student Leader (Vice-President of the Faculty Student Union)