Wen Fan

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Education

Imperial College London • Dept.Bioengineering February 2024 – Now
Ph.D. of Bioengineering • *Micro-Nano Robotics* • *Medical Robotics*

University of Bristol • Dept.Engineering Mathematics February 2023 – February 2024
Ph.D. of Engineering Mathematics • *Tactile Robotics* • *Graph Neural Networks*

University of Manchester • Dept.Electrical & Electronic Engineering October 2020 – October 2021
M.Sc. of Advanced Control & System Engineering • *Average score: 79.4%* • *Award: Distinction*

Core courses: Applied Control (86) • Optimal & Robust Control (82) • Robotics & Autonomous Systems (82)
• Process & Model Predictive Control (84) • Control Fundamentals (80) • Nonlinear & Adaptive Control (82)
• State-space & Multivariable Control (79) • Digital Control & System Identification (78)

Hefei University of Technology • Dept.Electrical Engineering & Automation September 2016 – June 2020
B.E. of Automation • *Average score: 88%* • *Average score of core modules: 90%*

Core courses: Graduation Design (90) • Single Chip Microcomputer (96) • Sensor & Detection Technology (95)
• Modern Control (93) • Motion Control System (93) • Fundamentals of Electrical Machines & Drives (88)
• Data Communication & Network (92) • Principles of Automatic Control (93)

Awards

- The First-Class Scholarship in University (Rank Top 1% to 4%), 2019.11

Publications

MagicTac: A Novel High-Resolution 3D Multi-layer Grid-Based Tactile Sensor
– ICRA 2024 accepted in Fab 2024–

- Introducing the 3D multi-layer grid-based structure for elastomer construction, aiming to further enhance the sensing capability of vision-based tactile sensors, which can effectively capture fine textures and dynamic contact information.
- Utilizing the multi-material additive manufacturing technique to simplify the fabrication process, also called integral printing, leads to reduced fabrication time and cost.

ViTacTip: Design and Verification of a Novel Biomimetic Physical Vision-Tactile Fusion Sensor
– ICRA 2024 accepted in Fab 2024–

- A vision-tactile fusion device, ViTacTip. This sensor stands out for its dual-attributed acquisition capability, adepting not only at collecting tactile information but also at capturing visual features such as the color and geometry of objects it contacts.
- Proposing a Generative Adversarial Network (GAN)-based methodology to enhance modality switching between visual and tactile sensing, mitigating the challenges posed by variable ambient lighting conditions and improving the visualization of contact interactions.

Digital Twin-Driven Mixed Reality Framework for Immersive Teleoperation with Haptic Rendering
–RA-L accepted in Sep 2023–

- Introducing a digital twin technique for an MR-based immersive teleoperation system, leading to the development of the Digital Twin-driven Mixed Reality (DTMR).
- Building a novel haptic rendering system based on i) pneumatically-driven actuators for tactile feedback, and ii) a commercial haptic controller that enables kinaesthetic rendering and real-time motion tracking.
- Constructing a seamless bilateral teleoperation framework through the integration of immersive manipulation via DTMR, both kinaesthetic and tactile rendering devices.

Tac-VGNN: A Voronoi Graph Neural Network for Pose-Based Tactile Servoing
– ICRA 2023 published in May 2023–

- A novel Voronoi Graph representation is designed for processing the tactile information from bio-inspired marker-based optical tactile sensors, TacTip.
- A Tac-VGNN model is developed for tactile pose estimation, while the performances of interpretability and efficiency were evaluated on a surface following the task.
- Improving pose estimation accuracy along vertical depth by 28.57% over vanilla GNN without Voronoi features and achieving better performance on the real surface following tasks with smoother robot control trajectories.

Graph Neural Networks for Interpretable Tactile Sensing
– ICAC 2022 published in May 2022–

- Transform the tactile image data obtained by the TacTip sensor into a graph representation.
- Develop an optimal GCN-based model for object recognition based on empirical studies.
- Evaluate the interpretability of the GCN-based model for tactile object recognition.

One-Shot Domain-Adaptive Imitation Learning via Progressive Learning
– T-ASE published in Apr 2022–

- Train robot to learn general concepts by encoding concept representation features during the coarse learning phase, paving the way for the robot to learn action generation with high efficiency.
- Enable robot to generate precise motions using an LSTM-Attention hybrid model during the fine learning phase, ensuring the success rate by incorporating concept representation with temporal information.
- Employ a generative adversarial network to generate synthetic observation data in new scenarios during the imaginary learning phase, ensuring robot can adapt the pre-trained policies to new scenarios with ease.

From Teleoperation to Autonomous Robot-Assisted Microsurgery: A Survey
– MIR published in Mar 2022–

- Introduce the development tendency of RAMS from teleoperation to autonomous systems.
- Highlight the upcoming new research opportunities that require joint efforts from both clinicians and engineers to pursue further outcomes for RAMS in years to come.

Monocular Vision-based Robot Navigation in Fully Simulated Scamp5d and CoppeliaSim
– ArXiv submitted in Sep 2021–

- Scamp vision system is a general-purpose visual device with parallel in-sensor computing capabilities enabled by novel large-scale circuit design and system integration of photosensitive pixels, registers, and arithmetic units.
- A fully simulated environment integrating a Scamp simulator and CoppeliaSim is presented in this work, providing researchers with a flexible idea and prototype evaluation platform.

Projects

Adaptive Human-Robot Shared Control for Micromanipulation Mar 2022 – Sep 2022
Bristol Robot Laboratory (BRL), funded by the Royal Society

- Research assistant, in collaboration with the Medical Robotics Group at Imperial College Hamlyn.
- This project is motivated by the urgent need for intuitive and flexible micromanipulation systems to support the manipulation of micro-objects, where poor sensory feedback, physiological tremor, and obstructive view hamper precise micron-scale maneuvers.
- Human-robot shared control can integrate the advantages of both humans and robots. With a higher level of autonomy, operators can focus on more crucial and complex parts of micromanipulation while the repetitive and tedious work can be done by robots.

Mobile robot localisation with Sonar or LIDAR Apr 2021 – June 2021
Coursework of Autonomous & Robotics, University of Manchester

- Imply Sonar and LIDAR as perception sensors, then combine the received information of landmarks coordinates into wheeled robot navigation tasks.
- Design Baye's filter and particle filter for robot to achieve dynamic localization and further built occupancy grid probabilistic mapping in MATLAB.

Mobile robot trajectory tracking using SMC Mar 2021 – May 2021
Coursework of Applied Control, University of Manchester

- Design cascade control to realize point stabilization for the wheeled robot in Labview, with PID controller for the inner loop of motor angular velocity and P controller for out loop of robot position.
- Design sliding mode control (SMC) to realize different trajectory tracking tasks and imply the proposed method on a real wheeled robot for evaluation.

Design of full steering controller for electric forklift truck Jan 2020 – May 2020
Graduation design, School of Electrical & Automatics, Hefei University of Technology

- A 2-dof forklift model based on lateral motion and yaw motion has been built.
- Design an integrated fuzzy control with the conventional PID controller to realize adaptive parameter tuning which could provide forklifts the better steer performance.
- The hardware schematic diagram with software flow chart is designed.

A tyre-track hybrid obstacle avoidance robot design Sep 2017 – Dec 2017

Engineering Robot Competition, Hefei University of Technology

- Built a tire-track hybrid robot whose both front wheels can transfer between rubber tracks and the default wheels, by controlling three small supporting wheels inside each front wheel.
- Use default tires on flat ground to increase motion speed, supported by an RGB camera located at the bottom to realize the trajectory tracking.
- Extend the supporting wheels to form the track when encountering obstacles such as stairs and holes.

Technical Skills

- Programming languages: Python, C/C++
- Other computer experience: MATLAB, Inventor, Labview, MS Office Suite

Extra Curricular Activities

- Volunteer work with special needs students