Boyang Ti

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EDUCATION

Dalian University of Technology   *(2013.7-2017.6)*   *Liaoning, China*

Bachelor of Mechanical Design manufacture and Automation
- GPA: Major **90.7**/100.0
- Rank: **2**/64
- Top Grade Scholarship (5%), twice, 2013-2014 & 2014-2015

Harbin Institute of Technology   *(2017.9-Present)*   *Heilongjiang, China*

Ph.D. candidate, Mechanical Engineering
- Research Topic: **Imitation Learning; Robot Skill Learning; Optimal Control; Riemannian Geometry**

Idiap Research Institute *(2021.2-2022.9)*   *Martigny, Switzerland*

Research Intern
- Research Topic: **Optimal Control; Riemannian Geometry**

RESEARCH EXPERIENCE

Research on Human-Robot Collaboration Technology and Application for Aerospace Manufacturing

Project Participant   Sep. 2022-Jun. 2024
- Employ GMM-GMR method to characterize human demonstration skills and extract the motion feature;
- Propose a dynamic constraint DMPs method to achieve the generalization of peg-in-hole assembly skills under variable initial conditions, which can achieve flexible assembly with high and low stiffness peg, and the accuracy is 0.3mm;
- Based on the above strategy, a multi-information fusion assembly skills learning system is proposed, which makes it easy for non-professionals to complete the human-robot assembly skills transfer.
  Funded by Major Research Plan, National Nature Science Foundation of China (Grant No. 92048301)
  --PhD project and main research.

Efficient Human-Machine Collaboration and Intelligent Planning Technology Based on Multiple Operational Modes

Project Participant   Nov. 2022-Jun. 2024
- Robot can perform in a variety of operating modes (collaborative, local autonomous) based on the proposed admittance controller. The surgeon can freely drag the robot arm to the desired surgical position and autonomously switch between passive and active operating modes according to the proposed pattern recognition method.
  Funded by National Key Research and Development Program of China (Grant No. 2022YFB4700701)

Learning by Switching Roles in Physical Human-Robot Collaboration

Project Participant   Feb. 2022-Sep. 2022
- Extract the demonstration feature using multiple types of coordinate systems (Cartesian/Cylindrical/Spherical);
- Propose a framework based on Riemannian geometry and (i)LQR method for online planning and robustness to human disturbances;
- Based on the proposed framework to achieve grasping, box-opening skills learning, and collaborative grasping tasks under man-robot shared control.
  Funded by the Swiss National Science Foundation SWITCH project (https://switch-project.github.io/)
  --Visiting PhD project

Memory of Motion

Project Participant   Feb. 2021-Feb. 2022
- Employ an ADMM-iLQR strategy to solve an OCP considering tool affordance constraints in impact–aware tasks;
- Introduce a maximum directional manipulability cost in the optimal control framework to optimize the grasping and final manipulation posture;
- Make a comprehensive comparison of different approaches to measuring manipulability in directional tasks.
  Funded by European Commission's Horizon 2020 Programme Memory of Motion, https://www.memmo-project.eu/, Grant Agreement 780684
  --Visiting PhD project

Fundamental Researches on Cooperative Dual-Arm Mobile Robot

Project Participant   Sep. 2017-Sep. 2022
- Construct a model between the feature parameters of demonstration and the task parameters by MV-GPR method, which improves the ability of motion imitation and generalization;
- Propose a DMPs method based on Euclidean transformation to generalize the point-to-point motion and writing and wiping motion from any initial state.

--PhD project and main research

Automatic Grinding Platform Based on Laser Cleaning

Project Participant   May. 2019-Sep. 2021
- Build the communication links PC between SIMENS PLC, MiYi range sensor and KUKA KR6
- Design the upper computer software to control the automatic grinding platform

Robot technology and system for minimally invasive knee replacement surgery

Project Participant   Dec. 2017-Nov. 2020
- Propose a sequential planning strategy based on LQR method for sequential point-to-point task;
- By applying the proposed sequential planning strategy to the motion planning of the key parts of the knee joint, the flexible connection of the pre-cut points can be realized at the level of surgical planning.

Ant Colony Algorithm in the Mobile Robot Path Planning Simulation Research

Project Leader   Dec. 2016-Jun. 2017
- Propose an optimization algorithm of ant colony algorithm to speed up the stochastic search for the optimal path
- Propose an adaptive parameter optimization and correction strategy to improve the planning path
- Built the simulation platform using MATLAB/GUI for planning the optimal path and export the planning file

2019 JCAR Cup Inclusive Robot Industrial Application College Invitational Tournament

Team Leader   May. 2019-Aug. 2019
- Build the simulation grasping platform in Gazebo and complete the grasping task
- Complete the task of the physical platform to grasp the specified fruit from the stacked objects

PUBLICATIONS

Journal Article:

- **Ti B**, Gao Y, Zhao, J and Calinon, S. An Optimal Control Formulation of Tool Affordance Applied to Impact Tasks[J], **IEEE Transactions on Robotics**, 2024.
- **Ti B**, Razmjoo A, Gao Y, Zhao, J and Calinon, S. A Geometric Optimal Control Approach for Imitation and Generalization of Manipulation Skills[J], **Robotics and Autonomous Systems**, 2023.
- **Ti B**, Gao Y, Shi M and Zhao, J. Generalization of Orientation Trajectories and Force–Torque Profiles for Learning Human Assembly Skill[J]. **Robotics and Computer-Integrated Manufacturing**, 2022.
- **Ti B**, Gao Y, Shi M, Fu L and Zhao, J. Movement Generalization of Variable Initial Task State Based on Euclidean Transformation Dynamical Movement Primitives[J]. **International Journal of Advanced Robotic Systems**, 2021.
- **Ti B**, Gao Y, Li Q and Zhao J. Human Intention Understanding from Multiple Demonstrations and Behavior Generalization in Dynamic Movement Primitives Framework[J]. IEEE Access, 2019.

Conference Article:

- **Ti B**, Gao Y, Zhao J and Calinon, S. Imitation of Manipulation Skills Using Multiple Geometries[C] **2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)**. IEEE, 2022.
- **Ti B**, Gao Y, Li Q and Zhao J. Dynamic Movement Primitives for Movement Generation Using GMM-GMR Analytical Method[C] 2019 IEEE 2nd International Conference on Information and Computer Technologies (ICICT). IEEE, 2019.
- Shi M, Gao Y, **Ti B** and Zhao J. Obstacle Avoidance Methods Based on Geometric Information under the DMPs Framework[C] Intelligent Robotics and Applications: 14th International Conference, (ICIRA). Springer. 2021.
- Li Q, Gao Y, **Ti B** and Zhao J. Model-Error-Observer-Based Control of Robotic Manipulator with Uncertain Dynamics[C] 2019 IEEE 2nd International Conference on Information and Computer Technologies (ICICT). IEEE, 2019.

AWARDS and SCHOLORSHIPS

HIWIN Scholarship	*(Twice) 2013-2015*
Learning Excellence Award (First Prize)	*(Twice) 2013-2015*
Three-Good Students of Dalian University of Technology	*(Twice) 2013-2015*
Technology Innovation Award of Dalian University of Technology	*2013-2014*
Excellent Graduate of Dalian University of Technology	*2016-2017*
National Scholarship	*2017*

SKILLS

- Computer Skills:
  - Python, MATLAB, C, C#.
  - ROS, Gazebo, MATLAB, PyCharm, Visual Studio, AutoCAD, SolidWorks.
  - Latex, Word, PowerPoint, Excel, Visio.
- Language Skills:
  - Chinese (Native), English (Fluent), Japanese (Some knowledge of) and French (Learning)

LANGUAGE PROFICIENCY

- College English Test Band 6 (CET6): **499/710** (Listening: 170, Reading: 191, Writing and Translating: 138)
- Japanese Language Proficiency Test (N2): **104/180** (Reading: 38, Listening: 32, Language Knowledge: 34)