

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-Present

- 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, the accuracy is 0.3mm;
- Propose a method based on Dynamic Movement Primitives to solve the generalization problem of assembly motion;
- Based on the above strategies, a multi-information fusion assembly skills learning system framework 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-Present

- Using an admittance control method, the robot can perform in a variety of operating modes (collaborative, local autonomous). 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 system (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 using 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.

Funded by Major Research Plan, National Nature Science Foundation of China (Grant No. 91648201)

--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

Funded by Shanghai space research institute

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 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.

Funded by National Key Research and Development Program of China (Grant No. 2017YFB1303001)

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

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

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)