Tianyi Xiang

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Education

- **Yale University** — New haven, US
  Master of Science (MS) in Mechanical Engineering & Material Science — *Aug.2024 – Jun.2025*

  Core Modules: Neural networks & Learning System, Intermediate Machine Learning, Advanced Computational Vision, Deep Learning Theory and Applications.

- **Xi'an Jiaotong-Liverpool University (XJTLU); Rank 1 Best Overall** — Suzhou, China
  BEng Mechatronics and Robotic Systems; Major GPA: 4.0/4.0 — *Aug.2020 – Jun.2024*

  Core Modules: Dynamic Systems, Instrumentation and Control, Mechanical Engineering Design, Machine Learning, Industrial Automation and Robot Control, Robotic Systems, Pattern Recognition

Publications

[1] Yifan zhu, **Tianyi Xiang**, Aaron Dollar, Zherong Pan, "Real-to-Sim via End-to-End Differentiable Simulation and Rendering," *IEEE Robotics and Automation Letters (RA-L, 2024)*(under review);

[2] **Tianyi Xiang**, Borui Li, Quan Zhang, March Leach, Enggee Lim. "A Novel Approach to Grasping Control of Soft Robotic Grippers based on Digital Twin," 29^{th} *International Conference on Automation and Computing (ICAC 2024)* ;

[3] **Tianyi Xiang**, Borui Li, Xiaonan Pan, Quan Zhang. "Development of a Simple and Novel Digital Twin Framework for Industrial Robots in Intelligent Robotics Manufacturing," 20^{th} *International Conference on Automation Science and Engineering (CASE 2024)* ; Video

[4] Xie, B., Xie, Y., Ma, Y., Luo, N., **Xiang, T.**, et al., "High performance $(Zn_{0.5}Mg_{0.5})TiO_3$ ceramics based composite films for powering multi-mode translation unit and human motion monitoring", ACS Applied Materials & Interfaces. (under review).;

Research Experience

- **Real-to-Sim via End-to-End Differentiable Simulation and Rendering**
  Research Assistant, Yale University, Advisor: Prof. Aaron Dollar; Paper — *Aug.2024 - Present*
  - Implemented an end-to-end jointly differentiable representation of objects' shape, appearance, and physical properties.
  - Constructed an algorithm for identifying world models online from sparse robot observations, which referred as real-to-sim, with an end-to-end differentiable simulation and rendering pipeline.
  - Given 3D cloud data with tactile force sensor data from realsense D435 and UR5e, predicted object physical properties and rendered image with Unilateral Chamfer error 1.99mm and Pose error 12.2mm.

- **Liquid Manipulation: Category-level pose & dimension detector with pouring action optimizer**
  Group Project, Yale University, Advisor: Prof. Brian Scassellati; Video — *Aug.2024 - Dec.2024*
  - Implemented the single-Stage keypoint-based category-level object pose estimation into a Multiple detectors combined under ROS noetic platform; github link.
  - Given the pose and dimension messages of manipulable objects, converted the pouring action to a constrained optimization problem solved by scipy.github link
  - Leveraged ROS moveit melodic to cooperate with the constrained optimizer, achieving the orientation constrained motion planning with perception pipeline for collision avoidance github link

- **Forked PDDLstream Task and Motion planning (TAMP) online replanning.**
  Independent Research, Video — *Jul.2024 - Aug.2024*
  - Folked from Caelan Reed Garrett online replanning TAMP, implemented the pybullet simulation environment with TAMP toolkit via the PDDLstream language solved by Fast-Downard

- **Behaviour cloning (BC) learning-based Block Pushing task**
  Independant Research, Yale University; video — *May.2024 - Aug.2024*
  - Developed a behavior cloning model based on a multi-layer perceptron (MLP) architecture in the PyBullet simulator, integrating image observations and prior actions to inform the policy, as opposed to traditional behavior learning approaches.

- Addressed optimization challenges arising from discontinuities in the action space, achieving competitive or superior results compared to state-of-the-art offline reinforcement learning methods on human-expert tasks within the D4RL benchmark suite, without utilizing reward signals.

- **A Novel Approach to Grasping Control of Soft Robotic Grippers based on Digital Twin**
  Research Assistant, XJTLU, Advisor: Dr.Quan Zhang; Paper *Apr.2024 - Jun.2024*
  - Proposed a Digital Twin (DT) framework for real-time motion and pose control of pneumatic flexible gripper in Unity3D, modeled as underactuated robotic finger
  - Constructed the four-section piecewise constant curvature flexible gripper model kinematics and pure mathematical simulation in Unity3D, achieved maximum task space error under 3.4%
  - Implemented triple-domain mapping using RGB-D image processing calibration method with gemini-pro 3D depth camera

- **Development of a Simple and Novel Digital Twin Framework for Manufacturing Robots**
  Research Assistant, XJTLU, Advisor: Dr.Quan Zhang; Paper; Video *Jun.2023 - Apr.2024*
  - Enabled a Simple and Novel Digital Twin System based on C# and Robot Web Service (RWS) in Unity 3D and Web-based Platform, discarding the traditional 3rd party tools like ROS and costly device like PLC, but achieving efficient communication with 17ms Refreshing Rate.
  - Integrated the real-time path planning based on Levenberg-Marquard Inverse Kinematics Numerical Solution executed in MATLAB, achieving X-Y-Z Global Linear Motion Control and Multi-Joint Motion Control with Reachability 100%, and Accuracy 100%.
  - Created a User-friendly Web-based Platform by WEBGL with a Remote Surveillance Camera, and easy accessible Graphical User Interfaces (GUI) including functions like Pointer Operation, I/O System Operation in real-time control

- **Trajectory Planning with a DIY rocker-bogie mechanical design Mars Rover**
  Independent Research , XJTLU; Video *Sep.2023 - Feb.2024*
  - Recreating the rover's rocker-bogie suspension dynamic modeling system with servo and DC motor
  - leveraging Radar, Depth Cameras, and Simultaneous Localization and Mapping (SLAM), incorporating deep Reinforcement Learning for obstacle detection and avoidance
  - Designing and optimizing the trajectory strategy based on the Genetic Algorithm(GA) and geometrical interactions

- **The dynamic optimization of Automated Guided Vehicle (AGV)**
  2022 ABB Smart Innovation Competition: First prize; Intro *Jun.2022 - Sep.2023*
  - Applied dynamic optimization of local trajectory planning through LQR, Dual-loop PID, stanely method, and MPC Motion control algorithms to AGV incorporating B-spline and A-star method, with simulation and modelling in Automation studio, MapleSim, and Scene Viewer
  - Designed self-supervised spline interpolation techniques to generate control points, achieving a maximum deviation of lower 50%(in unit) in critical turning areas in rare 3% occurrence probability
  - Innovatively utilized intelligent visual distance-refresh methodology to compensate the non-completely homogeneous trajectory points due to B-spline planning incorporating with dual-loop PID
  - Obtained the sliding friction coefficient 0.2, by tire Magic Fomula to render the control algorithm designed applicable

- **Dynamic Optimization of ROS SLAM for Autonomous Vehicles**
  Independent research, XJTLU, video *Jun.2022 - Aug.2022*
  - Developed and implemented a SLAM-based navigation system for an autonomous vehicle with radar using ROS and Gazebo
  - Leveraged AMCL for adaptive localization and differential drive controllers, combining with Move_Base for efficient navigation in simulated environments.
  - Optimized sampling-based planning methodologies (e.g., A* and RRT), achieving a 30% increase in localization accuracy and a 25% reduction in computational overhead, significantly enhancing both precision and efficiency.

Awards and Honors

2024	*Best Overall Academic Performance (Rank 1 Overall)*	*Xi'an Jiaotong-Liverpool University*
2023	*University Academic Excellence Award (Rank 1/36)*	*Xi'an Jiaotong-Liverpool University*
2023	*University Summer Undergraduate Research Fellow*	*Xi'an Jiaotong-Liverpool University*
2022	*ABB Smart Innovation Competition: First prize(Rank 3/275)*	*ABB, B&R Industrial Automation*
2022	*University Academic Excellence Award (Rank 1/64)*	*Xi'an Jiaotong-Liverpool University*
2022	*University Summer Undergraduate Research Fellow*	*Xi'an Jiaotong-Liverpool University*

Teaching Experience

- **Research Assistant**
  XJTLU, Suzhou, China *Fall 2023 – Spring 2024*
  - PID parameterization and tuning for the servo motors which drive for the Cartesian robot station and Tripodworkstation, respectively
  - Designed the coding and implementation platform in Automation Studio affiliated to B&R Co.
  - Applied servo motor control system and mastered the basic operation of its maintenance

Skills

- **Programming**: PDDL, ROS(noetic), Python, C/C++/C#, MATLAB, RAPID(ABB)
- **Tools**: ROS, Ubuntu20.04, Pybullet, Visual Studio, Blender, Unity 3D, SolidWorks, Fusion 360, PTC cero, CAD, Origin, MATLAB, SIMULINK,
- **Language**: Mandarin(Native), English(Fluent, IELTS 7.0)