

# Xinyang Tian

Email: tianers@buaa.edu.cn Google Scholar: [link](#) Github: [link](#) Contact: +86 18810283175

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## EDUCATION

### Beihang University, Beijing, China

Ph.D. Mechatronic Engineering

Supervisor: Qiang Zhan

Beijing

Sep 2016.9 ~ Present

Thesis: Research on Key Technology of Modular Anthropomorphic Manipulator.

### Northeast Agricultural University, Harbin, China

B.S. Mechanical Engineering and Automation

Supervisor: Longzhe Quan

Harbin

Sep 2012.9 ~ 2016.6

Thesis: Dimensional Synthesis of Fruits and Vegetables Sorting Robot and Test Based on Delta Parallel Mechanism.

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## INTERESTS & SKILLS

- **Research Interests:** Robotic joint & manipulator design, impedance control, physical-human interaction.
- **Languages:** C++, Python, MATLAB.
- **General Tools:** SolidWorks, Fusion360, ANSYS, Altium Designer, Qt Creator, VS code.
- **Robot Simulation Tools:** ROS (melodic version), MATLAB/Simscape, Vrep.
- **Specialized Theory:** Robotics, Lie group, Passivity theory, Automatic control theory.

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## PUBLICATIONS & PATENTS

### PUBLICATIONS:

- [1] **Xinyang Tian**, Qiang Zhan. A Hermaphrodite Electromechanical Connector for Self-reconfigurable Robot Modules, *IEEE/ASME Transactions on Mechatronics*, vol. 26, no. 6, pp: 3276-3281, 2021. (**Q1, IF:5.867**)
- [2] **Xinyang Tian**, Qinhuai Xu, and Qiang Zhan. An analytical inverse kinematics solution with joint limits avoidance of 7-DOF anthropomorphic manipulators without offset, *Journal of the Franklin Institute*, vol.358, no.2, pp.1252-1272, 2021. (**Q1, IF:4.246**)
- [3] **Xinyang Tian**, Qiang Zhan. Design of ArmBot: A Self-Reconfigurable Robot Module with Electromechanical Connectors, In *Proc. 2019 4th International Conference on Robotics and Automation Engineering (ICRAE)*, 2019, pp. 163-167.
- [4] Qinhuai Xu, Qiang Zhan, and **Xinyang Tian**. Link Lengths Optimization Based on Multiple Performance Indexes of Anthropomorphic Manipulators, *IEEE Access*, vol. 9, pp. 20089-20099, 2021. (**Q2, IF:3.476**)
- [5] **Xinyang Tian**, Qiang Zhan, and Yin Zhang. Simplified Configuration Design of an Anthropomorphic Hand Imitating Specific Human Hand Grasps. *IEEE Robotics and Automation Letters*. (Revise)
- [6] **Xinyang Tian**, Qiang Zhan, and Ziyang Cheng. Ultra-Compact Joint Torque Sensor Units with Enhanced Resolution for Modular Manipulator. *IEEE Sensors*. (On line)
- [7] Qiang Zhan, **Xinyang Tian**, and Qinhuai Xu, A Continuous Approach for Task Transition of Redundant robot Under Hard Joint Constraints, *IEEE Robotics and Automation Letters*. (Under Review)
- [8] **Xinyang Tian**, Qiang Zhan, and Qinhuai Xu, Flexible Joint Controller Design Based on Desired Impedance Behavior, *Journal of Harbin Institute of Technology*. (EI, Minor revision)

### PATENTS:

- [1] Authorized invention patent CN201810281440.7, "Electromechanical connector for self-reconfigurable robot", Qiang Zhan, **Xinyang Tian**, Junqing Wang, and Chunhong Li.
- [2] Authorized invention patent CN202110754392.0, "Admittance control method of dexterous hand based on extended state observer", Qiang Zhan, **Xinyang Tian**.
- [3] Authorized invention patent CN201510186809.2, "Adaptive top-out fruit and vegetable gripper", Longzhe Quan, **Xinyang Tian**, et al.

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## PROJECTS

### Ph. D project

Dec 2019 – Aug 2022

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**Source:** Liberation Army Aviation Pre – Research Project

**Main work:**

- Inspired by Walk-Man robot, a 7-DOF anthropomorphic manipulator was designed, including three different sizes of robotic joint, three different sizes of joint torque sensors, and electromechanical coupling quick changer;
- Proposed an analytical inverse kinematics solution with arm manifold control, free - singularity and joint limits avoidance for 7-DOF manipulator;
- Established the inverse dynamic model of 7-DOF anthropomorphic manipulator using Newton – Euler method, and the model was simulated by MATLAB/Simscape and open source dynamics library **Pinocchio**, respectively;
- The parameter identification method and compliance control strategy of flexible joints were studied, and a parameter identification software was developed based on Qt Creator. On this basis, the motor-torque coefficient identification, friction identification, stiffness and damping identification were carried out, and the position/torque control of the flexible joint was realized based on the full-state feedback control theory;
- Set up a dynamic torque calibration platform for joint torque sensors, and a calibration software of joint torque sensor was developed based on Qt Creator;
- The collision detection of manipulator based on generalized momentum observer was studied. On this basis, a collision detection method considering end disturbance was proposed and verified by MATLAB/SIMSCAPE;
- The joint space/Cartesian space impedance control method of the manipulator were studied. On this basis, the tracking control (position & orientation) of the 7-DOF anthropomorphic manipulator with Nullspace compliant was further studied and verified by MATLAB/Simscape;
- Developed a human-interaction software for the manipulator prototype based on ROS + Qt Creator, and a series of experiments were carried out, such as forward/inverse kinematics, joint space/Cartesian space impedance control, Nullspace impedance control, and collision detection.

**Dexterous hand design and compliance control**

Oct 2017 – Jun 2021

**Source:** Beijing Nature Science Foundation

**Main work:**

- Responsible for the dexterous hand design, including structure design of finger & palm, scale and layout optimization;
- Proposed an admittance control method of dexterous hand based on extended state observer;
- Developed a hand prototype, and the dexterity of the prototype was verified by Cutkosky classification test.

**Research on self-reconfiguration modular robot technology**

Dec 2016 – May 2018

**Source:** Frontier Innovation of National Defense Science and Technology Special Zone Project

**Main work:**

- Responsible for the 3-DOF self-reconfigurable robot design, including modular joint design (structure), connector design (structure & hardware circuit);
- Proposed an electromechanical interface for power & communication transmission and orientation detection;
- Developed a human-interaction software 3-DOF self-reconfigurable robot based on Qt Creator, and a series of experiments of the prototype were carried out.

**HONORS & CERTIFICATIONS**

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|--|---------------------------------|
| • Glodon Social Scholarship  |                                 |
| • Beihang's Postgraduate outstanding academic innovation achievement award |                                 |
| • National Mathematics Competition for Postgraduate Students               | <b>The Second Prize (2016)</b>  |
| • “Challenge cup” National Competition                                     | <b>The Third Prize (2015)</b>   |
| • Mathematical Contest in Modeling Certificate of Achievement              | <b>Honorable Mention (2015)</b> |
| • Mathematical Contest in Modeling Certificate of Achievement              | <b>Honorable Mention (2014)</b> |
| • College English Test Band 6  |                                 |
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2019 - Now

2019 - 2020

2016 - 2019

Shoulder joint  $\times 2$       Elbow joint  $\times 3$       Wrist joint  $\times 2$

Large JTS  $\times 2$       Medium JTS  $\times 3$       Small JTS  $\times 2$

**7-DOF anthropomorphic manipulator**

Ring finger      Thumb      Palm      Electrical hardware

**Dexterous hand**

Initial State      Active electrical interface      Docking State      Passive electrical interface

Connector      Robot Modular joint      HerCel

Passive connection plate

(a) HerCel      ArmBot      24VDC power      USB-CAN      Connection board      Right electrical interface

(b)      (c)      (d)      Left electrical interface

**Self-reconfigurable robot**

Missile head alignment device      DC motor PCB      Capacitance torque sensor PCB      DC to DC buck PCB      Resistance welding device      Exploration robot      Capsule cleaner

**Other projects**

Ph. D project

Nature science foundation Special Zone project

Other