

Yuqing Liu

MSc Student in Robotics | University of Twente,
Netherlands



Introduction

Passionate MSc student specializing in robotics, with a strong background in mechatronics and robotic systems. Skilled in kinematics, robot control, embedded systems, and computer vision. Currently exploring machine perception, autonomous navigation, and reinforcement learning.

Education

- **University of Twente** — MSc in Robotics
Netherlands | Sep 2024 – Jun 2026
- **Xi'an Jiaotong-Liverpool University** — BSc in Mechatronics and Robotic Systems
Suzhou, China | Sep 2020 – Jun 2024

Experience

ETRON Technologies — Research Intern

Suzhou, Jiangsu, China | Jun 2022 – Aug 2022

- Responsible for development and debugging of the upper computer system on an electrical medical microscope.

- Gained hands-on experience in C, C++ programming and embedded systems development.
- Worked on real-time system control and upper-layer software integration for medical devices.

Research Experience

Smart Trolley for Lab

Xi'an Jiaotong-Liverpool University — Summer Undergraduate Research Fund (SURF) Program

Supervisor: Dr. Min Chen | Jun 2023 – Aug 2023

- Designed and built a trolley system for gripping and recognizing laboratory workpieces.
- Responsibilities included end effector design, topology optimization, and computer vision algorithm development using OpenCV.
- Improved mechanical design for laboratory applications, making the robotic trolley more compact and easier to operate.
- Developed an enhanced visual recognition system for better object detection and laboratory task automation.
- Presented research results through a comprehensive poster at the SURF event.



Supervisor: Dr. Min Chen
Group code : 20230211

Members: Yunqing Wang, Shunjie Gu, Yichen Wang, Minwen Su
Liu Yang, Yuqing Liu, Huizhong Wu, Jia Kai Sun, Ziwei Zhu

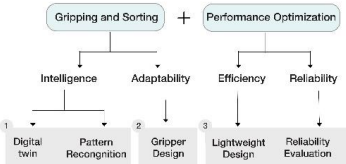
Muti-scale Generative Lightweight Design of Free Shape Robots

- illustrated by a dextrous and smart mobile robot

Abstract

Spurred by additive manufactured (AM) and artificial intelligence (AI) technologies, high-performance smart robots get an intensive attention. In this project, a dextrous while smart robot is created for efficiently packing and sorting special-shaped components in laboratories. Leveraging additive manufacturing, we explore a reliable gripper from multiple structural scales and improve mobility performance via Multi-scale lightweight design strategies. In parallel, pattern recognition and digital twin technologies are adopted for planning and detecting grip behavior in an automated manner. The advanced technologies are effectively utilized and integrated into the robot which avoids unnecessary labor force and improves laboratory environment.

Design Requirements

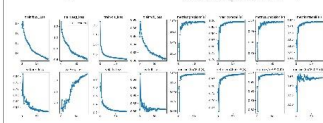
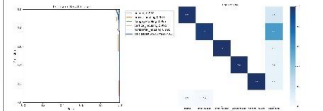


③ Smart Grasping and Supervising

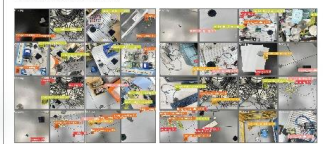
Deep learning-based object detection and grasping is used for an automated picking and sorting. For improving and supervising gripping behavior, time-to-time data transmission and control are realized through digital twinning.

Pattern recognition for regulating grasping behavior on the shape complex parts

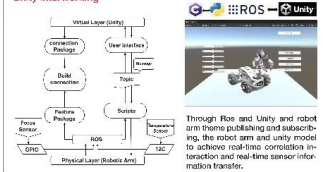
It can be seen from the curve that the areas enclosed by the Recall-recision curves of the five parts are close to 1, so it can be seen that the precision of target detection is very high.



As can be seen from the figure, the average confidence of the parts is higher than 0.5, and even the minimum is 1, indicating that the probability of detecting whether it is the target part is great.



Digital twin for Robotic Arm is implemented through ROS and Unity interworking



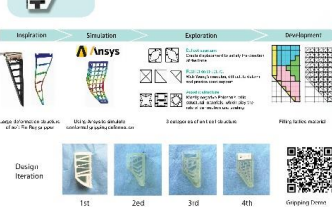
① Flexible Gripper Design

Components in laboratories are various and shape-complex and they are often placed in a random and scattered distribution. In order for an effective grip on complex components, structural deformation mechanisms are explored under mesoscale and macroscale dimensions respectively. Here, we proposed two design strategies for a stable gripping.

Sol 1: Multi-scale structure design + Customized add-ons

● Utilizing mesoscale lattice units for a conformal grip and loading bio-mimic add-on to grip complex parts

Lattice structure
Aims: Achieving an conformal gripping deformation mechanism
Methodology: The combination and arrangement of microscopic unit cells can cause macroscopic mechanical deformation
Highlights: soft materials, 2D latvices filling, 3 categories of unit cells



Add-ons
Aims: Customizing for shape-specific components
Methodology: Texture and shape design inspired by nature creatures
Highlights: Hybrid material fabrication, flexible structure, texture design

Layer	Content and material	Ground objects with network surface	Vulnerable objects
Design	Not ceramic	Not ceramic	Not ceramic
Optimize	Not ceramic	Not ceramic	Not ceramic
Finality	Not ceramic	Not ceramic	Not ceramic

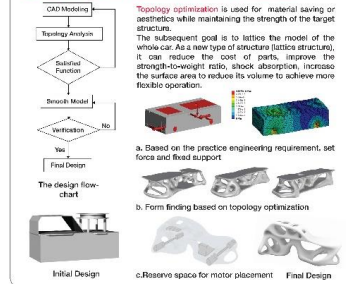
Sol 2: Large deformation structure+wire control

● Leveraging the large geometric deformation to wrap up parts under the single-wire control mechanism by additive manufacturing

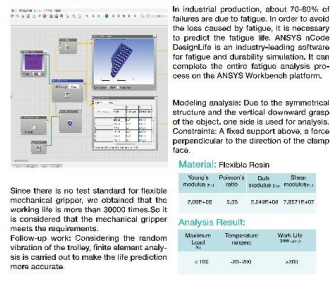


② Lightweight design and Reliability Evaluation

● Lightweight design based on Topology optimization



● Fatigue life prediction based on nCode,ANSYS Workbench

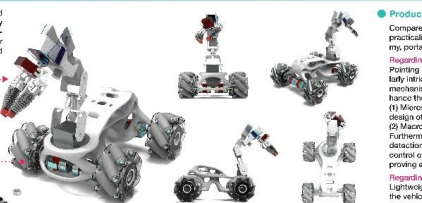


Conclusion & Discussion

This project integrates various advanced technologies, including AM-based multiscale structure design, vision-based grasping, digital twinning, topology optimization, and fatigue analysis. In parallel, the application of this concept is expected for high-end industries such as telemedicine, space exploration and unmanned transport for enhancing effectiveness and productivity.

● Future Scheme

- Current object detection algorithms are unstable and are easily affected by environment factors such as lighting, occlusion, and background interference. Detection error rate place frequently. The robustness of algorithms needs to be improved.
- Investigate further the deformation mechanisms of macroscopic lattice units and try the optimal lattice construction into specific application scenarios. In addition, we will take advantage of a multi-scale lattice fabrication for the exploration of lattice-based grippers.
- We will entirely pressure sensors into the robotic gripper for real-time grasp perception. That can avoid damaging fragile items during grasping process.



● Product features

- Compared to traditional manual sorting, the irregular-shaped parts sorting vehicle robot exhibits practicality, durability, accuracy, and lightweight design features, showing the advantages of economy, portability and intelligence.
- Regarding product functionality: Pointing to the random and scattered placement scenario of parts in laboratory settings, particularly intricate parts of varying sizes and complex shapes, this study investigates the deformation mechanisms of the structure from both a microscopic and macroscopic standpoint, aiming to enhance the success rate of part grasping.
- (1) Microscopically, we combine a deformation mechanism based on unit cell filling and bionic design of gripper add-ons.
- (2) Macroscopically, we come out an integrated wire-controlled convergence gripper scheme. Furthermore, to achieve automated sorting, research is conducted on deep learning-based object detection and pattern recognition grasping. Additionally, real-time data transmission and remote control of detection and grasping actions are realized through digital twinning, thereby further improving efficiency and accuracy.
- Regarding product performance: Lightweight design Topology optimization techniques are utilized to achieve lightweight design of the vehicle body and walls, enhancing the vehicle's mobility and endurance.
- Reliability: Fatigue analysis using ncode is employed to evaluate the durability of the grippers.

Acknowledgement

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Reference

- 1. Zhang, Y., Wang, Y., & Li, J. (2021). Topology optimization of a gripper. In: Proceedings of the 2021 IEEE International Conference on Robotics and Automation (ICRA), pp. 1-6.
- 2. Wang, Y., & Li, J. (2021). Topology optimization of a gripper. In: Proceedings of the 2021 IEEE International Conference on Robotics and Automation (ICRA), pp. 1-6.
- 3. Wang, Y., & Li, J. (2021). Topology optimization of a gripper. In: Proceedings of the 2021 IEEE International Conference on Robotics and Automation (ICRA), pp. 1-6.

Skills

- Robotics Systems

- Robot Kinematics and Dynamics
- Robotics Programming
- Embedded Systems Development
- Computer Vision (OpenCV)
- Machine Perception
- Autonomous Navigation
- C / C++ Programming
- Embedded C Programming
- Reinforcement Learning