Wei-Hsuan Cheng

Taipei, Taiwan johnathancheng0125@gmail.com Wei-Hsuan Cheng
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Education

National Taiwan University (NTU) *May 2025*
Master's in Biomechatronics Engineering

- Overall GPA: 4.14/4.3
- Scholarships: 2023 Master's Student Scholarship (First Place) from Dept. Biomechatronics Engineering, NTU
- **Coursework:** Robotics, Optimal Control, Stochastic Control, Robust Control, System Identification, Linear Systems
- **Master's Thesis:** Application of Vision- and Force-Based Supervisory Teleoperation for Robotic Dexterous Manipulation Tasks in Industrial Surveillance

National Tsing Hua University (NTHU) *June 2022*
Bachelor in Interdisciplinary Programme of Nuclear Science (IPNS)

- Specialising in Energy Engineering and Power Mechanical Engineering.

Skills

Programming: C++, Python, MATLAB, JavaScript, LaTeX

Robotics Research Interests: Motion Planning and Control, Kalman Filtering, Computer Vision, Vision- and Force-based Control, Mobile Robot Localisation and Navigation, Application of Conformal Geometric Algebra (CGA) in Robotics

Software/Hardware/Tools: ROS 1 & 2, MoveIt2!, PCL, PyQt5, Git, Docker, SolidWorks, onshape, NVIDIA Jetson, STM32/ESP32 MCU

Languages: Mandarin Chinese (native), English (fluent; proficient in academic presentations and team leadership as NTU project lead for a mixed local–international team)

Research Experience

Delta-NTU Joint Research & Development Centre *Taipei, Taiwan*
Project leader in the collaboration research project of NTU and the CTO Office in Delta Electronics, Inc. *Dec 2023 – May 2025*

Supervisory Teleoperation of Manipulator for Surveillance

- Develop a reliable supervisory robotic system for performing dexterous manipulation tasks in industrial surveillance scenario (*e.g.* buttons, switches, and valves operations). The system utilises a local–remote teleoperation setup with wireless communication, separating the local site—which comprises the control console, user interface, and input device—from the remote site, where the robot performs tasks with sensors and algorithms deployed.
- **Unified 6-DoF Vision Alignment:** Employ a state-of-the-art deep learning method for 6D object pose estimation with a position-based visual servo (PBVS) control scheme. This combination serves as a unified 6-DoF vision alignment method, which is essential for performing precise manipulation tasks for versatile objects in industrial settings.
- **Vision Alignment Corrected by Force:** Apply force control to further correct the vision alignment errors. The integration of two complementary sensory modalities (vision-and-force) provides enhanced accuracy for robotic dexterous manipulation.

The key results of the project were successfully demonstrated to the CEO at the **2024 Delta Electronics Annual Innovation Showcase**.

Robots and Medical Mechatronics Lab (RMML) *Taipei, Taiwan*
Master's student researcher, advised by Prof. Ping-Lang Yen *Sept 2022 – May 2025*

Project Experiences and Contributions

- Agricultural Robot:
  - Improve EKF-SLAM for agricultural tracked mobile robot by involving IMU bias estimation and on-line state covariance update.
  - Apply vision-based control scheme and object 6D pose estimation for robotic tomato harvesting.
- Surgical Robot:
  - Improve attitude and angular velocity estimation, and the visual servo control scheme for surgical robot end-effector using multi-sensor fusion and a quaternion-based EKF.

Selected Projects

Attitude and Angular Velocity Estimation of Surgical Robot Using Sensor Fusion with Optical Tracker, IMU, and Quaternion-based Extended Kalman Filter kf_cpp, *May 2023*

- A multi-sensor fusion framework is used for estimating the attitude and angular velocity of surgical robot end-effector, for better robustness (against occlusions) and tracking precision in minimally invasive surgeries.
- An quaternion-based EKF algorithm is derived based on a constant angular velocity model.
- The EKF and UKF algorithm are implemented in ROS 2 C++.

Kendo Robot: Combining Robotics Technologies with Martial Art kendo_robot, *Dec 2023*

- A supervisory teleoperation kendo robot system. The robotic arm holding kendo sword tracks the opponent's pose and wait for the operator's command to attack on different body positions.
- Detect and track the 3D human body by DL-based real-time human pose estimation algorithm and RGB-D alignment. An interactive GUI is built using JavaScript for real-time visualisation and robotic motion planning.
- Robotic arm IK solver and sword motion planner are designed based on a new mathematical framework, conformal geometric algebra (CGA).
- Developed using ROS 1 Python, and a web-based interacture GUI uisng JavaScript. ROS-JavaScript communication through web socket.

CGA IK: Closed-Form Inverse Kinematics Solver based on CGA cga_ik, *Nov 2023*

- Aim to promote a new mathematical framework **conformal geometric algebra (CGA)** for robotics applications.
- Implemented closed-form IK solvers for a 6-DoF collaborative robot (cobot) and a 3-DoF spherical parallel manipulator (SPM) based on CGA.
- Simulated and visualised in a web-based interactive GUI using JavaScript. Implemented in ROS 2 C++ and tested on a real robot.

stewart_platform_sim: Six-DoF Stewart-Gough Platform Simulation stewart_platform_sim, *July 2025*

- ROS 2 Python simulation of a six-DoF Stewart platform (or Stewart-Gough platform), which is a parallel manipulator comprising a fixed base platform, a moving end-effector platform, and six serial SPS sturctures.
- The inverse kinematics (IK) and differential kinematics (DK) problems are solved as to obtain the required leg lengths and leg velocities for driving the robot to achieve a desired motion in $SE(3)$.

Teaching Assistants (TAs)

Engineering Mathematics (I) *Autumn 2022*

Introduction to Foreign Literature on Bio-Systems Engineering *Autumn 2022*

Awards

Robotics Competition Winner (Kendo Robot) as a team leader in the course project of CSIE5074 Robotics, offered by Prof. Li-Chen Fu @ NTU EE. *Dec 2023*