CURRICULUM VITAE

Xinlei Zhang

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RESEARCH INTERESTS & GOAL

My research interests lie in the **theories** and **applications** in **robotics**, including **state estimation** & **system dynamics**, **nonlinear control**, and **data-driven methods**. My goal is to advance robotics research by integrating artificial intelligence and control theory methods.

EDUCATION

North Carolina State University | **Mechanical Engineering** 08/2024 - Present
Department of Aerospace and Mechanical Engineering Raleigh, US

South China University of Technology | **Intelligent Manufacturing** 09/2020 - 07/2024
Shien-Ming Wu School of Intelligent Engineering Guangzhou, China
Overall GPA 3.78/4.00
Related Courses

- Applied Calculus II 96/100, Linear Algebra 97/100, Probability and Statistics 89/100
- Artificial Intelligence Technology and Applications 90/100, Data Structure 91/100
- Sensor Technology and Applications 90/100, Mechatronics 92/100
- System Dynamics 91/100, Classical Control Theory 92/10, Modern Control Theory 95/100

PUBLICATION & PATENT

On Ambiguity in 6-DoF Magnetic Pose Estimation | ***First Author*** Second-round Review
Xinlei Zhang, Shuda Dong, Yifeng Zeng and Heng Wang
Submitted to **International Journal of Robotics Research (IJRR)**

A Virtual Ultrasonography Simulator for Skill Training Using Magnetic-Inertial Probe Tracking Pending
Heng Wang, Shuangyi Wang, Suqi Liu, Shuda Dong, Xinlei Zhang
Applied to CN Patent, No.CN116312122A

RESEARCH EXPERIENCE

The Lab of Magnetic-Controlled Robot, SCUT 09/2021-07/2024
Research Assistant, advised by Prof. Heng Wang

6-DoF Magnetic-Inertial Pose Estimation 09/2021-12/2021

- **Contribution:**
  - Debugged the magnetic-inertial sensor and sensor-arduino-Matlab communication.
  - Reviewed the literature regarding the magnetic-inertial pose estimation methods.
  - Learned and completed the probabilistic modeling of magnetic-inertial sensor measuring process.
  - Implemented the constrained extended Kalman filter (CEKF) to fuse a constant velocity model and magnetic-inertial sensor measurements to achieve pose estimation.
  - Defined the ambiguity issue in magnetic-inertial pose estimation system and proposed its identification method, to analyze and interpret the observability in this nonlinear system.
- **Outcome:**
  - Achieved millimeter-degree 6-DoF pose estimation accuracy in experiments.
  - Applied for one **CN patent**.

On Ambiguity in 6-DoF Magnetic Pose Estimation 01/2022-Present

- **Contribution:**
  - Utilized the geometry of the special Euclidean group to decouple position and orientation in ambiguity issue.
  - Employed the numerical optimization method to tackle the non-linearity in magnetic field distribution.

- Systematized the framework to analyze the ambiguity issue in magnetic pose estimation systems, including its definition, categorization, identification algorithms and impact on pose estimation.
- Proposed the optimal magnetic source design in magnetic pose estimation system to achieve 6-DoF pose estimation without ambiguity.
- Derived the equation describing the dynamical nature of ambiguity issue.
- Designed and conducted experiments to verify the framework and the performance of the optimal system.

- **Outcome:**
  - Achieved millimeter-degree-accuracy and unambiguous 6-DoF pose estimation with the prototype.
  - Submitted one manuscript to **International Journal of Robotics Research**, under the second-round review.
  - Earned recognition and funding through the **Chinese National Training Program of Innovation and Entrepreneurship for Undergraduates**, with a total funding amount of $1300.

Related Course Projects

Tendon-Driven and Flex Sensor Based Gesture Sensing Hand Exoskeleton | *Team Leader* Spring 2023

- **10 motors** are controlled to stretch tendons attached to the hand exoskeleton, achieving independent control of all five fingers. Moreover, **flex sensors** are fixed with fingers to measure their bending extent, providing gesture information, to construct the **closed-loop gesture control** of fingers.
- **Key words:** PID Motor Control, 3D Modeling and Manufacturing of Exoskeleton, Tendon-driven Mechanism, Bending Sensor, Closed-loop Gesture Tracking.

Wireless-Powered Animation System Displayed by Rotating LEDs | *Team Leader* Fall 2022

- **Multiple embedded system modules**, motor-driving, infrared-monitoring, wireless-charging and sounding-effect, were controlled to present the **self-designed animation** based on the principle of persistence of vision.
- **Key words:** Wireless-charging Coil & Circuit Design, Infrared Sensor, Sounding Module, Animation Presented by Rotating LED Stripe.

Omni-Motion, Bluetooth-control and Self-Reloading Automatic Catapult | *Team Leader* Spring 2022

- The **kinematic model** of the 4 omni-wheel motion was analyzed to achieve the **omni-direction control**. Remote operation was achieved using the **Bluetooth** device and **one self-designed android app**. Moreover, a self-reloading mechatronics device was developed by **3D printing, laser cutting and circuit design** technologies.
- **Key words:** Omni-motion UGV Design and Manufacturing, Bluetooth Module & Android App, Self-reloading Mechanism, Lever-Spring-Motor Shooting Mechanism.

Machine Learning & IMU Based Classifier on Ping-Pong Players' Motion | *Team Leader* Fall 2021

- **Neural network** and **decision tree** classifiers were ensembled to distinguish the motion of forehand drive and backhand stroke of a Ping-Pong player based on the inertial data. Moreover, **One-class SVM** and **Local outlier factor** were employed to detect wrong motions during training which may bring damage to the player's wrist.
- **Key words:** Inertial Sensor, Classifier: Neural Network & Decision Tree, Fault Detection: One-class SVM & Local Outlier Factor, Ping-Pong Training Monitoring.

Selected Awards & Honors

Mathematical Contest in Modeling 05/2023
Honorable Mention (Second-Class Award), Top 30%

Alibaba Cloud Programming Contest in SCUT 03/2023
Third-Class Award, Top 15%

Undergraduate Internship Scholarship, China Scholarship Council & University of Alberta 08/2022
Only 1 in South China University of Technology and total 9 in China

National Contest on Micro Sensing and Intelligent Technology 10/2021
National First Prize & Excellent Defense, Top 4%

Skills

Languages: Chinese (Native), English (IELTS: 7.0/9.0)
Programming: MATLAB & Simulink, Python, C, C++, R
Others: ROS2, SolidWorks, Embedded System Development, Photo & Video Editing, LaTeX & Markdown