

Kai-Chieh Hsu

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Research Interests

Machine Learning	reinforcement learning and neural networks for safety-critical robotic systems
Human-Robot Interaction	inverse reinforcement learning and active human feedback queries to infer human's preference
Multi-Agent Planning	game-theoretic based approach in zero-sum differential game

Education

Princeton University (PU)

Princeton, NJ, USA

Ph.D. Candidate in Electrical and Computer Engineering

Sept. 2019 - PRESENT

- Achieved 4.0/4.0 GPA
- Thesis Advisor: Prof. Jaime Fernández Fisac

National Taiwan University (NTU)

Taipei, Taiwan

B.S. in Electrical Engineering

Sept. 2014 - Jan. 2019

- Achieved 4.19/4.30 overall GPA and ranked in **top 5%**
- Research Advisors: Prof. An-Yeu (Andy) Wu and Prof. Jean-Fu Kiang

Skills

- **Program Languages** Python, MATLAB, Verilog, C++
- **Others** PyTorch, Git, SLURM, NumPyro, CVX, \LaTeX

Research Projects

Reach-Avoid Reinforcement Learning

PU, NJ, USA

Safe Robotics Lab, Prof. Jaime Fernández Fisac

July 2020 - PRESENT

- Derive a time-discounted formulation of the reach-avoid optimal control problem that lends itself to **(deep) reinforcement learning** methods by inducing contraction mapping property
- Propose a **supervisory control** scheme by treating the approximate optimal policy as an untrusted oracle
- Deploy our reach-avoid Q-Learning in a range of nonlinear systems, including an **attack-defense game**

Inverse Specification

PU, NJ, USA

Safe Robotics Lab, Prof. Jaime Fernández Fisac

July 2020 - PRESENT

- Use Bayesian optimization to infer constraints **interactively with humans** by asking for ranking feedback on multiple candidates
- **Select queries actively** to speed up the convergence to the true preference based on information-theoretic metrics
- Survey in **inverse optimal control** and **imitation learning**

ECG Real-Time Telemonitoring

NTU, Taiwan

Access IC Lab, Prof. An-Yeu (Andy) Wu

Aug. 2017 - Mar. 2019

- **Edge Classification:** Incorporate **compressed sensing**, task-driven dictionary learning (predictive sparse coding) and PCA to render light-weighted classifier and overcome limited labeled data challenge
- **On-Demand Recovery:** Design a two-stage algorithm that classifies and reconstructs only problematic signals. This algorithm utilizes the information from classification stage to speed up the reconstruction algorithm
- **Hardware Design and Chip Implementation:** Propose a hardware architecture for on-demand recovery to allow hardware sharing between classification and reconstruction algorithms

Direction-of-Arrival (DOA) Estimation

NTU, Taiwan

Group of Electromagnetic Applications, Prof. Jean-Fu Kiang

Feb. 2017 - Mar. 2019

- **Antenna Uncertainty:** Utilized special matrix structure with Khatri-Rao subspace-based Multiple Signal Classification (MUSIC) to improve immunity to uncertainties and detect DOAs with sensors half the number of sources
- **More Sources Than Sensors:** Proposed a new antenna array structure to increase the number of detectable sources based on fourth-order statistics and compressive sensing approach
- **Mixed Carrier Frequency (CF) Known and Unknown Sources:** Proposed a two-step algorithm to first estimate DOA of CF-known sources and then joint estimate the DOA and CF of CF-unknown sources

Publications

- [7] **K.-C. Hsu***, V. Rubies-Royo*, C. J. Tomlin and J. F. Fisac, “Safety and Liveness Guarantees through Reach-Avoid Reinforcement Learning,” in *Proceedings of Robotics: Science and Systems (RSS)*, Held Virtually, July 2021. | [📄](#)
- [6] C.-Y. Chou, **K.-C. Hsu**, B.-H. Cho, K.-C. Chen and A.-Y. (Andy) Wu, “Low-Complexity On-demand Reconstruction for Compressively Sensed Problematic Signals,” in *IEEE Trans. Signal Process.*, vol. 68, pp. 4094-4107, July 2020. | [📄](#)
- [5] **K.-C. Hsu** and J.-F. Kiang, “Joint Estimation of DOA and Frequency From A Mixture of Frequency Known and Unknown Sources with Orthogonal Coprime Arrays,” in *Sensors*, 19(2), 335, Jan. 2019. | [📄](#)
- [4] **K.-C. Hsu**, B.-H. Cho, C.-Y. Chou and A.-Y. (Andy) Wu, “Low-Complexity Compressed Analysis in Eigenspace with Limited Labeled Data for Real-Time Electrocardiography Telemonitoring,” in *IEEE Global Conference on Signal and Information Processing (GlobalSIP)*, Anaheim, USA, Nov. 2018. | [📄](#)
- [3] **K.-C. Hsu** and J.-F. Kiang, “DOA Estimation With Triply Primed Arrays Based on Fourth-Order Statistics,” in *IEEE AP-S Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting*, Boston, USA, July 2018. | [📄](#)
- [2] **K.-C. Hsu** and J.-F. Kiang, “DOA Estimation Using Triply Primed Arrays Based on Fourth-Order Statistics,” in *Progress In Electromagnetics Research M*, Vol. 67, pp. 55-64, Mar. 2018. | [📄](#)
- [1] **K.-C. Hsu** and J.-F. Kiang, “DOA Estimation of Quasi-Stationary Signals Using a Partly-Calibrated Uniform Linear Array with Fewer Sensors Than Sources,” in *Progress In Electromagnetics Research M*, Vol. 63, pp. 185-193, Jan. 2018. | [📄](#)

Honors & Awards

- 3rd Prize** in Integrated Circuit Design Contest
• Out of about 300 teams
Ministry of Education, Taiwan
July 2018
- 2nd Prize** in Taiwan Creative Electromagnetic Implementation Competition
• Under the supervision of Prof. Tzong-Lin Wu | [📄](#)
High-speed RF and mm-Wave Tech. Center, Taiwan
Aug. 2017
- 8th place** in Data Structure and Programming Contest
• Out of about 250 students
Cadence, Taiwan
Mar. 2017
- Digital IC Design Certificate**
• Familiar with Verilog, logic synthesis, simulation and STA
National Chip Implementation Center, Taiwan
Nov. 2018
- Graduate Representative** in NTUEE graduate ceremony
• Given to top ten students of four years
Dept. of EE, NTU, Taiwan
June 2018
- Professor Chun-Hsiung Chen Scholarship**
• Rewarded outstanding performances in electromagnetic fields
Electromagnetic Industry-Academia Consortium, Taiwan
Jan. 2018
- Presidential Awards**
• Given to top ten students of that semester
Dept. of EE, NTU, Taiwan
second semester of 2014 and 2016

Research & Teaching Experiences

- Research Assistant**
Safe Robotics Lab, Prof. Jaime Fernández Fisac
PU, NJ, USA
Aug. 2020 - PRESENT
- Teaching Assistant**
ELE364: Machine Learning for Predictive Data Analytics
PU, NJ, USA
Sept. 2020 - Dec. 2020
- Research Assistant**
Access IC Lab, Prof. An-Yeu (Andy) Wu
NTU, Taiwan
Feb. 2018 - Mar. 2019
- Undergraduate Researcher**
Group of Electromagnetic Applications, Prof. Jean-Fu Kiang
NTU, Taiwan
Feb. 2017 - Mar. 2019
- Teaching Assistant**
Digital System Design
NTU, Taiwan
Feb. 2018 - June 2018

Professional Activities

- Reviewer** IEEE Transactions on Vehicular Technology, IETE Technical Review