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. 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

Reinforcement Learning for the Reach-Avoid Problem

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 **shielding** 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 System Design

PU, NJ, USA

Safe Robotics Lab (Prof. Jaime Fernández Fisac) — July 2020 - PRESENT

- Infer reward function and constraints by only **human preferences**
- Select queries actively to speed up the convergence to the true preference based on mutual information metric
- Survey in **inverse optimal control** and **generative adversarial imitation learning**

ECG Real-Time Telemonitoring

NTU, Taiwan

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

[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 — Ministry of Education, Taiwan
- Out of about 300 teams — July 2018

2nd Prize in Taiwan Creative Electromagnetic Implementation Competition — High-speed RF and mm-Wave Tech. Center, Taiwan
- Under the supervision of Tzong-Lin Wu, IEEE Fellow | — Aug. 2017

8th place in Data Structure and Programming Contest — Cadence, Taiwan
- Out of about 250 students — Mar. 2017

Digital IC Design Certificate — National Chip Implementation Center, Taiwan
- Familiar with Verilog, logic synthesis, simulation and STA — Nov. 2018

Graduate Representative in NTUEE graduate ceremony — Dept. of EE, NTU, Taiwan
- Given to top ten students of four years — June 2018

Professor Chun-Hsiung Chen Scholarship — Electromagnetic Industry-Academia Consortium, Taiwan
- Rewarded outstanding performances in electromagnetic fields — Jan. 2018

Presidential Awards — Dept. of EE, NTU, Taiwan
- Given to top ten students of that semester — second semester of 2014 and 2016

Research & Teaching Experiences

Research Assistant — PU, NJ, USA
Safe Robotics Lab (Prof. Jaime Fernández Fisac) — Aug. 2020 - PRESENT

Teaching Assistant — PU, NJ, USA
ELE364: Machine Learning for Predictive Data Analytics — Sept. 2020 - Dec. 2020

Research Assistant — NTU, Taiwan
Access IC Lab (Prof. An-Yeu (Andy) Wu) — Feb. 2018 - Mar. 2019

Undergraduate Researcher — NTU, Taiwan
Group of Electromagnetic Applications (Prof. Jean-Fu Kiang) — Feb. 2017 - Mar. 2019

Teaching Assistant — NTU, Taiwan
Digital System Design — Feb. 2018 - June 2018

Professional Activities

Reviewer IEEE Transactions on Vehicular Technology, IETE Technical Review