

Guan-Horng Liu

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EDUCATION

- Georgia Institute of Technology (GaTech)** Atlanta, GA, USA
Ph.D. in Machine Learning from 08/2019
 - Advised under Prof. Evangelos Theodorou on deep learning & optimal control.
- Carnegie Mellon University (CMU)** Pittsburgh, PA, USA
M.S. in Robotics (GPA 4.0/4.3) 05/2017
 - Thesis: High-dimensional planning and learning for off-road driving.
 - Selected courses: *Deep reinforcement learning(A)*, *Statistical Techniques in Robotics(A)*, *Computer vision(A+)*
- Tokyo Institute of Technology (TIT)** Tokyo, Japan
One-Year Research Exchange Program (GPA 4.0/4.0) 06/2015
 - Tech report: Autonomous navigation of the unmanned surface vehicle.
- National Taiwan University (NTU)** Taipei, Taiwan
B.S. in Mechanical Engineering (GPA: 3.99/4.0) 06/2014
 - Graduated Cum Laude & Best Paper Award in 2013 IEEE/SICE ISS.

RESEARCH EXPERIENCE

- Deep Learning Theory from Stochastic Processes & Optimal Control Perspective [1, 2]** Atlanta, GA, USA
Advisor: Prof. Evangelos Theodorou (Center for Machine Learning, GaTech) from 08/2019
 - Aligned existing deep learning theory through optimal control and stochastic dynamics viewpoint.
 - Deriving new optimal control theory for dimension-varying systems to analyze deep neural networks.
 - Modeling stochastic gradient descent with jump diffusion processes to reveal generalization properties.
 - Proposing algorithms using discrete geometric mechanics technique such as variational integrator.
- Learning End-to-end Multimodal Sensor Policy [3, 4]** Pittsburgh, PA, USA
Advisor: Prof. George Kantor (Robotics Institute, CMU) 11/2016 – 07/2017
 - Promoted sensor fusion in multimodal deep reinforcement learning (M-DRL), making multisensory policies robust to un-perfect sensing and even partial sensor failure.
 - Proposed a novel stochastic technique called Sensor Dropout to reduce sensitivity to any sensor subset.
 - Introduced a new auxiliary loss on policy network along with standard DRL loss to reduce the action variations.
 - Reduced performance degrades in noisy environments from 50% to 10% on physical-based racing car (TORCS).
- High-Dimensional Deep Inverse RL & Planning for All-Terrain Vehicle [5]** Pittsburgh, PA, USA
Advisor: Prof. George Kantor (Robotics Institute, CMU) 09/2015 – 06/2017
 - Constructed an off-road terrain traversable function by learning human preference from demonstrations.
 - Optimized expert's optimality with an additional parameter by extending the formulation to Gibbs distribution.
 - Derived vehicle response model using transfer function and neural network for local paths generation.
 - Demoed off-road high-speed maneuvering on a full-size ATV with ROS system.
- Autonomous Navigation for Maritime Surface Vehicle [6]** Tokyo, Japan
Advisor: Prof. Edwards F. Fukushima (Hirose Fukushima Robotics Lab, TIT) 09/2013 – 06/2014
 - Developed autonomous navigation to compete in "Maritime Robotx Challenge" as TIT team member.
 - Constructed simulation platform via MATLAB Simulink for performance testing and evaluation.
 - Designed wave-adaptive propulsion system and power configuration.
- Bio-Inspired Kangaroo Robot [7, 8]** Taipei, Taiwan
Advisor: Prof. Pei-Chun Lin (Bio-inspired Robotics Lab, NTU) 01/2012 – 10/2013
 - Built independently-designed kangaroo robot with dynamic jogging characteristic.
 - Derived dynamic robot leg movement based on reduced-order dynamic model.
 - Implemented active tail counterbalance mechanism using feedback control strategy.

PUBLICATIONS

- [1] **GH Liu**, E Theodorou, (2020) "Differential Dynamic Programming Neural Optimizer", Under submission to *International Conference on Machine Learning*
- [2] **GH Liu**, E Theodorou, (2019) "Deep Learning Theory Review: An Optimal Control and Dynamical Systems Perspective", *Arxiv preprint (1908.10920)*
- [3] **GH Liu**, A Siravuru, S Selvaraj, G Kantor, & M Veloso, (2017) "Learning End-to-end Multimodal Sensor Policies for Autonomous Navigation", *Conference on Robot Learning*, Mountain View, CA, USA
- [4] **GH Liu**, A Siravuru, S Selvaraj, G Kantor, & M Veloso, (2017) "Multi-modal Deep Reinforcement Learning with a Novel Sensor-based Dropout", *Multi-disciplinary Conference on Reinforcement Learning and Decision Making*, Ann Arbor, MI, US
- [5] **GH Liu**, (2017) "High Dimensional Planning and Learning for Off-Road Driving", *CMU RI Master Thesis*
- [6] **GH Liu**, AY Yasutomi, & EF Fukushima, (2014) "Autonomous Control of the WAM-V Catamaran Type Unmanned Surface Vehicle: Propulsion System Design", *Conference of the Robotics Society of Japan*
- [7] **GH Liu**, HY Lin, HY Lin, ST Chen, & PC Lin, (2014) "A Bio-Inspired Hopping Kangaroo Robot with an Active Tail", *Journal of Bionic Engineering*, vol.11, pp.541-555.
- [8] **GH Liu**, HY Lin, HY Lin, ST Chen, & PC Lin, (2013) "Design of a Kangaroo Robot with Dynamic Jogging Locomotion," *IEEE/SICE International Symposium on System Integration*

AWARDS & SCHOLARSHIP

Taiwan Oversea Scholarship (Acceptance rate 19%), <i>Government scholarship for selected PhDs</i>	05/2019
Project Spotlight (Acceptance rate 14%), <i>Deep Reinforcement Learning, CMU 10-703</i>	06/2017
Best Paper Award , <i>IEEE/SICE International Symposium on System Integration</i>	12/2013
Third Prize (3 out of 22 teams), <i>Chuan-Yan Technical Thesis Paper Competition (Taipei, Taiwan)</i>	10/2013
Bronze Medal (3 out of 30+ team), <i>NTU Robot Design Competition (Taipei, Taiwan)</i>	04/2012
Japan Student Service Organization Scholarship	11/2013
Presidential Awards (Received 4x) , <i>Top 5% in class, NTU</i>	09/2009 – 06/2014

SELECTED PROJECTS

- Visual SLAM with Segmentation Aid in Dynamic Urban Environment** Fall 2016
CMU 16-831: Statistical Techniques in Robotics (A, Instructor: Prof. Michael Kaess & Prof. Kris Kitani)
- Integrated semantic segmentation with SLAM algorithms, including ORB-SLAM and LSD-SLAM.
 - Reduced the drifting of visual odometry by 32% on Cityscapes dataset with moving vehicles & pedestrians.
- Real-Time Pose Estimation & Tracking for Human Robot Interaction** Spring 2016
CMU 16-720: Computer Vision (A+, Instructor: Prof. Deva Ramanan)
- Implemented 6 DOF pose tracking & texture recognition for model-based rigid objects.
 - Utilized fast edge-based tracking, with accurate texture detection on sparse feature (SIFT).

WORK EXPERIENCE

- Uber Advanced Technology Group** Pittsburgh, PA, USA
Position: Robotics Software Engineer 09/2017 – 12/2018
- Developed motion planning algorithm and software libraries for self-driving vehicles.
 - Designed modules that quantify safe and comfortable autonomous lane changing behavior.
 - Modeled lane change evolution with human-like preference, generated motion primitives for trajectory optimization.
 - Implemented and maintained reusable software libraries to support all related modules.
- Aptiv Mobility Group** Pittsburgh, PA, USA
Position: Robotics Summer Research Intern 06/2016 – 08/2016
- Developed a parallel parking planner using strategy-guided finite state machine as searching template.
 - Developed an advanced planner GUI on PyQt capable of exhaustive testing and drag-and-drop reconfigurations.
 - Researched human-like driving strategies using inverse reinforcement learning (IRL) algorithm.