

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*.

PUBLICATIONS

- [1] **GH Liu**, TR Chen, E Theodorou, (2021) "Dynamic Game Theoretic Neural Optimizer", *International Conference on Machine Learning (ICML)*
- [2] **GH Liu**, TR Chen, E Theodorou, (2021) "DDPNOpt: Differential Dynamic Programming Neural Optimizer", *International Conference on Learning Representations (ICLR)*
- [3] E Evans, O So, A Kendall, **GH Liu**, E Theodorou, (2021) "Spatio-Temporal Differential Dynamic Programming for Control of Fields", *Arxiv preprint (2104.04044)*
- [4] Z Wang, O So, J Gibson, B Vlahov, M Gandhi, **GH Liu**, E Theodorou, (2021) "Variational Inference MPC using Tsallis Divergence", *Robotics: Science and Systems*
- [5] **GH Liu**, E Theodorou, (2019) "Deep Learning Theory Review: An Optimal Control and Dynamical Systems Perspective", *Arxiv preprint (1908.10920)*
- [6] **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*
- [7] **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*
- [8] **GH Liu**, (2017) "High Dimensional Planning and Learning for Off-Road Driving", *CMU RI Master Thesis*
- [9] **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*
- [10] **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.
- [11] **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

ICML 2021 Oral (Acceptance rate 3%),	05/2021
ICLR 2021 Spotlight (Acceptance rate 3.8%),	01/2021
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), Chuian-Yan Technical Thesis Paper Competition (<i>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), Top 5% in class, NTU	09/2009 – 06/2014

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.

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.