Guan-Horng Liu

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RESEARCH INTEREST

Robot learning & control - deep reinforcement learning, policy optimization & analysis, imitation learning, stochastic optimal control, and model-predictive control.

EDUCATION

Georgia Institute of Technology (GaTech)   *Atlanta, GA, USA*
   Ph.D. in Robotics   *from 01/2019*
- Advised under <u>Prof. Evangelos Theodorou</u> on optimal control & deep learning with uncertainty.

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

Learning End-to-end Multimodal Sensor Policy [1, 2]   *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 degrade in noisy environments from 50% to 10% on physical-based racing car (TORCS).

High-Dimensional Deep Inverse RL & Planning for All-Terrain Vehicle [3]   *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.
- Derived equations for learning from failures, which overcome the problems of spatially sparse gradient feedback.
- Optimized expert's optimality with an additional parameter by extending the formulation to Gibbs distribution.
- Designed an RRT*-based local planner in 2 DOF control space and propagated in 6 DOF state space.
- 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 [4]   *Tokyo, Japan*
   Advisor: Prof. Edwardo 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 [5, 6]   *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**, 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

[2] **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

[3] **GH Liu**, (2017) "High Dimensional Planning and Learning for Off-Road Driving", *CMU RI Master Thesis*

[4] **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*

[5] **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.

[6] **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*

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.

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).

AWARDS & SCHOLARSHIP

Project Spotlight (Acceptance rate 14%), *Deep Reinforcement Learning*, CMU 10-703 (PA, USA)	*06/2017*
Best Paper Award, *IEEE/SICE International Symposium on System Integration* (*Kobe, Japan*)	*12/2013*
Japan Student Service Organization Scholarship (*Tokyo, Japan*)	*11/2013*
Third Prize (3 out of 22 teams), Chuian-Yan Technical Thesis Paper Competition (*Taipei, Taiwan*)	*10/2013*
Bronze Medal (3 out of 30+ team), *NTU Robot Design Competition* (*Taipei, Taiwan*)	*04/2012*
Presidential Awards (Received 4x), *Top 5% in class, NTU (Taipei, Taiwan)*	*09/2009 – 06/2014*

SKILLS

Programming Language: C/C++, Python, OpenCL, CUDA, MATLAB, Java, LabVIEW
Application Software: Linux, ROS, Tensorflow, Pytorch, OMPL, OpenCV, PCL, OpenRAVE