Chen-Lung 'Eric' Lu

Email : eric565648@gmail.com
Email (2) : luc5@rpi.edu
Phone: +1-5189770826
Website: https://eric565648.github.io/
Lab: John Wen Research Group @ RPI
Address: Rensselaer Polytechnic Institute
via CII 8129, 110 8th St., Troy, NY. 12180

Education and Professional Experiences:

Ph.D. in Department of Electrical, Computer and Systems Engineering (ECSE),
Rensselaer Polytechnic Institute (RPI), Troy, NY. Sep. 2021 ~

M.S. in Institute of Electrical and Control Engineering (ECE),
National Chiao Tung University (NCTU), Taiwan. Sep. 2018 ~ Apr. 2021
* Team lead of Team NCTU to the DARPA Subterranean Challenge, Tunnel Circuit and Urban Circuit in Pittsburgh PA in 2019 and Elma, WA in 2020.

Visiting Student in Dept. of Information Technology and Electrical Engineering,
Eidgenössische Technische Hochschule (ETH) Zürich Feb. to Aug., 2018
* I joined the "Autolab" in IDSC under Prof. Frazolli and was supervised by Dr. Andrea Censi and Dr. Jacopo Tani to contribute to Duckietown in the Zürich.

B.S. in Electrical and Computer Engineering (ECE),
National Chiao Tung University (NCTU), Taiwan. Sep. 2014 ~ Sep. 2018
* Coordinator for the Duckietown @ NCTU

Precent Projects and Publications:

Robot Motion Program - with GE

Robotic Arms comparing to CNC machine have much larger work space with a cheaper cost. However, it remain a challenge to balance between accuracy, speed, and speed variation. In cold spray process, we would like the motion to be fast, yet remain certain accuracy and constant speed. Nevertheless, users typically do not have access to the lower level control other than the pre-defined motion primitives like moveL, moveC, moveJ, which are universally provided by all robotics companies. The goal is to optimize the motion programs such that the arms can track fast and accurate with constant speed. We analyzed the poses of robotics arm to first optimized the relative pose between parts and arms, then generate and optimized the motion program.

* Developed Python Interface for FANUC Robots. https://github.com/eric565648/fanuc_motion_program_exec
* Improve the baseline solution by twice as much and even more.

Emotional Expressive Robot

Robots are very different from usual machines. Human usually consider robots have personality or even emotions. Emotions can be considered as a internal states which can be convey without verbal cues. In addition, Expressing internal states with physical cues can highly increase the efficiency in communication. Therefore, I followed the framework proposed to develop a emotional expressive robot. Taking the advantage of crowd sourcing and machine learning, and according to the final user study, the robot is able to express happiness.

* Video: https://youtu.be/G78Iz2lNfrQ
* Project Repo: https://github.com/eric565648/robotics1_project

DARPA Subterranean Challenge

The DARPA Subterranean Challenge seeks novel approach toward fully autonomous search and rescue system in underground (i.e. tunnels, urban kind area, natural cave), unknown environment. We use SLAM, artifacts classification with deep learning approach, control of robot with reinforcement learning in the environment to solve most of the problem. SLAM is crucial for SAR missions. However, in degraded sensing environments like subterranean environments, SLAM usually fail due to different reasons. We inherit the mindset of short baseline localization with supporting vehicles in AUV navigation technique which faced the challenges for a long time due to austere underwater environments. We installed ultra wide bandwidth (UWB) module on a heterogeneous robot team with one support vehicle to localize one scout vehicle in the frame of support vehicle. Such method is environment resilient which we thus can perform localizability-aware SLAM to ensure failure-free SLAM.

* **Team Lead of Team NCTU**
* **C.-L. Lu**, et al., "A Heterogeneous Unmanned Ground Vehicle and Blimp Robot Team for Search and Rescue using Data-driven Autonomy and Communication-aware Navigation" Field Robotics, 2, 557-594
* J.-T. Huang, **C.-L. Lu**, P.-K. Chang, C.-I. Huang, C.-C. Hsu, Z. L. Ewe, P.-J. Huang, and H.-C. Wang, "Cross-Modal Contrastive Learning of Representations for Navigation using Lightweight, Low-Cost Millimeter Wave Radar for Adverse Environmental Conditions" *IEEE Robotics and Automation Letters (Early Access)* April 2021
* Y.-W. Huang, **C.-L. Lu**, K.-L. Chen, P.-S. Ser, J.-T. Huang, Y.-C. Shen, P.-W. Chen, P.-K. Chang, S.-C. Lee, H.-C. Wang, "Duckiefloat: a Collision-Tolerant Resource-Constrained Blimp for Long-Term Autonomy in Subterranean Environments" (arxiv: 1910.14275)

Blind Navigation with a Guiding Robot and UWB Beacons

Navigation ability is critical to provide independent mobility for people who are blind or visually impair (BVI). However, in real world situations, visual-based trail may suffer from occlusions from pedestrians or other obstacles. We proposed an assistive guiding robot which is capable of navigating through "virtual trails," by ultra-wide bandwidth (UWB). The robot navigates according to the relevant pose of itself with respect to the "virtual trail" which is derived from the ranging measurements of UWB modules installed on the robot and the deployed sound-UWB anchors. The anchors and the robot further provided semantic sound feedbacks to inform point-of-interests (POI) in the environments intuitively.

* **C.-L. Lu,** C.-I. Huang, B.-H. Wang, Z.-Y. Liu, Y. Chen, H.-C. Wang, and P.-Y. Kuo. "Assistive Navigation using Deep Reinforcement Learning Guiding Robot with UWB/Voice Beacons and Semantic Feedbacks for Blind and Visually Impaired People" (Submitted to Frontier of Robotics and AI, Special Issue: Assistive Technologies for Sensory-Disabled People)
* N.-C. Lin, S.-H. Liu, Y.-W. Huang, Y.-S. Su, **C.-L. Lu**, W.-T. Hsu, L.-W. Chiu, S. Teng, L. Giarré,

H.-C. Wang. "Toward an Open Platform of Blind Navigation via Interactions with Autonomous Robots," In ACM Conference on Human Factors in Computing Systems (CHI 2019) - Blind Navigation Workshop, Glasgow.

Duckietown: A Platform for Autonomy Research and Education

Duckietown is a robotic research and education platform developed in MIT in 2016 and extended to multiple branches around the world including Eidgenössische Technische Hochschule Zürich (ETHZ), Toyota Technological Institute at Chicago (TTIC), Université de Montréal (UdeM) and National Chiao Tung University (NCTU) in Fall 2017. I was part of the Auto-Localization project when I was a visiting student in ETHZ. The Auto-localization of Duckietown is about localizing Duckiebots inside a Duckietown. I designed, developed, tested and refined the decentralized localization and tracking network comprising over fifty image sensors to build up the system. We finally extend the Auto-Localization system to the Anchorball system to provide a multi-robot map merging and cooperation solution in an unknown environment in DARPA Subterranean Challenge. Beside Auto-Localization Project, upon the AI Driving Olympics (AIDO), I built a self-driving vehicle with deep learning approaches in "gym-Duckietown" which is a simulated Duckietown based on OpenAI-gym. The deep learning agent predicts the affordances, i.e. lateral distance and orientation, of the vehicle for the subsequent PID controller to perform self-driving. In the mean time, I served as a teaching assistant in the NCTU branch, and designed two of the course modules using Robot Operating System (ROS), Jupyter Notebook, Python, and OpenCV. I also coordinated the edition of "Duckument", the key learning materials of Duckietown, in the part of NCTU branch and "The First Chinese Textbook of Duckietown in the World" which we used as the learning material for our lectures.

* A. Censi, L. Paull*, J. Tani, T. Ackermann, O. Beijbom, B. Berkai, G. Bernasconi, A. K. Bowser, S. Bing, P.-W. Chen, Y.-C. Chen, M. Chevalier-Boisvert, B. Considine, J. D. Castri, M. D. Cicco, M. Diaz, P. A. Diederichs, F. Golemo, R. Hristov, L. Hsu, Y.-W. Huang, C.-H. Hung, Q.-S. Jia, J. Kindle, D. Lapandic, **C.-L. Lu**, S. Mallya, B. Mehta, A. Neff, E. Nice, Y.-H. Ou, A. Qbaich, J. Quack, C. Ruch, A. Sigal, N. Stolz, A. Unghia, B. Weber, S. Wilson, Z.-X. Xia, T. V. Yasin, Nivethan, Yogarajah, J. Zilly, Y. Bengio, T. Zhang, H.-C. Wang, S. Soatto, M. Egerstedt, and E. Frazzoli. "The AI Driving Olympics at NIPS 2018," RSS Workshop on New Benchmarks, Metrics, and Competitions for Robotic Learning, Pittsburgh.
* Outreach in the Duckietown workshop at RoboCup 2019 in Sydney, Australia, providing a hands-on introduction to the Duckietown platform.
* Outreach in the AI Driving Olympics at ICRA 2019 in Montreal,Canada, providing a hands-on introduction to the Duckietown and Duckiepond platform.
* Outreach of Duckietown at 2018 Zurich E-Prix (Formula E)
* Coordinator for 4 outreach activities for high-school students in Taiwan.

Leaderships:

Director of Student Association of Department of Electrical and Computer Engineering (2016~2017)
Event General Coordinator of Night of ECE 2017 (2017)
Head of Activity of Taiwan Model United Nation 2016 (2016)

Technical Skills:

Programming: C/C++ (3 years exp.), Python (5 years exp.), Matlab, JAVA

Middleware and Libraries: Robot Operating System (ROS) (5 years exp.), Tensorflow, Pytorch, PCL, Apriltags, OpenCV

Knowledge: Robotics, Control, SLAM, Deep supervised learning, Deep reinforcement learning, Discrete/Digital Signal Processing, Basic computer vision, Basic control theory.