Chen-Lung 'Eric' Lu

Email : eric565648@gmail.com or eric565648.eed03@g2.nctu.edu.tw
Phone: +886-9-20099148
Lab: Assistive Robotics Group
Address: National Chiao Tung University
via Daxue Rd. No. 1001, EE 622
30010 East Dist., Hsinchu City, Taiwan (R.O.C)

Research Interests:

My research interests focus on **robotics,** especially on **localization and optimization via a decentralized system (i.e. "watchtowers in a city") and in degraded environments (i.e. DARPA SubT Challenge), multi-robot behavior** and **manipulation**. However, I'm open to any interesting robotics project and research. I joined the **Assistive Robotics Group** at National Chiao Tung University since March 2017, and start to learn and later share my passions in autonomous vehicles by **teaching and giving lectures** with Duckietown. In the semester spring 2018, I enrolled in **ETH Zürich (Switzerland)** as a visiting student, and joined the **"autolab" in IDSC** under Prof. Frazolli and the supervision of Dr. Andrea Censi and Dr. Jacopo Tani to contribute to Duckietown in the branch Züruch. Recently I participated in **DARPA Subterranean Challenge, Tunnel Circuit, Urban Circuit** as the Team Lead of Team NCTU, especially focusing on SBL-UWB localization method to enable localizability-aware SLAM.
I also serve as the director of the department student association and volunteer many actives**,** both play big roles in my college life. I hope to build robots to make the world a better place.

Education:

M.E. in Institute of Electrical and Control Engineering (ECE),
National Chiao Tung University (NCTU), Taiwan. 2018~
Visiting Student in Dept. of Information Technology and Electrical Engineering,
Eidgenössische Technische Hochschule (ETH) Zürich 2018~2018
B.S. in Electrical and Computer Engineering (ECE),
National Chiao Tung University (NCTU), Taiwan. 2014~2018

Technical Skills:

Programming: C/C++ (3 years exp.), Python (2 years exp.), JAVA
Middleware and Libraries: Robot Operating System (ROS), Pytorch, PCL, Apriltags, OpenCV
Knowledge: Robotics, Deep supervised learning, Deep reinforcement learning, Discrete/Digital Signal Processing, Basic computer vision, Basic control theory.

Recent Projects and Professional Experiences:

DARPA Subterranean Challenge
- **Team Lead of Team NCTU @ NCTU**

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. The team have to solve autonomy, perception, mobility, and networking problem in such severe environment. We use SLAM, artifacts classification with deep learning approach, control of robot in the environment to solve most of the problem. We further leverage the communication technique "Super Glora" from our industrial partner "K-best" which is a communication technique based on LoRa but have better performance in our on-site experiment. Beside leading the team, I develop an "Anchorball" system which allow multi-robot map merging and cooperation. Also, I do perform assessment on both Super Glora and LoRa module for comparison.

- **Short Baseline - UWB Localization@ NCTU**

  SLAM is crucial for SAR missions. However, in degraded sensing environments like subterranean environments, SLAM usually fail due to different reasons. For example, LiDAR-based SLAM may fail due to lack of geometry features, vision-based SLAM may fail due to varied level of illumination. 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. A heterogeneous robot team with a support vehicle and a scout vehicle is used in the research. We installed ultra wide bandwidth (UWB) module on the support vehicle and localize the 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.

- **Anchorball System @ NCTU**

  The Anchorball system is meant to provide a multi-robot map merging and cooperation solution in an unknown environment. We borrow the idea from the previous work "Auto-localization in Duckietown" and deploy Anchorball, the specialize "watchtower" inside unknown environment and serve as a robust active landmark. We then leverage the well-know iSAM libraries for pose-graph optimization and merging.

In-class project - Year 2019

- **Localization of Self-Driving Car**

  In the course of Self-Driving Car, we had a little competition on the performance of localization of self-driving car in the end of semester. We are given logs collected on the car including, GPS, LiDAR, IMU, stereo images and a pre-built point cloud map of the university. The competitors were asked to localize the vehicle in the map. We used ICP with LiDAR as our main solution. We further solved the initial guess problem of the ICP algorithm with our own developed "Fast Iterative Initial Guess" method.

- **Autonomous Driving via Vehicle Affordance Prediction**

  In the course of Deep Learning and Practice, we built a self-driving vehicle with deep learning approach in a simulation environment. The affordance of a vehicle is the state of the vehicle within the environment including the position and orientation relative to the road, the distance with other vehicles. We had our deep learning network predict the position and orientation of the vehicle and apply PID control after to perform self-driving. We collect and perform the self0driving car in "gym-Duckietown" which is a simulated Duckietown based on OpenAI-gym. This work is and modification on the paper, , in ICCV 2015. We substituted the network with our own network and also tried some other well-known and developed network (etc. ResNet-18, ResNet-50).

Duckietown: A Platform for Autonomy Research and Education

- **A short introduction for Duckietown**

Duckietown is a robotic research and education platform developed in MIT in 2016. There are many branches in the world, such as in Eidgenössische Technische Hochschule Zürich (ETHZ), Toyota Technological Institute at Chicago (TTIC), Université de Montréal (UdeM) and National Chiao Tung University (NCTU) in Fall 2017. The course number of the ETHZ course is 151-0323-00L Autonomous Mobility on Demand: From Car to Fleet. More information please see duckietown.org

- **Auto-localization of Duckietown @ IDSC ETH Zürich**
  The Auto-localization of Duckietown is about localizing Duckiebots inside a Duckietown. We used famous Apriltags library and little "watchtower"s we built in the Duckietown with cameras and Raspberry PIs to localize Duckiebots. I designed, developed, tested and refined the decentralized localization and tracking network comprising over fifty image sensors to build up the system.

- **Teaching Assistant in Duckietown @ NCTU**
  I serve as a teaching assistant in the NCTU branch, and co-design two of the course modules using Robot Operating System (ROS), Jupyter Notebook, Python, and OpenCV. I also lead a project team working on multi-robot planning.

- **Lecturer in Duckietown Summer School, Duckietown Summer School 2017 (Summer 2017) (English lecture)**
  Duckietown Summer School is a course to train potential instructors and teaching assistant. I work in the stuff team to host 24 participants from Koera, Indonesia, and Taiwan with 6 potential courses. The official website of Duckietown Summer School: http://duckietown.nctu.edu.tw/summer_school.html

- **Coordinator for the Duckietown Learning Materials @ NCTU**
  This autumn, ETHZ, TTIC, UdeM and NCTU are having joint Duckietown courses. "Duckument" is the key learning materials, and I am in charge of the parts for the NCTU branch. I also coordinate and edit "The First Chinese Textbook of Duckietown in the World" as our autumn. We hope the Duckietown learning materials can help more students around the work to learn robotics.

Multi-robot Control and Manipulation, with Prof. Hsueh-Cheng Nick Wang
- The goal of the project is to make multiple homogeneous/heterogeneous robot manipulate objects cooperatively. The project is extended from the Duckietown, and we will use build a GUI control panel for better task assignments for multiple robots.
- Professional Training for the Universal Robotics Arm (UR5), expected in Nov. 2017. The training is to get familiar with industrial robotic arm to perform tasks in real-world tasks.

Music Player and Mixer with Java
- Using Java to program a music player. Besides playing music, we use an Fast Fourier transform (FFT) to show the spectrum of the music at the same time. Also, we added some cool effects like echo, distortion, etc.

Teaching Assistant in the Innovative Intelligent Electronics Lab (Spring 2017), Department of Electrical and Computer Engineering, NCTU, Taiwan
- The Innovative Intelligent Electronics Lab aims at introducing embedded platforms such as Raspberry Pi 3, Ameba (by Realtek), Linkit One (by MediaTeK), Linkit 7688 (by MediaTek), and inspires students for carrying out their own innovative ideas. I am the teaching assistant to support students' projects and check they have no problem with those embedded boards.

Related Courses:

Introduction to Digital Processing (A+), Object-Oriented Programming (A), JAVA Programming (A), Automatic Control Systems (B+), Creative Software Project (Autonomous Vehicle), Sensing and Intelligent System, Imaging Processing

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)

Last Update: 2019/08/08