Haowen Lai

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Tsinghua University, Haidian District, Beijing, 100084, P. R. China

EDUCATION

Tsinghua University **Beijing, China**
M.S. in Control Science and Engineering Sept. 2019 - expected Jun. 2022

Tongji University **Shanghai, China**
B.E. in Automation Sept. 2015 - Jul.2019

- GPA: 4.85/5.00, ranking: 1/79

RESEARCH INTEREST

Autonomous System; SLAM; Robot Perception; Place Recognition; Visual/LiDAR-based Localization; Lifelong SLAM; Multi-robot System; Multi-sensor Fusion; Point Cloud Registration; Robot Navigation and Exploration; Autonomous Driving; 3D Object Detection; Computer Vision; Machine Learning; Robotics

PUBLICATIONS

[1] **H. Lai**, P. Yin and S. Scherer, "AdaFusion: Visual-LiDAR Fusion with Adaptive Weights for Place Recognition," *IEEE Transactions on Industrial Electronics (TIE).* Under Review. [pdf]

[2] R. Yan, R. Deng, **H. Lai**, W. Zhang, Z. Shi and Y. Zhong, "Multiplayer Homicidal Chauffeur Reach-Avoid Games via Guaranteed Winning Strategies," *IEEE Transactions on Automatic Control (TAC).* Under Review. [pdf]

[3] **H. Lai**, R. Yan, W. Zhang, Z. Shi and Y. Zhong, "Reach-Avoid Differential Games via Finite-Time Heading Tracking," *IEEE Conference on Decision and Control (CDC)*, 2021. [pdf]

[4] **H. Lai**, W. Liang, R. Yan, Z. Shi and Y. Zhong, "LiDAR-Inertial based Localization and Perception for Indoor Pursuit-Evasion Differential Games," *IEEE Chinese Control Conference (CCC)*, 2021. [pdf]

[5] **H. Lai**, Q. Kang, L. Pan et al., "A Novel Scale Recognition Method for Pointer Meters Adapted to Different Types and Shapes," *IEEE International Conference on Automation Science and Engineering (CASE)*, 2019. [pdf]

PATENTS

[1] **H. Lai** and X. Jiang, "A Map Construction Method and a LiDAR-inertial Odometry," China Patent Application 202110618535.5, filed Jun. 2021. Patent Pending.

[2] B. Wen, J. Zhan, S. Liang, T. Lu, Q. Xiong, X. Jiang and **H. Lai**, "Registration Method based on CNN Point Cloud Object Detection," China Patent Application 202011545903.X, filed Dec. 2020. Patent Pending.

[3] Q. Kang and **H. Lai**, "Automatic Reading Method for Pointer Meters based on Scale Seeking," China Patent Application 201910266384.4, filed Jul. 2019. Patent Authorized.

[4] **H. Lai**, J. Jiang, J. Chen and L. Jiang, "Method and System for Camera Calibration based on Deep Learning," China Patent Application 201811198141.3, filed Oct. 2018. Patent Authorized.

[5] **H. Lai**, J. Chen, J. Jiang and L. Jiang "Method and System for Robot Arm Controlling based on Deep Learning," China Patent Application 201811198158.9, filed Oct. 2018. Patent Authorized.

RESEARCH EXPERIENCES

Research Intern, advisor: Prof. Sebastian Scherer **Carnegie Mellon University – Air Lab**

AutoMerge: Automatic Multi-agent Cooperated Map Merging System *Dec. 2021 - present*

- Researched on the problem of merging large-scale and low-overlap 3D point cloud maps without any prior information about their initial relative poses
- Developed an offline version, including a global localization frontend resistant to viewpoint changes and a pose graph optimization backend for fusing all local maps

Adaptive Visual-LiDAR Fusion for Place Recognition and Global Localization *May. 2021 - Oct. 2021*

- Researched on the problem of place recognition with the method that adaptively selects and weights LiDAR and visual features according to different environments
- Proposed a weight generation branch including multi-scale attention and two-stage fusion that could produce adaptive weights to adjust the importance and contribution of features of different modalities
- Reproduced the feature extraction backbone and improved it by utilizing batch normalization (BN)
- Built the whole network including data preparation, network training and evaluation in Python and PyTorch

Research Assistant, advisor: Prof. Yisheng Zhong **Tsinghua University – UAV Lab**

LiDAR-Inertial based Self-Localization and Target Perception for Robots *Jan. 2021 - Jul. 2021*

- Utilized a tightly-coupled LiDAR inertial odometry for self-localization in unknown GPS-denied environment
- Proposed a model fitting based target perception method to determine the position of opponents from point clouds
- Applied autonomous localization and perception to indoor multi-robot pursuit-evasion games

Intelligent and Unmanned Indoor Navigation Robot – Student Researcher *Jan. 2020 - Sept. 2020*

- Tested and compared the results of mapping, localization and loop closure detection of several SLAM methods such as gmapping, RGBD SLAM v2, RTAB-MAP, etc.
- Built the wheel robots and developed a multi-robot system including visual SLAM and navigation based on ROS
- Researched on the problems of robot navigation that avoids obstacles of lower objects via RGB-D camera, and autonomous exploration with boundary search based on BFS

Student Researcher, advisor: Prof. Qi Kang **Tongji University – BitaAI Lab**

Vision-based Automatic Reading System for Pointer Meters *Nov. 2018 - Aug. 2019*

- Trained the SSD + MobileNet object detection network on the MS COCO dataset to locate the dial
- Proposed an Adaptive Scale Seeking algorithm based on image characteristics to automatically read both uniform and non-uniform scale meters in constraint environment
- Built an image collection device with Wi-Fi connection based on STM32 Microcontroller Unit (MCU)
- Developed a user-friendly data management GUI for monitoring, recording and controlling the whole system

PROJECTS

Team Leader **Intel Cup ESDC 2018**

Self-Learning Model-Free Robot Arm System for Grabbing and Classification *Jan. 2018 - Aug. 2018*

- Won the national first prize (top 8% of 164 teams) of the *Intel Cup ESDC 2018* competition
- Responsible for the visual localization of robot joints and target cubes based on ArUco markers and image segmentation, respectively
- Developed the self-learning control model as a multi-layer fully connected neural network with TensorFlow, and collected motor control values and the corresponding target coordinates for training
- Implemented the communication between the two manipulators via Socket and that between the host computer and the control board through CAN bus

Team Leader, advisor: Prof. Fanhuai Shi **National Innovation Project**

Follow You up: Selfie UAV with Gesture Interaction *Apr. 2017 - Apr. 2018*

- Won the third prize of the *16th Tan Kah-Kee Youth Invention Award (Shanghai)*
- Enable real-time detection and tracking of human body using RGB-D camera and machine learning, and control the drone to follow human based on the ROS framework
- Realized the segmentation of gesture based on skin color, and used TensorFlow to build CNN for recognition

INDUSTRIAL EXPERIENCE

Novauto Technology Co., Ltd. (Beijing, China) **Engineering Intern**

Autonomous Driving Center, leader: Qi Xiong *Aug. 2020 - Apr. 2021*

- Developed the tightly-coupled LiDAR-inertial SLAM method which was deployed and tested on real cars
- Researched on multi-sensor fusion based on factor graph, including LiDAR, IMU, GPS/RTK
- Realized the localization of vehicle in real time with previously built point cloud maps based on a combination of LiDAR inertial odometry and NDT algorithm

HONORS AND AWARDS

- Outstanding Undergraduate of Shanghai, (top 5%) 2019
- Excellent Student of Tongji University, (top 5%) 2018, 2017& 2016
- Phoenix Contact Scholarship, (excellence in study and research) 2018
- Siemens Scholarship, (top 5%) 2018
- The National First Prize in Intel Cup ESDC, (top 8% of 164 teams) 2018
- The Third Prize of the 16th Tan Kah-Kee Youth Invention Award 2018
- Qidi Scholarship of Tongji University, (excellence in research) 2017
- National Scholarship for Undergraduate, (top 2.5%) 2017
- The First Prize of Tongji Scholarship of Excellence, (top 5%) 2016

TEACHING EXPERIENCES

Teaching Assistant **Tsinghua University**

Operations Research *Spring 2021, 2020*

- Duties: grading homework and exams, answering questions

Calculus A (1) *Fall 2019*

- Duties: grading homework and exams, giving exercise courses, answering questions

PROFESSIONAL ACTIVITIES

Presentations

- Oral Presentation at the IEEE Conference on Decision and Control *Dec. 2021*
  "Reach-Avoid Differential Games via Finite-Time Heading Tracking" (online) Austin, USA
- Oral Presentation at the IEEE Chinese Control Conference *Jul. 2021*
  "LiDAR-Inertial based Localization and Perception for Indoor Pursuit-Evasion Differential Games" Shanghai
- Invited Talk in Group Meeting *Oct. 2020*
  "Introduction to Simultaneous Localization and Mapping (SLAM)" Autonomous Driving Center, Novauto
- Oral Presentation at the IEEE Conference on Automation Science and Engineering *Aug. 2019*
  "A Novel Scale Recognition Method for Pointer Meters Adapted to Different Types and Shapes" Vancouver

Academic Activities

- Organizer of the ICRA 2022 General Place Recognition Competition *Feb. 2022 - present*
  Duty: maintenance of the website and the submission platform, development of tools and datasets

SKILLS

Language: English – Fluent, Chinese – Native, Cantonese – Native

Programming: C, C++, Python, MATLAB

Technical: PyTorch, TensorFlow, OpenCV, ROS, PCL, Open3D, Eigen, Ceres, g2o, GTSAM