Ran Cheng

An Intelligent Robotics Researcher

MLL 411, McGill University, Montreal, Canada
ran.cheng2@mail.mcgill.ca
rancheng.github.io
774-823-4304

Education

McGill University, Computer Science — Montreal, Canada
Master of Science in Computer Science — *Expected May 2020*

Thesis: Guided Robust Visual Navigation with Deep Learning

Relevant Coursework: Intelligent Robotics, Reinforcement Learning, Applied Machine Learning

Coursera — Online
Honored Degrees & Long-term Community Contributor — *Aug 2015 - Aug 2017*

Completed Courses: Neural Network for Machine Learning (UToronto), Robotics: Specialization (UPenn), Machine Learning (Stanford)

Tongji University, School of Software Engineering — Shanghai, China
Bachelor of Engineer, Software Engineering; GPA: 3.89/4.0 — *Aug 2011 - Aug 2015*

Honors and Awards: Outstanding Diploma thesis, National Aspiration Fellowship, Second Class Prize Fellowship, Social Activism Award, IBM Outstanding Contribution Award, Microsoft Imagine Cup, FTC (First Tech Challenge, a Robot Competition Conference) Technician

Experience

Mobile Robotics Lab, McGill University — Montreal, Canada
Research Assistant, Supervisor: ***Gregory Dudek*** — *Sep 2017 - Now*

- **Deep Monocular VO**: Designed a semi-supervised monocular depth estimator for video using sparse bundle adjustment in a sliding window, achieved 0.117 (top5) RMSE in **NYU v2** and 2.981 (top10) RMSE in **Kitti eigen-split**. backbone is Unet+CSPN, trained with semi-dense map point tracked by VO, implemented with PyTorch.
- **NavGuideNet**: A **synthesized hierarchical neural network** for autonomous navigation in complex environment and variant landscapes (tested in field/underwater environments). Backbone encoder is **Resnet18**, **latent code** was concaternated with control signals and decoder is **de-convolution network** (transposed convolution), average lost rate in underwater experiments decreased 91.5%, average aligned trajectory RMSE is 6.39 with improvement of 51.8% (gitlab)
- **Deep RL Auto Driving (Sim2Real)**: Re-implemented CAD2RL in python and extended to multiple policy gradient based backends **(A3C+LSTM, DDPG, TRPO, PPO, TD3)** in continuous action space, simulator is is **Microsoft AirSim** tested on RC car and UAV.

iLab Tongji/University of South California — Shanghai, China, Los Angeles, USA
Research Assistant, Supervisor: ***Jianwei Lu, Laurent Itti*** — *Apr 2015 - Jul 2017*

- **SLAM Fusion**: Vision (monocular) LiDar fusion with direct method (jointly optimize optical flow with Sparse Bundle Adjustment on ORB features) extra constraint from LiDar helps eliminating depth from null space.
- **Visual SLAM with Saliency**: joint optimizing the graph (G2O) with salient voting as extra binary edges.

UCLA — Los Angeles, USA
Part-time Research Assistant, Supervisor: ***Yi Xing*** — *Jul 2015 - Jan 2016*

- **Code Parallelization**: optimized their RNA analysis tool, [stable release (rMATS 3.0.9)], binding the large matrix calculations with C11 (SSE/AVX vectorization, Intel) and CUDA (cuBLAS , Nvidia)

Projects

- **Visual SLAM**: Refactored **Stereo-DSO** (gitlab) with keyframe and feature point based **loop closure, BA** (**Ceres** solver). Using Tracking-Mapping-ReTracking three thread architecture, run on Nvidia-TX2 with 15 FPS. Comprehensively **re-implemented** DSO and annotated with exhaustive explains.
- **Deep Monocular Dense 3D Reconstruction**: Dense 3D reconstruction with **monodepth2** initialized Visual Odometry, leveraging traditional photometric consistancy, occlusion discrepancy, and local geometrical-smooth assumptions to **optimize depth estimation** (**LM** method) and **register** 3D map point clouds.
- **Abstraction Augmented Deep RL**: Abstract rgb image with Unet shaped network to digest image in latent representation, and learn from latent inputs, average convergence time increased 27.3%, maximum reward (10M iterations) is 1.21 times than baseline model without abstraction augmentation, experiments conducted under self-collected dataset from AirSim simulator (github)
- **Forgetting Model for BP**: Introduced forgetting model for back propagation as in gradient dynamic routine, inspired from forgetting curve, I invented forgetting factor to regulate delta weights updates, (math proof)
- **LOAM**: extended LOAM with co-visibility check, optimized with Ceres optimizer and asynchronous threading

Publications

- Deep Monocular Visual Odometry with Direct Method, **R. Cheng**, D. Meger, G. Dudek **CVPR 2020** preprint
- Robust Off-road Robotics Visual Navigation with Back-Projection Learning, **R. Cheng**, G. Dudek, D.Meger, **ICRA 2020**, preprint
- Abstraction Augmentation for Deep Reinforcement Learning, **R. Cheng**, G. Dudek, D. Meger **CoRL 2019**, paper
- Navigation in the Service of Enhanced Pose Estimation, Travis Manderson, **Ran Cheng**, David Meger and Gregory Dudek, **ISER 2018**, paper
- Vision-Based Autonomous Underwater Swimming in Dense Coral for Combined Collision Avoidance and Target Selection, T. Manderson, **R. Cheng**, D. Meger, G. Dudek, **IROS 2018**, paper