Liyang Wang

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Professional Summary

- Senior Supervisor R&D Engineer in COMAC Beijing Aircraft Technology Research Institute. Research focus on Deep Learning and Reinforcement Learning. Main project is flight Four-Dimensional trajectory planning under multiple constraints and optimization objectives. Supervising 8 team members for Navigation and Guidance module development within FMS (flight management system).
- Senior Software Engineer in Baidu USA. Project focus on autonomous driving of excavator solutions development and delivery for customer. Research focus on robot arm motion planning, robot base path planning, data driven dynamics modelling and controller design.
- Ph.D in Mechanical and Aerospace Engineering of Rutgers university. Perform practical and theoretical research in state estimation, sensor fusion, path planning, image processing, machine learning, and control with robotic applications.

Skills

- **General**: Robotics, Reinforcement learning, Deep learning, Task level planning, Path planning, Motion planning, Trajectory optimization, Controller design
- **Technical**: ROS, Python, Pytorch, C++, C, MATLAB
- **Coursework**: Advanced control, Optimal design, Analytical dynamics, Reinforcement learning, Deep learning, Computer vision, Digital image processing, Analog/Digital circuits, Signal and system

Education

Rutgers, The State University of New Jersey — Piscataway, NJ, USA
Ph.D., Mechanical and Aerospace Engineering — 2015 – 2019

University of Chinese Academy of Sciences — Beijing, China
MA.Eng, Electronic Communication Engineering — 2012 – 2015

Beihang University — Beijing, China
B.E., Electronic Engineering — 2008 – 2012

Work Experience

COMAC Beijing Aircraft Technology Research Institute — Beijing, China
Senior Supervisor R&D Engineer — August 2022 – present

- Civil Aeroplane 4D Trajectory Planning. – Based on the requirements of avoiding no-fly zones and other aircraft, meeting altitude and aircraft capability constraints, while also providing economic and comfort considerations, I have divided the task into three stages for resolution: horizontal path planning, vertical path planning, and velocity planning. In the first two stages, various techniques including RRT*, Dijkstra, Breadth-First Search (BFS), and B-spline smoothing are employed to generate a spatially smooth path. In the velocity planning stage, to address challenges such as the difficulty in designing multi-objective optimization cost functions and the time-consuming nature of graph searching, a deep reinforcement learning method based on the Proximal Policy Optimization (PPO) algorithm is proposed. Current research shows that the AI method on velocity planning stage fulfills all hard constraints, does not require specific tuning for different scenarios, shows better comfort property, and generates result faster in general.
- Supervisor of Navigation/Guidance Team for FMS Development. – Structural breakdown and interface design of the Navigation and Guidance module within FMS. Leverage team members' diverse backgrounds and experience to allocate tasks effectively. Conduct analysis of team deliverables, employing key performance indicators to assess outcomes, identify areas of improvement, and refine project strategies.
- Aircraft Taxiing. – Automated planning of taxiing routes based on graph search. Kinematic and dynamic modeling of aircraft nose landing gear configuration. Design and implementation of MPC controllers. Building simulation environments using ROS and validating algorithms. Conducting actual aircraft taxiing tests and verifying their performance.

Baidu USA Sunnyvale, CA, USA
Senior Software Engineer December 2019 – June 2022

- Excavator Planning. – Task level planning, truck loading, trenching, and flatten task planner are designed and realized. The method is hierarchical and rule based. According to entire task, first, base moving and dig-dump sub-tasks are generated in sequence. Then motion primitives are planned for each sub-task. For motion level planning, optimized dig, dump, sweep, move base motion are realized. STOMP are used for trajectory optimization. A^* is used for base path planning.

- Excavator Modeling, Hydraulic System Control. – Hierarchical controller structure is designed. PID and MPC controller are used for high level controller which gives target joint/base velocities. Low level controller mapping the joint/base velocities into current as input to hydraulics. To solve stuck problem when digging, a research on excavator bucket manipulation is conducted. RNN is used to learn bucket manipulation dynamics, and then use MPC frame to find the best controls which minimize tracking error and avoid jam at the same time.

- Autonomous Excavator Platform. – System design and integration for autonomous excavation. It includes an embedded low level control board to communicate between excavator and high level algorithm computer. Three modules are run at high level algorithm computer: Perception, Planning, and Controller. At the same time, a kinematic simulator is also developed for algorithms test and validation, which is able to update terrain (represented by point cloud), joint states, and excavator position based on initialized states and control inputs.

- Robot Guide Dog. – Research mainly focus on human-bot system modeling, path planning, and MPC controller design with obstacle avoidance. EKF used for bot and human positioning. Global path planning is based on graph search method with optimization.

Rutgers, The State University of New Jersey Piscataway, NJ, USA
Graduate Research September 2015 – October 2019

- Developed autonomous landing of a quadrotor UAV on a moving vessel deck. – The designed method search and recognize moving landing target using vision algorithms, estimate UAV states based on sensor fusion and coordinate transformations, guide UAV to approach and landing autonomously using PID controllers. A self-designed moving landing pad robot is used for emulating vessel deck movement. The robot is powered by a STM32 micro-controller, and 3 servers are used to generate movement.
- Developed new approach of on-board sensor only, feature based monocular 3–D SLAM algorithm. – The designed method is able to output absolute scaled 3–D map and UAV position simultaneously in previously unknown environments. The method is validated by experiments using a quadrotor UAV. SURF features are extracted for matching, and additional algorithms are designed to identify and remove matching errors. With results from the developed SLAM algorithm, Kalman Filter is applied to improve the accuracy of localization.
- Developed machine learning models for estimating wind speed profiles using UAV flight data. – Learning algorithm used is K-nearest neighborhood method. The method is validated by experiments using a quadrotor UAV to provide flight data, a fan for wind field generation, and an anemometer for reference.
- Developed a low–cost quadrotor UAV platform for research. – Features include: Long flight time with good payload; Strong sensor system; Cutting edge two-level on-board processor design; Manual control signal connected for safety; Wireless communication module for flight monitoring; PX4 autopilot backup system for robustness; Status LEDs.

Hangzhou Zhongke Microelectronics Co. Ltd Hangzhou, Zhejiang, China
Visiting Student Researcher May 2013 – May 2015

- Dead reckoning and GPS combined navigation for ground vehicles. – Dead reckoning algorithms designed base on ground vehicle model. Measurements from hall effect sensor, IMU, and magnetic field sensor. Data fusion using Kalman Filter.
- Strapdown inertial navigation algorithms. – Fourth order Runge-Kutta numerical solution.
- Pedometer design. – Digital signal processing, using 3–axis accelerometer as data source.

Publications

- **L. Wang**, R.Zeng, **Velocity Planning with Multi-Objectives in Displacement-Time Graphs Using Deep Reinforcement Learning**, 41st IEEE Conference on Robotics and Automation (ICRA 2024) (Under Review).

- Y.Zhu, **L. Wang**, L.Zhang, **Excavation of Fragmented Rocks with Multi-modal Model-based Reinforcement Learning**, 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). IEEE, 2022: 6523-6530.
- Z.Ye, Q. Guo, **L. Wang**, L.Zhang, **Imitation Learning and Model Integrated Excavator Trajectory Planning**, 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). IEEE, 2022: 5737-5743.
- R.Song, Z.Ye, **L. Wang**, T.He, L.Zhang, **Autonomous Wheel Loader Trajectory Tracking Control Using LPV-MPC**, 2022 American Control Conference (ACC). IEEE, 2022: 2063-2069.
- **L. Wang**, Z. Ye, and L. Zhang, **Hierarchical Planning for Autonomous Excavator on Material Loading Tasks**, ISARC, Dubai, UAE. Vol 38, Pages: 827-834. 2021.
- L. Zhang, J. Zhao, P. Long, **L. Wang**, L. Qian, F. Lu, X. Song, and D. Manocha, **An autonomous excavator system for material loading tasks**, Science Robotics, Vol.6, Issue.55, Pages: eabc3164. 2021.
- **L. Wang**, J. Zhao, and L. Zhang, **NavDog: Robotic Navigation Guide Dog via Model Predictive Control and Human-Robot Modeling**, Proceedings of the 36th Annual ACM Symposium on Applied Computing, Pages: 815-818. 2021.
- **L. Wang**, G. Misra, and X. Bai, **A K Nearest Neighborhood Based Wind Estimation for Rotary–Wing VTOL UAVs**, Drones, Vol. 3, No. 2 (2019): 31.
- **L. Wang** and X. Bai, **Quadrotor Autonomous Approaching and Landing on a Vessel Deck**, Journal of Intelligent & Robotic Systems, Vol. 92, No. 1 (2018): 125–143.
- **L. Wang**, K. Zhai, W. He, and J. Xu, **Application of Fourth-order Runge-Kutta algorithm in SINS**, Computer Simulation, Vol. 11 (2014): 56–59.
- **L. Wang**, W. He, C. Ma, and X. Bai, **New method of GPS/DR data fusion for land vehicle**, Computer Simulation, Vol. 7 (2015): 164–167+172.
- **L. Wang**, K. Zhai, W. He, and C. Ma, **Real-time filtering method for low-cost MEMS gyroscope**, Application of Electronic Technique, Vol. 01 (2015): 50–52+56.

Awards and honors

- TPG TC Technology Innovation Award, Baidu, 2021.
- TPG Technology Pioneer Award, Baidu, 2020.
- Graduate fellowship, Rutgers, The State University of New Jersey, 2015.
- Outstanding student, University of Chinese Academy of Sciences, 2014.
- Third class scholarship, Beihang University, 2011.
- Second class award of Fengru Cup technology competition, Beihang University, 2011.