Yuezhe Zhang

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Education

TU Delft **Sep 2021 – Aug 2023**
Master of Science in Robotics, with honours, GPA — 8.5/10 *Delft*

Beijing Institute of Technology **Sep 2017 – July 2021**
Bachelor of Science in Mechatronics Engineering, with honours, GPA — 87/100 *Xuteli School, Beijing*

Publication

- **Yuezhe Zhang**, Corrado Pezzato, Elia Trevisan, Chadi Salmi, Carlos Hernández Corbato, and Javier Alonso-Mora. *"Multi-Modal MPPI and Active Inference for Reactive Task and Motion Planning"*. Under review at IEEE Robotics and Automation Letters (2023).

Master Thesis

Multi-Modal MPPI and Active Inference for Reactive TAMP **May 2022 – Aug 2023**
Supervised by Dr. Javier Alonso-Mora *Autonomous Multi-Robots Laboratory*

- The work aims to address the issue of *geometric ambiguities, which are hard to determine at planning time, within a reactive TAMP framework.*
- We address this question by proposing a control scheme in the context of reactive task and motion planning by bridging active inference and a sampling-based MPC through the planning of cost functions instead of actions. We propose a Multi-Modal Model Predictive Path Integral controller (M3P2I) that combines alternative cost functions, ensuring a seamless transition between them through weights updating.

Internship

Sampling-based Path Planning for Unmanned Vessels | *ROS, C++* **May 2022 – Sep 2022**
Demcon Unmanned Systems

- Demcon Unmanned Systems manufactures and supplies unmanned vessels with autonomous capabilities. The vessels are equipped with sensors like LiDAR and GPS to build a map of the environment. Currently, a mission planner is used to specify the start and goal positions and the predefined path by the user, which requires the path planner to generate a safe and effective path avoiding potential obstacles and following the predefined path. However, the current using Brute Force Branching and RRT algorithms in the path planner encounters issues in terms of computational efficiency and circumventing large obstacles.
- To overcome these issues, I designed an efficient real-time sampling-based path planning algorithm, called Torch, for the path tracking of unmanned vessels.
- The proposed algorithm Torch can grow with specified parameters, including FoV, edge angle, edge length, and a number of layers. The new structure allows the required samples to grow polynomially with the increase of the number of layers, which addresses the exponential growth issue of Brute Force Branching. The algorithm can also be combined with RRT to reach further areas, where the torch structure provides a warm start for the RRT and alleviates the stochastic inconsistent issue of RRT, which is beneficial when circumventing wide and long obstacles.
- Simulation tests were conducted in the CoppeliaSim Simulator and ROS environment written in C++. The results have shown that the Torch algorithm can avoid single obstacles with fewer samples than the other two algorithms. The torch can be combined with RRT to circumvent a 40m wide obstacle and a 50m long obstacle. When the number of samples is less than 1200, the tree-generating frequency is 10 to 50 Hz, when the number of samples is between 1800 and 2000, the frequency is 7 to 25 Hz. The computational efficiency and CPU consumption of Torch also outperform the other two algorithms.

Course Projects

TIAGo: A Sorting Robot for Hagelslag | *ROS, C++* **Mar 2022 – Apr 2022**

- Equipped with symbolic knowledge using Planning Domain Definition Language (PDDL), our robot TIAGo, can sort among empty and full hagelsag and place them on the shelf or drop them into the basket in ROS simulation. Our simulation has shown that both grippers can perform the actions of pick, place, and discard independently and the system can also cope with the situation when new products are added to the environment without any changes to the framework other than the information to the knowledge base.
- I created an environment of our own to suit the needs of our task. I refined the grasp location to the new mass center to avoid products falling off the hands. I implemented pre- and post-place poses to enable accurate placing and thus reduced the risk of failure of RRTConnect.
- The paper can be found in ResearchGate.

Global Planning and Local Obstacle Avoidance for a Drone | *Python* **Nov 2021 – Jan 2022**

- I implemented autonomous navigation of a quadrotor based on the global path search method RRT*. I also smoothed the trajectory by conducting minimum snap optimization combined with smart time allocation.
- We implemented a non-linear MPC controller as a local planner, which can avoid local obstacles on top of the tracking task while giving a collision avoidance guarantee. we tested our method in several scenarios.

Object Detection and Control Algorithm for an Intelligent Vehicle | *ROS, C++* **Oct 2021**

- My teammate implemented a person detection package that can process the front-camera image and detect 2D bounding boxes of all people using OpenCV.
- I implemented an object detection package that can detect 3D bounding boxes of all barrels in the lidar point cloud using PCL.
- We together implemented a control package that utilized the perceived image and point cloud bounding boxes, steered away from the barrels, and braked in front of the person.

Bachelor Thesis

Driving Behavior Classification and Trajectory Prediction **Sep 2020 – May 2021**

Intelligent Vehicle Lab, BIT

- Studied the lane-changing behaviors and analyzed the interaction between the ego and surrounding vehicles based on the NGSIM dataset. Selected relevant features and used PCA to obtain the main characteristics of the vehicle trajectory.
- Used K-means clustering algorithm to identify different driving behavior data distribution and obtained the labels of different categories.
- Supervised learning method was used to predict the probability of driver behavior category according to vehicle features, and the driver behavior recognition is carried out.
- A long and short term memory network (LSTM) was established to predict the vehicle's trajectory within 1 second by combining the labeling results of the vehicle driving behavior obtained by clustering and comprehensively considering the historical trajectory information of the ego vehicle and the surrounding vehicles.

Honours and Awards

First Prize in Chinese Mathematics Competition — 2018
Third Prize in ABB (China) Innovation Contest — 2019
Second Prize in MathorCup Mathematical Modeling Contest — 2020
Chinese Encouragement Scholarship*2 (Top 10%) — 2018, 2020
First Prize in Renmin Scholarship*3 (Top 20%) — 2018, 2019, 2020

Online Courses

Probability - The Science of Uncertainty and Data — MIT
Introduction to Computational Thinking and Data Science — MIT
Introduction to Computer Science and Programming Using Python — MIT
Advanced Database Queries — NYU
Introduction to Probability — Harvard