Sihang Wei

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EDUCATION

University of Michigan — Ann Arbor, United States
M.S. | *Electrical and Computer Engineering* | *Area: Computer Vision*| *GPA: 3.97* — Aug. 2020 – Apr. 2023

University of Michigan — Ann Arbor, United States
M.S. | *Mechanical Engineering* | *Areas: Controls; Robotics; Learning*| *GPA: 3.97* — Aug. 2020 – Apr. 2023

University of Michigan-Shanghai Jiao Tong University Joint Institute — Shanghai, China
Visiting Student | *Mechanical Engineering* | *Areas: Unsupervised Learning; IC Engines*| *GPA: 4.00* — Aug. 2020 – Jun. 2021

Nanjing Institute of Technology — Nanjing, China
B.S.Eng. | *Automation*| *Areas: Electromagnetic System Design; DOE*| *GPA: 3.65* — Aug. 2016 – Jun. 2020

RESEARCH INTEREST

- Multi-Agent System
- UAV planning with safety constraints
- Decision making under uncertainty
- Deep Learning for Vision System
- Vision navigation and robust control
- Uncertainty quantification and estimation

PROJECTS AND RESEARCH EXPERIENCE

Delivery Drones Dispatch Policy Under Wind Uncertainty — July. 2022 - Present
Supervised by Prof. Max Z. Li at University of Michigan

- Surveyed the state-of-the-art trajectory generation with obstacle problems for UAV, which can be solved by optimal control via sampling-based search, graph-search and artificial potential fields method.
- Formulated the delivery drones dispatch problems. Classified delivery tasks as high priority and low priority drones respectively to perform simultaneous exploration and exploitation in unknown environments.
- Proposed exploration tasks aiming to reduce the quantified uncertainty, which implicitly aids task completion in the long term. While exploitation tasks making full use of gathered information to optimize operation.
- Leveraged Gaussian Process Regression (GPR) to quantify wind uncertainty. Based on this, learned model is advantageous in estimating the confidence of proposed path and proposal of further exploration tasks.
- Present Markov Decision Process (MDP) framework for Informative Path Planning (IPP) with mutual-information for both high priority and low priority delivery drones to better explore and exploit.

Synchronization and Obstacle Avoidance of Multi-Agent System| ***Report***| ***Slides*** Feb. 2022 - May. 2022
Supervised by Prof. Dimitra Panagou at University of Michigan

- Formulated the problem of synchronization and obstacle avoidance of Multi-Agent System over a directed graph subject to communication link faults.
- Leveraged observer-based controller scheme with linear-quadratic regulator (LQR) and model predictive control (MPC). Explored Control Lyapunov Function and Control Barrier Function (CBF-CLF) based method for obstacle avoidance of leader and follower agents
- Adopted a distributed resilient state estimation method upon which we present our own control protocols to address the communication link faults.

Online Map Recognition using Bayesian Updates | ***Report*** | ***Slides*** — Feb. 2022 - May. 2022
Supervised by Prof. Maani Ghaffari at University of Michigan

- Present a system for online map recognition method with Hidden Markov Model where the state is the belief that we are in a given map and observations are particle distributions.
- Adopted particle filter based Adaptive Monte-Carlo Localization (AMCL) as our re-localization approach.
- Developed a novel heuristic-based likelihood model to model the conditional probability of a particle distribution given a map with our main factors for place recognition belief Update from the particle filter being covariance of the estimated position, and the ratio of free space occupying particles.
- Conducted experiments with Gazebo simulation and visualization of localization process through RVIZ in ROS based on ROBOTIS Turtlebot3 robot platform with our own dataset.

Captioning Image to Assist People Who are Blind | ***Report*** | ***Slides*** Oct. 2021 - Dec. 2021

Supervised by Prof. Andrew Owens at University of Michigan

- Surveyed attention-based deep learning model methods applied in image captioning areas.
- Implemented a model composed of Residual neural network (ResNet) and soft attention mechanism to generate high-level representative features. These features are then fed into a Long Short-Term Memory (LSTM) network to output a description of the image in valid English description.
- Trained the model on VizWiz dataset with BLEU metric, the model achieved comparable to state-of-the-art performance and generated highly descriptive captions that can potentially greatly improve the lives of visually impaired people.

Learning to Play Flappy Bird Based on A3C Algorithm | ***Report*** Feb. 2021 - May. 2021

Supervised by Prof. Honglak Lee at University of Michigan

- Implemented the Deep Q-leanring From Demonstration (DQFD) algorithm in Minecraft for tree chopping. Adopted a priority buffer and choose a large n-step to tackle the sparse and delayed rewards
- Experiments in Minecraft showed that our best agent could achieve promising results, 39 trees per episode.

Survey of Deep Learning Based UAV Pose Estimation | ***Report*** Feb. 2021 - May. 2021

Supervised by Prof. Vasileios Tzoumas at University of Michigan

- Surveyed supervised learning schemes such as YOLO and the PoseNet framework specifically developed to solve object detection, indoor localization and SLAM problems.

Study of Time-sequenced In-cylinder Engine Flow Fields Prediction| ***Report*** Sept. 2020 – Jan. 2021

Supervised by Prof. David Hung at University of Michigan-Shanghai Jiao Tong University Joint Institute

- Learned high-speed particle image velocimetry (PIV) techniques to describe the 3D features of direct injection engine in-cylinder flow. Surveyed cutting edge methods of detecting and quantifying the transient vortex characteristics to provide a reliable way of improving temporal resolution in PIV flow data.
- Applied K-means and Fuzzy-C-Means clustering algorithm for detection of time-resolved transient vortex patterns to mitigate the loss of transient flow information based on conventional ensemble flow field analysis.
- Predicted the underlying dynamics of the interaction between in-cylinder flows using Long Short-term Memory (LSTM) based bidirectional recurrent neural network (bi-RNN) model. Experiment conducted show that the bi-RNN model can accurately predict the bulk flow and vortex motions from early intake stroke to compression stroke.

Electromagnetic Valvetrain System Design of IC Engines| ***Paper*** | ***Paper***| ***Patent*** Oct. 2018 – Jun. 2020

Supervised by Prof. Yuanyuan Zhang at Nanjing Institute of Technology

- Designed a novel Electromagnetic Fully Variable Valvetrain system. Projected new intake and Exhaust system correspondingly. Built the test bench to carry out further calibration and optimization experiments.
- Present Response Surface Methodology and Design of experiments (DOE) to determine essential parameters and then used Gaussian Regression to modelling the system. Controller was developed in terms of optimal valve train timing and valve lift based on improved NSGA-II algorithm for our valvetrain system.
- Conducted experiments with electric dynamometers on our self-built test bench.

PUBLICATION

Multi-objective Optimization of Intake Pipe and Valve Timing Based on Improved NSGA-II | *Sihang Wei*
Journal of Physics: Conference Series

Optimization of variable valve timing and valve lift based on response surface methodology and experiments | *Sihang Wei, Yuanyuan Zhang*
under review of *Proceedings of the Institution of Mechanical Engineers, Part D*

HONORS AND AWARDS

Merit Studnet $\times 2$ 2017, 2019, 2020
Merit based grant for students top 5% in Automation Department

First Class Scholarship $\times 5$ 2017, 2019, 2020
Merit based scholarship for students top 3% within the Engineering Faculty

Excellent Project Award 2019
Recognition for innovation and entrepreneurship within the whole school

TECHNICAL SKILLS

Languages: English (TOEFL:107 R:29 L:29 S:25 W:24), Mandarin(Native)
Programming: Python(Pytorch, TensorFlow), MATLAB and Simulink, C++, Julia, ROS
Modeling and CAE: UG NX, Solidworks, Autodesk Inventor, Altair HyperWorks, GT-Power, Ansys
Statiscal Analysis and Embedded System: DPSS, Design-Expert, STM32, Ardunio
Document Creation: Microsoft Office, LaTex, Markdown, Overleaf

SELECTED COURSES

- Visual Navigation for Aerial Vehicle
- Statistical Learning, Estimation and Learning
- Deep Learning for Computer Vision
- Flight and Trajectory Optimization
- Navigation and guidance of Aerospace Vehicles
- Multi-Agent System
- Mobile Robotics
- Machine Learning