

Lei Fan

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EDUCATION

- **Northwestern University** Evanston, IL, United States
Ph.D. candidate in Electrical Engineering, advised by Prof. Ying Wu Sep. 2019 - Dec. 2023 (Expected)
- **Sun Yat-sen University** Guangzhou, China
M.S. in Computer Science, advised by Prof. Long Chen Sep. 2017 - June 2019
- **Sun Yat-sen University** Guangzhou, China
B.E. in Computer Science Sep. 2013 - June 2017

RESEARCH INTERESTS

- **Embodied AI - active vision**
Involving intelligent control strategies into the visual recognition process to handle different recognition challenges.
- **Uncertainty estimation for classification models**
Enabling classification models to say "I do not know", especially for robots in open-world scenarios.
- **Continual learning**
Handling novel knowledge, like new object classes that could continuously emerge during robot's exploration.

PUBLICATIONS

- **During my Ph.D.**

- [1] **Lei Fan**, Bo Liu, Haoxiang Li, Ying Wu, Gang Hua, "**Flexible Visual Recognition by Evidential Modeling of Confusion and Ignorance**", accepted by the IEEE International Conference on Computer Vision, 2023.
 - [2] **Lei Fan**, Ying Wu, "**Avoiding Lingering in Learning Active Recognition by Adversarial Disturbance**", accepted by IEEE/CVF Winter Conference on Applications of Computer Vision, 2023.
 - [3] **Lei Fan**, Yunxuan Li, Chen Jiang, Ying Wu, "**Unsupervised Depth Completion and Denoising for RGB-D Sensors**", accepted by IEEE International Conference on Robotics and Automation, 2022.
 - [4] **Lei Fan**, Peixi Xiong, Wei Wei, Ying Wu, "**FLAR: A Unified Prototype Framework for Few-sample Lifelong Active Recognition**", accepted by the IEEE International Conference on Computer Vision, 2021.
- [In submission] **Lei Fan**, Mingfu Liang, Yunxuan Li, Ying Wu, "**Evidential Active Recognition**"

- **Before my Ph.D. (Topics: Perception for Autonomous Driving, 3D Scene Understanding, etc)**

- [5] Jiasong Zhu, **Lei Fan**, Wei Tian, Long Chen, Dongpu Cao, and Fei-Yue Wang, "**Toward the Ghosting Phenomenon in a Stereo-Based Map With a Collaborative RGB-D Repair**", accepted by IEEE Transactions on Intelligent Transportation Systems, 2020.
- [6] Yucai Bai, **Lei Fan**, Ziyu Pan, and Long Chen, "**Monocular Outdoor Semantic Mapping with a Multi-task Network**", accepted by IEEE/RSJ International Conference on Intelligent Robots and Systems 2019.
- [7] **Lei Fan**, Long Chen, Chaoqiang Zhang, Wei Tian, and Dongpu Cao, "**Collaborative 3D Completion of Color and Depth in a Specified Area with Superpixels**", accepted by IEEE Transactions on Industrial Electronics, 2018.
- [8] **Lei Fan**, Long Chen, Kai Huang and Dongpu Cao, "**Planecell: Representing Structural Space with Plane Elements**", accepted as **Best Student Paper** by IEEE Intelligent Vehicles Symposium, 2018.
- [9] Long Chen, **Lei Fan**, Jianda Chen, Dongpu Cao, and Feiyue Wang, "**A Full Density Stereo Matching System Based on the Combination of CNNs and Slanted-planes**", accepted by IEEE Transactions on Systems, Man, and Cybernetics: Systems, 2017.
- [10] Long Chen, Yuhang He, and **Lei Fan**, "**Let the Robot Tell: Describe Car Image with Natural Language via LSTM**", accepted by Pattern Recognition Letters, 2017.
- [11] Long Chen, **Lei Fan**, Guodong Xie, Kai Huang, and Andreas Nuchter, "**Moving-Object Detection from Consecutive Stereo Pairs using Slanted Plane Smoothing**", accepted by IEEE Transactions on Intelligent Transportation Systems, 2017.
- [12] Long Chen, Libo Sun, Teng Yang, **Lei Fan**, Kai Huang, and Zhe Xuanyuan, "**RGB-T SLAM: A Flexible SLAM Framework by Combining Appearance and Thermal Information**", accepted by IEEE International Conference on Robotics and Automation, 2017.

RECENT RESEARCH PROJECTS

- **Active Visual Recognition in the Habitat Simulator** Sep. 2022 - Present
Developing active recognition in a realistic simulator and deploying it on a mobile platform.
 - **Motivations:** Existing active recognition works are mostly done with toy datasets, like manipulating unoccluded 3D CAD models. Realistic recognition challenges, like bad viewing positions, occlusions, and other unsatisfactory recognition conditions, has been largely neglected in previous works.

- **Details:** a. Defining the active recognition task, which is not covered in existing Habitat-lab challenges. Collecting and organizing the datasets for active recognition based on different recognition difficulty levels. b. Developing a recognition agent that could actively explore the open environment and then recognize the target object with temporal and scenario contexts.
- **Joint Learning of Recognizer and Policy in Active Recognition** Jan. 2022 - June 2022
Exploring issues in the simultaneous training of both the vision and the policy modules.
 - **Motivations:** Joint learning of two modules, i.e., the recognition module and the policy, could lead to unintended consequences. The policy only visits views that the recognizer is already sufficiently trained to obtain rewards, which hurts its generalization ability during testing.
 - **Details:** The proposed method introduces an adversarial policy to compete with the major recognition policy. During training, the adversarial policy continuously perturbs the agent for more effective and thorough training of both the recognizer and the policy module. The work is accepted by WACV 2023.
- **Controllable Image Generation for Articulated Objects** Sep. 2021 - Dec. 2021
3D-aware NeRF-based GAN model for articulated objects, like the human body.
 - **Motivations:** a. Compared to human image generation methods operating in the 2D domain, synthesizing 3D human models and then projecting to 2D could give a better attribute disentanglement. b. 3D manipulation of articulated objects is better for generating temporal consistent videos.
 - **Details:** The proposed method disentangles the articulated body into a composition model of rigid parts. The movement of each rigid part is detached from a canonical representation. The proposed method is trained with 2D images only. This work is under review.
- **Active Recognition with Limited Training Samples and Continual Learning** June 2021 - Dec. 2021
Handling realistic challenges of active recognition during the agent's exploration.
 - **Motivations:** a. During exploration, novel objects could gradually appear. To recognize them, the agent should be able to expand its own knowledge, i.e., lifelong/continual learning. b. The novel acquired object categories usually do not have abundant labeling data. How to learn active recognition strategies under a limited-data setting?
 - **Details:** a. Developing a rehearsal-based active recognition method with limited exemplar memory. The forgetting is then alleviated by using the distillation loss on the saved exemplars. A center-based classification method is used to handle limited training samples. b. The experiments are conducted on both object and scene recognition. This work is accepted by ICCV 2021.

WORK EXPERIENCE

- **Amazon Robotics** Seattle, WA, United States
Applied Scientist Intern June 2023 - Sep. 2023 (Expected)
 - **Topic:** Monocular joint depth and surface normal estimation. Item placement stability analysis.
- **Wormpex AI Research** Bellevue, WA, United States
Research Intern, Mentor: Dr. Bo Liu, Dr. Haoxiang Li, and Dr. Gang Hua June 2022 - Sep. 2022
 - **Topic:** Uncertainty quantification for deep visual recognition.
 - **Details:** a. Reviewing recent studies on recent deep uncertainty estimations, including Bayesian-based and evidence-based methods. Conducting various experiments on recent uncertainty estimation methods and also relevant applications, like active learning and open-set recognition. b. Propose an approach to estimate ignorance and confusion at the same time. The method is established under the Dempster-Shafer theory and subjective logic. Opinions are then developed by doing evidence combinations.
- **Yosion Analytics** Chicago, IL, United States
Research Intern, Mentor: Dr. Nan Jiang June 2020 - Sep. 2020
 - **Topic:** Autonomous forklift in a human-machine co-working environment.
 - **Details:** a. Developing a camera-based pallet recognition and localization system for precise autonomous pallet lifting. b. Developing a vision-based empty pallet space detection system that could be used under changing lighting conditions. The system runs on a Raspberry Pi in real time.
- **DJI** Shenzhen, China
Visual Engineer Intern June 2016 - Sep. 2016
 - **Topic:** Stereo matching using the fish-eye cameras on drones.
 - **Details:** Calibrating and rectifying the stereo fish-eye cameras. Developing stereo matching algorithms for fish-eye cameras, which could give a broader depth view for 3D reconstruction and obstacle avoidance.

SELECTED SCHOLARSHIPS & HONORS

- **Northwestern University Murphy Fellowship** 2019-2020
- **Best Student Paper, IEEE Intelligent Vehicle Symposium** 2018
- **National Merit Scholarship, China** 2018

ACADEMIC SERVICES

- **Invited Conference Reviewer** CVPR 2021-2023, ICCV 2021, ECCV 2022, WACV 2023, ICRA 2019, IROS 2021, IV 2018-2020, etc.