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RESEARCH INTERESTS

My research interests primarily focus on advancing robotics and autonomous systems, particularly in achieving human-level perception and comprehensive environmental understanding for mobile robotic platforms. I aim to develop cutting-edge AI techniques and methodologies to enable robust and efficient spatial perception solutions, enhancing the reliability, intelligence, and security of intelligent machines in real-world scenarios. Additionally, my research includes efficient camera localization using state space models for edge-cloud collaborative IoT and terminal devices, further enhancing AI applications in these areas.

Techniques: Visual Localization, Adversarial Training, Data Augmentation, Domain Adaptation, 3D Reconstruction, and Neural Rendering

Applications: Autonomous Driving, Robotics, Virtual Reality, edge-cloud collaborative IoT and terminal devices

PUBLICATIONS

RADA: Robust Adversarial Data Augmentation for Camera Localization in Challenging Conditions (Accepted by IROS 2023)

Paper link [https://arxiv.org/abs/2112.02469], GitHub [https://github.com/jialuwang123321/RADA], Video [https://www.youtube.com/watch?v=niOv7-fJeCA]

Camera localization is a fundamental problem for many applications in computer vision, robotics, and autonomy. Despite recent deep learning-based approaches, the lack of robustness in challenging conditions persists due to changes in appearance caused by texture-less planes, repeating structures, reflective surfaces, motion blur, and illumination changes. Data augmentation is an attractive solution, but standard image perturbation methods fail to improve localization robustness. To address this, we propose RADA, which concentrates on perturbing the most vulnerable pixels to generate relatively less image perturbations that perplex the network. Our method outperforms previous augmentation techniques, achieving up to twice the accuracy of state-of-the-art models even under 'unseen' challenging weather conditions.

WSCLoc: Weakly-Supervised Sparse-View Camera Relocalization via Radiance Field (Accepted by IROS 2024, Oral Presentation)

Paper link [https://arxiv.org/html/2403.15272v1]

Despite the advancements in deep learning for camera relocalization tasks, obtaining ground truth pose labels required for the training process remains a costly endeavor. While current weakly supervised methods excel in lightweight label generation, their performance notably declines in scenarios with sparse views. In response to this

challenge, we introduce WSCLoc, a system capable of being customized to various deep learning-based relocalization models to enhance their performance under weakly-supervised and sparse view conditions. This is realized with two stages. In the initial stage, WSCLoc employs a multilayer perceptron-based structure called WFT-NeRF to co-optimize image reconstruction quality and initial pose information. To ensure a stable learning process, we incorporate temporal information as input. Furthermore, instead of optimizing SE(3), we opt for sim(3) optimization to explicitly enforce a scale constraint. In the second stage, we co-optimize the pre-trained WFT-NeRF and WFT-Pose. This optimization is enhanced by Time-Encoding based Random View Synthesis and supervised by inter-frame geometric constraints that consider pose, depth, and RGB information. We validate our approaches on two publicly available datasets, one outdoor and one indoor. Our experimental results demonstrate that our weakly-supervised relocalization solutions achieve superior pose estimation accuracy in sparse-view scenarios, comparable to state-of-the-art camera relocalization methods. We will make our code publicly available.

MambaLoc: Efficient Camera Localization with State Space Model for Edge-Cloud Collaborative IoT and Terminal Devices (Submitted to TCSVT)

This work addresses four major challenges in camera localization neural networks: slow training speed, high computational demands that hinder deployment on end devices, difficulty in continuous learning with new viewpoints, and poor robustness to sparse scenes. Innovatively applying Mamba to the camera localization domain, we propose MambaLoc, which combines the local fine-grained feature recognition of self-attention mechanisms with Mamba's global information integration advantages. By incorporating SSM into Non-local Neural Networks, we achieve competitive results across various visual tasks while reducing computational complexity. Through extensive experiments, we evaluate MambaLoc's four core capabilities: (1) High Efficiency: achieving training and inference speeds several times to tens of times faster than traditional methods; (2) Low Computational Cost: deployable on edge and end devices due to fewer network training parameters; (3) Supports Unlabeled (Self-supervised) Incremental Learning: continually refining the trained model with newly captured images during camera exploration; (4) Robust to Sparse Training Images: suitable for specialized camera localization applications requiring lower data exchange costs between edge and cloud, and using sparse key frames in edge-slam loop detection tasks. With these unique advantages, MambaLoc provides a stable and efficient solution for the widespread implementation of end-to-end camera localization neural networks. All code and models are available.

BIOGRAPHY

Oct. 2020-
Jan. 2025

Ph.D. in Computer Science, University of Oxford, UK

- **Group:** Department of Computer Science
- **Techniques :** Visual Localization, 3D Reconstruction, Neural Rendering Applications:
- **Applications:** Autonomous Driving, Robotics, AR/VR,
- **Supervisor:**
  - **Professor Niki Trigoni FREng Professor**(*See Home Page*), **Professor Andrew Markham** (*See Home Page*)

MSc, *Telecommunications*, University College London, UK

Sep. 2018- Nov. 2019	• **Degree:** First Class Honors Degree (I have got **70%+** for **all** models) • **Group:** Department of Electronic and Electrical Engineering (*See Home Page*) • **Topics:** - Deep learning algorithm design: to build a self-adaptive deep neuro network for mobile phones to tradeoff energy saving and prediction accuracy. Its performance is evaluated in different application scenarios using TensorFlow. - High proficiency of Digital and Wireless communications, Signal Processing and Telecommunications Theory. • **Supervisor: Prof. Yiannis, Andreopoulos** (*See Home Page*)
Sep. 2016- July. 2018	**Bachelor's degree, *Electronic Engineering & Communications*, University of Liverpool, UK** • **Degree:** First Class Honors Degree (Year 3 GPA 3.96/4.0) • **Group**: Department of Electronic and Electrical Engineering (See Home Page) • **Topics**: Electronic Engineering and Communication • **Supervisor**: **Dr. Lin Jiang (*See Home Page*), Lab Header.**

HONORS & AWARDS

2018-2019	**Awards:** MSc Telecommunications Best Project Prize	1st Author
2017-2018	**Awards:** HoD Entrepreneurship Award (5/200 1st prize)	1st Author

PROJECTS

2018-2019	**Scalable Complexity-Accuracy Tuning of Deep Neural Networks (UCL MSc Telecommunications 2018/19 Best Project Prize)** This project is to build a self-adaptive deep neuro network for mobile phones. During power-saving mode, the network will drop a partial of input channels without significant degradation of prediction accuracy. It will be tested in different application scenarios such as image classification and character recognition. The first step is to apply a series of monotonically non-increasing parameters to channels in specific layers to re-rank their importance. Less important channels will be discarded prior to others during feed-forward propagation. The research is based on the "Incomplete Dot Products (IDP)" algorithm, which was proposed by B. McDanel in Harvard University.
2017-2018	**Voice Controlled Smart Home Robot** (*See Video*) Final Year Project, University of Liverpool. The project created a robot serving three main purposes: 1) daily chatting with people 2) remote control of home appliance using the oral command 3). an auto-following-human car-base. It was designed to be a companion for the old who live alone. As the only author, I completed the whole system independently (from both hardware and software sides). Detailed information is listed below. The project got 81% marks (top 10 out of 300 projects).

An Overview of "Voice Controlled Smart Home Robot Project"		
Functions	**Intensions**	**Applied Techniques**
Voice Control of Home appliance (Lights, Fan…)	Giving instructions in everyday language	Signal processing Wireless communication Easy-VR3 Editor Programming
Security Alarm	An obstacle detection & warning system	Machine learning Microcontroller technique
Emergency Calling	Click the emergency button on the robot for emergency calling	Microcontroller programming
Daily Chatting	Home appliances control & daily chatting (Local database)	Voice processing Microcontroller programming
Online Search Engine	Weather broadcast, music player, news…(Online database)	Python (Third party API for weather…)
"Follow-Me" Chassis	Auto-following sensors for close proximity protection	Machine learning CE-circuit & IR sensors

2016-2017

The Smart Home Project, 2nd Year Project, University of Liverpool.

I assembled a group of five to model a smart home system that served two main porpuses:1) A smart light system whose intensity can be automatically adjusted according to room lighting conditions. 2) A smart alarm system that can alert users when strangers entering the room. I deliberately tuned its sensing wavelength to be 7~10μm for distinguishing between interference and thieves. The project won the 1st price of HoD Entrepreneurship Award in 2017 (top 5 out of 200 groups).

INTERNSHIP & SOCIAL WORK

4/2024-9/2024	**Research Student Attachment Programme in The Hong Kong Polytechnic University**
9/2019-1/2020	**Internship in CPS Group of Computer Science Department, University of Oxford**
2017-2018	**Course Representative of EEE Department, University of Liverpool**
6/2015-8/2015	**Team Members in FTTH Project, China Unicom**
5/2015	**Sales Assistant Internship in IFT 2015 Annual Meeting & Food Expo, Likang Nutrition Foods Co.Ltd**