Changjiang Cai Ph.D.

Staff Research Engineer in 3D Vision – InnoPeak Technology, Inc

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About

I am currently a Staff Research Engineer specializing in 3D computer vision at InnoPeak Technology, Inc. (a.k.a. OPPO US Research Center), where I am working on projects in 3D reconstruction and XR (AR/VR/MR). Previously, I earned my Ph.D. in Computer Science from Stevens Institute of Technology, focusing on depth estimation and 3D reconstruction. My work aims to advance the capabilities and applications of 3D vision technologies.

Work Experience

Full-time   **InnoPeak Technology, Inc. Palo Alto, CA**
Staff Research Engineer   *Nov 2022 – Present*

Full-time   **InnoPeak Technology, Inc. Palo Alto, CA**
Sr. Research Engineer   *Jun 2021 – Nov 2022*

Summer intern   **Futurewei Technologies, Inc. Seattle, WA**
Research Intern   *May 2020 – Aug 2020*

Summer intern   **UII America, Cambridge, MA**
Research Intern   *May 2019 – Aug 2019*

Education

Stevens Institute of Technology   **Hoboken, New Jersey, USA**
Doctor of Philosophy in Computer Science, in May 2021
Thesis: Domain Generalization, Adaptive Filtering and Multi-View
Consistency in End-to-End Stereo Matching   *Advisor*: Philippos Mordohai

Stevens Institute of Technology   **Hoboken, New Jersey, USA**
Master of Engineering in Electrical Engineering, in February 2016
Thesis: Epitome Transform Coding: Towards Joint Compression of
a Set of Images   *Advisor*: Gang Hua

Xi'an Jiaotong University   **Xi'an, Shaanxi, China**
Mechanical Engineering
Research Area: Digital Image Processing.   *Advisor*: Dehong Yu

Northwestern Polytechnical University   **Xi'an, Shaanxi, China**
B.E. in Automobile Engineering, in July 2009
Thesis: Structural Design and 3D Modeling of an Assistive Robot.   *Advisor*: Renping Shao

Project Experience

2022.11 - Present   **Staff Research Engineer**   *InnoPeak Tech.* (*a.k.a. OPPO US Research*)

Projects: R&D for XR (VR/AR/MR) applications

- Developed and deployed deep learning-based depth estimation algorithms on headset devices.
- Optimized models using quantization and pruning techniques, such as Quantization Aware Training (QAT).
- Conducted model conversions for on-device deployment, transitioning algorithms from PyTorch to ONNX to SNPE, optimized for Qualcomm Snapdragon chipsets.

2021.06 - 2022.10   **Senior Research Engineer**   *InnoPeak Tech.* (*a.k.a. OPPO US Research*)
Projects: cutting-edge algorithms R&D for XR (VR/AR/MR) applications

- Conducted depth estimation and 3D reconstruction using Multi-View Stereo (MVS), as detailed in our CVPR'23 paper RIAV-MVS.
- Developed 3D plane reconstruction techniques via MVS with slanted plane hypotheses, presented in our CVPR'22 paper PlaneMVS.

2017.01 - 2021.05   **Ph.D. Student Researcher**   Stevens Institute of Technology

Projects: depth estimation and 3D reconstruction via stereo matching

- DAF-StereoNets: Do End-to-end Stereo Algorithms Under-utilize Information?   3DV'20
  - Implemented a pipeline to leverage segmentation cues by mapping image intensities into embeddings, which then generate local attention masks for accurate disparity estimation.
  - Enhanced state-of-the-art stereo matching networks, including DispNetC, GCNet, PSMNet, and GANet, with content-adaptive deep filtering techniques.
  - Implemented the algorithms in PyTorch (See GitHub Code).
- MSNets: Matching-space Stereo Networks for Cross-domain Generalization   3DV'20
  - Proposed a novel family of end-to-end stereo matching architectures with domain-invariant generalization.
  - Implemented the algorithms in C++/PyThon (See GitHub Code).
- CBMV: A **C**oalesced **B**idirectional **M**atching **V**olume for Disparity Estimation   CVPR'18
  - Generated a matching volume by coalescing diverse evidence from a bidirectional matching process via random forest classifiers.
  - Implemented the algorithms in C++/CUDA/PyThon (See GitHub Code).

2020.05 - 2020.08   **Summer Research Intern**   Futurewei Technologies, Inc. Seattle, WA

Project: Self-/Un-supervised Robust Presentation Learning

- Developed methods for self- or unsupervised learning to enhance robust representation, aiming to improve dense predictions across various tasks including semantic segmentation, optical flow estimation, and depth estimation.

○ 2019.05 - 2019.08   **Summer Research Intern**   UII America, Cambridge, MA

Project: Depth-Aware Human Mesh Recovery

- Developed a method utilizing RGB-D images to estimate parametric human mesh models.
- Introduced a dynamic data fusion module to enhance learning by integrating RGB-only and RGB-D datasets effectively.
- Implemented the algorithm in PyTorch; details of the proposed approach are available in the ArXiv technical report.

○ 2015.09 - 2016.10   **Master Student Researcher**   Stevens Institute of Technology
Project: Crowdsourcing: Budget-conscious Ranking by Non-interactive Crowdsourcing

- Designed a crowdsourced ranking algorithm to generate optimal full rankings from pairwise comparisons within a limited budget.
- Developed exact and heuristic algorithms to derive the most accurate full ranking based on transitive closure of pairwise preferences.
- Implemented the algorithms in C++ (See GitHub Code). Discussed in detail in ICDCS'17 paper.

○ 2015.01 - 2015.08   **Master Student Researcher**   Stevens Institute of Technology

Project: Epitome Transform Coding: Towards Joint Compression of a Set of Images

- Developed epitome transform coding for joint compression of image sets.
- Proposed a compact yet comprehensive epitome image representation, ensuring each block from the image collection matched a prototype block in the epitome.
- Implemented the solution in C++ using the FFTW library for optimized convolution (See GitHub Code).

Academic Services

○ **Reviewer for the following conferences:**

- European Conference on Computer Vision (ECCV, 2024)
- IEEE/CVF Conf. on Computer Vision and Pattern Recognition (CVPR, 2023,2024)
- Conference on Neural Information Processing Systems (NeurIPS, 2023)
- International Conference on Computer Vision (ICCV, 2023)
- AAAI Conference on Artificial Intelligence (AAAI, 2022,2023)
- ACM Multimedia Conference (ACMMM, 2020-2022)
- International Conference on Pattern Recognition (ICPR, 2022)

- International Conference on Multimedia Information Processing and Retrieval (MIPR, 2022)

o **Reviewer for the following journals**:

  - IEEE Transactions on Image Processing (TIP)
  - IEEE Transactions on Multimedia (TMM)
  - International Journal of Computer Vision (IJCV)
  - Springer Multimedia Systems

o **Teaching Assistant**:

  - CS442 - Database Management Systems, Stevens Institute of Technology, Aug - Dec 2016

Skills

o **Programming Languages:** Python, C/C++, CUDA, Python& C++ Hybrid, MATLAB

o **Deep Learning:** PyTorch, TensorFlow, Keras, Caffe

o **Machine Learning:** OpenCV, Numpy, Scikit-learn, Scipy, Pandas

o **Other Library & APIs:** Cython, Boost C++, Matplotlib

o **Database:** MySQL, PostgreSQL

o **Tools:** Vim, Git, Docker, CMake, Bash, Tmux, MeshLab, Latex

o **OS Platforms:** Linux, macOS, Windows

o **Languages:** English (proficient), Chinese (native)

o **Hobbies:** Basketball, Running, Bicycling, Guitar, Driving for road trip

Publications

Please visit my *Google Scholar* page for additional details.

Published

o Ziyue Feng, Huangying Zhan, Zheng Chen, Qingan Yan, Xiangyu Xu, **Changjiang Cai**, Bing Li, Qilun Zhu, Yi Xu. *NARUTO: Neural Active Reconstruction from Uncertain Target Observations.* In CVPR 2024, Seattle, US, June 2024

o **Changjiang Cai**, Pan Ji, Qingan Yan, Yi Xu. *RIAV-MVS: Recurrent-Indexing an Asymmetric Volume for Multi-View Stereo.* In CVPR 2023, Vancouver, Canada, June 2023

o Mohammed Kutbi, Haoxiang Li, Yizhe Chang, Bo Sun, Xin Li, **Changjiang Cai**, Nikolaos Agadakos, Gang Hua, Philippos Mordohai. *Egocentric Computer Vision for Hands-Free Robotic Wheelchair Navigation.* In Journal of Intelligent & Robotic Systems, 2023

- Jiachen Liu, Pan Ji, Nitin Bansal, **Changjiang Cai**, Qingan Yan, Xiaolei Huang, Yi Xu. *PlaneMVS: 3D Plane Reconstruction from Multi-View Stereo.* In CVPR 2022, New Orleans, LA, June 2022.

- **Changjiang Cai**, Philippos Mordohai. *Do End-to-end Stereo Algorithms Under-utilize Information?* In International Conference on 3D Vision (3DV), 2020.

- **Changjiang Cai**, Matteo Poggi, Stefano Mattoccia, and Philippos Mordohai, *Matching-space Stereo Networks for Cross-domain Generalization.* In International Conference on 3D Vision (3DV), 2020.

- Konstantinos Batsos, **Changjiang Cai**, Philippos Mordohai. *CBMV: A coalesced bidirectional matching volume for disparity estimation.* In CVPR 2018, Salt Lake City, Utah, June 2018.

- **Changjiang Cai**, Haipei Sun, Boxiang Dong, Bo Zhang, Ting Wang, Hui Wang. *Pairwise Ranking Aggregation by Non-interactive Crowdsourcing with Budget Constraints.* The 37th IEEE International Conference on Distributed Computing (ICDCS), June, 2017, Atlanta, GA.

- Haoxiang Li, Mohammed Kutbi, Xin Li, **Changjiang Cai**, Philippos Mordohai, Gang Hua, *An Egocentric Computer Vision based Co-Robot Wheelchair.* IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2016.

Patents

- Ziyan Wu, Srikrishna Karanam, **Changjiang Cai**, Georgios Georgakis. *Systems and methods for human pose and shape recovery*, US Patent App. 18095857, 2023.

Preprints

- Zheng Chen, Qingan Yan, Huangying Zhan, **Changjiang Cai**, Xiangyu Xu, Yuzhong Huang, Weihan Wang, Ziyue Feng, Lantao Liu, Yi Xu. *PlanarNeRF: Online Learning of Planar Primitives with Neural Radiance Fields.* arXiv:2401.00871

- Xiangyu Xu, Lichang Chen, **Changjiang Cai**, Huangying Zhan, Qingan Yan, Pan Ji, Junsong Yuan, Heng Huang, Yi Xu. *Dynamic Voxel Grid Optimization for High-Fidelity RGB-D Supervised Surface Reconstruction.* arXiv:2304.06178

- Zhiqi Zhang, Pan Ji, Nitin Bansal, **Changjiang Cai**, Qingan Yan, Xiangyu Xu, Yi Xu. *CLIP-FLow: Contrastive Learning by semi-supervised Iterative Pseudo labeling for Optical Flow Estimation.* arXiv:2210.14383

- Ren Li, **Changjiang Cai**, Georgios Georgakis, Srikrishna Karanam, Terrence Chen, Ziyan Wu. *Towards Robust RGB-D Human Mesh Recovery.* arXiv:1911.07383.