HANG QIU

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RESEARCH INTERESTS

Collaborative Autonomous Systems, Cyber-physical Systems, Systems for ML, Edge ML, 3D Sensing, Cooperative Perception, Mapping and Localization, Mobile Computing, Wireless Networking.

APPOINTMENTS

Waymo, *Bellevue, WA, USA* *2022∼ pres.*

Software Engineer, Perception

Stanford University, *Stanford, CA, USA* *2021∼ 2022*

Postdoctoral Scholar, Department of Electrical Engineering

Waymo, *Mountain View, CA, USA* *summer 2021*

Intern, Perception

Microsoft Research, *Redmond, WA, USA* *2017∼ 2019*

Research Intern, Contractor, Mobility and Networking Group

IBM Research, *Yorktown Heights, NY, USA* *summer 2015*

Research Intern, T.J. Watson Research Center

EDUCATION

Ph.D. | *Electrical and Computer Engineering* *2020*

University of Southern California, Los Angeles, USA

Dissertation: Networked Cooperative Perception: Towards Robust and Efficient Autonomous Driving

M.S. | *Computer Science* *2020*

University of Southern California, Los Angeles, USA

B.S. | *Electronic Engineering* *2013*

Shanghai Jiao Tong University, Shanghai, China

Thesis: Distributed Channel-Assignment and Throughput Control in Multi-Radio Multi-Channel Wireless Network

PROFESSIONAL EXPERIENCE

Stanford University, *Postdoctoral Scholar* *Stanford, CA, 2021∼pres.*

- Designed edge ML monitoring and debugging system, ML-EXray, a programming framework for end-to-end ML deployment validation to enable verifiable ML on edge devices.
- Collaborated with Google and Meta to uncover deployment issues in industry edge ML production pipelines.

General Motors R&D, *Collaborator* *Warren, MI, 2013∼pres.*

- Designed Augmented Vehicular Reality (AVR), a collaborative sensing system which enabled live extended 3D vision beyond occlusion and range for better autonomous driving decisions. [Featured in GetMobile Magazine]

- Built a lightweight self-healing HDMap system, Carmap, which enabled real-time 3D map difference updates, and invented a robust simultaneous localization and mapping (SLAM) approach leveraging map differences.
- Designed scalable cooperative perception system (AutoCast) that coordinates and schedules sensor sharing among clusters of vehicles, enabling live extended 3D vision for dense traffic scenarios.
- Invented cooperative autonomous driving model, Coopernaut, which encodes voxelized point cloud into compact representation using Point Transformer for bandwidth efficient sharing and more informed driving.

Waymo LLC., *Perception Intern* *Mountain View, CA, Summer 2021*

- Developed a deep learning network for segmentation problems using LIDAR point clouds (details confidential).

Microsoft Research, *Collaborator, Research Intern* *Redmond, WA, 2017∼2019*

- Developed automated crowdsourcing platform, Satyam, for machine vision groundtruth collection at scale.
- Designed annotation quality control framework for complex vision tasks such as detection, tracking, and segmentation to produce high quality labels in face of untrained workers, human errors, and spammers.
- Built world's largest trans-seasonal detection and tracking dataset, FourSeasons, that captures long term seasonal and diurnal variations with traffic surveillance cameras videos spanning over a year.
- Designed active labeling, MCAL, a hybrid human-machine labeling framework, to reduce the annotation cost using machine labeling while balancing training and labeling cost. [Integrated into Microsoft Azure ML]

IBM Research, *Research Intern* *Yorktown Heights, NY, Summer 2015*

- Devised collaborative video analytics system, Kestrel, that tracks vehicle in a heterogeneous camera network.
- Optimized deep neural network to execute on mobile devices to detect objects, extract features, and resolve path ambiguities by careful association in real-time, reducing mobile energy budget by an order of magnitude.

PUBLICATION

Refereed Publication

[1] AutoCast: Scalable Infrastructure-less Cooperative Perception for Distributed Collaborative Driving
Hang Qiu, Pohan Huang, Namo Asavisanu, Xiaochen Liu, Konstantinos Psounis, and Ramesh Govindan
Proceedings of the 20th Annual International Conference on Mobile Systems, Applications, and Services (MobiSys '22), 2022

[2] Coopernaut: End-to-End Driving with Cooperative Perception for Networked Vehicles
Hang Qiu*, Jiaxun Cui*, Dian Chen, Peter Stone, and Yuke Zhu
Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR '22), 2022

[3] ML-EXray: Visibility into ML Deployment on the Edge
Hang Qiu, Ioanna Vavelidou, Jian Li, Evgenya Pergament, Pete Warden, Sandeep Chinchali, Zain Asgar, and Sachin Katti
Proceedings of Machine Learning and Systems (MLSys '22), 2022 - *Outstanding Paper Award*

[4] Sensing the Sensor: Estimating Camera Properties with Minimal Information
Pradipta Ghosh, Xiaochen Liu, **Hang Qiu**, Marcos A. M. Vieira, Gaurav S. Sukhatme, and Ramesh Govindan
ACM Transactions on Sensor Networks (TOSN '22). 2022

[5] Optimal Resource Allocation for Crowdsourced Image Processing
Kristina Sorensen Wheatman, Fidan Mehmeti, Mark Mahon, **Hang Qiu**, Kevin S. Chan, and Thomas F. La Porta
IEEE Transactions on Mobile Computing (TMC '22). 2022

[6] CarMap: Fast 3D Feature Map Updates for Automobiles
Fawad Ahmad, **Hang Qiu**, Ray Eells, Fan Bai, and Ramesh Govindan
Proceedings of the 17th Symposium on Networked Systems Design and Implementation (NSDI '20), 2020

[7] FedML: A Research Library and Benchmark for Federated Machine Learning
Chaoyang He, Songze Li, Jinhyun So, Mi Zhang, Hongyi Wang, Xiaoyang Wang, Praneeth Vepakomma, Abhishek Singh, **Hang Qiu**, Li Shen, et al.
Proceedings of the 34th Conference on Neural Information Processing Systems (NeurIPS '20), Workshop on Scalability, Privacy, and Security in Federated Learning (NeurIPS '20-SpicyFL), 2020 - Best Paper Award

[8] Optimal Resource Allocation for Crowdsourced Image Processing
Kristina Sorensen Wheatman, Fidan Mehmeti, Mark Mahon, **Hang Qiu**, Kevin Chan, and Thomas La Porta
Proceedings of the 17th Annual IEEE International Conference on Sensing, Communication, and Networking (SECON '20), 2020

[9] On Tracking Realistic Targets in a Megacity with Contested Air and Spectrum Access
Jongdeog Lee, Tarek Abdelzaher, **Hang Qiu**, Ramesh Govindan, Kelvin Marcus, Reginald Hobbs, Niranjan Suri, and Will Dron
Proceedings of the 37th Military Communications Conference (MILCOM '18), 2018

[10] AVR: Augmented Vehicular Reality
Hang Qiu, Fawad Ahmad, Fan Bai, Marco Gruteser, and Ramesh Govindan
Proceedings of the 16th Annual International Conference on Mobile Systems, Applications, and Services (MobiSys '18), 2018 - Best Paper Runner-up Award

[11] Kestrel: Video analytics for augmented multi-camera vehicle tracking
Hang Qiu, Xiaochen Liu, Swati Rallapalli, Archith J Bency, Kevin Chan, Rahul Urgaonkar, BS Manjunath, and Ramesh Govindan
Proceedings of the 3rd IEEE/ACM International Conference on Internet-of-Things Design and Implementation (IoTDI '18), 2018

[12] Augmented Vehicular Reality: Enabling Extended Vision for Future Vehicles
Hang Qiu, Fawad Ahmad, Ramesh Govindan, Marco Gruteser, Fan Bai, and Gorkem Kar
Proceedings of the 18th International Workshop on Mobile Computing Systems and Applications (HotMobile '17), 2017

[13] Towards Robust Vehicular Context Sensing
Hang Qiu, Jinzhu Chen, Shubham Jain, Yurong Jiang, Matt McCartney, Gorkem Kar, Fan Bai, Donald K Grimm, Marco Gruteser, and Ramesh Govindan
IEEE Transactions on Vehicular Technology (TVT). 2017

[14] High-Rate WiFi Broadcasting in Crowded Scenarios via Lightweight Coordination of Multiple Access Points
Hang Qiu, Konstantinos Psounis, Giuseppe Caire, Keith M. Chugg, and Kaidong Wang

Proceedings of the 17th ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc '16), 2016

[15] CARLOC: Precise Positioning of Automobiles

Yurong Jiang, **Hang Qiu**, Matthew McCartney, Gaurav Sukhatme, Marco Gruteser, Fan Bai, Donald Grimm, and Ramesh Govindan
Proceedings of the 13th ACM Conference on Embedded Networked Sensor Systems (SenSys '15), 2015

[16] CARLOG: A Platform for Flexible and Efficient Automotive Sensing

Yurong Jiang, **Hang Qiu**, Matthew McCartney, William G. J. Halfond, Fan Bai, Donald Grimm, and Ramesh Govindan
Proceedings of the 12th ACM Conference on Embedded Network Sensor Systems (SenSys '14), 2014

Technical Reports

[1] On Localizing a Camera from a Single Image

Pradipta Ghosh, Xiaochen Liu, **Hang Qiu**, Marcos AM Vieira, Gaurav S Sukhatme, and Ramesh Govindan
ArXiv, 2020

[2] Minimum Cost Active Labeling

Hang Qiu, Krishna Chintalapudi, and Ramesh Govindan
ArXiv, 2020

[3] Satyam: Democratizing Groundtruth for Machine Vision

Hang Qiu, Krishna Chintalapudi, and Ramesh Govindan
Integrated into Microsoft Azure ML. Used by UCSB, USC, UIUC, ARL., 2018
Featured in Microsoft Ignite 2019

[4] Flexible and Efficient Sensor Fusion for Automotive Apps

Yurong Jiang, **Hang Qiu**, Matthew McCartney, William GJ Halfond, Fan Bai, Donald Grimm, and Ramesh Govindan
Citeseer, 2013

Invited Articles

[1] Augmented Vehicular Reality: Enabling Extended Vision for Future Automobiles

Hang Qiu, Fawad Ahmad, Fan Bai, Marco Gruteser, and Ramesh Govindan
GetMobile: Mobile Comp. and Comm., 2019
Invited article (Best Paper runner-up of Mobisys'18)

[2] QuickSketch: Building 3D Representations in Unknown Environments using Crowdsourcing

Fawad Ahmad, **Hang Qiu**, Xiaochen Liu, Fan Bai, and Ramesh Govindan
21st International Conference on Information Fusion (Fusion '18), 2018

[3] My Story with ICM

Xilun Chen, **Hang Qiu**, and Chunzhi Yang
UMAP Journal 34.2 & 34.3 Summer Fall 2013 Edition - The 2013 MCM ICM Contest Edition, 2013
Invited article (Outstanding Winner of ICM'12)

PATENTS

[1] Method and Apparatus for a Context-aware Crowd-sourced Sparse High Definition Map
Fawad Ahmad, **Hang Qiu**, Ramesh Govindan, Donald K Grimm, and Fan Bai
- *Worldwide Patent: US20200278217 / CN111638536 / DE102020102725*

[2] Crowd-sensed Point Cloud Map
Fawad Ahmad, **Hang Qiu**, Fan Bai, and Ramesh Govindan
- *Worldwide Patent: US20190266748 / CN110186467 / DE102019104482*

[3] Method and Apparatus of Networked Scene Rendering and Augmentation in Vehicular Environments in Autonomous Driving Systems
Hang Qiu, Ramesh Govindan, Marco Gruteser, and Fan Bai
- *Worldwide Patent: US20180261095 / CN108574929 / DE102018105293*

[4] Energy-efficient Cooperative Sensing Schedule for Heterogeneous Users in Cognitive Radio Network
Xin Huang, Xinxin Feng, **Hang Qiu**, Gaofei Sun, Xiaohua Tian, Feng Yang, and Xinbing Wang
- *Patent: CN102905381*

[5] Greedy Channel-allocation in Multi-radio Multi-channel Multi-hop Wireless Network
Hang Qiu, Xin Huang, Qi Shi, Xinbing Wang, and Jun Tian
- *Patent: CN103634846*

[6] Automatic Line-tracking Floor Waxing Machine
Hang Qiu and Xin Huang
- *Patent: CN202458213*

PRESENTATIONS

ML-EXray: Visibility into ML Deployment on the Edge

University of California, San Diego, California, USA	*Sep 2022*
MLSys Conference, Santa Clara, USA	*Aug 2022*
University of California, Irvine, California, USA	*Mar 2022*
Stanford University, Stanford, California, USA	*Feb 2022*

AutoCast: Scalable Infrastructure-less Cooperative Perception for Distributed Collaborative Driving

IEEE MFI, 1st Cooperative Perception Workshop, Virtual	*Sep 2022*
ACM Mobisys, Portland, USA	*Jun 2022*

Towards Ultra-reliable Cooperative Autonomous Systems

Meta, Reality Lab, Menlo Park, Virtual	*Apr 2022*
University of California, Riverside, California, USA	*Mar 2022*
Yale University, Virtual	*Feb 2022*
University of California, San Diego, Virtual	*Feb 2022*
University of California, Irvine, Virtual	*Apr 2020*
Duke University, Virtual	*Mar 2020*

3D Sensing for Autonomous Robots and Smart Infrastructure

IEEE SmartComp Tutorial, Virtual *Aug 2021*

AVR: Augmented Vehicular Reality

Intel's Autonomous Driving CoP Workshop, Santa Clara, California, USA *Oct 2018*
Semiconductor Research Corporation (SRC), TechCon, Austin, Texas, USA *Sep 2018*
John Hopcroft Center, Shanghai Jiao Tong University, Shanghai, China *Jun 2018*
ACM Mobisys, Munich, Germany *Jun 2018*
CONIX Research Center Workshop, San Diego, California, USA *Jan 2018*
ACM HotMobile, Sonoma, California, USA *Feb 2017*

Kestrel: Video Analytics for Augmented Multi-Camera Vehicle Tracking

ACM/IEEE IoTDI, Orlando, Florida, USA *Apr 2018*

High-Rate WiFi Broadcasting in Crowded Scenarios via Lightweight Coordination of Multiple APs

ACM MobiHoc, Paderborn, Germany *Jul 2016*

SERVICES

Conference Reviewer

USENIX Symposium on Networked Systems Design and Implementation *(NSDI)*
ACM International Conference on Mobile Systems, Applications, and Services *(MobiSys)*
Conference on Robotic Learning *(CoRL)*
IEEE International Conference on Robotics and Automation *(ICRA)*
AAAI Conference on Artificial Intelligence *(AAAI)*
IEEE Conference on Computer Communications *(INFOCOM)*
ACM/IEEE Symposium on Edge Computing *(SEC)*
ACM International Conference on Information Processing in Sensor Networks *(IPSN)*
IEEE International Conference on Sensing, Communication and Networking *(SECON)*
IEEE Vehicular Networking Conference *(VNC)*
IEEE International Conference on Parallel and Distributed Systems *(ICPADS)*

Journal Reviewer

IEEE Transactions on Networking *(TON)*
IEEE Journal on Selected Areas in Communications *(JSAC)*
IEEE Transactions on Vehicular Technology *(TVT)*
IEEE Robotics and Automation Letters *(RA-L)*
IEEE Transactions on Mobile Computing *(TMC)*
IEEE Access
IEEE Transactions on Cloud Computing *(TCC)*

Tutorial Organizer

3D sensing for autonomous robots and smart infrastructure, *IEEE SmartComp '21*

SIGMOBILE YouTube Channel

HotMobile'17, Mobicom'16, Mobihoc'16, Sensys'16

Teaching and Mentoring

Teaching

Co-instructor, *ML on Embedded Systems (Stanford EE 292D), Co-Instructor: S.Katti, Z.Asgar, P.Warden* — *Fall 2021*

Teaching Assistant, *Wireless Networks (USC ECE 597), Instructor: B. Krishnamachari* — *Spring 2020*

Teaching Assistant, *Computer Communications (USC CSCI 551), Instructor: R. Govindan* — *Fall 2017*

Guest Lecturer, *Wireless Networks (USC ECE 597), Instructor: K. Psounis* — *Spring 2020*

Guest Lecturer, *Wireless Networks (USC ECE 597), Instructor: K. Psounis* — *Spring 2015*

Panelist, *Seminar in Computer Science Research (USC CSCI 697), Instructor: L. Golubchik* — *Spring 2019*

Mentoring

Jiaxun Cui (PhD): *Collaborative Autonomous Driving (CVPR '22)* — *2020∼pres.*

Namo Asavisanu (PhD): *Scalable Cooperative Perception (Mobisys '22)* — *2020∼pres.*

Ioanna Vavelidou (PhD): *Edge ML Monitoring and Debugging (MLSys '22)* — *Fall 2021*

Fawad Ahmad (PhD): *Fast 3D Feature Map Updates for Automobiles (NSDI '20)* — *2016∼2020*

Ray Eells (BS): *Autonomous Vehicle Control using Extended Vision* — *2018∼2020*

Meghraj Bendre (MS): *Understanding Computer Vision Robustness under Seasonal Changes* — *Summer 2018*

Jens Windau (PhD): *Human Pose and Gesture Monitoring using Wearable Sensors* — *Fall 2016*

Bhavana Srinivas (MS): *Improving Campus WiFi Service* — *Fall 2014*

Honors and Awards

Outstanding Paper Award, *MLSys 2022, Santa Clara, USA* — *2022*

Outstanding Research Assistant Award, *USC* — *2021*

Qualcomm Innovation Fellowship, Finalist, *San Diego, USA* — *2019*

Best Paper Award, runner-up, *ACM Mobisys 2018, Munich, Germany* — *2018*

Viterbi Graduate Student Annenberg Fellowship, *USC* — *2013∼2017*

Outstanding Winner, *Interdisciplinary Contest in Modeling (ICM), USA* — *2012*

National Fellowship (Top 1%), *China* — *2010, 2011, 2012*

First-Class (Top 1%) Academic Excellence Fellowship, *Shanghai Jiao Tong University* — *2010, 2011, 2012*

Academic Star (Top 1%), *Shanghai Jiao Tong University* — *2012*

NSF/SIGMOBILE Travel Grants, *ACM Mobicom'16, ACM Sensys'16, ACM HotMobile'17*

Software and Dataset

[1] AutoCast Github: https://github.com/hangqiu/AutoCast

[2] Coopernaut Github: https://github.com/UT-Austin-RPL/Coopernaut

[3] Coopernaut Website and Dataset: https://ut-austin-rpl.github.io/Coopernaut/

[4] ML-EXray Github: https://github.com/hangqiu/ML-EXray

[5] CarMap Github: https://github.com/USC-NSL/CarMap

[6] FourSeasons Dataset and Benchmark: https://trafficcamdataset.wordpress.com/

[7] Satyam Github: https://github.com/satyamresearch/satyam

[8] AVR Github: https://github.com/hangqiu/AVR16