

# HANG QIU

Assistant Professor

Electrical and Computer Engineering

Computer Science and Engineering

University of California, Riverside

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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

<b>University of California, Riverside</b> , <i>Riverside, CA, USA</i>	2023~ <i>pres.</i>
<i>Assistant Professor</i> , Department of ECE and CSE	
<b>Waymo</b> , <i>Bellevue, WA, USA</i>	2022~ 2023
<i>Software Engineer</i> , Perception	
<b>Stanford University</b> , <i>Stanford, CA, USA</i>	2021~ 2022
<i>Postdoctoral Scholar</i> , Department of Electrical Engineering	
<b>Waymo</b> , <i>Mountain View, CA, USA</i>	<i>summer</i> 2021
<i>Intern</i> , Perception	
<b>Microsoft Research</b> , <i>Redmond, WA, USA</i>	2017~ 2019
<i>Research Intern</i> , Contractor, Mobility and Networking Group	
<b>IBM Research</b> , <i>Yorktown Heights, NY, USA</i>	<i>summer</i> 2015
<i>Research Intern</i> , T.J. Watson Research Center	

## EDUCATION

<b>Ph.D.</b>   <i>Electrical and Computer Engineering</i>	2020
<i>University of Southern California</i> , Los Angeles, USA	
<i>Dissertation: Networked Cooperative Perception: Towards Robust and Efficient Autonomous Driving</i>	
<b>M.S.</b>   <i>Computer Science</i>	2020
<i>University of Southern California</i> , Los Angeles, USA	
<b>B.S.</b>   <i>Electronic Engineering</i>	2013
<i>Shanghai Jiao Tong University</i> , Shanghai, China	
<i>Thesis: Distributed Channel-Assignment and Throughput Control in Multi-Radio Multi-Channel Wireless Network</i>	

## HONORS AND AWARDS

<b>Outstanding Paper Award</b> , <i>MLSys 2022, Santa Clara, USA</i>	2022
<b>Outstanding Research Assistant Award</b> , <i>USC</i>	2021
<b>Qualcomm Innovation Fellowship, Finalist</b> , <i>San Diego, USA</i>	2019

<b>Best Paper Award, runner-up</b> , <i>ACM Mobisys 2018, Munich, Germany</i>	2018
<b>Viterbi Graduate Student Annenberg Fellowship</b> , <i>USC</i>	2013~2017
<b>Outstanding Winner</b> , <i>Interdisciplinary Contest in Modeling (ICM), USA</i>	2012
<b>National Fellowship (Top 1%)</b> , <i>China</i>	2010, 2011, 2012
<b>First-Class (Top 1%) Academic Excellence Fellowship</b> , <i>Shanghai Jiao Tong University</i>	2010, 2011, 2012
<b>Academic Star (Top 1%)</b> , <i>Shanghai Jiao Tong University</i>	2012
<b>NSF/SIGMOBILE Travel Grants</b> , <i>ACM Mobicom'16, ACM Sensys'16, ACM HotMobile'17</i>	

## PROFESSIONAL EXPERIENCE

**Waymo LLC.**, *Software Engineer* *Bellevue, WA, 2022~pres.*

- Work in perception and mapping (details confidential).

**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

### *Preprints*

- [1] [CMP: Cooperative Motion Prediction with Multi-Agent Communication](#)  
Zhuoyuan Wu, Yuping Wang, Hengbo Ma, Zhaowei Li, **Hang Qiu**, and Jiachen Li
  
- [2] [Embodied Understanding of Driving Scenarios](#)  
Yunsong Zhou, Linyan Huang, Qingwen Bu, Jia Zeng, Tianyu Li, **Hang Qiu**, Hongzi Zhu, Minyi Guo, Yu Qiao, and Hongyang Li

### *Refereed Publication*

- [1] [Pillar Attention Encoder for Adaptive Cooperative Perception](#)  
Zhengwei Bai, Guoyuan Wu, Matthew J. Barth, **Hang Qiu**, Yongkang Liu, Emrah Akin Sisbot, and Kentaro Oguchi  
*IEEE Internet of Things Journal (IOT-J)*. 2024
  
- [2] [WOMD-LiDAR: Raw Sensor Dataset Benchmark for Motion Forecasting](#)  
Kan Chen, Runzhou Ge, **Hang Qiu**, Rami Ai-Rfou, Charles R. Qi, Xuanyu Zhou, Zoey Yang, Scott Ettinger, Pei Sun, Zhaoqi Leng, Mustafa Mustafa, Ivan Bogun, Weiyue Wang, Mingxing Tan, and Dragomir Anguelov  
*Proceedings of 2024 IEEE International Conference on Robotics and Automation (ICRA '24)*, 2024
  
- [3] [MCAL: Minimum Cost Human-Machine Active Labeling](#)  
**Hang Qiu**, Krishna Chintalapudi, and Ramesh Govindan  
*Proceedings of the Eleventh International Conference on Learning Representations (ICLR '23)*, 2023
  
- [4] [AutoCast: Scalable Infrastructure-less Cooperative Perception for Distributed Collaborative Driving](#)  
**Hang Qiu**, Pohan Huang, Nam Asavisanu, Xiaochen Liu, Konstantinos Psounis, and Ramesh Govindan  
*Proceedings of the 20th Annual International Conference on Mobile Systems, Applications, and Services (MobiSys '22)*, 2022
  
- [5] [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
  
- [6] [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*
  
- [7] [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
  
- [8] [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

- [9] [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
- [10] [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*
- [11] [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
- [12] [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
- [13] [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*
- [14] [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
- [15] [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
- [16] [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
- [17] [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
- [18] [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*

[19] [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] [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*

[3] [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**, Gaofer 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

### Scene Understanding beyond the Visible

ECE Colloquium, University of California, Los Angeles, USA	Mar 2024
International Workshop on Trustworthy Autonomous CPS, San Diego, USA	Jan 2024
Center for Environmental Research and Technology, Riverside, USA	Dec 2023
ECE Colloquium, University of California, Riverside, USA	Oct 2023
International Conference on ICT Convergence (ICTC), Jeju Island, Korea, Virtual	Oct 2023
International Conference on Learning Representations (ICLR), Kigali, Rwanda, Virtual	May 2023

### MCAL: Minimum-Cost Human Machine Active Labeling

International Conference on Learning Representations (ICLR), Kigali, Rwanda, Virtual	May 2023
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### 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

Center for Robotics and Intelligent Systems, Riverside, USA	Oct 2023
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
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### **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
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### **High-Rate WiFi Broadcasting in Crowded Scenarios via Lightweight Coordination of Multiple APs**

ACM MobiHoc, Paderborn, Germany	Jul 2016
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## **SERVICES**

### ***Technical Program Committee***

USENIX Symposium on Networked Systems Design and Implementation ( <i>NSDI'25</i> )
ACM International Conference on Mobile Systems, Applications, and Services ( <i>MobiSys'24</i> )
NDSS Symposium on Vehicle Security and Privacy ( <i>NDSS VehicleSec'24</i> )
IEEE Conference on Computer Communications ( <i>INFOCOM'24</i> )
ACM International Conference on Mobile Systems, Applications, and Services ( <i>MobiSys'23</i> )
IEEE International Conference on Parallel and Distributed Systems ( <i>ICPADS'22</i> )

### ***Editorial Board***

Guest Editor, IEEE Vehicular Technology Magazine, <i>VTM</i>
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### ***Conference Organizer***

Co-organizer, SoCal Robotics Symposium, <i>SCR'24</i>
Session Chair, ACM International Conference on Mobile Systems, Applications, and Services, <i>MobiSys'24</i>
Session Chair, IEEE Conference on Computer Communications, <i>INFOCOM'24</i>

### ***Workshop Organizer***

Chair, Adaptive AIoT Systems, <i>ACM Mobisys '24</i>
Co-organizer, Foundation Models for Autonomous Systems (Autonomous Driving Challenge), <i>CVPR '24</i>
Chair, 3D sensing for autonomous robots and smart infrastructure, <i>IEEE SmartComp '21</i>

### ***Conference Reviewer***

USENIX Symposium on Networked Systems Design and Implementation ( <i>NSDI</i> )
ACM International Conference on Mobile Systems, Applications, and Services ( <i>MobiSys</i> )

IEEE/CVF Computer Vision and Pattern Recognition Conference (CVPR)  
 IEEE/CVF International Conference on Computer Vision (ICCV)  
 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 International Conference on Measurement and Modeling of Computer Systems (SIGMETRICS)  
 International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)  
 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 Network Magazine  
 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)

### ***ACM SIGMOBILE YouTube Channel***

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

## **TEACHING AND MENTORING**

### ***Teaching***

Instructor, <i>Introduction to Self-driving Stack (UCR EE 260C)</i>	Spring 2024
Instructor, <i>Edge Computing (UCR CS/EE 131)</i>	Winter 2024
Co-instructor, <i>ML on Embedded Systems (Stanford EE 292D)</i> , Co-Instructor: S.Katti, Z.Asgar, P.Warden	Fall 2021
Teaching Assistant, <i>Wireless Networks (USC ECE 597)</i> , Instructor: B. Krishnamachari	Spring 2020
Teaching Assistant, <i>Computer Communications (USC CSCI 551)</i> , Instructor: R. Govindan	Fall 2017
Guest Lecturer, <i>Wireless Networks (USC ECE 597)</i> , Instructor: K. Psounis	Spring 2020
Guest Lecturer, <i>Wireless Networks (USC ECE 597)</i> , Instructor: K. Psounis	Spring 2015
Panelist, <i>Seminar in Computer Science Research (USC CSCI 697)</i> , Instructor: L. Golubchik	Spring 2019



## 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://trafficcamedataset.wordpress.com/>
- [7] Satyam Github: <https://github.com/satyamresearch/satyam>
- [8] AVR Github: <https://github.com/hangqiu/AVR16>