Dr. Gopi Krishna Tummala

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Research Interests

I am interested broadly in road-safety systems. In particular, Behavior Planning and Prediction of Autonomous vehicles, Camera Calibration techniques, Collaborative vehicular applications, Machine Learning, Deep Learning, Computer Vision, Sensor fusion and modelling of vehicular sensors, Vehicular communications, Autonomous vehicles.

Research Summary.

My current research interests focus mainly on *designing reinforcement learning algorithms for Behavior planning and prediction of Autonomous vehicles*. These broad class of algorithms are the brain and heart of the Autonomous vehicle and are responsible for making driving decisions such as, left-lane change, right-lane change, accelerate. Prior to this, I have worked on *collaborative vehicular sensing and indoor navigation services for people with visual disabilities* (PVDs). I have studied two lines of works pertaining to collaborative vehicular applications. The first line of work exploits Inter Vehicular Communication (IVC) to create a local map of neighboring vehicles by analyzing dashboard camera information or, IVC channel information to selectively communicate with neighboring vehicles (front vehicle etc.). The second line of work explores Vehicle to Infrastructure (V2I) communication for enabling hands-free payments from the car (parking-fee, toll-fee etc.). In a collaboration project with Microsoft Research, I have designed novel techniques to automatically calibrate the infrastructure cameras for a better understanding of traffic flow characteristics and enhance easiness of V2I pairing. These *automatic calibration techniques* are scalable and enables hands-free calibration of thousands of traffic cameras. Continuing this project, I have developed automatic calibration techniques for dashboard cameras which enable Advanced Driver Assistance System applications using commodity devices. To understand the importance of the calibration accuracies and their effect on real world applications, I have studied the calibration errors, other sensor imperfections and sensor fusion errors in context of Autonomous vehicles during my internship at Qualcomm Research.

Professional Preparation

1.	IIT, Madras, India	Electrical Engineering.	B. Tech	3.6	May 2012
2.	Ohio State University, Columbus	Computer Science	MS	3.6	May 2018
3.	Ohio State University, Columbus	Computer Science	PhD	3.6	Aug 2019

Appointments

1.	Senior Systems Engineer	Qualcomm Research, San Diego, CA	Jan '19 – Present
2	Engineering Intern	Qualcomm Research, San Diego, CA	May '18 – Aug '18
2.	Research Assistant	Ohio State University, Columbus, OH	May '13 – Dec'18

3.	Research Intern	Microsoft Research, Bangalore, IN	May '16 – Aug'16
4.	Teaching Assistant	Ohio State University, Columbus, OH	May '13 – May'15
5.	Software Analyst	Standard Chartered Bank, Chennai, IN	Jun '12 – May'13
6	Project Intern	Tata Elxsi Chennai, Chennai, IN	May '11 – Aug'11

Thesis Publications.

1. Tummala, Gopi Krishna. *Automatic Camera Calibration Techniques for Collaborative Vehicular Applications*. Diss. The Ohio State University, 2019.
2. Tummala, Gopi Krishna. *Null Space of Channel Matrix*. Diss. Indian Institute of Technology (IIT) Madras, 2012.

Journal Publications.

1. Romil Bhardwaj (Co-Primary), Gopi Krishna Tummala (Co-Primary), Ganesan Ramalingam, Ramachandran Ramjee and Prasun Sinha, "AutoCalib: Automatic traffic Camera Calibration at Scale," in **Proc. of ACM TOSN** March 2018

Conference Publications.

1. Gopi Krishna Tummala, Tanmoy Das, Prasun Sinha and Rajiv Ramnath "SmartDashCam: Automatic Live Calibration for DashCams", in Proc. Of **ACM IPSN 2019**

2. Romil Bhardwaj (Co-Primary), Gopi Krishna Tummala (Co-Primary), Ganesan Ramalingam, Ramachandran Ramjee and Prasun Sinha, "AutoCalib: Automatic traffic Camera Calibration at Scale," in **Proc. of Buildsys**, Delft, Netherlands, Nov 2017, **Best Paper Award and Best Demo Award**

3. Gopi Krishna Tummala, Dong Li, Prasun Sinha, "Live View of On-Road Vehicular Information", **IEEE SECON 2017**

4. Gopi Krishna Tummala, Dong Li, Prasun Sinha, "RoadMap: Mapping Vehicles to IP Addresses using Motion Signatures", **ACM CarSys 2016**

5. Gopi Krishna Tummala, Istdeo Singh and K Giridhar, Null-Space of Block Convolution Matrix", **In Proc. of IEEE National Conference on Communications**, Delhi, India, Feb [15-17] 2013.

6. Tanmoy Das, Gopi Krishna Tummala and Prasun Sinha, "TagTone: Scalable RFID Communication through Multi-Frequency Analysis", **Proc. of IEEE INFOCOMM-MiSeNet** 2018 **Best Paper Award**

7. Rupam Kundu, Gopi Krishna Tummala and Prasun Sinha CaneScanner: Obstacle Detection for People with Visual Disabilities", in **Proc. of IEEE INFOCOMM- MiSeNet** 2018.

8. Rupam Kundu, Gopi Krishna Tummala and Prasun Sinha "Navigation assistance for Individuals with Visual Impairments in Indoor Environment", **Proc. of IEEE COMSNETS** 2017

9. Gopi Krishna Tummala, Rupam Kundu, Prasun Sinha, Rajiv Ramnath, "Vision-Track: Vision based indoor tracking in anchor-free regions", **Proc. of ACM HotWireless**, New York, Oct 2016

10. Bo Chen, Gopi Krishna Tummala, Yue Qiao and Kannan Srinivasan, "In-band wireless cut-through: Is it possible?", **Proc. of ACM HotWireless**, 2014

Technical Reports

1. Gopi Krishna Tummala, Derrick Cobb, Rajiv Ramnath and Prasun Sinha, Soft-Swipe: Enabling High-Accuracy Pairing of Vehicles to Lanes using COTS Technology", **OSU Tech Report OSU-CISRC-6/17-TR02**

Poster Presentations

1. Rupam Kundu, Gopi Krishna Tummala and Prasun Sinha, Poster: VisualLoc: Vision Based Localization using a single Smart-Bulb.", In **Proc. of ACM BuildSys 2017**

2. Gopi Krishna Tummala, Derrick Cobb, Prasun Sinha and Rajiv Ramnath, "Soft-Swipe: Enabling High-Accuracy Pairing of Vehicles to Lanes using COTS Technology", **ACM CarSys 2016 Poster**

Patents

1. Gopi Krishna Tummala, Derrick Cobb, Prasun Sinha and Rajiv Ramnath, Methods and Apparatus for enabling Mobile communication device based Secure Interaction from Vehicles through Motion Signatures", **U.S. Patent No. 10,032,370**.

2. Tanmoy Das, Gopi Krishna Tummala and Prasun Sinha, Scalable RFID Communication through Multi-Frequency Analysis", Patent Application No. **PCT/US18/58167.**

3. Ganesan Ramalingam, Ramjee Ramachandran, Romil Bharadwaj and Gopi Krishna Tummala "Automatic Camera Calibration.", **U.S. Patent Application No. 15/946,731.**

Teaching

1. Lecturer for Introduction to Computer Programing in Java [Spring-2014], [Fall-2014, 2015]. Responsible for course content development, teaching lectures and conducting lab sessions, discussions etc.
2. Grader for Introduction to Low-Level Programming and Computer Organization [Fall-2013].
3. Grader for The UNIX Programming Environment [Fall-2013].

Technical Skills

1. Python, C++, Java, C, SQL, PHP, Shell/Bash, HTML/CSS

2. OpenCV, ROS, TensorFlow, MATLAB, GNU Radio, NS3, Arduino, SUMO, Wireshark, Android

Honors

1. IEEE MiSeNet 2018-best paper award

2. ACM BuildSys 2017 best paper award

3. ACM BuildSys 2017 best demo award

4. NSF Travel award to attend ACM SenSys/BuildSys 2018

5. NSF Travel award to attend IEEE SECON 2017

6. Received 40% share of royalty awarded by Honda North America.

7. IIT Madras Merit cum Means (MCM) Scholarship Award.

8. All India Rank 274 among 4 lakh applicants in the highly competitive IIT-JEE.

9. Top 200 (top 1%) in the nation in NSEP (Physics Olympiad).

10. Top 200 (top 1%) in the nation in AMTI (Maths Olympiad).

11. KKR Educational Intuitions Merit Scholarship, top 50 of the state Andhra Pradesh, India.

Academic and Volunteer activities.

1. Reviewer for IEEE/ACM Transactions on Sensor Network (TOSN) journal

2. Reviewer for IEEE/ACM Transactions on Mobile Computing (TMC) journal

3. Paper Management System Administrator for IEEE SECON 2016

4. Mess Secretary, IIT Madras 2010-2011.

5. Equipment Coordinator for SHASTRA, IIT Madras annual TechFest.

Research Projects

1. [**2019 to Now**] Designing reinforcement learning based algorithms behavior planning and prediction of Autonomous vehicles.

    a. Designed algorithms for Behavior Prediction (both intention and trajectory prediction) of vehicles.

    b. Designed simulation platform for developing Behavior Planning and

Prediction algorithms.

   c. Designed a framework for analyzing the driving behavior by selectively aggregating the driving events.

   d. Developed algorithms which are responsible for yielding to the cut-in vehicles for Autonomous vehicles.

2. [**2013 to 2018**] Advancing Vehicular Navigation and Manufacturing by Exploring Location services. (Supervised by Dr. Prasun Sinha and Dr. Rajiv Ramnath, The Ohio State University).

   a. Designed a system *DashCalib* for hands-free Dashboard camera calibration.

   b. Designed a system *VMaps* for generating Local Vehicular Neighborhood Map with Frequency-Pair Analysis.

   c. Designed a system *Soft-Swipe* for Enabling High-Accuracy Pairing of Vehicles to Lanes using COTS Technology. (Patent bought by Honda)

   d. Designed a system *RoadView* for viewing the Road Ahead through Collaboration of vehicles and improves vehicles sensed by a factor of 1.8x.

   e. Designed a system *RoadMap* for mapping vehicles observed over a dashboard camera to respective IP-Addresses.

3. [**Summer of 2018**] Behavior planning and prediction research for Autonomous vehicles (Supervised by Dr. Ahmed Sadek, Mr. Arunandan Sharma and De. Feng Han Qualcomm Research, San Diego, CA).
   a. Developed different concepts to evaluate the behavior of Autonomous vehicles.
   b. Developed a VIRES Virtual Test Drive (VTD) based autonomous vehicle simulator to pipeline testing of different behavior planning and prediction algorithms.

   c. Designed calibration error, sensors fusion noise models based on several real-world driving runs of Qualcomm autonomous vehicle.

4. [**2016 to 2017**] Designing Automatic Traffic Camera calibration techniques. (Supervised by Dr. Ramjee Ramachandran, Dr. Ganesan Ramalingam and Dr. Prasun Sinha, Microsoft Research, India)

   a. Designed a scalable system AutoCalib for hands-free traffic camera calibration with speed estimation errors of <10%

5. [**2016 to 2017**] Indoor Navigation and sensing solutions for People with Visual Disabilities. (Supervised by Dr. Prasun Sinha The Ohio State University)

   a. Designing a system CaneScanner for low powered object detection using smart white canes.

    b. Designed a system Vision-Track for accurate Indoor tracking of a moving camera with < 3% tracking errors.
6. [**2013 to 2014**] Implementation and Evaluation of Wireless cutthrough routing. (Supervised by Dr. Kannan Srinivasan, The Ohio State University, USA)

    a. Implemented Full-Duplex analog and digital cancellation modules on NI PXI.

    b. Designed a large-scale wireless network simulator for testing different routing algorithms based on real world channel traces and interference models.

7. [**2011 to 2013**] Efficient algorithms for computing Null space of Block Convolution Matrix. (Supervised by Dr. K. Giridhar Department of Electrical Engineering, IIT Madras, India)

    a. Designed efficient algorithms for computing Null-Space of MIMO-OFDM channel matrix (block convolution matrix) exploiting its special structure.

    b. Reduced matrix inversion run-time complexity from cubic order to linear.

8. [**2011 to 2012**] Run-time optimization for LTE Downlink (PDCCH) blind decoding problem (Supervised by Mr. Pradeep J. R, Tata Elxsi, Chennai, India)

    a. Surveyed LTE protocols and identified the bottleneck runtime problems for the LTE stack.

    b. Designed optimal run-time algorithms for Downlink Control Channel (PDCCH) blind search and DCI coding problem (carrier aggregation problem).