Ding Zhao | Curriculum Vitae

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Professional Interests

My research develops tools to test the performance of intelligent physical systems and learn their **capabilities and limitations** in support of persistent and long-term autonomy and human-machine interactions. Mathematically, it requires designing **learning** approaches to estimate and predict rare events (failure) by modeling the **high dimension** operational environment from **big data** and creating efficient sampling algorithms. Particularly, I want to use my knowledge to thrive the **smart cities** with new mobility service leading to an **automated, connected, shared, and green transportation**. The vehicular knowledge (i.e., safety, energy, emissions, design, cybersecurity) gained can also be applied to many other types of robots. The three pillars of my research include

- **Design and test theories** of intelligent physical systems
- **Modeling and evaluation approaches** of high dimension, stochastic, and dynamic data
- **Implementation techniques** of robots in real-time, simulated, and mixed reality environment

Education

University of Michigan **Ann Arbor**
Ph.D. in the Department of Mechanical Engineering *2011–2016*
Faculty advisor: Prof. Huei Peng
Dissertation Title: "Accelerated Evaluation of Automated Vehicles"

Jilin University **Changchun, China**
Bachelor (Summa Cum Laude) in the Department of Automotive Engineering *2006–2010*
Faculty advisor: Prof. Hsin Guan
Thesis Title: "Design a Full-Size Four-wheel-steering and Four-wheel-drive Vehicle"

Academic and Industrial Experience

Dec 2017 – Present	**Visiting Scholar**, Stanford University, Host: Prof. Peter Glynn
Oct 2017 – Present	**Assistant Research Scientist**, Michigan Institute for Data Science
Jun 2017 – Present	**Assistant Research Scientist**, Robotics Institute, University of Michigan
May 2017 – Present	**Assistant Research Scientist**, Mechanical Engineering, University of Michigan
2016 – 2017	**Research Fellow**, University of Michigan Transportation Research Institute
2011 – 2016	**Research Assistant**, Mechanical Engineering, University of Michigan
May 2012 – Dec 2012 (8 months)	**Design Engineer (Intern)**, Research and Innovation Center, Ford Motor, Dearborn, MI

Funded Research Projects

My funding mainly comes from automotive industry and the federal government. The following tables list the ongoing or accomplished projects. **I wrote the first proposal drafts for seven out of the eight projects I led as PI or Co-PI and got $1.5 million funding under my name.** I also have a few proposals currently under review at NSF, Ford, and Toyota as the PI.

Table I Projects led by me as PI or Co-PI

Sponsor	Dates	Role	Project title	Budget
Toyota Research Institute	1/1/18-12/31/19	PI	Extracting Traffic Primitives from Millions of Naturalistic Driving Encounters – A Synthesized Method based on Nonparametric Bayesian and Deep Unsupervised Learning	$254,593
Denso	10/1/17-9/30/19	Sole PI	A unified, auto-checking, and self-analyzing data platform for intelligent driving applications	$198,445
DOE[1]	3/1/17-2/28/20	Project Manager	Integrated power and thermal management for connected and automated vehicles through real-time adaptation and optimization	$1,600,000
SFMotor	1/1/17-5/10/18	PI	Platform construction and basic function developments for autonomous vehicle	$150,000
Mcity	5/1/16-12/31/17	PI	Development of evaluation approaches and the certificate system for automated vehicles based on the accelerated evaluation	$200,000
SAIC[2]	6/1/17-12/31/17	Co-PI	Methodology on Connected and Automated Vehicles Testing and Evaluation based on Accelerated Evaluation Theory	$118,316
Toyota Research Institute	3/1/17-2/28/19	Co-PI	Development of a "primary other test vehicle" for the testing and evaluation of high-level automated vehicles	$723,748
Mcity	5/1/16-12/31/17	Co-PI	Towards centimeter accurate localization using low cost GPS: algorithms for data fusing within V2X networks	$200,000
Accomplished Projects				
Denso	9/1/16-8/31/17	Co-PI	Development of a simulation tool for AV testing and evaluation	$83,300
				$3,528,402

Table II Projects conducted by me as Research Fellow (RF) or Research Assistant (RA)

Sponsor	Dates	Role	Project title	Budget
Ford	5/1/16-8/31/18	RF	Accelerated evaluation of automated vehicles	$200,000
Toyota	5/1/16-12/31/16	RF	Crash avoidance systems safety evaluation of an important class of electronic control systems	$3,000,000
MTRAC[3]	9/1/14-8/31/15	RA	Computationally efficient and robust design codes for power-split hybrid powertrains	$20,000
NIOSH[4]	5/1/16-12/31/17	RA	Evaluation of commercial vehicle active safety systems and their effect on truck driver behaviors	$60,000
Ford	6/1/17-12/31/17	RA	A portable brake control and diagnosis system for stopping distance reduction and braking efficiency assessment	$200,000
				$3,480,000

[1] DOE: The United States Department of Energy

[2] SAIC: Shanghai Automotive Industry Corporation

[3] MTRAC: Michigan Translational Research and Commercialization

[4] NIOSH: National Institute for Occupational Safety and Health

Publication

Journal Papers (In Review)

** Corresponding authors.*

[J19] D. Yang*, J. Kun*, **D. Zhao***, C. Yu, C. Zhong, S. Xie, Z. Xiao, X. Jiao, S. Wang, K. Zhang, "Intelligent and Connected Vehicles: Current Status and Future Perspectives", *Science China, Technological Sciences*, **(invited paper)**, 2017.

[J18] W. Wang, **D. Zhao***, "Extracting Traffic Primitives Directly from Naturalistically Logged Data for Self-Driving Applications," *IEEE Robotics and Automation Letters*, 2017.

[J17] W. Wang, J. Xi, **D. Zhao***, "Driving Style Analysis Using Primitive Driving Patterns With Bayesian Nonparametric Approaches," *IEEE Transactions on Intelligent Transportation Systems*, 2017.

[J16] W. Wang, J. Xi*, J. K. Hedrick, **D. Zhao***, "Learning-Based Personalized Driver Model Using Bounded Generalized Gaussian Mixture Method," *IEEE Transactions on Cybernetics*, 2017.

[J15] M. Shen, J. Sun, H. Peng, **D. Zhao***, "Improving Localization Accuracy in Connected Vehicle Networks Using Rao-Blackwellized Particle Filters: Theory, Simulations, and Experiments," *IEEE Transactions on Intelligent Transportation Systems*, 2017.

[J14] W. Wang, J. Xi*, W. Han, **D. Zhao***, "A Learning-Based Approach for Lane Departure Warning Systems with a Personalized Driver Model," *IEEE Transactions on Vehicular Technology*, 2017.

[J13] W. Wang, J. Xi*, J. K. Hedrick, **D. Zhao***, "Learning and Inferring a Driver's Brake Action in Car-Following Scenarios," *IEEE Transactions on Vehicular Technology*, 2017.

[J12] **D. Zhao***, M. Shen, Y. Guo, B. Chen, W. Wang, "On Modeling Pedestrian Crossing and Its Application in Automated Vehicle Testing", *IEEE Transactions on Intelligent Vehicle*, 2017.

Journal Papers (Accepted)

[J11] W. Wang, **D. Zhao***, "Evaluation of Lane Departure Correction Systems Using a Stochastic Driver Model," *IEEE Transactions on Intelligent Vehicle*, 2017.

[J10] M. Shen, J. Sun, **D. Zhao***, "The Impact of Road Configuration in V2V-based Cooperative Localization: Mathematical Analysis and Real-world Evaluation," *IEEE Transactions on Intelligent Transportation Systems*, 2017.

[J9] Z. Huang, H. Lam, D. J. LeBlanc, **D. Zhao***, "Accelerated Evaluation of Automated Vehicles using Piecewise Mixture Models," *IEEE Transactions on Intelligent Transportation Systems*, 2017.

[J8] W. Wang, C. Liu, **D. Zhao***, "How Much Data is Enough? - A Statistical Approach with Case Study on Longitudinal Driving Behavior," *IEEE Transactions on Intelligent Vehicle*, 2017.

[J7] X. Huang*, **D. Zhao**, H. Peng, "Empirical Study of DSRC Performance Based on Safety Pilot Model Deployment Data," *IEEE Transactions on Intelligent Transportation Systems*, 2017.

[J6] **D. Zhao***, X. Huang, H. Peng, H. Lam, D. J. LeBlanc, "Accelerated Evaluation of Automated

Vehicles in Car-Following Maneuvers," *IEEE Transactions on Intelligent Transportation Systems*, 2017.

[J5] **D. Zhao***, H. Lam, H. Peng, D. J. LeBlanc, S. Bao, K. Nobukawa, C. S. Pan, "Accelerated Evaluation of Automated Vehicles Safety in Lane-Change Scenarios Based on Importance Sampling Techniques," *IEEE Transactions on Intelligent Transportation Systems*, vol. 18, no. 3, pp. 595-607, March 2017.

[J4] W. Zhuang*, X. Zhang, **D. Zhao**, H. Peng, L. Wang, "Optimal Design of Three-planetary-gear Power-split Hybrid Powertrains," *International Journal of Automotive Technology*, vol. 17, no. 2, pp. 299-309, Apr. 2016.

[J3] K. Nobukawa*, S. Bao, D. J. LeBlanc, **D. Zhao**, H. Peng, C. S. Pan, "Gap Acceptance During Lane Changes by Large-Truck Drivers - An Image-Based Analysis," *IEEE Transactions on Intelligent Transportation Systems*, vol. 17, no. 3, Mar. 2016.

[J2] **D. Zhao***, W. Cui, H. Sun, "The Design and Analysis of Integrated-wheel Drive and Electric Steering Vehicle Traveling mechanism," *Science Technology and Engineering*, vol. 10, no. 19, pp. 4687-4692, 2010.

[J1] J. Li*, **D. Zhao**, L. Zhu, J. Liu, "Matching of Velocity Threshold for Vehicle Driving Fuel Economy Control Strategy," *Journal of Jilin University (Engineering and Technology Edition)*, vol. 40, no. 02, pp. 0320-0323, 2010.

Conferences Papers (In Review)

[C20] Z. Huang, Y. Guo, H. Lam, **D. Zhao***, "A Versatile Approach for the Evaluation and Testing of Automated Vehicles based on Kernel Methods," *American Control Conference (**ACC**)*, June 27-29, Milwaukee, 2018.

[C19] M. Shen, H. Zhao, J. Sun, **D. Zhao***, "Semi-Interpenetrating Cooperative Localization in Connected Vehicle Networks," *IEEE International Conference on Robotics and Automation (**ICRA**)*, Brisbane, May 21-25, 2018.

[C18] Y. Guo, Z. Su, D. Berenson, **D. Zhao***, "Kinodynamic-based Aggressive Trajectory Planner For Narrow Passage," *IEEE International Conference on Robotics and Automation (**ICRA**)*, Brisbane, May 21-25, 2018.

Conferences Papers (Accepted)

[C17] **D. Zhao***, Y. Guo, Y. J. Jia, "TrafficNet: An Open Naturalistic Driving Scenario Library," *Proceedings of the IEEE 20th International Intelligent Transportation Systems Conference (**ITSC**)*, Yokohama, Japan, October 16-19, 2017.

[C16] Z. Huang, H. Lam, **D. Zhao***, "Learning the Performances of Intelligent Vehicles with Gaussian Mixture and Monotonicity Information," *Proceedings of the IEEE 20th International Intelligent Transportation Systems Conference (**ITSC**)*, Yokohama, Japan, October 16-19, 2017.

[C15] Z. Huang, H. Lam, **D. Zhao***, "Towards Affordable On-track Testing for Autonomous Vehicle - A Kriging-based Statistical Approach," *Proceedings of the IEEE 20th International Intelligent Transportation Systems Conference (**ITSC**)*, Yokohama, Japan, October 16-19, 2017.

[C14] M. Shen, Jin Sun, **D. Zhao***, "Optimization of Vehicle Connections in V2V-based Cooperative Localization," *Proceedings of the IEEE 20th International Intelligent Transportation Systems*

*Conference (**ITSC**)*, Yokohama, Japan, October 16-19, 2017.

[C13] Z. Huang*, H. Lam, **D. Zhao**, "Sequential Experimentation to Evaluate Automated Vehicles," *Winter Simulation Conference (**WSC**)*, Las Vegas, U.S.A., December 3-6, 2017.

[C12] X. Wang, **D. Zhao***, H. Peng, D. J. LeBlanc, "Analysis and Modeling of Unprotected Intersection Left-Turn Conflicts based on Naturalistic Driving Data," *IEEE Intelligent Vehicle Symposium (**IV**)*, Redondo Beach, U.S.A., June 11-14, 2017.

[C11] **D. Zhao***, W. Wang, D. J. LeBlanc, "Evaluation of Semi-autonomous Lane Departure Assistant System with Naturalistic Driving Data," *IEEE Intelligent Vehicle Symposium (**IV**)*, Redondo Beach, U.S.A., June 11-14, 2017.

[C10] Y. J. Jia, **D. Zhao***, Qi A. Chen, Z. M. Mao, "Towards Secure and Safe Appified Automated Vehicles," *IEEE Intelligent Vehicle Symposium (**IV**)*, Redondo Beach, U.S.A., June 11-14, 2017.

[C9] B. Chen, **D. Zhao***, H. Peng, "Evaluation of Automated Vehicles Encountering Pedestrians at Unsignalized Crossings," *IEEE Intelligent Vehicle Symposium (**IV**)*, Redondo Beach, U.S.A., June 11-14, 2017.

[C8] M. Shen, **D. Zhao***, J. Sun, "Effect of Road Configurations on GNSS-based Cooperative Localization Using Map Matching," *IEEE 85th Vehicular Technology Conference (**VTC**)*, Sydney, Australia, June 4-7, 2017.

[C7] Z. Huang, **D. Zhao***, H. Lam, D. J. LeBlanc, H. Peng, 'Evaluation of Automated Vehicles in the Frontal Cut-in Scenario - an Enhanced Approach using Piecewise Mixture Model," *IEEE International Conference on Robotics and Automation (**ICRA**)*, Singapore, May 29-June 3, 2017.

[C6] W. Wang, **D. Zhao**, J. Xi*, D. J. LeBlanc, J. K. Hedrick, "Development and Evaluation of Two Learning-Based Personalized Driver Models for Car-Following Behaviors," *American Control Conference (**ACC**)*, Seattle, U.S.A., May 24-26, 2017.

[C5] M. Shen, **D. Zhao***, J. Sun, "Enhancement of Low-cost GNSS Localization in Connected Vehicle Networks using Rao-Blackwellized Particle Filters," *Proceedings of the IEEE 19th International Intelligent Transportation Systems Conference (**ITSC**)*, Rio de Janeiro, Brazil, Nov 1-4, 2016.

[C4] **D. Zhao***, H. Peng, H. Lam, S. Bao, K. Nobukawa, D. J. LeBlanc, C. S. Pan, "Accelerated Evaluation of Automated Vehicles in Lane Change Scenarios," in *Proceedings of the ASME 2015 Dynamic Systems and Control Conference (**DSCC**)*, Columbus, U.S.A., Oct 28-30, 2015.

[C3] **D. Zhao***, H. Peng, S. Bao, K. Nobukawa, D. J. LeBlanc, C. S. Pan, "Accelerated Evaluation of Automated Vehicles using Extracted Naturalistic Driving Data," *Proceedings of the 24th Symposium of the International Association for Vehicle System Dynamics (**IAVSD**)*, Graz, Austria, August 17-21, 2015.

[C2] **D. Zhao***, H. Peng, K. Nobukawa, S. Bao, D. J. LeBlanc, C. S. Pan, "Analysis of Mandatory and Discretionary Lane Change Behaviors for Heavy Trucks," in *the 14th International Symposium on Advanced Vehicle Control (**AVEC**)*, Tokyo, Japan, September 22-26, 2014.

[C1] **D. Zhao***, H. Sun, and W. Cui, "Research on the Platform Design and Control System for the Wheel-side Steering-driving Coordination Vehicle," in *the 2010 IEEE International Conference on Mechatronics and Automation (**ICMA**)*, Xi'an, China, August 4-7, 2010.

Patents/Inventions

[P7] "Blue Hybrid Software" (45% contribution, under review).

[P6] CN 101973307 B, Main pin zero bias wire-controlled independent driven and steering automobile running mechanism and electric vehicle.

[P5] CN 201842130 U, Electromobile and drive-by-wire independent driving and steering automobile traveling mechanism with zero-offset master pin.

[P4] CN 101648573 B, Automobile traveling mechanism with wheel hub comprehensively drive and turning.

[P3] CN 201494493 U, Vehicle walking mechanism with wheel edge combination driving and steering.

[P2] CN 201198869 Y, Bidirectional bearing.

[P1] CN201187538 Y, Sliding clutch.

Invited Talks

University of California, Berkeley - Mechanical Engineering **Berkeley, USA**
"Statistically Certified Test Approaches for Intelligent Physical Systems" *11/21/2017*

Stanford University, - Stanford Intelligent Systems Laboratory (SISL) **Palo Alto, USA**
"Learning Methods of Rare Events and Its Application on Autonomous Evaluation" *11/20/2017*

Detroit Chinese Engineers Association **Troy, USA**
"Testing and Evaluation of Automated Vehicles" *11/12/2017*

The 24th World Congress on Intelligent Transport Systems **Montreal, Canada**
"Using Traffic Data to Build a Safer and Smarter Transportation" *11/2/2017*

China Automotive Technology and Research Center **Tianjin, China**
"Using Traffic Data to Build a Safer and Smarter Transportation" *10/20/2017*

National Intelligent Vehicles and Smart Transportation Demo Zone **Beijing, China**
"Virtual Testing, On-Road Testing, and Mixed Reality Testing" *10/20/2017*

Uber **Pittsburgh, USA**
"Accelerated Evaluation Methods" *8/12/2017*

GM **Webex**
"Modeling Simulation Environment for the Development and Testing of Automated Vehicles" *8/11/2017*

GM **Webex**
"Towards Zero Crash - The Modern Testing of AVs" *7/29/2017*

Mcity **Ann Arbor, USA**
"White Paper on Accelerated Evaluation" *7/17/2017*

China Academy of Telecommunication Research **Beijing, China**
"Development of Test Scenarios for Connected and Automated Vehicles - Our Work at Mcity" *5/17/2017*

Tongji University **Shanghai, China**
"Learning the Limitations of Intelligent Agents - a New Accelerated Evaluation Approach" *4/28/2017*

Shanghai Automotive Industry Corporation **Shanghai, China**
"Accelerated Evaluation, Big Naturalistic Driving Data, and How They Work Together for AV Testing" *4/29/2017*

University of Michigan Transportation Institute **Ann Arbor, USA**
"OpenCAV: an Open Collaborative Platform for Connected and Autonomous Vehicle Research" *4/14/2017*

Lawrence Berkeley National Laboratory **Berkeley, USA**
"Building Trust in Connected and Automated Vehicles" *1/12/2017*

Tsinghua University **Beijing, China**
"Is an Automated Vehicle Safe? - Evaluation methods of Automated Vehicles" *7/6/2016*

Yutong Bus **Zhengzhou, China**
"Test and Evaluation of Automated Vehicles" *7/5/2016*

Yutong Bus **Zhengzhou, China**
"Cooperative Localization in Connected Vehicle Networks" *7/5/2016*

Baidu **Beijing, China**
"Testing Highly Intelligent Vehicles" *7/1/2016*

University of California, Berkeley - Civil Engineering **Berkeley, USA**
"Accelerated Evaluation based on Importance Sampling Theory" *5/18/2016*

Awards

- Best poster awards, 2nd place in UMTRI Transportation Safety Research Symposium, 2015
- Fellowship Award, Mechanical Engineering, University of Michigan, Ann Arbor, 2011
- Summa Cum Laude (0.034%), highest honor among 40,000 undergraduate students in Jilin University, 2010
- Honor Student of Changchun City, Changchun city Government, China, 2010
- The Red Flag Scholarship, First Automobile Works Group Corporation, 2010
- National Scholarship, the Ministry of Education of the P.R. of China, 2010
- National Scholarship, the Ministry of Education of the P.R. of China, 2009
- Academic Research Star, Jilin University, 2009
- National Innovation Funds (highest level), "Analysis of dynamics for the next generation electric vehicle", Ministry of Education of the People's Republic of China, 2009
- National Innovation Funds (highest level), "Study on the fuel consumption of a new type of clutch", Ministry of Education of the People's Republic of China, 2007
- 8^{th} place in the National Formula SAE competition, Society of Automotive Engineers, 2011.
- 3^{rd} place in the National Honda Energy-Saving Sports Tournament, Honda, 2008.

- 3rd place in the National Honda Energy-Saving Sports Tournament, Honda, 2007.

Dissertation Committees (Ph.D.)

- [Proposal] Yunhan Jack Jia, "Securing Modern Appified Platform through Systematic Program Analysis and Design", Department of Electrical Engineering and Computer Sciences, University of Michigan, November 2017
- Zhiyuan Huang, "Learning-based Robust Optimization for Data Integration in Optimization under Uncertainty", Department of Industrial and Operations Engineering, University of Michigan

Professional Activities

Committees and Panels Membership:

- **Technical Program Committee** **Dynamic Systems and Control Conference, 2016**
  ASME Committee on Automotive and Transportation Systems
  IEEE Committee on Automotive Controls of the Control Systems Society
- **Technical Program Committee** **American Control Conference, 2017**
  ASME Committee on Automotive and Transportation Systems
  IEEE Committee on Automotive Controls of the Control Systems Society

Reviewer for the Following Journals and Conferences:

- IEEE Transaction on Intelligent Transportation Systems
- IEEE Transaction on Vehicular Technologies
- IEEE Transaction on Intelligent Vehicles
- IEEE Transaction on Industrial Electronics
- IEEE Transaction on Industrial Informatics
- IEEE Transaction on Human-Machine Systems
- IEEE Vehicular Technology Magazine
- IEEE Sensors Journal
- IEEE Intelligent Transportation Systems Conference
- IEEE Vehicular Technology Conference
- IEEE Intelligent Vehicle Symposium
- IET Intelligent Transport Systems
- International Journal of Vehicle Design
- Transportation Research Part C
- Applied Energy

- Traffic Injury Prevention
- Mechatronics
- Simulation Modeling Practice and Theory
- Simulation Modelling Practice and Theory
- ASME Validation and Verification Symposium
- SAE International

Teaching and Mentorship

Current Group Members:

Postdoc

- Xun Gong, @ME

Ph.D. Students, Co-supervised

- Zhiyuan Huang, @IOE, with Henry Lam
- Xinpeng Wang, @ME, with Huei Peng
- Yunhan Jack Jia, @CS, with Morley Mao
- Songan Zhang, @ME, with Huei Peng

Master Research Assistants | Independent Study

- Yaohui Guo, @Robo
- Kai Jia, @Robo
- Zhaolun Su, @CS
- Ping Yu, @EE
- Xiaoshu Liu, @EE
- Huajing Zhao, @ME
- Jiacheng Zhu, @ME
- Xinzhi Fan, @Robo
- Sisi Li, @Robo
- Mansur Maturidi Arief, @IOE
- Aditya Ramesh, @EE
- Ashish Sajwan, Auto@ME
- Weilun Peng, @ME

Visiting Students

- Zhaobin Mo, Undergrad@Auto-Tsinghua
- Zhong Cao, PHD@Auto-Tsinghua
- Wenshuo Wang, PhD@ME-BIT
- Junjie Chen, PhD@Electronic and Information Engineering-Beijing Jiaotong Univ

Previous Group Members:

Macheng Shen, Master@UM $\rightarrow$ PhD@MIT
Xinpeng Wang, Undergrad@Tsinghua $\rightarrow$ PhD@UM