Zishen Wan

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RESEARCH INTERESTS

Research Areas: Computer Architecture, VLSI, Autonomous Machine, EDA, Embedded System
Research Vision: My research is at the intersection of VLSI, computer architecture, and embedded systems. I build hardware and system for autonomous machines and edge intelligence through cross-stack software-hardware co-design, with the vision to advance their performance, efficiency, resilience, and robustness.

EDUCATION

2020-2025 (Expected) **Georgia Institute of Technology, Atlanta, GA, USA**
Ph.D., School of Electrical and Computer Engineering (ECE)
- *Advisor:* Prof. Arijit Raychowdhury
- *Research Topic:* Efficient and Reliable Hardware and System Design for Edge Intelligence
- *GPA:* 4.0/4.0

2018-2020 **Harvard University, Cambridge, MA, USA**
M.S., School of Engineering and Applied Science (SEAS)
- *Advisor:* Prof. Vijay Janapa Reddi
- *Research Topic:* Reliability and Design Automation of Autonomous Machines
- *GPA:* 3.95/4

2014-2018 **Harbin Institute of Technology (HIT), Harbin, China**
B.E. with High Honors, Department of Electrical Engineering (EE)
- *GPA:* 93.5/100 (Rank: 2/230)

PERFESSIONAL EXPERIENCE

2020- **Georgia Institute of Technology, Atlanta, GA, USA**
Graduate Research Assistant

2018-2020 **Harvard University, Cambridge, MA, USA**
Graduate Research Assistant

2018 **Massachusetts Institute of Technology, Cambridge, MA, USA**
Graduate Research Assistant

2016-2018 **Harbin Institute of Technology, Harbin, China**
Undergraduate Research Assistant

2017 **National Tsing-Hua University, Hsinchu, Taiwan**
Visiting Student

2017 **National Chiao-Tung University, Hsinchu, Taiwan**
Visiting Student

SELECTED AWARDS AND HONORS

2023 **Roger P. Webb Graduate Research Assistant Excellence Award**, Georgia Tech
Recognition of Graduate Research Assistant (GRA) who have demonstrated excellent research performance. 2-4 students each year in Georgia Tech School of ECE.

2023 **IEEE Micro Top Picks**, Honorable Mention
Recognition of "the most significant research papers in computer architecture based on novelty and potential for long-term impact, published in the top computer architecture conferences of 2022"

2022 **1st Place, ACM/SIGBED Student Research Competition**
Ranked 1st of 30 participants in ACM student research competition at Embedded Systems Week (ESWEEK), will represent SIGBED to compete in ACM Grand Finals.

2022 **3rd Place, ACM/SIGDA Student Research Competition** (declined)
Ranked 3rd of 40 participants in ACM student research competition at International Conference on Computer-Aided Design (ICCAD).

2022 **Qualcomm Fellowship**

2022 **Young Fellow**, ACM/IEEE Design Autonomation Conference **(DAC)**

2022 **CRNCH PhD Fellowship**, Center for Novel Computing Hierarchies, Georgia Tech
2-4 graduate students each year in Georgia Tech College of Engineering and College of Computing

2021 **Best Research Video Award**, DAC Young Fellow Program
25 winners out of ~200 DAC young fellow students

2021 **Young Fellow**, ACM/IEEE Design Autonomation Conference **(DAC)**

2021 **4th Place**, ACM Student Research Competition at International Conference on Computer-Aided Design **(ICCAD)**

2020 **Best Paper Award** in IEEE Computer Architecture Letter **(CAL)**
Paper ranked highest among 42 accepted papers that year

2020 **Best Paper Award** in ACM/IEEE Design Autonomation Conference **(DAC)**
Paper ranked highest among 228 accepted papers out of 984 submissions that year

2020 **Dean's Fellowship**, Purdue University
2 winners out of over 1600 worldwide applicants, declined

2018 **Chiang Chen Overseas Graduate Scholarship**
10 of all undergraduates and graduates in China, $50,000/person

2018 **Best Undergraduate Thesis Award**, HIT
100 winners out of ~4000 thesis submissions

2018 **First Class** of *Chunhui* Innovation Achievement Award
3 of all undergraduates in HIT, highest student academic honor in HIT

2018 **China Telecom Scholarship**
5 of all undergraduates and graduates in HIT

2018 **Outstanding Graduates**, HIT
Top 1% of all undergraduates

2017 **Innovation and Entrepreneurship Scholarship**, Ministry of Industry and Information, China

2016 **First Prize**, National Undergraduate Mathematical Contest in Modeling, China
Team leader, 294 winners out of ~32000 teams, ranked highest among ~600 HIT teams

2016 **Siemens Academic Scholarship**
30 of all undergraduates and graduates in HIT

2016 **Outstanding Student** of Heilongjiang Province, China
Top 1% of all undergraduates

2015 **Johnson Electric Academic Scholarship**
15 of all undergraduates and graduates in HIT

2015-2017 **First Class** Academic Excellence Scholarship, HIT

Top 3% of all undergraduates

PUBLICATIONS

(* Indicates Equal Contributions)

Book

Synthesis Lectures on Computer Architecture

"Robotic Computing on FPGAs"
Shaoshan Liu, Zishen Wan, Bo Yu, Yu Wang
In Synthesis Lectures on Computer Architecture (Morgan & Claypool Publishers), pp.1-218, Jun 2021

Conference Publications

DAC 2023

"BERRY: Bit Error Robustness for Energy-Efficient Reinforcement Learning-Based Autonomous Systems"
Zishen Wan, Nandhini Chandramoorthy, Karthik Swaminathan, Pin-Yu Chen, Vijay Janapa Reddi, Arijit Raychowdhury
To appear in ACM/IEEE Design Automation Conference (DAC), July 2023
Acceptance Rate: 23%

DATE 2023

"Real-Time Fully Unsupervised Domain Adaptation for Lane Detection in Autonomous Driving"
Kshitij Bhardwaj, Zishen Wan, Arijit Raychowdhury, Ryan Goldhahn
To appear in Design, Automation and Test in Europe Conference (DATE), March 2023
Acceptance Rate: 24%

DATE 2023

"MAVFI: An End-to-End Fault Analysis Framework with Anomaly Detection and Recovery for Micro Aerial Vehicles"
Yu-Shun Hsiao*, Zishen Wan*, Tianyu Jia, Radhika Ghosal, Abdulrahman Mahmoud Arijit Raychowdhury, David Brooks, Gu-Yeon Wei, Vijay Janapa Reddi (*alphabetical order)
To appear in Design, Automation and Test in Europe Conference (DATE), March 2023
Acceptance Rate: 24%

ISSCC 2023

"A 73.53TOPS/W 14.74TOPS Heterogeneous RRAM In-Memory and SRAM Near-Memory SoC for Hybrid Frame and Event-Based Target Tracking"
Muya Chang*, Ashwin Lele*, Samuel Spetalnick, Brian Crafton, Shota Konna, Zishen Wan, Ashwin Bhat, Win-San Khwa, Yu-der Chih, Meng-Fan Chang, Arijit Raychowdhury
In IEEE International Solid-State Circuits Conference (ISSCC), February 2023
Acceptance Rate: 33% (205/629)

ICCAD 2022

"On Resilience and Robustness of Autonomous Systems"
Zishen Wan, Karthik Swaminathan, Pin-Yu Chen, Nandhini Chandramoorthy, Arijit Raychowdhury
In 41st IEEE/ACM International Conference on Computer-Aided Design (ICCAD), November 2022

MICRO 2022 (Selected as IEEE Micro Top Picks, Honorable Mention)

"Automatic Domain-Specific SoC Design for Autonomous Unmanned Aerial Vehicles"
Srivatsan Krishnan, Zishen Wan, Kshitij Bhardwaj, Paul Whatmough, Aleksandra Faust, Sabrina M. Neuman, Gu-Yeon Wei, David Brooks, Vijay Janapa Reddi
In 55th IEEE/ACM International Symposium on Microarchitecture (MICRO), October 2022
Acceptance Rate: 22% (83/369)

DAC 2022 "Improving Compute In-Memory ECC Reliability with Successive Correction"
Brian Crafton, Zishen Wan, Samuel Spetalnick, Jong-Hyeok Yoon, Wei Wu, Carlos Tokunaga, Vivek De, Arijit Raychowdhury
In 59th ACM/IEEE Design Automation Conference (DAC), July 2022
Acceptance Rate: 23% (231/987)

AICAS 2022 "Robotic Computing on FPGAs: Current Progress, Research Challenges, and Opportunities"
Zishen Wan, Ashwin Lele, Bo Yu, Shaoshan Liu, Yu Wang, Vijay Janapa Reddi, Cong (Callie) Hao, Arijit Raychowdhury
In IEEE International Conference on Artificial Intelligence Circuits and Systems (AICAS), June 2022

ISPASS 2022 "Roofline Model for UAVs: A Bottleneck Analysis Tool for Onboard Compute Characterization of Autonomous Unmanned Aerial Vehicles"
Srivatsan Krishnan, Zishen Wan, Kshitij Bhardwaj, Ninad Jadhav, Aleksandra Faust, Vijay Janapa Reddi
In IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS), June 2022
Acceptance Rate: 29% (24/83)

CICC 2022 "An Energy-Efficient and Runtime-Reconfigurable FPGA-Based Accelerator for Robotic Localization Systems"
Qiang Liu*, Zishen Wan*, Bo Yu*, Weizhuang Liu, Shaoshan Liu, Arijit Raychowdhury
In IEEE Custom Integrated Circuits Conference (CICC), April 2022
Acceptance Rate: 41% (97/235)

DATE 2022 "FRL-FI: Transient Fault Analysis for Federated Reinforcement Learning-Based Navigation Systems"
Zishen Wan, Aqeel Anwar, Abdulrahman Mahmoud, Tianyu Jia, Yu-Shun Hsiao, Vijay Janapa Reddi, Arijit Raychowdhury
In Design, Automation and Test in Europe Conference (DATE), March 2022
Acceptance Rate: 25%

ASP-DAC 2022
(Invited Paper) "Circuit and System Technologies for Energy-Efficient Edge Robotics"
Zishen Wan, Ashwin Lele, Arijit Raychowdhury
In Asia and South Pacific Design Automation Conference (ASP-DAC), January 2022

DAC 2021 "Analyzing and Improving Fault Tolerance of Learning-Based Navigation System"
Zishen Wan, Aqeel Anwar, Yu-Shun Hsiao, Tianyu Jia, Vijay Janapa Reddi, Arijit Raychowdhury
In 58th ACM/IEEE Design Automation Conference (DAC), December 2021
Acceptance Rate: 23%

AICAS 2021 "An Energy-Efficient Quad-Camera Visual System for Autonomous Machines on FPGA Platform"
Zishen Wan*, Yuyang Zhang*, Arijit Raychowdhury, Bo Yu, Yanjun Zhang, Shaoshan Liu
In IEEE International Conference on Artificial Intelligence Circuits and Systems (AICAS), June 2021

AICAS 2021 "iELAS: An ELAS-Based Energy-Efficient Accelerator for Real-Time Stereo Matching on FPGA Platform"

Tian Gao*, Zishen Wan*, Yuyang Zhang, Bo Yu, Yanjun Zhang, Shaoshan Liu, Arijit Raychowdhury
In IEEE International Conference on Artificial Intelligence Circuits and Systems (AICAS), June 2021

DAC 2020 (Best Paper Award) "Algorithm-Hardware Co-Design of Adaptive Floating-Point Encodings for Resilient Deep Learning Inference"
Thierry Tambe, En-Yu Yang, Zishen Wan, Yuntian Deng, Vijay Janapa Reddi, Alexander Rush, David Brooks, Gu-Yeon Wei
In 57th ACM/IEEE Design Automation Conference (DAC), July 2020
Acceptance Rate: 23% (228/984)

Journal Publications

TMLR 2022 "QuaRL: Quantization for Fast and Environmentally Sustainable Reinforcement Learning"
Srivatsan Krishnan*, Max Lam*, Sharad Chitlangian*, Zishen Wan, Gabriel Barth-Maron, Aleksandra Faust, Vijay Janapa Reddi
In Transactions on Machine Learning Research (TMLR), July 2022

CAS-M 2021 "A Survey of FPGA-Based Robotic Computing"
Zishen Wan*, Bo Yu*, Thomas Yuang Li, Jie Tang, Yuhao Zhu, Yu Wang, Arijit Raychowdhury, Shaoshan Liu
In IEEE Circuits and Systems Magazine (CAS-M), June 2021

CAL 2020 (Best Paper Award) "The Sky Is Not the Limit: A Visual Performance Model for Cyber-Physical Co-Design in Autonomous Machines"
Srivatsan Krishnan, Zishen Wan, Kshitij Bhardwaj, Paul Whatmough, Aleksandra Faust, Gu-Yeon Wei, David Brooks, Vijay Janapa Reddi
In IEEE Computer Architecture Letters (CAL), March 2020

JJAP 2019 "Electrically Tunable Temporal Imaging in a Graphene-Based Waveguide"
Peng Xie, Yu Wen, Zishen Wan, Xinyu Wang, Jiarui Liu, Wenqiang Yang, Xiaofeng Li, Yishan Wang
In Japanese Journal of Applied Physics, 58(5):050914, April 2019

Workshop Publications

ICML 2022 "Multi-Task Federated Reinforcement Learning with Adversaries"
Aqeel Anwar, Zishen Wan, Arijit Raychowdhury
In International Conference on Machine Learning (ICML), Adversarial Machine Learning Workshop, July 2022

NVMW 2022 "RRAM-ECC: Improving Reliability of RRAM-Based Compute In-Memory"
Zishen Wan*, Brian Crafton*, Samuel Spetalnick, Jong-Hyeok Yoon, Arijit Raychowdhury
In 13th Annual Non-Volatile Memories Workshop (NVMW), May 2022

ICLR 2021 "ActorQ: Quantization for Actor-Learner Distributed Reinforcement Learning"
Max Lam*, Sharad Chitlangian*, Srivatsan Krishnan*, Zishen Wan, Gabriel Barth-Maron, Aleksandra Faust, Vijay Janapa Reddi
In International Conference on Learning Representations (ICLR), Hardware-Aware Efficient Training Workshop, May 2021

MLSys 2020 "Quantized Reinforcement Learning (QuaRL)"
Srivatsan Krishnan*, Sharad Chitlangian*, Max Lam*, Zishen Wan, Aleksandra Faust, Vijay Janapa Reddi
In Conference on Machine Learning and System (MLSys), Resource-Constrained Machine Learning Workshop, March 2020

Preprints

Preprint 2021 "AutoSoC: Automating Algorithm-SoC Co-design for Aerial Robots"
Srivatsan Krishnan, Thierry Tambe, Zishen Wan, Vijay Janapa Reddi
arXiv preprint arXiv:2109.05683, 2021

Preprint 2019 "Adaptivfloat: A Floating-point Based Data Type for Resilient Deep Learning Inference"
Thierry Tambe, En-yu Yang, Zishen Wan, Yuntian Deng, Vijay Janapa Reddi, Alexander Rush, David Brooks, Gu-Yeon Wei
arXiv preprint arXiv:1909.13271, 2019

SELECTED TALKS

Mar 2023 "Intelligence in Robotic Computing: Exploring Agile Design Flows for Building Efficient and Resilient Autonomous Systems"
At Georgia Tech Efficient and Intelligent Computing (EIC) Lab, Atlanta, GA, USA

Feb 2023 "Intelligence in Robotic Computing: Exploring Agile Design Flows for Building Efficient and Resilient Autonomous Systems"
At CRNCH (Center for Research into Novel Computing Hierarchies) Annual Summit, Atlanta, GA, USA

Nov 2022 "Intelligence in Robotic Computing: Exploring Agile Design Flows for Building Efficient and Resilient Autonomous Systems"
At ACM Student Research Competition (SRC) at ICCAD 2022, San Diego, CA, USA

Nov 2022 "Efficient and Resilient Computing for Autonomous Systems"
At ACM Student Research Competition (SRC) at ESWEEK 2022, virtual

Oct 2022 "Efficient Algorithm-Hardware Co-Design for Robotic Mapping and Localization"
At 5th IBM AI Compute Symposium, IBM T.J. Watson Research Center, Yorktown Heights, NY, USA

Oct 2022 "Efficient Algorithm-Hardware Co-Design for Robotic Mapping and Localization"
At CBRIC (Center for Brain-Inspired Computing) Annual Summit, Purdue University, West Lafayette, IN, USA

Jun 2022 "Reliability of Autonomous Machines – System Perspective"
At COMPSAC Plenary Panel, Torino, Italy (virtual)

Mar 2022 "FPGA-Based Robotic Computing: Current Progress, Challenges, and Opportunities"
Guest Lecture in Georgia Tech ECE8893 (Parallel Programming for FPGAs), Atlanta, GA, USA

Feb 2022 "FPGA-Based Robotic Computing: Current Progress, Challenges, and Opportunities"

At CRNCH (Center for Research into Novel Computing Hierarchies) Annual Summit, Atlanta, GA, USA

Nov 2021 "Efficient and Reliable Computing for Autonomous Machines"
At ACM Student Research Competition (SRC) at ICCAD 2021, virtual

Oct 2021 "Enabling Reliable and Safe Autonomous Systems"
At CBRIC (Center for Brain-Inspired Computing) Annual Summit, Purdue University, West Lafayette, IN, USA (virtual)

Aug 2021 "Analyzing and Improving Resilience of Autonomous Systems - From Hardware Faults Perspective"
At CBRIC (Center for Brain-Inspired Computing) Industry Talk, virtual

RELATED COURSES

GT ECE8893 Parallel Programming for FPGAs
Instructor: Prof. Cong (Callie) Hao

GT ECE6115 Interconnection Networks for High-Performance Systems
Instructor: Prof. Tushar Krishna
Project: SCALE-Sim + Accelergy: Enabling Timing Predictability and Energy Estimation of Systolic CNN-Accelerator

GT ECE6130 Advanced VLSI Systems
Instructor: Prof. Saibal Mukhopadhyay

GT ECE8803 Memory Device Technologies and Applications
Instructor: Prof. Shimeng Yu

GT CS7292 Reliable Computer Architecture
Instructor: Prof. Moinuddin Qureshi
Project: Low-Cost Error Detection and Correction for Compute In-Memory Systems

GT CS6476 Computer Vision
Instructor: Prof. James Hays

Harvard CS246 Advanced Computer Architecture
Instructor: Prof. David Brooks
Project: SoC-DNN Design Space Exploration and Optimization

Harvard CS247r Special Topics in Computer Architecture
Instructor: Prof. David Brooks
Project: Study of Posit Numeric in Speech Recognition Neural Inference

Harvard CS249r (Best Project Award) Edge Computing - Autonomous Machines
Instructor: Prof. Vijay Janapa Reddi
Project: AutoX: Automating Algorithm-SoC Co-Design for Aerial Robots

Harvard ES201 Decision Theory
Instructor: Prof. Demba Ba
Project: Web Traffic Time Series Forecasting

MIT 6.374 (Best Project Award) Analysis and Design of Digital Integrated Circuits
Instructor: Prof. Vivienne Sze
Project: Image Pre-processor for Robust DNN Resistant to Adversarial Attacks

MIT 6.888 Hardware Architecture for Deep Learning
Instructor: Prof. Vivienne Sze & Prof. Joel Emer

MIT 6.867 Machine Learning
Instructor: Prof. Devavrat Shah, Prof. Suvrit Sra, Prof. David Sontag
Project: Generative Model for Human Pose Transferring Between Videos

MENTORSHIP

Fall 2022 Maanas Purushothapu (BS - Georgia Tech), Nishant Sharma (BS - Georgia Tech)
Project: Accelerating Robotic Computing with FPGAs

Spring 2022 Zhenkun Fan (MS - Georgia Tech)
Project: Benchmarking Unsupervised Adaptation on Edge Devices

Spring 2022 Ying-Hao Wei (MS - Georgia Tech)
Project: Reliability Analysis and Improvement of Autonomous Intelligent Systems

Fall 2021 Katarine Emanuela Klitzke (Undergrad - Georgia Tech)
Project: Architectural Analysis and Benchmarking for UAV Navigation Systems

Summer 2020 Prateek Pinisetti (Undergrad - Harvard)
Project: Performance Modeling for Cyber-Physical Co-Design in UAV

ACADEMIC SERVICE

ML Commons ML Commons (MLPerf) Research Working Group
Co-found ML Commons Resilience and Robustness Research Working Group, 2022

DAC IEEE/ACM Design Automation Conference (DAC)
Technical Program Committee, 2023

IEEE T-CAD IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems
Reviewer, 2023

IEEE TBioCAS IEEE Transactions on Biomedical Circuits and Systems
Reviewer, 2023

ISCA IEEE/ACM International Symposium on Computer Architecture (ISCA)
Artifact Evaluation Committee, 2023

MICRO IEEE/ACM International Symposium on Microarchitecture (MICRO)
Artifact Evaluation Committee, 2022

ASPLOS IEEE/ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS)
Artifact Evaluation Committee, 2023
Artifact Evaluation Committee, 2022

IISWC IEEE International Symposium on Workload Characterization (IISWC)
Artifact Evaluation Committee, 2022
Student Volunteer, 2019

NPC IFIP International Conference on Network and Parallel Computing (NPC)
Technical Program Committee, 2022

COMPSAC IEEE Computers, Software & Applications Conference (COMPSAC)
Panelist, 2022

IEEE Entrep. IEEE Entrepreneurship of China Region
Steering Committee, 2023

SKILLS

Programming Python, C/C++, Verilog/SystemVerilog, MATLAB

ML Framework Pytorch, TensorFlow, Keras, Caffe

Tool Virtuoso, Design Compiler, Innovous, Calibre, Vivado, Quartus, OrCAD, MultiSim, Altium Designer, Unreal Engine, AirSim