

Weihong Xu

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RESEARCH INTERESTS

- Algorithm Optimization in Wireless Communication
- Hardware Design for Computing and Communication

EDUCATION

Southeast University

Nanjing, China

M.S. in Information Science and Engineering, expected Jun. 2020

Sept. 2017 - Present

- Advisors: Prof. **Chuan Zhang** and Prof. **Yair Be'ery** from Tel Aviv University, Israel
- Courses: Digital Signal Processing, Fundamentals of Information Theory

Southeast University

Nanjing, China

B.E. in Information Engineering

Sept. 2013 - Jun. 2017

- Overall GPA: 88.1/100
- Thesis: Acceleration of Convolutional Neural Networks based on Fast Algorithms
- Outstanding Bachelor Thesis Award, Advisor: Prof. **Chuan Zhang**
- Courses: Digital Communications, Communication Network, Computer Architecture, Design of ASIC

Engineering School of Information and Digital Technologies

Paris, France

Exchange Student

Sept. 2016 - Feb. 2017

- GPA: 4.0/4.0
- Courses: Network and System Programming, Application with Web Service and C# Environment

RESEARCH EXPERIENCE

Energy-efficient Accelerator Design for Convolutional Neural Network

Southeast University

*Research Assistant, advised by Prof. **Chuan Zhang***

Feb. 2017 - Apr. 2019

- Reduced the computational complexity of convolution layers by 44% on ResNet-50 through exploiting *fast Fermat number transform*.
- Developed low bit-width and logarithm quantization methods to compress CNN models by $5.3\times$ and speed up inference tasks without multiplication.
- Designed and implemented reconfigurable hardware architectures on FPGA, and developed analytical models to optimize the energy consumption of dataflow.
- Related publications: [C2], [C3], [J2]

Deep Learning Methods in Wireless Communication Systems

Southeast University

*Research Assistant, advised by Prof. **Chuan Zhang** and Prof. **Yair Be'ery***

Jun. 2017 - Present

- Applied gradient descent optimizations of deep learning to enhance the error-correction performance of decoder for polar codes.
- Exploited convolutional neural networks to realize channel equalization for the cancellation of *intersymbol interference (ISI)* and non-linear distortion.
- Reduced complexity of *expectation propagation (EP)* MIMO detection for massive antenna arrays by exploiting approximate matrix inversion methods.
- Designed VLSI architectures with high throughput and low latency for MIMO detector and polar decoder, and implemented them on ASIC.
- Related publications: [C1], [C4], [C5], [C6], [J1], [J3], [J4]

PROJECT & INTERNSHIP

Project: Neural Network based Wireless Vision Detection System

Sapporo, Japan

Team Mentor

May 2019

- Designed edge computing systems to realize real-time computer vision applications.
 - Implemented dual-camera sampling and H.264 encoder on FPGA.
 - Implemented 2×2 MIMO transceivers to improve transmit rate.
 - Fine-grained parallelism and multi-thread optimization on GPU.
- Project participated in *2019 IEEE Circuits and Systems Society Student Design Competition*.
 - Won the **1st place** in Asia and Pacific region, and was among the **top 4** teams from worldwide.
 - Link: <https://ieee-cas.org/2018-2019-cass-student-design-competition-world-and-regional-winners>

Flexible MIMO Processor for 5G Systems

Intel Labs China

Research Intern, advised by **Sunny Zhang**

Jun. 2019 - Present

- Developed reconfigurable 5G MIMO processor supporting various detection algorithms.
 - Designed fully pipelined arithmetic modules for *K-best sphere decoding*.
 - Designed systolic array for *minimum mean square error (MMSE)* detection.
 - Developed commercial IP core to automatically generate Verilog code for Intel Quartus FPGA.
 - Conducted simulations and experiments on 5G testbed.

PUBLICATIONS

Conference.....

- [C1] **Weihong Xu**, Zhizhen Wu, Yeong-Luh Ueng, Xiaohu You, and Chuan Zhang. "Improved polar decoder based on deep learning." In *IEEE International Workshop on Signal Processing Systems (SiPS)*, Lorient, France, Oct. 2017.
- [C2] **Weihong Xu**, Xiaohu You, and Chuan Zhang. "Using Fermat number transform to accelerate convolutional neural network." In *IEEE International Conference on ASIC (ASICON)*, Guiyang, China, Oct. 2017.
- [C3] **Weihong Xu**, Zaichen Zhang, Xiaohu You, and Chuan Zhang. "Efficient deep convolutional neural networks accelerator without multiplication and retraining." In *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Calgary, AB, Canada, Apr. 2018.
- [C4] **Weihong Xu**, Zhiwei Zhong, Yair Be'ery, Xiaohu You, and Chuan Zhang. "Joint neural network equalizer and decoder." In *International Symposium on Wireless Communication Systems (ISWCS)*, Lisbon, Portugal, Sept. 2018.
- [C5] **Weihong Xu**, Xiaohu You, Chuan Zhang, and Yair Be'ery. "Polar decoding on sparse graphs with deep learning." In *the 52nd Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, California, USA, Oct. 2018.
- [C6] **Weihong Xu**, Xiaosi Tan, Xiaohu You, Chuan Zhang, and Yair Be'ery. "On the efficient design of neural networks in communication systems." To appear in *the 53rd Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, California, USA, Nov. 2019.

Journal.....

- [J1] **Weihong Xu**, Xiaosi Tan, Yair Be'ery, Zaichen Zhang, Xiaohu You, and Chuan Zhang. "Deep learning-aided belief propagation decoder for polar codes." Under peer review of *IEEE Transactions on Vehicular Technology (TVT)*, 2019.
- [J2] **Weihong Xu**, Zaichen Zhang, Xiaohu You, and Chuan Zhang. "Reconfigurable and low-complexity accelerator for convolutional and generative networks over finite fields." Under revision of *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD)*, 2019.
- [J3] Xiaosi Tan, **Weihong Xu**, Yair Be'ery, Zaichen Zhang, Xiaohu You, and Chuan Zhang. "Improving

massive MIMO message passing detectors with deep neural network." Under revision of *IEEE Transactions on Vehicular Technology (TVT)*, 2019.

[J4] Xiaosi Tan, **Weihong Xu**, Yaping Zhang, Xiaohu You, and Chuan Zhang. "Efficient expectation propagation massive MIMO detector with Neumann-series approximation." To appear in *IEEE Transactions on Circuits and Systems II: Express Briefs*, 2019.

AWARDS & ACHIEVEMENTS

- Travel Grant of IEEE Circuits and Systems Society for Student Design Competition *May 2019*
- Graduate Scholarship in SEU (Top 3% students) *Oct. 2018*
- Outstanding Bachelor Thesis Award in SEU (Top 3% students) *Jun. 2017*
- Second Prize of National Undergraduate Electronic Design Competition *Aug. 2016*
- Honorable Mention in Mathematical Contest in Modeling *2015*

SKILLS & SERVICES

- **Independent Journal Reviewer**
 - IEEE Transactions on Signal Processing *2019*
 - IEEE Transactions on Cognitive Communications and Networking *2019*
- **Programming Languages and Skills**
 - Python, Tensorflow and Pytorch: Simulated and verified error-correction performance of deep learning-aided polar decoder and channel equalizer.
 - C++ and CUDA: Developed belief propagation decoder for polar codes and optimized CNN inference on NVIDIA GPU.
 - Verilog HDL: Implemented polar decoder, massive MIMO detector and CNN accelerator in publication papers and evaluated their performance on FPGA and ASIC platforms.

REFERENCES

Chuan Zhang

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Yair Be'ery

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Sunny Zhang

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