Weihong Xu

Nangong Rd, Nanjing, Jiangsu Province, China, 211111

xuweih0712@gmail.com +86-186-5183-3181 wh-xu.github.io

RESEARCH INTERESTS

- **Algorithm Optimization in Wireless Communication**: Optimizing algorithms for baseband signal processing in next-generation wireless systems, including massive MIMO and forward error-correction.
- **High-speed System for Digital Signal Processing**: Designing and implementing efficient hardware architecture for emerging digital system, including neuromorphic computing and 5G baseband processing.

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**
- 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× 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 *inter-symbol 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 Transac-*

tions 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 (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 optimize CNN inference on NVIDIA GPU.
  - Verilog HDL: Implemented polar decoder, massive MIMO detector and CNN accelerator in publication papers and evaluate their performance on FPGA and ASIC platforms.

REFERENCES

Chuan Zhang
Professor
National Mobile Communications Research Laboratory
Southeast University
Nanjing, China
chzhang@seu.edu.cn

Yair Be'ery
Professor
Department of Electrical Engineering
Tel Aviv University
Ramat Aviv, Israel
ybeery@eng.tau.ac.il

Sunny Zhang
Director
Communication Computing Lab
Intel Labs China
Beijing, China
sunny.zhang@intel.com