

## Education

### Georgia Institute of Technology, Ph.D.

School of Electrical and Computer Engineering

- Graduate Research Assistant, Advisor: Prof. Arijit Raychowdhury
- Research focus: Neuro-symbolic (NS) computer architecture and circuit tape-out.

Atlanta, Georgia, USA

Aug. 2023 - 2028 (expected)

### Zhejiang University, B.Eng.

College of Information Science and Electronic Engineering.

- **3 consecutive** Award of Merits for HongKong, Macau, Taiwan, and Overseas Chinese, 2020<sup>‡</sup>, 2021<sup>\*</sup>, 2022<sup>†</sup>. Ministry of Education, P.R.China.
- Research sponsorship/scholarship from Fellow of IEEE/ACM Prof. X. Sharon Hu, 2022.
- Research scholarship from the University of Notre Dame, IN, USA 2022.
- **First Place**, ACM Student Research Competition at ACM/IEEE Int'l Conference on Computer-Aided Design (ICCAD), 2022.
- **Best presentation award** at ACM/IEEE ESWEK EIC workshop, 2022.
- Third-Class Scholarship for Award of Merits, 2022. Top 25%\*. Issued: Zhejiang University.
- Outstanding student of innovation 2022, academic records 2022, foreign exchange 2022. Top 30% each. Issued: Zhejiang University.

Hangzhou, Zhejiang, P.R.China

Sep.2019 - July 2023 (expected)

## Publications & Patents & Selected Projects

1. **Che-Kai Liu**, H. Chen, M. Imani, K. Ni, A. Kazemi, A. F. Laguna, M. Niemier, X. S. Hu, L. Zhao, C. Zhuo and X. Yin. **COSIME: FeFET based Associative Memory for In-Memory Cosine Similarity Search**. *full paper, Int'l Conference on Computer-Aided Design (ICCAD), 2022. (acceptance rate: 22%)*
2. H. E. Barkam, S. Yun, P. R. Genssler, Z. Zou, **Che-Kai Liu**, H. Amrouch and M. Imani. HDGIM: Hyperdimensional Genome Sequence Matching on Unreliable Highly-Scaled FeFET. *full paper, accepted to IEEE/ACM Design Automation and Test in Europe (DATE), 2023. (acceptance rate: 25%)*
3. **Che-Kai Liu**, H. E. Barkam, Z. Zou, H. Chen, S. Yun, C. Zhuo, X. Yin, H. Najafi and M. Imani. Seamless Integration Sensing with Hyperdimensional Computing. *Submitted to 60th IEEE/ACM Design Automation Conference (DAC), 2023*
4. M. Issa\*, **Che-Kai Liu**\*, S. Yun, H. Chen, X. Yin, A. Roohi, S. Angizi and M. Imani. XSensor: In-Sensor Autoencoder Compression for Compact Information Sensing. **\*: Co-first author**, *Submitted to 53rd Annual IEEE/IFIP International Conference on Dependable Systems and Networks (DSN), 2023.*
5. Z. Xu, C. Li, R. Mao, Z. Yang, **Che-Kai Liu**, M. Imani, C. Zhuo, C. Li and X. Yin. A Reconfigurable Design for In-Memory Nearest Neighbor Search. *Submitted, 2023.*
6. M. Li\*, **Che-Kai Liu**\*, K. Ni, X.S. Hu. A systematic approach for the reconfigurable in-memory device. **\*: Co-first author**, *In prep., 2023.*
7. US Patent/P.R.China Invention Patent, 2022: Compute-in-memory for cosine similarity nearest neighbor search. X. Yin, **Che-Kai Liu**, H. Chen, and C. Zhuo. Pending/No. 202211025181.4
8. P.R.China Invention Patent, 2022: Multi-bit in-memory multiplication and XNOR unit. X. Yin, **Che-Kai Liu**, H. Chen, and C. Zhuo. No. 202210390722.7
9. P.R.China National Research Program, 2021. **Che-Kai Liu**, and H. Chen. Final defense grade: excellent (Top 20%), granted with 12000 CNY.
10. B.Eng. Degree Thesis: **Cross-Layer Optimization for Computing-in-Memory Circuits, Architectures and Applications**. 2023. Advisors: Xunzhao Yin, X. Sharon Hu, Mohsen Imani

## Graduate Research Projects

### Georgia Institute of Technology

Graduate Research Assistant, advisor: Prof. Arijit Raychowdhury

- Hardware acceleration for NS-AI applications.

Remote

Dec. 2022 - June 2023

## Undergraduate Research Experiences

### University of California, Irvine

Visitor, advisor: Prof. Mohsen Imani

- Seamless integration sensing with Hyperdimensional Computing (HDC) (see 3). Efficient in-sensor hardware with autoencoder (see 4). **Contribution:** Conceive project. Design architecture for in-sensor radar/lidar in HDC encoding and inference. Adjusting bit-precision for ADC and investigating application-level behavior. HDC algorithm in Python. Paper write-ups. Autoencoder hardware design's energy/area/latency estimation with C++ DNN-Neurosim. Kernel math write-up. Give a **lecture** for 11 Ph.D.s regarding compute-in-memory (CiM) in the group meeting.
- **Collaboration:** Content addressable memory for genome sequence matching (see 2).

Irvine, California, USA

Aug. 2022 - Dec. 2022 (8-10 **on campus**)

### University of Notre Dame

Visitor, advisor: Prof. X. Sharon Hu

- Reconfigurable FeFET CiM for cosine, dot product, Euclidean, and Manhattan distance (see 6). **Contribution:** Conceive project. Investigate equivalent expressions for nearest neighbor search with Sift/Deep/Glove datasets with self-calibrated Python code. GPU benchmark with *Nvidia-smi* tool. Design space exploration for 22nm FeFET programming scheme by using SPICE and transform the problem into optimization in math. Formulate and solve the optimization problem with Matlab.

Notre Dame, Indiana, USA

Apr. 2022 - Present (6-8 **on campus**)

- COSIME: Invent cosine similarity based in-memory engine using FeFET. (see 1 and 8). **Contribution:** Conceive project. All SPICE simulations, including all Monte Carlo simulations. Neurosim C++ simulation. All small signal circuit analysis. All paper write-up. All patent write-ups.
- Invent multi-bit in-memory multiplication cell (see 9). **Contribution:** Conceive project. All SPICE simulation. All patent write-ups.
- Collaborate (see 5) and mentor National and Provincial Research Programs in the lab.

## Skills & Academic Service & Talks & Interests

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- Skills** SPICE (Cadence Virtuoso), Python (Pytorch), C, Verilog, MATLAB, Assembly (RISC-V)
- Review** IEEE JETCAS x2 (Invited by editors, Prof. S. Yu and Prof. H. Najafi)
- Talks** ACM/IEEE 41<sup>st</sup> ICCAD'22; Student Research Competition@ICCAD'22; ACM/IEEE ESWEK'22 EIC workshop
- Interests** Sports (3 basketball champions; Minister of our sports dept.; 90+hr of volunteering). Travel. Discourse.

## References

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- **Dr. Arijit Raychowdhury**, Steve W. Chaddick School Chair and Professor, Fellow of IEEE.
  - School of Electrical and Computer Engineering, Georgia Institute of Technology.
- **Dr. Mohsen Imani**, Tenure-track Professor.
  - Dept. of Information and Computer Sciences, University of California, Irvine.
- **Dr. Xiaobo Sharon Hu**, Professor, Fellow of IEEE and ACM.
  - Dept. of Computer Science and Engineering, University of Notre Dame.
- **Dr. Xunzhao Yin**, Tenure-track Professor.
  - College of Information Science and Electronic Engineering, Zhejiang University.