

Che-Kai Liu

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Education & Selected Awards

Zhejiang University. B.Eng. (Overseas student)

Hangzhou, Zhejiang, P.R.China

College of Information Science and Electronic Engineering. GPA:3.72/4. Third year/Major GPA: 3.87/4

Sep.2019 - June 2023

- **3 consecutive** Award of Merits for HongKong, Macau, Taiwan, and Overseas Chinese, 2020
- Research sponsorship/scholarship from Fellow of IEEE/ACM Prof. X. Sharon Hu, 2022.
- Research scholarship from the University of Notre Dame, 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 ESWEEK EIC workshop, 2022.
- Third-Class Scholarship for Award of Merits, 2022.
- Outstanding student of innovation 2022, academic records 2022, foreign exchange 2022.

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, 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. Thesis, 2023: **A Cross-layer design approach in CiM - from circuit to architecture to application**. Advisors: X. Yin, X. S. Hu, M. Imani

Research Experiences

Zhejiang University

Zhejiang, P.R.China

Researcher, advisor: Prof. Xunzhao Yin

Dec. 2020 - Present

- COSIME: Invent cosine similarity based in-memory engine using FeFET. (see 1 and 7). **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 8). **Contribution**: Conceive project. All SPICE simulation. All patent write-ups.
- Collaborate (see 5) and mentor National and Provincial Research Programs in the lab.

University of Notre Dame

Indiana, USA

Researcher, advisor: Prof. X. Sharon Hu

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

- 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.

University of California, Irvine

California, USA

Researcher, advisor: Prof. Mohsen Imani

Aug. 2022 - Present (8-10 on campus)

- Seamless integration sensing with 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).

Skills & Academic Service & Talks & Interests

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| Skills | SPICE (Cadence Virtuoso), Python (Pytorch), C, Verilog, Assembly (RISC-V), MATLAB |
| Review | IEEE JETCAS x2 (Invited by editors, Prof. S. Yu and Prof. H. Najafi); ACM/IEEE ASP-DAC'23 (Under Prof. M. Imani) |
| Talks | ACM/IEEE 41 st ICCAD'22; Student Research Competition@ICCAD'22; ACM/IEEE ESWEEK'22 EIC workshop |
| Interests | Sports (3 basketball champions; Minister of our sports dept.; 90+hr of volunteering). Travel. Discourse. |