Zihan Chen

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About Me

I'm a Ph.D. student in computer systems, developing compiler, parallel computing, and system-level techniques to improve the efficiency, programmability, scalability, and fault tolerance of emerging quantum computers.

Education

Rutgers University — New Brunswick, New Jersey
Ph.D. in Computer Science — *Expected in 2028*
M.Sc. in Computer Science — *Sep. 2022 – May 2024*
Advised by Dr. Eddy Z. Zhang

Nanjing University of Information Science & Technology — Nanjing, China
B.E. in Telecommunication Engineering — *Sep. 2018 – May 2022*
Changwang School of Honors, *joint program with* University of Chinese Academy of Sciences

Projects

Compiler for Hamiltonian Simulation on Hybrid CV-DV Quantum Computers
Genesis Compiler: ISCA'25 & Slides & Code

- Built the first end-to-end hybrid CV-DV compiler featuring a custom **domain-specific language** (DSL) and a **multi-level IR** pipeline translating mathematical Hamiltonians into executable instruction sequences
- Implemented symbolic, matrix-free Hamiltonian decomposition via **recursive template rewriting**, leveraging product-formula and block-encoding patterns
- Addressed novel hybrid hardware mapping challenges using **TSP-inspired ancilla routing** and extended **Sabre-style** connectivity optimization
- Exploring hybrid CV–DV compilation with commutation rules and Quantum Signal Processing synthesis
- **6K+ LOC** compiler codebase supporting multiple Hamiltonians with comprehensive documentation and tutorials

Quantum Circuits Optimizer using Phase Polynomial IR
PhasePoly Optimizer: QCE'25 Poster & Arxiv & Available Soon

- Developed PhasePoly, a quantum circuit optimizer leveraging phase polynomial IR (CNOT, R_z). Introduced a unified single **parity-matrix** representation that jointly optimizes phase-parity and output-parity networks
- Resolved **dependency constraints** of prior frameworks by merging phase polynomial blocks via **static single assignment-style** rotation merging and **cross-block** IR optimization, achieving state-of-the-art circuit reduction
- Implemented a size-bounded **A-star** search engine, achieving up to **50%** total gate reduction (**avg. 34.70%**) and up to **48.57%** CNOT gate reduction (**avg. 26.83%**) on standard benchmark circuits
- Demonstrated superior scalability and optimization performance over QUESO, Quartz, and GRAY-SYNTH on diverse benchmark suites and large-scale stress tests up to **400 qubits** and $\mathbf{10^5}$ **gates**
- Analyzed effectiveness under **FTQC protocols** and explored **hardware-aware strategies** for **NISQ** circuits

End-to-End Compilation and Optimization for Fault-Tolerant Shor's Factorization Algorithm
Ongoing Research

- For **2048-bit RSA factorization** via Shor's algorithm, developing a holistic compilation framework that unifies **logical-level optimization** with **fault-tolerant protocol co-design**
- Implementing quantum arithmetic optimizations using coset representation and windowed quantum lookup tables
- Applying co-design across multiple **FTQC schemes** to generate deployable, high-performance physical circuits
- Scaling compilation up to 10^{11} **instructions** through **parallelized and modular optimization**

Experience

Software Engineer Intern, CARINA AI | Python, C# — Remote, USA
Mentor: Dr. Feng Xue. Contributed to INTContour, DeIdentifier, and AutoBrachy — *May 2023 – May 2024*

Migrated GPU-based products from distributed on-premise deployments to a secure cloud solution, ensuring efficient data transfer and full compliance with medical privacy standards

- Developed a **C# WPF client** enabling medical physicians to access remote AI-powered medical imaging analysis
- Extracted medical imaging data and diagnostic reports from clinic's databases using C# and Python APIs, utilized **DICOM** protocols and **FHIR** standard for secure data querying and retrieval

- Implemented lightweight hash-based **de-identification** with key-value mapping to manage and re-identify client data securely
- Designed **data-forwarding nodes** for clinical cloud platforms with IT-configurable settings, ensuring strict data security and seamless system integration
- Delivered **8K+ LOC** with iterative updates from customer feedback and refactored codebases under the **MVVM** pattern to enhance modularity, speeding up the following products iteration

Teaching Assistant New Brunswick, New Jersey
Rutgers University *Sep. 2023 – Present*

- CS 336: Principles of Information and Data Management (**5 times**)
- ECE 568: Software Engineering of Web Applications (**1 time**)
- ECE 518: Mobile Embedded Systems and On-Device AI (**1 time**)

Academic Service

Organizer of Rutgers QEC: Theory and Systems Reading Group

- Organized weekly reading groups discussing Quantum Error Correction (QEC), covering theoretical concepts, compiler optimizations, and AI-driven techniques.
- Hosted 20 invited talks by 14 speakers from 5 different academic institutions (as of Oct 2025).

Technical Papers Program Committee

- QCE'25

Artifact Evaluation Committee

- SOSP'25
- MICRO'25

Talks and Presentations

[Talk] Compiler framework on hybrid CV-DV quantum computers for Hamiltonian simulation
North Carolina State University, CV-DV Group Meeting. Slides *Remote. May 21, 2025*

Selected Publications

[1] **Zihan Chen***, Jiakang Li*, Minghao Guo*, Henry Chen, Zirui Li, Joel Bierman, Yipeng Huang, Huiyang Zhou, Yuan Liu, Eddy Z. Zhang. 2025. *Genesis: A Compiler for Hamiltonian Simulation on Hybrid CV-DV Quantum Computers.* In *Proceedings of the 52nd Annual International Symposium on Computer Architecture (ISCA '25).*

[2] **Zihan Chen**, Henry Chen, Yuwei Jin, Minghao Guo, Enhyeok Jang, Jiakang Li, Caitlin Chan, Won Woo Ro, Eddy Z. Zhang. 2025. *PhasePoly: An Optimization Framework for Phase Polynomials in Quantum Circuits. arXiv preprint arXiv:2506.20624.*

* indicates equal contribution.

Selected Patents

[1] *Atherosclerosis Risk Prediction Method Based on Dynamic Information Value Criterion and Ensemble Learning.* Chinese Patent, CN114388129A. Link

[2] *Low-Redundancy Atherosclerosis Risk Prediction Method Based on Dijkstra's Algorithm.* Chinese Patent, CN114550941A. Link

[3] *A Scanning Helmet Integrated with QR Code Recognition Functionality.* Chinese Utility Model Patent, CN214547597U. Link

Skills

Programming(Proficient): Python, C++, SQL
Programming(Familiar): C#, JavaScript, Go, Java
Libraries & Toolkits: PyTorch, Qiskit, BQSKit, Scikit-learn, ANTLR, SciPy
Developer Tools: Git, Docker, Conda, tmux, Make/CMake
Frameworks: Django, Spring Boot, React, Electron
Miscs: Powerlifting, Boxing, Chess, Yo-Yo Ma's Music