

# Cheng-En Tsai



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## EDUCATION

### National Taiwan University

Sep. 2021 – Dec. 2025

B.S. in Electrical Engineering

- **Overall GPA:** 4.15/4.3 (3.95/4.0)
- **Honors:** Dean's List Awards (2021 Fall, 2024 Spring)
- **Coursework:** Special Topics on Quantum Design Automation(A), Quantum Information and Computation(A+), Introduction to Electronic Design Automation(A+), Computer Architecture(A+), Machine Learning(A+)

## PUBLICATIONS

- [1] C.-T. Kuo, C.-E. Tsai and C.-Y. R. Huang, "A Novel Ultra-Low Logic Step Fault-Tolerant Quantum Circuit Synthesis via Lattice Surgery," DATE 2026.
- [2] C.-E. Tsai and H.-C. Cheng, "LossAgg-QFL: A communication-efficient quantum federated learning framework for non-iid data," in Proceedings of PNAS 2026.
- [3] M.-T. Lau et al., including C.-E. Tsai and C.-Y. R. Huang, "Qsyn: A developer-friendly quantum circuit synthesis framework for NISQ era and beyond," in \*2024 IEEE International Conference on Quantum Computing and Engineering (QCE)\*, pp. 535–536, IEEE, Sept. 2024.

## PROFESSIONAL EXPERIENCE

### Google

Jun. 2025 – Sep. 2025

Hardware Engineering Intern

- Developed a Python-based automation tool for schematic and layout review, surpassing Cadence's Electrical Rule Checker (ERC) with customizable rule checks, signal integrity diagnostics, and an intuitive PyQt5-powered GUI.
- Implemented advanced features including In-Board Measuring Point analysis aligned with Intel AIBC standards, automated derating checks, and design comparison, significantly reducing manual review time.
- Enabled compatibility with Cadence Allegro PCB Editor via Extracta and Design Entry HDL, showcasing adaptability across industry-standard EDA tools for schematic and board-level design.

## RESEARCH EXPERIENCE

### Design Verification Lab, NTU

Jan. 2023 – Present

Undergraduate Researcher | Advisor: Prof. Chung-Yang (Ric) Huang

#### An Ultra-Low Logic Step Fault-Tolerant Quantum Circuit Synthesis via Lattice Surgery

- Developed FTQCS, a ZX-calculus-based synthesis framework that compiles quantum circuits into lattice-surgery schedules for surface-code execution.
- Reduced asymptotic space-time cost from  $O(n^3)$  to  $O(n^2)$  and demonstrated over 148× execution speedup and up to 8.4× lower overhead compared to prior compilers.

#### Qsyn: A Developer-Friendly Quantum Circuit Synthesis Framework [\[Github\]](#) [\[arXiv\]](#)

- Designed and implemented an end-to-end quantum circuit synthesis tool in C++ by integrating optimization algorithms to enhance efficiency and scalability.
- Applied Gray-code synthesis to translate tensor decompositions into quantum gates and enable structured optimization with given gate sets.

### Quantum Information Lab, NTU

Feb. 2024 – Present

Undergraduate Researcher | Advisor: Prof. Hao-Chung Cheng

#### LossAgg-QFL: A Communication-Efficient QFL Framework for Non-IID Data [\[GitHub\]](#)

- Proposed LossAgg-QFL, a communication-efficient, gradient-free quantum federated learning framework where clients transmit only scalar losses, enabling scalable training on non-IID data and compatibility with NISQ devices.
- Achieved up to 48.1% accuracy improvement over FedAdam on MNIST under non-IID settings, while reducing communication and circuit executions from parameter-dependent  $\mathcal{O}(p)$  to constant  $\mathcal{O}(1)$  per iteration.

Undergraduate Researcher | Advisor: Prof. Mike Y. Chen

**CrossHaptics: Real-time Haptic Feedback for VR Games via Vibration Pattern Analysis**

- Designed a C# program to automatically capture VR controller vibration patterns from game developers, enabling support for additional haptic devices in all VR games.
- Conducted user studies and analyzed feedback to refine system performance and user experience iteratively.

**SELECTED PROJECTS****Reinforcement Logic Optimization for a General Cost Function** [\[Github\]](#) [\[Report\]](#)

Apr. 2024 – Jun. 2024

Electronic Design Automation

- Developed a program to optimize digital circuits based on a black-box cost estimator, addressing complex optimization beyond traditional PPA metrics.
- Implemented the A2C reinforcement learning algorithm and Simulated Annealing on Yosys-ABC for circuit optimization, achieving up to 55.3% improvement in loss compared to the Greedy algorithm.

**T-Count Optimization Framework for Clifford+T Quantum Circuits** [\[Report\]](#)

Apr. 2024 – Jun. 2024

Quantum Information and Computation

- Developed a unified T-count optimization framework that integrates multiple reduction techniques including TMerge, Internal-H-OPT and advanced phase polynomial methods such as TODD for efficient circuit synthesis.
- Enhanced overall circuit efficiency by combining Gray synthesis (GraySyn) with T-parallelism (T-Par) strategies to exploit structural regularities and gate-level concurrency.

**Quantum Circuit Enumeration with Unitary Matrix** [\[Report\]](#)

Nov. 2023 – Jan. 2024

Quantum Design Automation

- Read in a valid unitary matrix, converting the tensor into several 2-level matrices.
- Use gray-code synthesis to map the matrices into quantum gates, decomposing and optimizing to get the final quantum circuit with the given basic gate sets.

**Improved SAT-based ATPG on ABC: Incremental PBO with better compaction** [\[Report\]](#)

Apr. 2025 – Jun. 2025

VLSI Testing

- Developed an incremental SAT-based ATPG framework using Pseudo-Boolean Optimization (PBO) to minimize pattern count and runtime, achieving improved compaction efficiency.
- Encoded complete fault lists into a single SAT instance with structural Boolean objectives, enabling selective pattern generation and extensibility to fault diagnosis.

**PROFESSIONAL EXPERIENCE****Quantum Information and Computation (COMME5061)**

Feb. 2025 – Jun. 2025

Teaching Assistant | Instructor: Prof. Hao-Chung Cheng

- Supported graduate-level quantum computing coursework by designing exams, grading assignments, answering student inquiries on quantum information theory, and guiding final project development.

**Cornerstone EECS Design and Implementation (EE1006)**

Feb. 2025 – Jun. 2025

Teaching Assistant | Instructor: Prof. Ho-Lin Chen and Prof. Chia-Yi Yeh

- Guided first-year EE students in building line-tracing autonomous vehicles and self-proposed projects, developing maker skills in both hardware and software.

**LEADERSHIP****NTUEE Summer Camp**

Oct. 2023 – Jul. 2024

Coordinator

- Led a team of 100 electrical engineering students to organize a 7-day educational camp for 120 high school students, introducing core EE concepts through hands-on activities and lectures.

**NTUEE × DFLL Orientation Camp**

Jan. 2023 – Aug. 2023

Vice Coordinator

- Led 80 EE and DFLL students to host a 3-day orientation camp for incoming freshmen, designing interactive activities to foster cross-department engagement and community building.