Nithin Raveendran

Quantum Error Correction Scientist — Research Professor

Tucson, AZ — nithin@arizona.edu — LinkedIn — Google Scholar

PROFESSIONAL SUMMARY

Quantum error correction (QEC) scientist and technical team leader with over 8 years of experience in code construction, decoder algorithm design, and hardware-aware implementation for fault-tolerant quantum computing. Co-Principal Investigator on NSF-funded project with pioneering contributions in quantum trapping set theory, soft-syndrome decoding, neural-networks augmented BP, and practical decoder implementation. Proven ability to lead interdisciplinary teams—including classical FPGA engineers, quantum physicists, and machine learning researchers—to translate theory into scalable, hardware-deployable QEC solutions. Mentor and systems thinker, with experience navigating academic and industry-funded projects.

SELECTED PROJECTS & ACHIEVEMENTS

Co-PI on NSF CISE-CIF Grant #2420424 (2024–2027) Technical lead and principal investigator on a $600K NSF project targeting scalable and fault-tolerant quantum decoding. Leading cross-functional efforts on algorithm design, decoder architecture, and student mentorship.

Pioneering Trapping Set Analysis in Quantum LDPC Codes (2018–Present) Led the development of a new theoretical framework for identifying and mitigating trapping sets in QLDPC decoders. This foundational work underpins several decoder improvement designs developed in QLDPC research.

Low-latency QLDPC Decoding Architectures (2022–Present) Directed the design of soft-syndrome decoders and bit-flip variants for fast, hardware-amenable quantum LDPC decoding. Oversaw benchmarking against physical noise models. Collaborated closely with FPGA engineers and hardware teams.

Constant-Overhead Fault-Tolerant Quantum Computation with Atom Arrays (2023–2024) High-impact research published in *Nature Physics* demonstrating scalable fault-tolerant quantum computation with reconfigurable atom arrays. Integrated QEC expertise into physical layer modeling, working with leading physicists and experimentalists to validate QLDPC performance.

Concatenated QEC with GKP + QLDPC Codes (2021–2022) Led integration of continuous-variable and discrete QEC paradigms. Architected hybrid decoder systems and initiated collaborations with physicists and hardware-focused labs. Developed into ongoing collaborative work under the SQMS project.

Neural Network-Enhanced Decoding (2019–Present) Developed and co-supervised students building neural BP decoding pipelines targeting error floor reduction. Working on its generalization under realistic quantum noise. Provided leadership in experimental framework design, analysis, and publication.

FPGA Implementation of Iterative Decoders (2018–2020) Guided system-level implementation of classical and quantum LDPC decoder architectures on FPGA platforms. Interfaced with digital design and verification teams to ensure cross-platform compatibility.

EDUCATION

Ph.D. in Electrical Engineering, Communication Systems, University of Arizona, Tucson, AZ, 2021
Dissertation: Trapping Sets of Iterative Decoders for Quantum and Classical LDPC Codes Advisor: Prof. Bane Vasic; Co-advisor: Dr. Saikat Guha
MSc (Engg.) in Communication Systems, Indian Institute of Science (IISc), Bangalore, India, 2015
Thesis: A Modified Sum-Product Algorithm Over Graphs With Short Cycles, Advisor: Shayan Srinivasa
B.E. (Hons.) in Electrical Engineering, BITS Pilani, India, 2011

EXPERIENCE

Assistant Research Professor, Dept. of Electrical and Computer Engineering, University of Arizona

(2022–Present) PI-level leadership in NSF-funded QEC projects. Managing PhD students and directing decoder design pipelines across software and hardware tracks.
Postdoctoral Research Associate, University of Arizona (2021–2022) Led new decoder development in hybrid GKP + QLDPC schemes. Acted as co-advisor to PhD students.
Graduate Research Assistant, University of Arizona (2015–2021) Independently initiated projects on trapping set theory in quantum LDPC codes, worked on neural decoders, and classical error floor estimators. Presented and published 20+ papers while interacting and learning from expert collaborators.

TECHNICAL SKILLS

Languages: Python, C++, Matlab, LaTeX, SystemVerilog **Quantum Frameworks:** Qiskit, Stim, Cirq (basic) **Tools/Platforms:** FPGA toolchains, Git, ModelSim, Docker, Linux shell scripting **Machine Learning:** PyTorch, TensorFlow **Other:** LATEX typesetting, research presentation, academic writing

SELECTED PUBLICATIONS

- Xu et al., *"Constant-overhead fault-tolerant quantum computation with reconfigurable atom arrays,"* Nature Physics, Apr. 2024.
- Raveendran et al., *"Soft syndrome iterative decoding of quantum LDPC codes and hardware architectures,"* EPJ Quantum Technol. 10(1), 2023.
- Raveendran et al., *"Trapping Sets of Quantum LDPC Codes,"* Quantum, vol. 5, p. 562, Oct. 2021.
- Raveendran et al., *"Low-latency flipping decoders for improving error floor performance in quantum LDPC codes,"* ISTC 2023.

Full publication list: Google Scholar

PATENTS

Provisional and pending U.S. patents filed related to:

- Decoder architectures for QLDPC codes using soft syndrome metrics
- Neural-network guided belief propagation methods for QEC
- Improved Decoder Designs for QLDPC codes

LEADERSHIP & MENTORSHIP

- Mentoring 3 PhD students working on QLDPC decoders, neural decoder designs, qubit/qudit error correction systems, and realistic noise models.
- Guided high school students in QEC research via the SARSEF STAR Lab program.
- Recipient of ECE Outstanding Graduate Student Award, University of Arizona (Fall 2021).
- Panelist and invited speaker at IEEE QCE, ITA, QuanTalks, and IBM Quantum Network Colloquium.
- Reviewer for Nature, Physical Review X Quantum, IEEE TIT, TCOM, and major conferences.
- Organized and led tutorials on QEC decoding at IEEE ITA Workshop and the NSF Center for Quantum Networks (CQN) workshops.

References available upon request.