# MD MAHABUBUL ALAM

Pennsylvania State University, University Park

✉ mxa890@psu.edu ☎ +1-334-524-6864, ☙ Web

## SUMMARY

Ph.D. student ($4^{th}$ year) experienced in (i) quantum computing (qubit mapping/compilation, QAOA, QNN), (ii) applied statistical learning, and (iii) VLSI/EDA - seeking full-time opportunities in quantum computing.

## EDUCATION

**Pennsylvania State University, University Park, PA**                    *January 2018 - Present*
PhD Candidate in Electrical Engineering, *GPA: 3.92/4.0*
Thesis Topic: Methodologies to Restore the Computational Power of Quantum-Classical Hybrid Algorithms.
Advisor: Dr. Swaroop Ghosh

**Auburn University, AL**                    *January 2017 - December 2017*
Graduate Student (Credits transferred to Penn State) in Electrical Engineering, *GPA: 4.0/4.0*

**Bangladesh University of Engineering and Technology**                    *May 2010 - August 2015*
Bachelor of Science in Electrical and Electronic Engineering, *GPA: 3.73/4.0*

## ACHIEVEMENTS

- James E Marley Graduate Fellowship in Engineering, College of Engineering, Penn State, Spring 2021.
- Second Place, Student Research Competition at the IEEE/ACM International Conference on Computer Aided Design, 2020 (SRC@ICCAD2020).
- Richard Newton Young Student Fellow, IEEE/ACM Design Automation Conference (DAC), 2020.
- NSF Student Travel Award, IEEE VLSI Test Symposium (VTS), 2018.
- Dean's List and Faculty Honors as an undergraduate student (2015/2013), Bangladesh.
- Merit scholarships for excellence in junior, secondary, and higher-secondary public examinations, Bangladesh.

## RESEARCH EXPERIENCE

**Graduate Research Assistant (Penn State)**                    *January 2019 - Present*

- Developed a **scalable and noise-resilient** quantum neural network (QNN) architecture called **QNet** and demonstrated ≈43% better accuracy on average over the state-of-the-art methods under noise [j5].
- Developed **efficient circuit compilation methodologies** for quantum approximate optimization algorithm **(QAOA)** and achieved ≈23% reduction in gate-count, ≈53% reduction in circuit-depth, and ≈25.8% improvement in success probability on average over the state-of-the-art [c15, c16, c17].
- Developed a **parameter initialization** scheme to accelerate **QAOA** using **machine learning** and demonstrated ≈44.9% speed-up on average for various MaxCut problems [c11].
- Studied the performance of **QAOA under noise** [a2, c13]. These were the **first works in the literature** to present numerical evidence on the **flattening of QAOA solution space** under noise.
- Developed heuristics to address spatial and temporal qubit quality fluctuations (**Qubit Re-allocation** [c5]/ **Noise-aware Training of Parameterized Quantum Circuits** [c6]).
- Developed a family of **Camouflaged Flip-flops** using threshold defined mosfet switches to obfuscate timing paths in sequential circuits [c4].

**Graduate Research Assistant (Auburn University)**                    *January 2017 - December 2017*

- Developed a **Recycled IC Detection** technique using the aging induced frequency degradation of ring oscillators and a digital signature of the test-time frequency to be stored in an on-chip NVM [c2].
- Developed a low-cost **Edge Device Authentication** scheme for the internet of things [c1].

- Surveyed various IoT/CPS system architectures, edge device architectures and their resource constraints, and security implications for the semiconductor industry due to pervasive deployment of these systems [j1].

## PUBLICATIONS

**Synopsis:**

21 Conferences, 5 Journals, 1 Poster, 4 Pre-prints
Citations: 229, h-index: 8 (*Google Scholar*)

**Conferences:**

[c21] **Mahabubul Alam**, Satwik Kundu, Rasit Topaloglu, and Swaroop Ghosh. "Quantum-Classical Hybrid Machine Learning for Image Classification." ACM/IEEE International Conference On Computer Aided Design (ICCAD), 2021 (Invited Paper).

[c20] Junde Li, **Mahabubul Alam**, Congzhou Sha, Jian Wang, Nikolay Dokholyan, and Swaroop Ghosh. "Drug Discovery Approaches using Quantum Machine Learning." IEEE/ACM Design Automation Conference (DAC), 2021 (Invited Paper).

[c19] Abdullah Ash Saki, **Mahabubul Alam**, Koustubh Phalak, Aakarshitha Suresh, Rasit Topaloglu, Swaroop Ghosh. "A Survey and Tutorial on Security and Resilience of Quantum Computing." IEEE European Test Symposium (ETS), 2021 (Embedded Tutorial Paper).

[c18] Abdullah Ash-Saki, **Mahabubul Alam**, and Swaroop Ghosh. "Impact of Noise on the Resilience and the Security of Quantum Computing." IEEE International Symposium on Quality Electronic Design (ISQED), 2021 (Invited Paper).

[c17] **Mahabubul Alam**, Abdullah Ash-Saki, and Swaroop Ghosh. "Circuit Compilation Methodologies for Quantum Approximate Optimization Algorithm." International Symposium on Microarchitecture (MICRO), 2020 (Acceptance Rate $\approx$ 19.0%).

[c16] **Mahabubul Alam**, Abdullah Ash-Saki, and Swaroop Ghosh. "Noise-resilient Compilation Policies for Quantum Approximate Optimization Algorithm." ACM/IEEE International Conference On Computer Aided Design (ICCAD), 2020 (Invited Paper).

[c15] **Mahabubul alam**, Abdullah Ash-Saki, and Swaroop Ghosh. "An Efficient Circuit Compilation Flow for Quantum Approximate Optimization Algorithm." ACM/IEEE Design Automation Conference (DAC), 2020 (Acceptance Rate $\approx$ 24.0%).

[c14] Ling Qiu, **Mahabubul, Alam**, Abdullah Ash-Saki, and Swaroop Ghosh. "Resiliency Analysis and Improvement of Variational Quantum Factoring in Superconducting Qubit." ACM/IEEE International Symposium on Low Power Electronics and Design (ISLPED), 2020 (Acceptance Rate $\approx$ 24.0%).

[c13] **Mahabubul Alam**, Abdullah Ash-Saki, and Swaroop Ghosh. "Design-Space Exploration of Quantum Approximate Optimization Algorithm under Noise." IEEE Custom Integrated Circuits Conference (CICC), 2020 (Acceptance Rate $\approx$ 20.0%).

[c12] Abdullah Ash-Saki, **Mahabubul Alam**, and Swaroop Ghosh. "Improving Reliability of Quantum True Random Number Generator using Machine Learning." IEEE International Symposium on Quality Electronic Design (ISQED), 2020 (Acceptance Rate $\approx$ 30.0%).

[c11] **Mahabubul Alam**, Abdullah Ash-Saki, and Swaroop Ghosh. "Accelerating Quantum Approximate Optimization Algorithm using Machine Learning." ACM/IEEE Design Automation and Test in Europe (DATE), 2020 (Acceptance Rate $\approx$ 37.0%).

[c10] Ling Qiu, **Mahabubul Alam**, Abdullah Ash-Saki, and Swaroop Ghosh. "Analyzing Resilience of Variational Quantum Factoring under Realistic Noise." Annual GOMACTech Conference, San Diego, CA, USA, 2020.

[c9] Junde Li, **Mahabubul Alam**, Abdullah Ash-Saki, and Swaroop Ghosh. "Hierarchical Improvement of Quantum Approximate Optimization Algorithm for Object Detection." IEEE International Symposium on Quality Electronic Design (ISQED), 2020 (Invited Paper).

[c8] Debjyoti Bhattacharjee, Abdullah Ash-Saki, **Mahabubul Alam**, Anupam Chattopadhyay, and Swaroop Ghosh "MUQUT: Multi-Constraint Quantum Circuit Mapping on NISQ Computers." ACM/IEEE International Conference On Computer Aided Design (ICCAD), 2019 (Invited Paper).

[c7] **Mahabubul Alam**, Yimin Ding, Xingjie Ni, and Swaroo Ghosh. "Logic Obfuscation using Metasurface Holography." IEEE International Midwest Symposium on Circuits and Systems (MWSCAS), 2019 (Invited Paper).

[c6] **Mahabubul Alam**, Abdullah Ash-Saki, and Swaroop Ghosh. "Addressing Temporal Variations in Qubit Quality Metrics for Parameterized Quantum Circuits." ACM/IEEE International Symposium on Low Power Electronics and Design (ISLPED), 2019 (Acceptance Rate $\approx$ 23.0%).

[c5] Abdullah Ash-Saki, **Mahabubul Alam**, and Swaroop Ghosh. "QURE: Qubit Re-allocation in Noisy Intermediate-Scale Quantum Computers." ACM/IEEE Design Automation Conference (DAC), 2019 (Acceptance Rate $\approx$ 24.3%).

[c4] **Mahabubul Alam**, Swaroop Ghosh, and Sujay S. Hosur. "TOIC: Timing Obfuscated Integrated Circuits." ACM Great Lakes Symposium on VLSI (GLSVLSI), 2019 (Acceptance Rate $\approx$ 29.6%).

[c2] **Mahabubul Alam**, Sreeja Chowdhury, Mark M. Tehranipoor, and Ujjwal Guin. "Robust, low-cost, and accurate detection of recycled ICs using digital signatures." IEEE International Symposium on Hardware Oriented Security and Trust (HOST), 2018 (Acceptance Rate $\approx$ 24.0%).

[c1] Ujjwal Guin, Adit Singh, **Mahabubul Alam**, Janice Canedo, and Anthony Skjellum. "A secure low-cost edge device authentication scheme for the Internet of Things." IEEE International Conference on VLSI Design (VLSID), 2018 (Acceptance Rate $\approx$ 24.0%).

**Journals:**

[j5] **Mahabubul Alam**, and Swaroop Ghosh. "QNet: A Scalable and Noise-resilient Quantum Neural Network Architecture for Noisy Intermediate-Scale Quantum Computers." Frontiers in Physics, 2021 (Under Review).

[j4] Koustubh Phalak, Abdullah Ash-Saki, **Mahabubul Alam**, Rasit Topaloglu, and Swaroop Ghosh. "Quantum PUF for Security and Trust in Quantum Computing." IEEE Journal on Emerging and Selected Topics in Circuits and Systems (JETCAS), 2021.

[j3] Abdullah Ash-Saki, **Mahabubul Alam**, and Swaroop Ghosh. "Experimental characterization, modeling, and analysis of crosstalk in a quantum computer." IEEE Transactions on Quantum Engineering (TQE), 2020.

[j2] Abdullah Ash-Saki, Sung H. Lin, **Mahabubul Alam**, Sandeep K. Thirumala, Sumeet K. Gupta, and Swaroop Ghosh. "A Family of Compact Non-Volatile Flip-Flops With Ferroelectric FET." IEEE Transactions on Circuits and Systems–I: Regular Papers (TCAS-I), 2019 (Impact Factor - 3.934).

[j1] **Mahabubul Alam**, Mark M. Tehranipoor, and Ujjwal Guin. "Tsensors vision, infrastructure and security challenges in trillion sensor era." Springer Journal of Hardware and Systems Security (HASS), 2017.

**Posters:**

[p1] Abdullah Ash-Saki, **Mahabubul Alam**, and Swaroop Ghosh. "True Random Number Generator using Superconducting Qubits." MRS Device Research Conference (DRC), 2019.

**Pre-prints:**

[a4] Aakarshitha Suresh, Abdullah Ash-Saki, **Mahabubul Alam**, Swaroop Ghosh "A Quantum Circuit Obfuscation Methodology for Security and Privacy." arXiv preprint arXiv:2104.05943, 2021.

[a3] Junde Li, **Mahabubul Alam**, and Swaroop Ghosh. "Large-scale Quantum Approximate Optimization via Divide-and-Conquer." arXiv preprint arXiv:2102.13288, 2020.

[a2] **Mahabubul Alam**, Abdullah Ash-Saki, and Swaroop Ghosh. "Analysis of Quantum Approximate Optimization Algorithm under Realistic Noise in Superconducting Qubits." arXiv preprint arXiv:1907.09631, 2019.

[a1] Abdullah Ash-Saki, **Mahabubul Alam**, and Swaroop Ghosh. "Study of Decoherence in Quantum Computers: A Circuit-Design Perspective." arXiv preprint arXiv:1904.04323, 2019.

## TALKS/PRESENTATIONS

- Tutorial talk on '*Noise Resilient Compilation Policies for Quantum Circuits*', IEEE International Midwest Symposium on Circuits and Systems (2020).

- Paper presentations - IEEE/ACM Design Automation Conference (2020), IEEE Custom Integrated Circuits Conference (2020), IEEE/ACM International Symposium on Microarchitecture (2020), and IEEE International Midwest Symposium on Circuits and Systems (2019).

- Poster presentations - IEEE/ACM Design Automation and Test in Europe (2020), and IEEE/ACM International Symposium on Low Power Electronics and Design (2019).

## PROFESSIONAL SERVICES

Reviewer of (i) IEEE Transactions on Circuits and Systems II, (ii) Springer Journal of Hardware and Systems Security, and (iii) ACM Transactions on Quantum Computing, and (iv) IEEE Transactions on Magnetics.

## COMMUNITY SERVICES

- Mentoring a group of graduate and undergraduate students for research immersion in quantum computing.

- Treasurer, Bangladesh Student Association, Penn State, Sep 2019 - Aug 2020.

- Volunteer/Presenter, Cyber-security Workshop, Penn State, Jul 8 - 11, 2019.

- Public Relations Secretary, Bangladesh Students Organization, Auburn University, Sep 2017 - Dec 2017.

- General Secretary, BUET Energy Club, Dhaka, Bangladesh, Jul 2014 - Aug 2015.

## WORK EXPERIENCE

**Graduate Technical Intern, Intel Corporation**                    *May 2020 - December 2020*

- Time-zero defective parts per million (DPPM) analysis using Intel proprietary tools (DART/XDART) for various products, assisted in methodology development for DPPM predictions on external foundry products, attended weekly discussions, and prepared reports/presentations.

- Assisted in test generation, and debug of TAP network.

**Interim Engineering Intern, Qualcomm, Bridgewater, NJ**                    *May 2018 - August 2018*

- Developed a floorplan congestion prediction framework (inspired from *link*).

**Graduate Teaching Assistant (Penn State)**                    *January 2018 - December 2018*

- Conducted two laboratory sessions per week ($\approx 40$ students) on electronic circuit design (inverter, amplifiers, current sources, etc.), held weekly office hour, and evaluated the lab-reports ($\approx 40$/week).

**Physical Design Engineer, Primesilicon Technologies, Bangladesh**                    *October 2015 - December 2016*

- Block-level floorplanning, power-mesh design, clock-tree synthesis, timing closure, and physical verification.

- Scripting in Perl/Tcl for data parsing and automation.

## SOFTWARE SKILLS

- **Engineering & Documentation Tools:** MATLAB, MS Excel/PowerPoint/Word, LaTeX.
- **EDA/CAD Tools:** IC Compiler, Design Compiler, Cadence Virtuoso, VCS, Verdi, Vivado, HSPICE.
- **Scripting/Programming:** Python, Tcl, Perl, C/C++, VBA, Verilog HDL, Assembly Language (8086).
- **Operating Systems:** Microsoft Windows, UNIX.

## MAJOR GRADUATE PROJECTS

- **16-bit Pipelined Processor:** Design of a 16-bit 5-stage (MIPS-like) pipelined processor with 16 instructions using Verilog HDL, and implementation on Nexys 4 DDR FPGA module.

- **10-bit, 5 MS/s ADC:** Schematic and layout of 10-bit 5 MS/s SAR ADC (monotonic capacitor switching topology) in 600nm technology node using Cadence Virtuoso.

- **2KB SRAM Array:** Schematic and layout of a 2KB SRAM array with peripherals in 180nm technology node using Cadence Virtuoso.

- **SRAM PUF:** SRAM PUF with the on-board SRAM chip of CMOD A7 FPGA module.

## GRADUATE COURSES

**Penn State**: Digital Integrated Circuits, Linear Integrated Circuits, Quantum Computing, Data Mining, Applied Statistics, Manufacturing Methods in Microelectronics, Ferroelectric Devices.

**Auburn University**: Advanced VLSI Design, Computer Architecture and Design, Information Networks and Technology, Analog Circuit Design, Introduction to Hardware Security.