Mohammad Tawhidul Hasan Bhuiyan

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Research Interest

Compiler, Profile-Guided Optimizations, Systems for Machine Learning, Hardware/Software Co-Design

Education

Columbia University — *New York, USA*
PhD in Electrical Engineering — Sept. 2024 – May 2030 (expected)

Bangladesh University of Engineering and Technology (BUET) — *Palashi, Dhaka, Bangladesh*
Masters of Science in Computer Science and Engineering — July 2021 – Aug. 2024

Bangladesh University of Engineering and Technology (BUET) — *Palashi, Dhaka, Bangladesh*
Bachelor of Science in Computer Science and Engineering — Mar. 2016 – Feb. 2021
Class rank: 1st

Employment

Columbia University — *New York, USA*
Graduate Research and Teaching Assistant — Sept. 2024 – Present

Bangladesh University of Engineering and Technology (BUET) — *Dhaka, Bangladesh*
Lecturer, Department of CSE — Sept. 2021 – Aug. 2024

Publications

- **Tawhid Bhuiyan**, Sumya Hoque, Angelica Moreira, Tanvir Ahmed Khan, **Stale Profile-Guided Optimizations**, Submitted to ASPLOS-2026
- Ryan Piersma*, **Tawhid Bhuiyan***, Tanvir Ahmed Khan, and Simha Sethumadhavan, **Highly Scalable Power Management Protocol**, Submitted to ISCA-2026, (*Co-first Authors)
- Amir Zarandi, **Tawhid Bhuiyan**, Laurent Schares, and Tanvir Ahmed Khan, **Rebasing GPU Micro-Architectural Power Modeling for Machine Learning Workloads**, Submitted to CAL-2026
- Ryan Piersma, **Tawhid Bhuiyan**, Tanvir Ahmed Khan, and Simha Sethumadhavan, **Reverse Engineering DVFS Mechanisms**, *2025 IEEE International Symposium on Hardware Oriented Security and Trust (HOST), San Jose, CA, USA, 2025*
- **Mohammad Tawhidul Hasan Bhuiyan**, Muhammad Rashed Alam and M. Sohel Rahman, **Computing the Largest Common Almost-Increasing Subsequence**, *Theoretical Computer Science, Volume 930, 2022, Pages 157-178, ISSN 0304-3975*
- **Mohammad Tawhidul Hasan Bhuiyan**, Irtesam Mahmud Khan, Sheikh Saifur Rahman Jony, Renee Robinson, Uyen-Sa D. T. Nguyen, David Keellings, M. Sohel Rahman, and Ubydul Haque, **The Disproportionate Impact of COVID-19 among Undocumented Immigrants and Racial Minorities in the US**, *International Journal of Environmental Research and Public Health, Volume 18(23): 12708, 2021, PubMedID 34886437, ISSN 1660-4601*

Projects

Optimizing Datacenter Applications with Stale Profile | *C++, Python, LLVM* *Sept. 2024 – Present*

- Developed algorithms to map hardware profiles from deployed datacenter applications to new application binaries, enabling effective optimization despite "stale" profile data.
- Integrated mapping heuristics with Meta's BOLT and Google's Propeller, demonstrating applicability across industry-standard optimization toolchains.

Highly Scalable Token-Based Power Management Protocol | *Python, Numba, Architecture* *Aug. 2025 – Present*

- Built a simulator for a token-based power management protocol capable of running cycle-accurate power distribution on top of both cycle-accurate and event-driven system components.
- Designed a novel protocol for system-wide power distribution. Achieved 2.4x more responsive power distribution compared to State-of-the-Art solutions for systems comprising thousands of interconnected components.

Optimizing GPU energy efficiency for LLM | *CUDA, NVIDIA Nsight, Architecture* *Feb. 2025 – Present*

- *Thermal-Aware GPU Power Modeling:*
  - Developed a high-fidelity power model for LLMs by correlating NVML/CUPTI energy traces with PyTorch layer-level timing.
  - Discovered that standard power models fail for compute-heavy kernels due to thermal throttling; implemented corrections to account for dynamic frequency scaling during long-sequence inference, enabling more accurate energy-per-token predictions.
- *Simulator Scalability & Validation (Accel-sim):*
  - Validated Accel-sim traces against real-world LLM workloads on NVIDIA Datacenter GPUs.
  - Identified critical scaling bottlenecks in Accel-sim's handling of transformer architectures and implemented patches to achieve accurate power modeling for large-scale models.
- *Energy Modeling for Multi-GPU Training (Astra-sim):*
  - Integrated custom energy models into Astra-sim to quantify energy consumption across distributed multi-GPU training setups.
  - Analyzed the performance-energy trade-offs for different models and network technologies.

Parallelization Suggestion for Python Programs | *Python, Compiler* *Jan. 2022 – Aug. 2024*

- Developed a compiler-based prototype to profile Python programs and suggest optimal parallelization strategies for distributed environments.
- Achieved performance parity with manually parallelized programs for a set of input programs from Kaggle.

Technical Skills

Architectural Simulators: Accel-sim, Astra-sim, DRAMsim3, Ramulator2, Calculon
Compiler & Systems: LLVM, BOLT, Propeller, AutoFDO
Performance Tools: perf, NVIDIA Nsight, NVML, CUPTI, PyTorch Profiler
Languages: C/C++, Python, Java, SQL, Bash, Rust, Haskell, JavaScript
Libraries: Polars, Numba, PyTorch, Scikit-Learn, Tensorflow, Pandas, NumPy, Matplotlib

Awards

- BUET Alumni Association Award for securing top position in the department
- Dean's Honor List, BUET in all 8 undergraduate semesters
- University Merit Scholarship, BUET

Teaching & Mentorship

Columbia University *Mentor*

- Mentored Amir Zarandi (Undergraduate student, Columbia University) in conducting original research, resulting in a co-authored paper which is under submission.
- Mentored 15 students across 4 technical projects. Guided teams through the design, implementation, and debugging complex systems. Some key projects include:
  - *Fine-grained GPU DVFS:* Leading the students to update Accel-sim to allow simulating and evaluating new DVFS techniques for GPU cores.
  - *HBM DVFS & Co-Optimization:* Leading the investigation into HBM idle power; utilizing DRAMsim3 and Ramulator2 to propose co-optimized DVFS mechanisms for GPU compute and memory.
  - *Power-Aware Collective Communication:* Guiding the integration of different ML models into Astra-sim to easily simulate different model architecture.

Bangladesh University of Engineering and Technology (BUET) *Lecturer*

- Developed curriculum and delivered lectures for core undergraduate courses:
  - *Operating Systems:* Led hands-on sessions on modifying open-source kernels; taught memory virtualization techniques and file systems.
  - *Database Systems:* Instructed on schema design, normalization theory, and the internal architecture of DB storage systems.

References

Tanvir Ahmed Khan
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Department of Electrical Engineering
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