Harshit Raj

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Education

Indian Institute of Technology Kanpur, India *Nov'20 - May'24*
Bachelor of Technology (B.Tech), Computer Science and Engineering *GPA: 9.3/10 (Major: 9.6/10)*

- Project Guides: Dr. Debadatta Mishra and Dr. Swarnendu Biswas
- Honors: Academic Excellence Award (3 times), Vidya Lakshmi Scholarship (2023, 2024), Convocation Award (2024)
- Coursework: Computer Networks, Advanced Computer Architecture, Linux Kernel Programming, Compiler Design

Research Experience

Unified Virtual Memory and Prefetcher in GPU *Dec'23 - May'24*
Advisors: Dr. Swarnendu Biswas and Dr. Debadatta Mishra *PROSPAR Group*

- Implemented Unified Virtual Memory (UVM) with 4KB pages and CPPE prefetching in PROSPAR's GPGPU-Sim fork
- Validated the UVM performance against published benchmarks and verified its correctness across different workloads
- Integrated and adapted a pattern-aware CPPE prefetcher and pre-eviction policy originally proposed for discrete GPUs
- Conducted performance evaluation of CPPE against standard prefetching policies like TBNp, Random, LRU, and Sequential Local and observed that CPPE demonstrated 1.3x more effective prefetching over next best policy (TBNp)
- Identified that incorporating runtime context improves prefetching effectiveness without additional hardware support
- Nominated for the Best Undergraduate Project with Impact on the Campus Community Award by the CSE Department

Microkernel Design *Dec'22 - Apr'23*
Advisor: Dr. Debadatta Mishra *CDOS Group*

- Analyzed the capability model, IPC path, and isolation guarantees of seL4 to build group's foundation on microkernel
- Decomposed group's monolithic Gem5-based OS and built a microkernel that exported file I/O as userspace component
- Designed a synchronous inter-process communication mechanism to support application and components communication
- Implemented root task access controls, and APIs with boilerplate code to add new components and drivers iteratively
- Measured 40% slowdown due to additional IPC and context-switch overhead, showing the security - performance tradeoff

Work Experience

Systems Engineer *Jun'24 - Present*
Quadeye Securities LLP - India's Largest High-Frequency Trading Firm *Gurgaon, India*

- Developing and maintaining latency-critical infrastructures for six trading exchanges with purse exceeding $40 million
- Analyze, design, and simulate trading rules and exchange behaviors to ensure real-time accuracy in market simulations
- Investigated feasibility of multiprocess parallelization of trading simulations, counter to prevailing industry assumptions
- Optimized compute intensive simulations and achieved up to 3.5x speedup by reducing time from 67 hours to 19 hours
- Solving industry challenges by adapting to latest changes and implementing solutions, like domain accelerators, meta language for trading signals, static variables dependency on global state, network optimization, patching libraries, etc.

Systems Engineering Intern (Received PPO) *May'23 - Jul'23*
Quadeye Securities LLP *Gurgaon, India*

- Improved heaptrack memory profiler by enabling seamless and safe runtime attachment across glibc, tcmalloc, and jemalloc implementations and optimized communication time between tracker and interpreter from 2200 ns to 85 ns
- Implemented and tested zero-copy operations and syscall batching using io uring to reduce TCP latency up to 35-40%

Product Engineer *Mar'22 - Jun'22*
Students' Placement Office, IIT Kanpur *spo-iitk*

- Rolled out a Recruitment Automation System, digitizing placement process for 4500+ companies and students annually
- Deployed the microservices-based backend developed in GoLang on a dedicated server in IIT Kanpur's data center
- Spearheaded a team of 6 students for frontend in NextJS and led the entire system from ideation to admin verification
- Received the Award for Best Socially Relevant Project from Prof. Jayathi Murthy, President of Oregon State University

Achievements

- **Ranjan Kumar Memorial Award** by IIT Kanpur *2024*
  For best socially relevant project among all graduating students at 57th Convocation Ceremony
  Presented by Dr. Jayathi Murthy, President of Oregon State University and Dr. Manindra Agrawal, Director of IITK
- **Vidya Lakshmi Scholarship** by IIT Madras *2024 & 2023*
  For the best overall undergraduate IITian across all IITs, selected by secret faculty nomination and recommendations

- **Jack of All Trades** by CSE, IIT Kanpur *2024*
  For best breadth in computer science and extracurricular achievements among all undergraduates
- **Gold medals in Inter IIT Tech Meet** by Inter IIT Tech Meet Organizers *2024 & 2023*
  In 2024, Meet 12.0 by IIT Madras, for improving the design of the microchipset for self-driving vehicles of JLR
  In 2023, Meet 11.0 by IIT Kanpur, for developing a distributed computing MVP for Grad Capital
- **Academic Excellence Award** by SSPC, IIT Kanpur *2022, 2021 & 2020*
  For Academic excellence in Bachelor of Technology in Computer Science and Engineering
- **Silver medal in Inter IIT Tech Meet** by Inter IIT Tech Meet 10.0 Organizer, IIT Kharagpur *2022*
  For developing a SEC Filing analyzer for SaaS companies in the high-preparation problem statement of Digital alpha
- **FIITJEE Scholarship for JEE** by FIITJEE *2021 & 2020*
  For achieving All India Rank 934 among 150,000 shortlisted students in JEE Advanced 2020 conducted by IIT Delhi
- Contributed to open-source tools and events including visit struct and heaptrack, to give back to FOSS community

Key Projects

Design and Pipelining of a MIPS Integer Processor Simulator *Sep'24 - Dec'24*
Course Project Under Dr. Mainak Chaudhuri
- Extended a cycle-accurate MIPS simulator by adding support for extra execution logic and subword memory instructions
- Integrated five-stage pipeline (IF, ID, EX, MEM, WB) into an unpipelined simulator, handling data and control hazards
- Achieved performance improvements and analyzed instruction mix and the pipeline efficiency using execution statistics

Cache Hierarchy and Branch Prediction Mechanisms *Aug'24 - Oct'24*
Course Project Under Dr. Mainak Chaudhuri *cs422*
- Analyzed cache performance of two-level inclusive cache policies like LRU, SRRIP, and NRU using Intel's Pin tool
- Implemented FNBT, Bimodal, SAg, GAg, gshare, and hybrid model branch predictors and evaluated on SPEC 2006
- Designed branch target predictors using BTB with PC-only and PC with global history indexing with LRU replacement

Compiler Design *Feb'23 - Apr'23*
Course Project Under Dr. Swarnendu Biswas *studious-java*
- Designed and built two-pass x86 Java compiler from scratch using Lex and Yacc based on Oracle's SDD specifications
- Implemented symbol table, 3-address code generation, and x86 assembly output with memory and register allocation
- Built error-handling system for reporting context-sensitive syntax checks, semantic rules, and runtime exception errors

Teaching

Teaching Assistant, Data Structures and Algorithms *Aug'23 - Dec'23 & Jan'24 - Apr'24*
Department of Computer Science and Engineering
- Appointed as Teaching Assistant for two consecutive semesters for subject expertise and good student engagement
- Created open ended assignments to encourage critical thinking and engaged with correctness of non-standard solutions
- Conducted tutorials and created support materials to simplify non-trivial topics, catering to 250+ students each term

Senior Academic Mentor *Aug'21 - Apr'23*
Institute Counselling Services
- Mentored over 120 students in the course Fundamentals of Computing and concepts related to computer science basics
- Held regular sessions and remedial classes to help students improve their understanding and build strong foundation

Skills

Programming: C++, C, Python, Bash Script, Golang, Java, SQL, Verilog HDL, MIPS, x86 assembly language
Tools and Utilities: Linux shell utilities, Git, SVN, GDB, Docker, CMake, PostgreSQL, AWS, LaTeX, Nginx
Languages: English (Fluent), Hindi (Native)

Leadership

Member, Senate Educational Policy Committee *Apr'23 - May'24*
Directorate, IIT Kanpur
- Nominated as member responsible for shaping core academic and research policies, curricula, and department initiatives
- Discussed and approved proposals for new departments and reforms like PhD exit options, curriculum breadth, etc.

Senator BT/BS Y20 *Mar'21 - Apr'22*
Students' Senate, IIT Kanpur
- Elected to represent 1200 students and contributed to the legislation of student-run bodies and raised student concerns
- Organized initiatives to increase interaction and promote mental health which saw participation of over 700 students
- After this tenure, served as student nominee of multiple committees, like disciplinary hearings and institute outreach