Aditya **Rohan**

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Research Interests

Computer Architecture — Secure Memory Hierarchies — Operating Systems

Publications

Reverse Engineering the Stream Prefetcher For Profit

Aditya Rohan, Biswabandan Panda and Prakhar Agarwal

Submitted to the *57th Annual Design Automation Conference* (**DAC 2020**).

Whispering Streamers: Covert Channel Through Stream Prefetchers

Aditya Rohan, Biswabandan Panda and Prakhar Agarwal

Poster accepted in ACM SRC at *52nd IEEE/ACM International Symposium on Microarchitecture* (**MICRO 2019**) Columbus, USA.[**Link**]

Can Monitoring System State + Counting Custom Instruction Sequences aid Malware Detection?

Aditya Rohan, Kanad Basu and Ramesh Karri

In proceedings of *28th IEEE Asian Test Symposium* (ATS'19) Kolkata, India

WiP: Reverse Engineering the Stream Prefetcher For Profit

Aditya Rohan, Prakhar Agarwal and Biswabandan Panda

Accepted at *Workshop on Hardware and Architectural Support for Security and Privacy* (**ISCA'19**) Phoenix, USA.[**Link**]

Work Experience

Research Scientist at NYU

New York

Hardware Security, Prof. Ramesh Karri, NYU — *May 2019- July 2019*

- Developing network-wide multi-system malicious activity tracker and program verification system.
- Developed a parallel system to monitor the different modalities on multiple single-board computers on the same network.
- Developed a program to collect HPCs at high frequency (upto 1MHz) for Odroid XU3 & XU4 boards.
- Studied the correlation between the hardware performance counters and various Post-Quantum cryptographic algorithms.

Research Assistant

Remote

Hardware Security, under Prof. Kanad Basu and Prof. Ramesh Karri, NYU — *May 2018-November 2018*

- Developed new methods for malware detection using debug hardware like ARM CoreSight and Intel Platform Analysis Technology
- Designed a simulator in Python to simulate x86, x86_64 and SPARCv9 assembly instructions.
- Trained a ML-based malware detector on these values to identify malware with upto 99.65% accuracy. Algorithms used: Random Forest, Decision Trees and kNN.
- Trained another classifier based on instruction ordering in the various architectures to achieve upto 100% accuracy in detecting malware.
- **In proceedings** of 28th IEEE Asian Test Symposium.

IGVC - Intelligent Ground Vehicle Competition

IIT Kanpur

Vision Subsystem, under Prof. Mangal Kothari — *Sept. 2017-May 2018*

- Designed a lane detection algorithm for Autonomous Ground Vehicle from real time video feed to navigate unknown terrains.
- Implemented and tailored GPU accelerated gSLICr segmentation algorithm for identifying white lanes on a golf course.
- Applied neural nets (in C++) and other algorithms for grass elimination and extraction of the lanes.
- Identified position accurate lanes using Hough Transform and birds eye node, for the complete localization of the vehicle.
- Placed 5th in the Design Competition and 12th Overall in IGVC 2018, Michigan, USA.

New York Office, IIT Kanpur

Kanpur, India

Infrastructure Management, under Prof. Manindra Agarwal — *May 2017 - August 2018*

- Lead a team of 3 interns in infrastructure group, continued as a volunteer and peer mentor.
- Deployed various containerized applications over a Kubernetes cluster with nodes spread across multiple data-centers.
- Worked on a scalable web-app with an extensive technology stack and implemented an OAuth2 based sign-in system for the web-app.
- Created a Finger-Print based attendance system in python to be used during the internship. Used and learned about minutae matching algorithms such as Bozorth and Mindtct.

Research Projects

Intelligent Hardware Prefetchers
IIT Kanpur

Research Project, under Prof. Mainak Choudhary — *Sept. 2019- Present*

- Developed an intelligent hardware prefetching algorithm to choose between multiple IP-based and address-based prefetching algorithms.
- Created a dynamic degree stream prefetcher based on the past prefetch accuracy, cache pollution and demand aggressiveness.
- Demonstrated third best single-core performance compared to the submissions of DPC3 2019. [**Code**][**Report**]

Reverse Engineering the Stream Prefetcher
IIT Kanpur

Research Project, under Prof. Biswabandan Panda — *December 2018- Present*

- Demonstrated a covert channel via the stream prefetcher, sending bits based on prefetch activity, with an accuracy of 91.3% at 13.49kbps.
- Discovered various properties regarding the dominance of direction/distance of prefetch on prefetch degree.
- Showed that the Stream Prefetchers are shared among virtual cores and reverse engineered the size of the stream table.
- Paper **Accepted**, at HASP 2019 in conjunction with ISCA 2019, received funding from the SRC for this research.

NVModule
IIT Kanpur

Research Project, under Prof. Debadatta Mishra — *January 2019- Present*

- Extended support for Non-Volatile Memory(NVRAM) in the linux kernel, with addition of sensitive and persistent type pages.
- Wrote micro-benchmarks to compare the various consistency mechanisms for NVRAMs, like UC, UC-, CLFLUSH, CLFLUSOPT and CLWB.
- Studying the performance and utility of various consistency mechanisms with real-world applications.

Profiling Parallel I/O
IIT Kanpur

Research Project, under Prof. Preeti Malakar — *January 2019- May 2019*

- Tested Darshan and Darshan Extended Tracing on IITK CSE Cluster (180 nodes) and HPC2010 Supercomputer.
- Performed experiments to show the effect of DXT and Darshan on native application's throughput and execution time.
- Demonstrated the node-distance independence of application throughput on HPC2010, with experimental data.[**Code**][**Report**]

Projects

Cache Access Analysis - Advanced Computer Architecture
IIT Kanpur

Course Project, under Prof. Mainak Choudhary — *August 2019 - Present*

- Developed a multi-level cache simulator for exclusive, inclusive and NINE policies. [**Code**][**Report**]
- Implemented replacement policies like LRU and Belady's algorithm (for the given SPEC trace).
- Used the above simulator to generate memory reuse profile for lower level caches, for both replacement policies.[**Code**][**Report**]

Linux Kernel - Topics in Operating Systems
IIT Kanpur

Course Project, under Prof. Debadatta Mishra — *January 2019 - April 2019*

- Implemented kernel module for counting the number of TLB misses, page-reads, page-writes for a given virtual memory area. Extended the same for a system with Page Table Isolation enabled.[**Code**]
- Modified the linux kernel to introduce cgroup variables to count the number of tcp/udp packets sent/received from a container.
- Introduced cgroup variables in the Linux kernel for throttling the rate of tcp/udp packets sent/received.

Secure Systems - Computer Systems Security
IIT Kanpur

Course Project, under Prof. Pramod Subramanyan — *January 2019 - April 2019*

- Implemented a secure file-system in Go, to work on a malicious web-server with key-value pairs stored on a secure server.[**Code**][**Report**]
- Modified the famous Zoobar application to fix buffer overflows and DoS vulnerabilities and added support for privilege separation.

MPICH Applications - Parallel Computing
IIT Kanpur

Course Project, under Prof. Preeti Malakar — *January 2019 - April 2019*

- Implemented various parallel blocking/non-blocking algorithms with MPICH like MPI_REDUCE, MPI_GATHER, MPI_BCAST etc.
- Modified the PNetCDF library for optimization of non-blocking method and added variable number of species[in Fortran].
- Implemented Ping-Pong benchmark in MPICH, tested performance on IITK-CSE Cluster (180 nodes) and HPC2010 Supercomputer.[**Code**]

TLB-based Microarchitectural Side-Channel Attack - Secure Memory Systems
IIT Kanpur

Course Project, under Prof. Biswabandan Panda — *July 2018-November 2018*

- Mounted a side-channel attack through the shared translation lookaside buffer to extract 256-bit EdDSA secret keys and RSA keys without privileged access.
- Reverse engineered the microarchitecture of TLB to find set and way associativty of vairous levels of TLB and their sharedness properties
- Developed pointer-chasing strategies to monitor latency of eviction sets from various levels of TLB.
- Mounted Flush-Reload, Prime-Probe, and other side-channel attacks on current processors

GemOS - Operating Systems
IIT Kanpur

Course Project, under Prof. Debadatta Mishra — *July 2018-November 2018*

- Implemented Multi-level paging, signals like SIGINT, SIGSEGV and SIGFPE and exception handlers like page-faults and divide-by-zero.
- Added system calls like expand, shrink, sleep, clone etc and implemented process scheduling with round-robin scheduling policy in GemOS.
- Designed a scalable FUSE filesystem acting as an object-store.[**Code**]

Relevant Courses

Advanced Computer Architecture∗
Topics in Operating Systems∗
Operating Systems
Data Structures and Algorithms
Computational Methods in Engineering
Computer Architecture∗
Computer Systems Security∗
Computer Organization
Partial Differential Equations
Multivariable Calculus
Secure Memory Systems∗
Parallel Computing∗
Introduction to Electronics
Introduction to Programming
Linear Algebra

∗: *Graduate level*

Teaching

Guest Lecturer — *IIT Kanpur*

CS665, under Prof. Biswabandan Panda — *Sept. 2019*

- Took a guest lecture on reverse-engineering techniques for various microarchitectural units.

Advanced Track Project Mentor — *IIT Kanpur*

ESC101, under Prof. Piyush Rai — *Aug 2019- Nov. 2019*

- Mentored two freshmen for an accelerated course project in game development.
- Instructed them in concepts of object oriented programming in python and C# via game development.

Academic Mentor — *IIT Kanpur*

ESC101, Counselling Service — *July 2017- April 2018*

- Took lectures for the course 'Introduction to Programming' for 50 students.
- Prepared practice programming questions and arranged practice tests/assignments for the same.
- Provided one-to-one mentoring for two students to help them get through the course work.

Skills

Programming C/C++, Python, x86 Assembly , Golang, MATLAB/GNU Octave
Utilities Linux shell utilities, Git, Docker, Kubernetes, LaTeX, MPICH/OpenMP, GDB, OpenCV, Keras
Architectural Tools ChampSim, Gem5, Pin Tool

Scholastic Achievements

2018 **SRC Student,** Member of funded research program for students, only UG member from IITK (Dec'18 - Oct'19) *India*
2016 **Top 0.1%,** among 1,50,000 candidates in JEE Advanced *India*
2016 **Top 0.1%,** among 1.5 million candidates in JEE Mains *India*
2014 **State Top 1%,** National Standard Examination in Physics, conducted by IAPT *India*
2014 **State Top 1%,** National Standard Examination in Chemistry, conducted by ACT *India*

Positions of Responsibility

- **Manager, Software Corner, Techkriti'18:** Created and tested problems for IOPC (International Online Programming Contest), which witnessed participants from more than 20 countries, competing for prizes worth 1.5 Lakh rupees
- **Team Leader-J2, Infrastructure Group NYO IITK:** Lead a team of sophomore and freshman SWE interns for two months.
- **Student Guide, Counselling Service:** Helped in conducting orientation for 850 students, with 6 peer mentee