

Pranav Kumar

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RESEARCH INTERESTS

Hardware Security, Computer Architecture and ML for Security

EDUCATION

- **The University of Texas at Austin** Expected: May 2019
Masters in Electrical and Computer Engineering – **Cumulative GPA: 4.0**
Advisor: Prof. Mohit Tiwari
Research Topics: Hardware-based malware defenses for x86 platforms and RISC-V based solutions.
- **Indian Institute of Technology Kanpur, India** – **9.0/10 (9.3/10 in major)** 2017
Bachelor in Electrical Engineering and Minor in Computer Systems
- **Class XII** - Indian School Certificate (ISC) - **95.2%** 2012

RESEARCH at SPARK Lab (UT Austin)

- **Detecting Advanced Malware as Instruction and Microarchitectural Anomalies** Ongoing
Mentored by Prof. Mohit Tiwari, Dept. of ECE, UT Austin [\[Report\]](#) [\[Slides\]](#)
 - Aim was to design and evaluate Hardware-based Malware Detectors (HMDs) against a broad class of advanced malware.
 - Intelligently iterated through and chose a set of hardware performance counters that modeled program execution precisely, a bag-of-words feature extraction algorithm and an XGBoost classifier as the design for our HMD.
 - Tested it against memory exploits, side channels, covert channels and microarchitectural timing channels on x86 systems with good results. Exploits like code-reuse attacks, ransomware and flush+flush cache attack were not detected.
 - Thus, explained the shortcomings of current systems and subsequently the need and proposed design for a RISC-V based solution (future work).
 - Work done was presented at **CFAR** (Center for Future Architectures Research) Annual Research Review 2017 at the University of Michigan, Ann Arbor; has been submitted to **ISCA 2018** and was presented at the 7th **RISC-V Workshop** in Milpitas CA.

PROJECTS

- **FPGA Implementation of an 8-bit Microprocessor & Audio Monitoring System** Fall 2016
Mentored by Prof. S. Qureshi, Electrical Engineering, IIT Kanpur [\[Code\]](#) [\[Report\]](#) [\[Slides\]](#)
 - Implemented an 8-bit microprocessor on FPGA (Xilinx Virtex-II Pro using Verilog).
 - Developed an audio monitoring system using the on-board ADC.
- **Machine Learning Projects** Machine Learning [\[Reports\]](#), Fall 2017
 - Projects on PCA applied on MNIST dataset, ICA for sound source separation, learning human movement with gaussian processes, implementing pacman via reinforcement learning and CNN applied on MNIST.
- **Cryptography, Software and System Security** HW/SW Security labs [\[Reports\]](#), Fall 2017
 - Projects on RSA & AES implementation (with 128-bit arithmetic) as an accelerator on RISC-V ISA sim, software security SEED labs, differential power analysis to obtain AES key, side channel attack on mysql queries and web server access control using SELinux.
- **Instrumenting Benchmarks & Pipelining MIPS** Computer Architecture labs, Spring 2017
 - Worked with the instrumentation tool PIN to analyze different instructions in SPEC 2006.
 - Subsequently implemented direction predictors for conditional branches and target predictors for indirect calls. Finally, pipelined the MIPS simulator.
- **Software and Web Security** MIT-6.858 based labs, Spring 2017
 - Found vulnerabilities in web application server code like buffer overflows; subsequently wrote stack smashing and return-to-libc exploits and fixed the bugs.
 - Mounted cross-site scripting, cross-site request forgery and side channel attacks on zoobar; subsequently fixed these browser vulnerabilities and implemented privilege separation.

- **Image Inpainting: Exemplar-based Object Removal from Images** Fall 2016
Class Project under Prof. Tanaya Guha, Electrical Engineering, IIT Kanpur [\[Report\]](#) [\[Slides\]](#)
 - Implemented Criminisi et al's algorithm and proposed a novel adaptive regularizer and an improved criterion for patch selection on top of it.
 - Achieved better results than the SOTA and adjudged as the **Best Project** for the course.
- **Extension of NachOS** Operating Systems labs, Fall 2016
 - Implemented system calls (fork, join, exec, yield, sleep, exit), scheduling (FIFO, SJF, Round Robin, Unix) and page replacement (FIFO, LRU, LRU-clock) algorithms on NachOS.
- **Computer Vision: 3D Display and User Interface** Winter 2014
Mentored by Prof. K.S. Venkatesh, Electrical Engineering, IIT Kanpur [\[Slides\]](#)
 - Built a desktop application for e-commerce websites to exhibit a 3D view of their products.
 - The application provided a real-time 3D experience by displaying the perspective view to the user.
 - Selected among the top 6 projects at the **Ericsson Innovation Awards** and awarded INR 25000.
 - Featured by [Mint](#), [Silicon India](#), [Storypick](#), [Networked India](#) and [OnlineShop4Me](#).
- **An Improved CMOS Design for a Full Adder Circuit** Fall 2016
Class Project under Prof. S. Qureshi, Electrical Engineering, IIT Kanpur [\[Report\]](#) [\[Slides\]](#)
 - Proposed an improved full adder design employing CMOS logic and implemented it on Mentor Graphics. The circuit functioned with lesser number of transistors and lower power consumption.

INTERNSHIPS

- **New York University – Design of a 10 GHz Class-A Power Amplifier using a Gallium Nitride Radio-Frequency Device Model** Summer 2016
Mentored by Prof. Shaloo Rakheja, Dept. of ECE, New York University [\[Slides\]](#)
 - Used the MIT Virtual-Source GaN RF model to design single-stage 2.14 GHz and 2-stage 10 GHz (SHF Microwave Spectrum) Class-A Power Amplifiers.
 - Studied the performance impact of technological parameters and further optimized accordingly.
- **New York University – An improved Virtual-source based transport model for quasi-ballistic transistors, MIT Virtual Source Model (MVS-2.0)** Summer 2015
Mentored by Prof. Shaloo Rakheja, Dept. of ECE, New York University
 - Implemented a revised model of the MIT Virtual Source Model in Verilog-A which took into account the dependence of carrier injection velocity on concentration, the VS charge on the non-equilibrium channel transport conditions and non-linearity of access resistances (now deployed on nanohub-U).

AWARDS AND ACHIEVEMENTS

- **Academic Excellence Award** by IIT Kanpur for outstanding academic performance.
- Travel grant to **Aalborg University Copenhagen** by the Danish Embassy for the Workshop in Innovation and Entrepreneurship (WOFIE) 2016 [\[Slides\]](#).
- **Summer Research Fellow 2016** by the Indian Academy of Sciences.
- **Ericsson Innovation Award-2015** by Ericsson, conferred to top 6 projects in India.
- **All India Rank (AIR) 1** in the Indian Railway Engineering Entrance Exam.
- **Indra Dhanush Scholarship** for excellence in academics and strong leadership skills.
- **All India Rank 520 (top 0.04 percentile)** in **IIT-JEE 2013** among 1.4 million candidates.
- **Intl. Rank 24** in the **International Mathematics Olympiad**, **128** in the **National Science Olympiad** and **201** in the **National Cyber Olympiad**, conducted by Science Olympiad Foundation.
- **Special Mention** in the 24hr Google Developer's Fest 2013 for making a shopping website, [BookMyTee](#).

RELEVANT COURSES

- **Computer Systems:** Computer Organization, Computer Architecture, Operating Systems, Computer Systems Security, Security at HW/SW Interface, Performance Evaluation & Benchmarking*
- **Mathematics:** Probability, Calculus, Linear Algebra, Differential Equations, Complex Analysis
- **Algorithms:** Data Structures and Algorithms, Fundamentals of Computing
- **Others:** Machine Learning, Software Architectures*

* - ongoing courses

TECHNICAL SKILL SET

- **Programming Languages:** C, C++, Java, Python, Scala, Verilog, 8085, MIPS and x86 Assembly
- **Softwares and Other Tools:** Xilinx ISE, Keysight ADS, Cadence, ModelSim, Mentor Graphics, GDB, MATLAB, nextnano, Spice, GNU Octave, \LaTeX , OpenCV, Tensorflow, Git
- **Development Platforms:** dsPIC, Xilinx Spartan and Virtex FPGAs

TEACHING/MENTORING EXPERIENCE

- **Project Mentor:** Mentored a junior undergraduate during Summer 2017 at NYU in the area of semiconductor device physics and RF circuit design.
- **Academic Mentor, Introduction to Electrodynamics:** Took remedial classes for the course, Introduction to Electrodynamics, and individually mentored academically deficient students.
- **Student Guide, Counselling Service:** Organized the Orientation Programme for the freshmen batch of 800 and specifically guided six students emotionally and academically.