Abhin Shah | Electrical Engineering

Personal Information

Senior Undergraduate, Indian Institute of Technology Bombay.
EMAIL: abhinshah02@gmail.com PHONE: +91 7738724517
INTERESTS: Information Theory, Coding Theory, Estimation, Compression, Quantum Transport, Thermodynamics.

Education

2014 - 2018 **Indian Institute of Technology Bombay, Mumbai**
Bachelor of Technology **(Honors)** | CGPA: **9.61 / 10.0**
Major: **Electrical Engineering** | Minor: **Computer Science**

2012 - 2014 Pace Junior Science College, Mumbai
Higher Secondary School Cerification | Score: 92.30 %

2002 - 2012 Vidyaniketan School, Islampur, Sangli
Secondary School Cerification | Score: 96.73 %

Publications

- **Abhin Shah**, Sai Vinjanampathy and Bhaskaran Muralidharan, "Classical information driven quantum dot thermal machines," Physical Review B, (in press) (2017).
- Su Li, **Abhin Shah** and Michael Gastpar, "Cooperative Data Exchange with Weighted Cost based on Basis Construction," in the Proceedings of the 55th Annual Allerton Conference on Communication, Control, and Computing (2017).

Research Projects

Coded Caching with Non-Uniform popularity distributions | Bachelor's Thesis
Guide: Prof. Nikhil Karamchandani, EE Department, IIT Bombay [July 2017 - Present]

Introduction:- Caching is a technique to reduce peak traffic rates by prefetching popular content into memories at the end users. In the coded caching scheme, placement of the files and delivery phase are jointly optimized to ensure that in the delivery phase several different demands can be satisfied with a single coded multicast transmission while minimizing the rate required to serve the requested content.

- Working on the network coded caching problem, with the constraint that there are two different classes of users, where each class has its own non-uniform popularity of the files.
- Designed a placement and delivery scheme with order optimal rates to satisfy all user demands.
- Constructed the placement phase using a threshold based technique to store some part of a certain number of top popular files for users in each class in the respective caches of the users.
- Incorporated the idea of decentralized coded caching with heterogenous caches for the delivery scheme of the top files which are popular to both the classes and stored in each user's cache.

Cooperative Data Exchange (CDE) with weighted cost | Summer Internship, LINX, **EPFL**
Guide: Prof. Michael Gastpar, EPFL, Switzerland [Summer 2017]

Introduction:- In the CDE problem, we have N users which are fully connected with each other. Each user initially only has a subset of the K packets making up a file and wants to recover the whole file. User i can make a broadcast transmission, which incurs cost w_i and is received by all other users.

- Presented a polynomial-time deterministic algorithm to compute the minimum weighted cost and determine the rate vector and the packets that should be used to generate each transmission.
- The algorithm is based on the idea of constructing a d-Basis and the coefficients of linear combinations in the optimal coding scheme are generated using the connection to Maximum Distance Separable codes.
- Proved that the minimum weighted cost function is a convex function of the total number of transmissions for integer rate cases.
- Worked on variants of CDE to ensure fairness in the communication scheme and dealing with helpers who help the users to recover the file but themselves do not wish to recover anything.

Classical information driven quantum dot thermal machines | Undergraduate Research Project
Guide: Prof. Bhaskaran Muralidharan, EE Department, IIT Bombay [December 2015 - May 2017]

Introduction:- The setup comprises a quantum dot coupled to two contacts that drive heat flow while coupled to a nuclear spin bath. The electrons in the quantum dot interact with the nuclear spins via hyperfine spin-flip processes as seen in GaAs quantum dots. The information flow is described via the rate of change of Shannon entropy in the nuclear bath.

- Demonstrated that the flow of information current results in a battery operation under transient conditions, as a consequence of Landauer erasure.
- Showed that the setup can perform as a transient power source even under a voltage bias across the dot.
- The role of Landauer erasure is determined to deliver a higher output power and a greater efficiency than a conventional quantum dot thermoelectric setup.
- Investigated the role of Nuclear relaxation processes and the Coulomb interaction in the dot.

Scholastic Achievements

Awards

- Awarded the **Institute Undergraduate Research Award** 01 in recognition to exemplary contribution towards research via the Undergraduate Research Project
- Conferred the annual **Institute Academic Prize** in 2017 for standing 2nd in the junior year
- Secured **AP grade** for exceptional performance (Awarded to less than top 2% of a class) in 2 courses namely, Quantum Transport in Nanoscale Devices & Electromagnetic Waves.
- All India Rank **126** out of 1.4 million students with a percentile of 99.99 in JEE-Advanced 2014
- Selected for a 4 day Nurturance camp in 2011 conducted by National Council for Education **Research & Training** in collaboration with **Homi Bhabha Centre for Science Education (TIFR)**
- **National Talent Search Scholarship**, since 2008, awarded by NCERT, Government of India

Olympiads

- Selected among **national top 1 %** for Indian National Physics **(INPhO)** and Mathematics **(INMO)** Olympiads and Indian National Junior Science Olympiad **(INJSO)**
- Awarded **Bronze Medal** at the 32nd Annual Mathematics Olympiad, IIT Bombay

Other Select Projects

Transmit Dongle for Communications Lab [Jan '17 - April '17]
Guide: Prof. Shalabh Gupta, IIT Bombay (Electronic Design Lab)

- Designed a low cost function generator hardware to produce arbitrary analog signals, with frequency up to 1 MHz, using samples produced via GNURadio and Python.
- The samples are sent via UART communication protocol to an CPLD (MAX V) which stores a copy of these samples (buffer) in an SRAM and finally outputs them onto a DAC (AFE 7070)
- AFE 7070 converts this into an analog signal, which in turn is transmitted as a modulated wave.

Myocardial Infarction Diagnosis using ECG Reports [March '17 - April '17]
Guide: Prof. Vikram Gadre, IIT Bombay (Course Project)

- Developed an ECG analysis model to classify anterior myocardial infarction cases. The Raw ECG signal was denoised from high frequency noise & filtered to remove Baseline Wander.
- A Four level 1-Dimensional Daubechies wavelet decomposition was used for extracting the key features and t-Distributed Stochastic Neighbor Embedding was used for Decision Making.

Pipelined Microprocessor Design [Oct'16 - Nov'16]
Guide: Prof. Virendra Singh, IIT Bombay

- Designed, implemented and tested a 6-stage pipelined multicycle RISC processor in VHDL for the LC-3b instruction set on DE0-Nano FPGA, consisting of arithmetic, logical and branching instructions
- Implemented the NMRU scheme and developed fully associative cache, flushing algorithm, Data-Forwarding, etc. to maximize the theoretical throughput of the processor

Augmented Pepper Spray - PepperShield [May'15 - June'15]
Students' Technical Activities Body, IIT-Bombay

- Created an Augmented Pepper Spray as a device for women's safety using an Arduino board, HC05 Bluetooth module and OV7670 Camera module
- Designed an Android Application which saves the attackers details and initiate emergency calls. The device takes a picture of the attacker and syncs with the user's smartphone to send an SOS
- Awarded the best project for social cause at **Tech and RnD Exposition**, IIT Bombay

Library Helpmate Robot [Jan'15 - Apr'15]
Guide: Prof. Kavi Arya, IIT Bombay

- Worked on Fire Bird V ATMEGA2560 Robot of Nex-Robotics to implement object detection and line following using PID algorithm
- Implemented Image Processing using OpenCV library in C++ for book detection and established wireless communication between laptop and robot using XBEE module (2.4GHz)

Mentorship and Teaching Experience

Spring 2017 | **Mentor, Institute Student Mentor Program** (ISMP)
Mentoring 12 freshmen from diverse backgrounds for their overall development and addressing their concerns regarding academics and general issues; attended training by Tata Institute of Social Sciences

Spring 2016 | **Mentor, Department Academic Mentorship Program** (DAMP)
Selected twice based on peer review and inter-personal skills for one-to-one mentoring of academically weak students and aided two students to clear their backlogs and get good grades.

Spring 2016 | **Teaching Assistant, Linear Algebra**
Conducted weekly tutorials for a class of 45 students, which consisted of involved problem solving and concept discussion sessions. Helped the section achieve the best average performance among 19 other similar sized sections

Autumn 2015 | **Teaching Assistant, Quantum Physics and Application**
Responsible for creating assignments and quizzes, along with holding weekly tutorial sessions for groups of 50 students. Selected on the basis of exceptional performance in the subject and good communication skills

Standardized Test Scores

- GRE: 327/340 (Quantitative: 170 Verbal: 157 Analytical Writing: 4.5/6.0)
- TOEFL: 106/120 (Reading: 26 Listening: 29 Speaking: 23 Writing: 28)

Technical Skills

Programming:	C/C++, Python, MATLAB, Scilab, VHDL, Java (with Android), JavaScript, Assembly, LaTeX
Software Packages:	NgSPICE, GNU Radio, SolidWorks, AutoCAD, Wireshark, EAGLE, Quartus, Android Studio, OpenCV, OpenGL
Hardware/Electronics:	CPLDs, FPGAs, Micro-controller Programming(AVR), Arduino, Raspberry Pi

Relevant Coursework

Electrical | Information Theory and Coding, Network Information Theory, Error Correcting Codes, Communication Systems, Digital Communications, Digital Signal Processing, Quantum Transport in Nanoscale Devices, Physics of Nanoelectronic Devices (I and II), Quantum Physics and Applications, Electromagnetic Waves, Control Systems

Computer Science | Data Structures and Algorithms, Machine Learning (via coursera), Computer Graphics, Computer and Network Security, Computer Networks, Computer Programming

Mathematics | Probability and Random Processes, Data Analysis and Interpretation, Linear Algebra, Multivariable and Vector Calculus, Complex Analysis, Differential Equations(I and II)

Extra-curricular Activities

Abacus:	Participated in International Standard Abacus Computation conducted by UCMAS (Malaysia)
Android:	Successfully completed Android App Development Course at IIT Bombay
Electronics:	Designed RC plane, Autonomous Arduino based Line Follower, RC Robot car at IIT Bombay
Chess:	Grand Master and Winner at District Level Chess Championship
Hockey:	Won bronze medal in the Hockey General Championship, IIT Bombay
Football:	Represented the Hostel team in the Football General Championship, IIT Bombay