Param Rathour

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Education

Indian Institute of Technology Bombay, Mumbai *(Jul 2019 - Present)*
Dual Degree (B.Tech + M.Tech) in Electrical Engineering (Specialization: Control and Computing) *(CPI: 8.59/10)*
Pursuing Minor in Computer Science & Engineering *(Minor CPI: 8.25/10)*
Sant Tukaram National Model School, Latur *(Jul 2017 - Apr 2019)*
Intermediate (Central Board of Secondary Education) *(Percentage: 96.6%)*
Podar International School, Latur *(Jul 2015 - Apr 2017)*
Matriculation (Central Board of Secondary Education) *(CGPA: 10/10)*

Work Experience

NVIDIA | GPU Subsystem

Guide: Raghuram L
ASIC Intern | Perfsim *(May 2022 - Present)*

- Studied about **PerfSim** building blocks, knobs, debugging and architectural & performance testing of models
- Enhancing the **NVLink** GPU-to-GPU interconnect performance model to incorporate multiple pipes per High-Speed Hub
- Integrated a 1-D arbiter class template to the **NVLink** performance model while maintaining its functionality

IIT Bombay Racing | Electrical Subsystem

Faculty Advisor: Prof. Amber Shrivastava
A cross-functional team of 70+ students which designs, fabricates and assembles an Electric Race Car for Formula Student UK
Junior Design Engineer | LV Safety Subsystem *(Sep 2020 - May 2021)*

- Simulated LV Safety board on **LTSpice** and verified the working of RTDS, Brake Light, Error Blocks of the subsystem
- Explored Electromagnetic Interference (**EMI**) Reductions Techniques to be incorporated into PCB designs
- Mentored 3 trainees in understanding the subsystem through FS rulebook, circuit design tasks and spice simulations

Trainee | Electrical Subsystem *(Jan 2020 - Aug 2020))*

- Investigated the Electronic Control Unit (**ECU**) subsystem, working with **RPM** and **position sensors** and realised working of the steering, acceleration pedal and brake sensors of the car with **Arduino IDE**
- Acquired the knowledge of Controller Area Network (**CAN**) and Data Acquisition (**DAQ**) systems and their implementation, wrote code for wireless communication using **LPC1768 Mbed** microcontroller and **XBee** module

Research Projects

Computational Commutative Algebra and Geometry

(July 2022 -Nov 2022)
Supervised Research Exposition (SRE) *(IIT Bombay)*
Guide: Prof. Debasattam Pal

- Investigated into the theory and computation of Gröbner Bases for ideals in a polynomial ring over a field
- Explored the algebraic and geometric applications of Gröbner Bases in solving Ideals, Varieties and Nullstellensatz problems
- Implemented solvers for System of Linear & Polynomial Equations and Sudoku in SageMath using Elimination Theory

Pushdown Timed Automata: Theory and Practice

(May 2022 - Dec 2022)
Guide: Prof. Akshay S.

- Explored various tools for the simulation and **reachability analysis** of Pushdown Automata and Pushdown Timed Automata
- Conceptualized suitable problems from Embedded Systems and WCET Benchmarks to model Pushdown Timed Automata
- Developed methodology to extract Pushdown Systems of boolean and Remopla programs using **Moped**

Data-Driven Dynamical Systems

(Jan 2023 - Apr 2023)
Guide: Prof. Vivek Borkar *(Course Project)*

- Explored the paradigms of Koopman Theory and Dynamic Mode Decomposition (**DMD**) and Extended DMD with Control
- Examined the ideas for discovering governing equations from data by Sparse Identification of Nonlinear Dynamics (**SINDy**)
- Investigated into Compressed Sensing and Sparse Regression techniques for solving the intermediate stages of SINDy

Scenario Approach to Robust Optimization

(May 2021 - Jul 2021)
Summer Undergraduate Research Program (SURP) *(EnPoWER, IIT Bombay)*
Guide: Prof. Debasish Chatterjee

- Worked on improving scenario approach to robust optimization problems in the **moderate to high dimensional** regime
- Studied **concentration of measure** phenomenon for the analysis of randomized algorithms and the scenario approach
- Analysed various randomized algorithms like **MCMC, Propp–Wilson, Simulated annealing** using Finite Markov Chains

Coded Computing for Straggler Mitigation, Security and Privacy

(Sep 2021 - Nov 2021)
Guide: Prof. Nikhil Karamchandani *(Course Project)*

- Investigated the concept of employing coding theory techniques to alleviate major problems in Distributed Computing
- Studied optimal coding methods for **Straggler Mitigation** in Matrix Multiplication and Multivariate Polynomial Evaluations
- Explored **Lagrange Coded Computing**, and its applications in **Secure & Private Multi Party Computing** (MPC)

Key Projects

Temperature Controller Using Heating Element and PWM Control *(Spring 2022)*
Guide: Prof. Kushal R. Tuckley *(Course Project)*
- Designed a low-cost, easy-to-maintain and reliable temperature controller system for food ovens with ability to maintain any temperature within the range of **90-260°C** with 1-2% accuracy and achieve it within 2 minutes
- Ideated a control mechanism accounting for the temperature difference, overheating of furnace and oscillations
- Selected suitable components for the driver circuitry, temperature sensing and interfacing by estimating thermal parameters
- Simulated, analysed and tested the system using **Simscape** physical modelling

Two-Way Fetch Superscalar Processor *(Spring 2022)*
Guide: Prof. Virendra Singh *(Course Project)*
- Designed a six-stage 16-bit superscalar processor capable of handling **19** arithmetic, logical, branching instructions
- Employed two-way instruction fetch, decode, dispatch, execute and write-back stages with **branch prediction** techniques
- Designed a **16-bit signed ALU** implementing addition using **Kogge–Stone fast adder**, and verified it using Intel Quartus

Tennis Scoreboard Simulator *(Spring 2021)*
Guide: Prof. V Raj Babu *(Course Project)*
- Simulated a tennis scoreboard using **Embedded C** in the **best-of-three tiebreak** set format on the **Pt-51** board
- Displayed directions to use and the score, Game Point, Set Point, Match Point for each player using an **LCD Module**
- Used **UART** Module and **RealTerm** software for interfacing between a keyboard and **Atmel AT89C51** micro-controller

Distributed Deep Learning *(Summer 2020)*
Institute Technical Summer Project (ITSP) *(Institute Technical Council, IIT Bombay)*
- Developed a **Hierarchically Distributed Deep CNN** in order to parallelise workload across nodes in the learning model
- Utilised the model to implement better training on **Super-High-Resolution Datasets** via **spatial segmentation** of each sample and observed increases in **training speed** and decrease in **memory utilisation** per node in the hierarchy network
- Verified the approach by using **Retinal OCT** dataset on Kaggle and analysed loss of information due to spatial-segmentation

Mini-8085 Microprocessor *(Spring 2022)*
Guide: Prof. Virendra Singh *(Course Project)*
- Designed a scaled down 8085 micro processor capable of handling **18** arithmetic, logical, branching instructions
- Devised level 2 hardware flowcharts, datapath organization, control words & decoding logic for provided ISA

Self Irrigation System *(Summer 2020)*
Tinkering Bootcamp, Learner's Space (LS) *(Tinkerers' Laboratory, IIT Bombay)*
- Developed using **Arduino IDE** to toggle between ON and OFF state according to readings from **DHT1** humidity sensor
- Provided **manual control** and **monitoring** through **Google Assistant** by projecting real-time data to **Blynk** servers

Technical Skills

Languages	C, C++, Python, Julia, MATLAB, Scilab, LaTeX, HTML, CSS, SQL
Frameworks & Libraries	Sage, Qiskit, NumPy, SciPy, pandas, scikit-learn, OpenCV, TensorFlow, Keras, PyTorch, Jekyll
Software	Git, Docker, Simulink, EAGLE, SPICE, Intel Quartus, Keil μVision, GNURadio, Adobe Illustrator
Hardware	Embedded C, VHDL, MIPS, 8051, 8086 Assembly, Arduino, ESP32, Raspberry Pi 4, Tiva-C

Key Courses Undertaken

Electrical	Processor Design, Digital Systems, Signal Processing, Information Theory, Error Correcting Codes
Control Systems	Nonlinear Systems, Multivariable Control, Optimal Control, Behavioral Theory of Systems
Computer Science	Logic for Computer Science, Data Structures and Algorithms, Design and Analysis of Algorithms, Operating Systems, Computer Networks, Game Theory and Algorithmic Mechanism Design Foundations of Intelligent and Learning Agents, Formal Methods in Machine Learning
Mathematics	Complex Analysis, Differential Equations, Linear Algebra, Large Sparse Matrix Computations Probability and Random Processes, Optimization, Introduction to Stochastic Optimization Discrete Structures, Number Theory and Cryptography, Topics in Cryptology, Calculus

Positions of Responsibility

Teaching Assistant | Computer Programming and Utilization *(Autumn 2021, Autumn 2022, Spring 2022, Autumn 2023)*
Guide: Prof. Bhaskaran Raman, Prof. Parag Chaudhuri, Prof. Akshay S., Prof. Ajit Rajwade (Computer Science and Engineering IIT Bombay)
- Academically guided **50 students,** clearing their doubts through weekly doubt sessions, labs and personal interaction
- Created and evaluated examination & lab problems and conducting help sessions for smooth running of course
- Brainstormed **60+ practice problems**, shared via a personal **webpage** with tips and more resources to enhance interest

Mentor | Summer of Science *(Summer 2021, Summer 2022)*
Topic: Linear Algebra and its Applications, Cryptography *(Maths and Physics Club, IIT Bombay)*
- Mentored **four students** in exploring the subject and guided them through various interesting resources
- Checked their progress regularly, personally cleared their doubts, reviewed and evaluated their reports & presentations

Editor | Department Newsletter Team *(2020)*
Background Hum: Team of 20 enthusiastic students *(Electrical Engineering Student Association, IIT Bombay)*
- Ideated and worked on an overview of **exciting labs** in the department to increase awareness among students
- Prepared content recommendations of scientific and engineering marvels to inspire curiosity among readers

Scholastic Achievements

- Secured **All India Rank 926** in Joint Entrance Examination (**JEE**) **Advanced** among 161 thousand candidates *(2019)*
- Secured **99.9%** percentile in Joint Entrance Examination (**JEE**) **Main** among 1.1 million candidates *(2019)*
- Scored **418** marks out of 450 in Birla Institute of Science and Technology Admission Test (**BITSAT**) *(2019)*
- Secured **99.92%** percentile in **MHT-CET** among 270 thousand candidates conducted by the Maharashtra Govt. *(2019)*
- Statewise top 1% in the National Standard Examination in Astronomy **(NSEA)** and Chemistry **(NSEC)** *(2019)*
- Recipient of the National Talent Search **(NTS)** Scholarship given by NCERT to 1000 students of country *(2017)*
- Awarded Academic Excellence Scholarship **(AES)** by SOF given to **one student per class per state** *(2017)*
- Recipient of the Maharashtra Talent Search **(MTS)** scholarship with **State Rank 11, 10, 16** respectively *(2015-17)*
- Recipient of State Scholarship by Maharashtra State Council of Examination with **State Rank 5** *(2014)*

Extracurriculars

Technical *(2019-2021)*	• Built a **RC Bot** capable of negotiating obstacles and designed & fabricated a **RC Trainer Plane** • Completed Summer of Science in **Game Theory** and **Nonlinear Dynamics** by Math & Physics Club • Completed **Scientific Computing** & **Data Analytics** Bootcamps and **Quantum Computing** Workshop • Qualified Round 1 of **Mathathon** conducted by Math & Physics Club
Volunteering *(2019-2022)*	• Conducted a session (TSC) attended by 100+ students for teaching concepts of **Computer Programming** and discussing doubts & previous year papers, organized by the Student Support Services, IIT Bombay • Volunteered for Career Counselling Campaign and A Session on Climate Change for 12,000+ underprivileged students from 8^{th} to 12^{th} conducted by **Abhyuday** in association with **NCC** across 80+ schools in Mumbai • **Mentored** students appearing for JEE during **COVID-19** crisis as part of **CovEd Education** initiative
Sports *(2022)*	• Awarded the Title of "Best Smashkarts Player" by Electrical Engineering Students' Association (EESA) • Part of **Inter-Department E-Sports Fest** winning squad representing Electrical Dept's **Smashkarts** team
Culturals *(2020)*	• Participated in **Group Act Competition**, Cultural GC organised by NCC IIT Bombay • Studied **Beginner Music Theory** as a part of Summer School of Cult conducted by ICC
NCC *(2020)*	• Completed a year-long **training program** as **NCC Cadet** under 2 MER NCC at IIT Bombay • Attended ten-day-long NCC **Annual Training Camp** (ATC) held during November-December 2019 • Part of **Republic Day Parade Contingent** held on 26^{th} January 2020 at IIT Bombay Gymkhana Ground

Miscellaneous Projects

Sensor Fusion – Implemented Complementary Filter for estimating orientation using Inertial Measurement Units (IMUs)
Mountain Car – Drove up a weak car on mountain using **Sarsa** with **Tile Coding** in **OpenAI Gym** environment
Path Following – Implemented in **MATLAB** using Pure Pursuit Algorithm and Vector Field Histogram for obstacle avoidance
MDP Planning – Implemented using Value Iteration, Howard's Policy Iteration and Linear Programming in Python
Moustique Cipher – Generated **Pseudorandom Bit Sequences** with almost perfect **linear complexity profiles** in Sage
Music Synthesizer – Designed a FSM to play 7 notes of Indian music in a particular order with **Behavioral Style VHDL**
Keyboard Scanning – Implemented **Key Debouncing** using Finite State Machine (FSM) in 8051 and MIPS Assembly
Dining Philosophers – Solved using both custom **semaphores** & **condition variables** independently with **pthreads API**
Course TimeTabling – Developed an Integer Linear Program with **Pulp** to allocate rooms and slots to courses appropriately
Corona Cases Tracker – Automated daily fetching of count of corona cases in India from web using **ESP32** and **ThingHTTP**
Automatic LED Lamp – Used **Schmitt Trigger** Circuit along with **LDR** in conjunction with a relay interfaced with an LED
Intruder Detection Alarm – Developed using a Passive Infrared **(PIR)** sensor which uses a buzzer module for alarm
Rotary Inverted Pendulum – Implemented in **MATLAB** using swing-up control and **LQR** balance control
Harry Potter's Invisibility Cloak – Induced transparency by **live removal of foreground** of a colour range using **OpenCV**
Digital Counter for Object Counting – Interfaced LED-IR detector pair to 7490, 7447A and LT-542 7-segment display