Aravind Bharathi
Engineering Physics
Indian Institute of Technology Bombay

190260009
UG Second Year
DOB: 10.02.2002

CPI: x.xx

Chennai, Tamil Nadu

Pursuing a minor in **Geo-informatics and Natural Resources Engineering** and honours in **Physics**

Publications

- Katla V., **Valluvan A. B.** et al. **"An Approach to Star Tracker Design for Nano-Satellite Applications"** extended abstract presented in National Conference on Small Satellite Technology and Applications, Trivandrum, India, 2020

Academic Achievements

- Secured a **perfect 10 CPI** in the Geo-informatics and Natural Resources Engineering Minor *(Present)*
- Achieved **xx.xx% percentile** out of 245,000 participants in **JEE Advanced** 2019 *(May 2019)*
- Achieved **xx.xx% percentile** out of 1,600,000 participants in **JEE Main** 2019 *(April 2019)*
- Secured **admission to the IISERs** on the basis of clearing the IISER Aptitude Test *(June 2019)*
- Attained **95.2%** in the All India Senior School Certificate Examination, Class 12 CBSE *(May 2019)*
- Secured a **perfect 10 CGPA** in Class 10 of Matriculation Studies under CBSE *(May 2017)*

Research Projects

Canopy Height Estimation

Guide: Professor J. Adinarayana, Head of Department, CSRE, IIT Bombay *(October 2020 - Present)*

- Conducted an extensive literature survey on the topics of **Computer Vision** and developed an understanding of techniques used in **Digital Photogrammetry** ranging from **Multi-View Stereo** Matching, **Structure from Motion**, and Depth-Map Estimation for large-scale scenes
- Generated and projected **dense point clouds** onto a 3D space, and analysed them using CloudCompare
- Investigated an open-source algorithm used in 3D modelling and optimised the source code to find the **height of crops** from drone-based **optical images**, and later geo-referenced the outputs using ground control points
- Applied computers and electronics to aid the **Indian Agricultural Sector** and learnt to handle **big data**
- This is a part of a much bigger project on **Data Sciences for Farming Support** (DSFS) Systems for Sustainable Crop Production Under Climate Change and involves multi-disciplinary consortium of research institutes under DST-JST scheme of Strategic International Collaborative Research Program

Technical Projects

Student Satellite Program

A 70 member student team dedicated to the vision of making IITB a centre of excellence in space technology

Star Tracker-based Attitude Determination System *(March 2020 - Present)*

A CubeSat-compatible Star Tracker-based Attitude Determination System to be tested on-board the PS4-OP

- Coded an **Iterative Feature Detection and Extraction Algorithm** on MATLAB followed by C++ to determine the centroids of stars from images simulating an outer-space environment for testing the Open-Loop Simulation of the Star Tracker and analysed the sources of error for the system like slew rate and de-focussing
- Reviewed a recursion based **Region Growth Algorithm** implemented as an alternate approach towards centroid determination
- Designed and reviewed the **layouts of Printed Circuit Boards** for a Voltage Regulator and a **SRAM Board** using EAGLE to interface with the electrical systems core FPGA module
- Implemented a **Star Matching Algorithm**, a ***k-vector* range searching** based algorithm that makes use of the distribution of centroids to match identified stars to a *Star Catalogue* of known celestial coordinates, on C and Embedded C to run tests on a micro-controller and conceive a hardware prototype for the mission
- The *matched* stars are used to estimate the attitude or orientation of the CubeSat when in orbit
- Applied systems engineering principles to arrive at the system and sub-system level **requirements from space environment**, launch load and power constraints provided by ISRO for designing the Star Tracker

Microcontroller Interfacing *(February 2020)*

- Understood and implemented **UART and SPI communication protocols** to achieve data transmission and sensor interfacing between two **ATxmega microcontrollers** using Embedded C on Atmel Studio

Astronomy Animation Team

Guide: Dr. Akshat Singhal, Department of Physics, IIT Bombay *(July - December 2020)*

- Developed **animation techniques** and gathered experience in **scriptable Python-based animation**
- Learnt and applied the various principles behind **representing rotations** from Axis Angles to **Quaternions**
- Rendered a procedural and qualitatively accurate **animation of a 3-body system** under a planar constraint
- Created procedural textured meshes for supernovae explosions and **gravitational wave projections**
- This initiative began through *Krittika, Institute Technical Council*, the Astronomy Club of IIT Bombay

Motion-Based Handwriting Recognition System

Insitute Technical Summer Project, Institute Technical Council, IIT Bombay *(April - June 2020)*

- Modelled a method of input to enable **writing in air or any surface** as part of a team of 4 members
- Coded the **signal processing** block of a trajectory recognition algorithm for a **pen-type** portable device
- Extracted and classified the reduced features with the help of a **Probabilistic Neural Network**

General Astronomy | Summer of Science

Maths and Physics Club, Institute Technical Council, IIT Bombay *(April - June 2020)*

- Made a report containing an overview of the **Big Bang theory**, its foundation and **observational support** as part of a 2 month long **reading project** taken under the guidance of a senior student mentor
- Studied and performed **scientific computing in Astronomy** on datafiles of images taken in outer space

Remote Controlled Bluetooth Bot | XLR8

Electronics and Robotics Club, Institute Technical Council, IIT Bombay *(September 2019)*

- Assembled a Bluetooth controlled bot capable of dodging obstacles and **navigating a challenging circuit**
- Implemented the electrical and mechanical aspects of it including a **differential driving mechanism**

Course Projects

Optical Sensor for Tropical Rainforest Imaging [GNR 401]

Guide: Prof. Avik Bhattacharya, CSRE, IIT Bombay *(September - October 2020)*

- Proposed a space-borne image sensor to critically understand the **effects of climate change** and capture significant temporal remote sensing data after a **critical survey and analysis** of current satellite payloads
- **Bridged the gap** between the need for expensive airborne hyperspectral imaging while providing continuous data needed to map carbon stocks and flux at the **broad spatial scales** required throughout the year

Analysis of Data from Underlying Event Characteristics [PH 219]

Guide: Prof. Sadhana Dash, Department of Physics, IIT Bombay *(October - December 2020)*

- Analysed **5.5 Gigabytes of data** generated from over **2 million** underlying event characteristics from charged particles in $p-p$ collisions, using a proprietary particle physics data analysis tool called **ROOT**
- Particles are observed as *tracks* in the detector and the *leading track* is the direction of the track along the particle with highest momentum. The no. of particles emitted in each event is given by the multiplicity class
- **Classified the events** based on the azimuthal angle with respect to the axis defined by the *leading track* and rapidity (speed) of the particle, and plotted the observations for different multiplicity classes

Fast Adder based Arithmetic-Logic Unit [EE 224]

Guide: Prof. Virendra Singh, Department of Electrical Engineering, IIT Bombay *(December 2020)*

- Designed a signed **16-bit Arithmetic-Logic Unit** (ALU) which computes signed addition, subtraction, NAND and XOR operations using Structural VHDL based on the *fast adder* **Kogge-Stone Architecture**
- Made test cases and verified the design using a testbench, and **simulated output waveforms** on Quartus

Positions of Responsibility

Convener

Maths and Physics Club, Institute Technical Council, IIT Bombay *(May 2020 - Present)*

- **Adapted the structure** of the club to an online format by organising several talks and **group discussions** while **curating trivia questions** for numerous online quizzing events for our **community of enthusiasts**
- Formulated and **led a targeted plan** to increase the frequency and quality of engaging content by **writing blog posts** and articles on little-known scientists and about **diverse concepts in science**
- Engaged **over 10000 followers** on our social media platforms, the result of a **3-fold increase** in this tenure
- Kept the **Club's Website** up-to-date, **building and expanding** on the work done by our past members
- Hosted a group discussion on Information Theory and Entropy which was attended by **over 100 enthusiasts**
- Designed and conducted a 4-day workshop on Number Theory and Cryptography with **over 400 attendees**
- Developed the course content, framed questions, **conducted live hands-on-sessions** and **delivered talks** for guiding the participants to understand the underlying concepts while clearing doubts in the QnA forum

Work Experience

Project Intern

FIITJEE Tamil Nadu and Kerala *(July - September 2020)*

- Helped in the **curation and reviewal of content** for one of the **premier institutes** for JEE coaching
- **Crafted presentations** with **LaTeX scripts** and animations for a learner-centric online mode of teaching

Workshops Attended

Learner's Space

Technical Summer School, Institute Technical Council, IIT Bombay *(June - July 2020)*

Scientific Computation and Mathematical Modelling *(6 weeks)*

- Animated and performed **data visualisation** using Python libraries like SciPy, **Matplotlib** and Seaborn
- **Mathematically modelled** real-life scenarios like **heat transfer**, wave equation and the Leontief model
- Coded methods of **numerical analysis** like **Runge-Kutta** and Euler methods to solve differential equations

Machine Learning and Deep Learning *(7 weeks)*

- Performed **data preparation** using Pandas and learnt the essential components of classical machine learning
- Developed an understanding about the pragmatics behind **Neural Networks and Deep Learning**
- Implemented various **regression and classification models** and employed different **dimensionality reduction** techniques

Key Courses Taken

Mathematics and Computing Numerical Analysis*, Complex Analysis, Differential Equations, Linear Algebra, Calculus, Data Analysis and Interpretation, Computer Programming and Utilisation

Physics General Theory of Relativity*, Quantum Mechanics I*, Waves,Oscillations and Optics*, Classical Mechanics, Special Theory of Relativity, Electricity and Magnetism, Quantum Physics and Applications

Electrical Digital Systems, Electronics and Semiconductor Devices, Basic Circuits lab*, Op-amp circuits lab*

Geo-informatics Geographic Information Systems*, Remote Sensing and Image Processing

* to be completed in Spring 2020-21

Technical Skills

Programming Languages C++, Python, MATLAB, VHDL, ROOT, Embedded C, C, HTML

CAD and Simulation Softwares EAGLE, Blender, MeshLab, CloudCompare, SPICE, Audacity

Integrated Development Environments Jupyter, Visual Studio Code, Atmel Studio, Quartus Prime

Public Speaking

Technical:

- Hosted a **group discussion on Game Theory** which was attended by **over 80 enthusiasts** as part of the Maths and Physics Club, IIT Bombay *(January 2021)*
- Delivered a series of **online lectures** and conducted live hands-on sessions as part of the **Number Theory and Crytography Workshop** hosted by the Maths and Physics Club, IIT Bombay *(December 2020)*
- Hosted a **group discussion on Information Theory** and Entropy which was attended by **over 100 enthusiasts** as part of the Maths and Physics Club, IIT Bombay *(November 2020)*
- Represented the school in the **mathematical modelling** competition at the state level **STEM expedition** conducted by CBSE *(January 2018)*

Miscellaneous:

- Anchored the **Ground Station Workshop** hosted by the Ham Radio Club, IIT Bombay *(January 2021)*
- Anchored the **Online Fresher's Tech Orientation** for the Institute Technical Council *(December 2020)*
- **Invited** to deliver two closed talks on **"Motivation for JEE"** to high school students attended by over 250 students each *(July 2020)*
- Performed at a stand-up comedy event hosted as part of a Freshers ice-breaker platform by the Institute Cultural Council *(September 2019)*
- **Placed second** in Stance Drafting at Ampersand 2018, Chettinad Vidyashram, Chennai *(July 2018)*

Extra-curriculars

Music:

*Awarded the **Level 3 Certificate** in Graded Examination in Music Performance, the **highest possible Grade 8**, for Piano, along with **32 credits** for Qualifications and Credit Framework by the **Trinity College of London** - becoming one of the youngest Indian to accomplish this in the process* *(2010 - December 2016)*

- Placed third in the inter-hostel Music Arcade competition at IIT Bombay *(February 2020)*
- Performed at **Surbahaar**, the flagship concert hosted by Symphony attended by over **2200** *(October 2019)*
- Won **second place** in performing arts - western music - in Freshiesta, IIT Bombay *(September 2019)*
- Performed in the **choir of the 57th Convocation** in IIT Bombay *(August 2019)*
- Represented the school at various regional and state level musicals *(June 2017 - September 2018)*
- Awarded a **special mention for individual musical excellence** at a regional level music competition hosted by Bhavan's Rajaji Vidyashram *(June 2018)*

Sports:

Adventure Cyclist and Recreational Triathlete *(2017 - Present)*

- Completed a **year long training** in Football under the **National Sports Organisation** *(March 2020)*
- Completed the **WCCG Mass 100, a 100km cycling tourney** around Chennai *(June 2019)*
- Represented the school at the regional and state level at various Football Tournaments *(2012 - 2017)*

Technical:

- Moderated a 3-day workshop on **Gravitational Wave Analysis** with over 200 participants *(December 2020)*
- **Placed first** in the **Programming Contest** held at KCG College of Technology, Chennai *(September 2018)*

Miscellaneous:

- Achieved a highest **typing speed** of **112 *words-per-minute*** and an average of 97 wpm *(January 2021)*
- Organiser at **Techfest 2019**, IIT Bombay managing a **footfall of over 130,000** *(January 2020)*