

Aravind Bharathi  
Engineering Physics  
Indian Institute of Technology Bombay

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UG Second Year  
DOB: 10.02.2002

CPI: 8.20

     
 Chennai, Tamil Nadu

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

## Publications

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- 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

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- Secured a **perfect 10 CPI** in the Geo-informatics and Natural Resources Engineering Minor (Present)
- Achieved **98.02% percentile** out of 245,000 participants in **JEE Advanced** 2019 (May 2019)
- Achieved **99.35% 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

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### 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

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### 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

Institute 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

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### 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



### Volunteer

*Saathi, IIT Bombay*

*(August 2019 - Present)*

- **Actively contributed** and participated in the **LGBTQIA+ support and resources group** in campus
- Helped in creating **public awareness** and outreach on our social media platforms with **over 6500 members**



## Work Experience

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### 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 **L<sup>A</sup>T<sub>E</sub>X** scripts and animations for a learner-centric online mode of teaching

## Workshops Attended

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### 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

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**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

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**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

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### 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 Cryptography 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

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### 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 57<sup>th</sup> 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)