Avirup Mandal, Ph.D.

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Research Interest

- Computer Graphics, Physically-based Animation, Signal Processing, Extended Reality (XR), Haptics
- Application of Differential Geometry & Machine Learning in Engineering and Graphics

Education

2018 – 23 ◇ **IIT Bombay**, Mumbai, India.
Ph.D., Electrical Engineering, CGPA: 9.33/10.0.
Dissertation: *Fast Remeshing-Free Methods for Complex Cutting and Fracture Simulation*.
Advisors: Prof. Subhasis Chaudhuri and Prof. Parag Chaudhuri.

2016 – 18 ◇ **IIT Bombay**, Mumbai, India.
M.Tech., Electrical Engineering, CGPA: 9.48/10.0.
Thesis: *Haptic Rendering of Submerged Objects*.
Advisor: Prof. Subhasis Chaudhuri.

2011 – 15 ◇ **Jadavpur University**, Kolkata, India.
B.E., Electronics & Telecommunication Engineering, CGPA: 9.03/10.0.

2009 – 11 ◇ **Burdwan Municipal High School**, West Bengal.
Higher Secondary, Science, Grade: 90%.

2007 – 09 ◇ **Burdwan Municipal High School**, West Bengal.
Secondary, General, Grade: 89.6%.

Work Experience

2023 – Present ◇ **IIT Bombay**, Mumbai, India.
Research Associate, Electrical Engineering.
Topic: *Understanding Natural Phenomena using Differential Geometry and Machine Learning*.
Mentor: Prof. Subhasis Chaudhuri.

2014 ◇ **Indian Statistical Institute**, Kolkata, India.
Research Intern, Electronics and Communication Sciences Unit.
Topic: *Object Detection and Tracking in Variable Background using Fuzzy Kalman Filter*.
Mentor: Prof. Kumar Sankar Ray.

Research Articles

Journals/Conferences

1. **A. Mandal**, P. Chaudhuri, and S. Chaudhuri. *Remeshing-Free Graph-Based Finite Element Method for Fracture Simulation*. Computer Graphics Forum. 2023.
2. **A. Mandal**, P. Chaudhuri, and S. Chaudhuri. *Simulating Fracture in Anisotropic Materials Containing Impurities*. ACM SIGGRAPH Conference on Motion, Interaction and Games - MIG. Guanajuato, Mexico. November 2022.
3. **A. Mandal**, P. Chaudhuri, and S. Chaudhuri. *Interactive Physics-Based Virtual Sculpting with Haptic Feedback*. ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games - I3D. Virtual event. May 2022. (Journal version appeared in Proceedings of the ACM on Computer Graphics and Interactive Techniques).
4. **A. Mandal**, P. Chaudhuri, and S. Chaudhuri. *Real-time Physics-based mesh deformation with haptic feedback and material anisotropy*. International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications - GRAPP. Lisbon, Portugal. February 2023.
5. **A. Mandal***, K. Ayush*, and P. Chaudhuri. *Non-linear Monte Carlo Ray Tracing for Visualizing Warped Spacetime*. International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications - IVAPP. Virtual event. February 2021. (Joint first authors).

6. **A. Mandal**, D. Sardar, and S. Chaudhuri. *Haptic Rendering of Solid Object Submerged in Flowing Fluid with Environment Dependent Texture*. EuroHaptics. Pisa, Italy. June 2018.

Patent

1. T. Kundu, K. Lahiri, **A. Mandal**, A. Mukherjee, M. K. Naskar, and S. Sinha. *Generic Data Compression for Heart Diagnosis*. U.S. Patent 9477701 B1 2016.

Posters

1. **A. Mandal**, P. Chaudhuri, and S. Chaudhuri. *Artist Controlled Fracture Design Using Impurity Maps*. SIGGRAPH Posters. Vancouver, BC, Canada. August 2022.
2. **A. Mandal**, P. Chaudhuri, and S. Chaudhuri. *Scalable Visual Simulation of Ductile and Brittle Fracture*. SIGGRAPH Posters. Virtual event. August 2021.

Academic Research Projects

I am broadly interested in developing *fast*, *efficient* and *robust* algorithms for ***physics-based animation*** and ***simulation of natural phenomena***. I worked on the following projects.

Graph-based Finite Element Method for Fracture Simulation

- Developed remeshing-free graph-based FEM for fracture simulation of ductile and brittle materials. Our method surpasses existing fracture simulation algorithms in terms of stability and speed.
- Successfully solved the long-standing challenge of the dependence simulation runtime on the number of cracks.

Random Graph-based FEM for Fracture Simulation in Impure Materials

- Developed random graph-based probabilistic damage mechanics to simulate fracture in impure materials.
- Designed an interactive framework to control the propagation of fracture patterns in an object.

Galerkin Enhanced Graph-based FEM for Virtual Sculpting

- Extended graph-based FEM using Galerkin Multigrid method to build an interactive, real-time virtual sculpting framework with appropriate haptic feedback.
- Parallelize simulation on a GPU using CUDA to accelerate simulation.

Non-linear Monte-Carlo Raytracing to Visualize Wrapped Spacetime

- Devised a non-linear Monte Carlo ray tracing algorithm to render scenes involving complex and massive interstellar objects like black holes and wormholes.
- Solved the field equations of General Relativity to calculate the geodesics of light rays for accurate visualization.

Haptic Rendering of Textured Solid Objects immersed in Fluid

- Simulated water flow using particle-based Lagrangian approach solution of Navier-Stokes equation.
- Rendered faithful haptic feedback force for water and submerged solid through a haptic device.

Sponsored Project Grants

Qualcomm Innovation Fellowship, 2022

- Five graduate students across India were individually awarded a prize of one million INR.

Qualcomm Innovation Fellowship, 2021

- Thirteen graduate students across India were individually awarded a prize of one million INR.

Awards and Achievements

2023 ◇ **SIGGRAPH Asia Doctoral Consortium**, SIGGRAPH Asia 2023.
2022 ◇ **Qualcomm Innovation Fellowship** *Super-Winner*, India.

Awards and Achievements (continued)

- **ACM Student Research Competition** *Semi-Finalist*, SIGGRAPH.

2021
- **Qualcomm Innovation Fellowship** *Winner*, India.
- **Best Paper Award** *Finalist*, IVAPP.
- **Best Teaching Assistant Award** (awarded twice), IIT Bombay.

2016
- **All India Rank 113** out of 152k candidates in *GATE* with *ECE specialization*.

2011
- **State Rank 94** out of 125k candidates in *West Bengal Joint Entrance Examination*.

Skills

Languages	Strong reading, writing and speaking competencies for English, Bengali.
Coding	C++, C, Python, Java, OpenGL, CUDA, OpenHaptics, LaTeX.
Tools	MATLAB, Houdini, Visual Studio, Eclipse, Android Studio, MeshLab.
Web Dev	Html, css.

Experience as Teaching Assistant

2016 – 21
- Communication Systems (EE 308) [*2016*], Digital Communications (EE 328) [*2017, 2019, 2020*], Digital Signal Processing (EE 603) [*2017, 2019, 2020, 2021*], Computer Vision (EE 702) [*2018*], Digital Signal Processing System Design and Implementation Lab (EE 750) [*2018*].

Relevant Courses

Graphics	Computer Graphics, Advanced Computer Graphics.
Mathematics	Applied Linear Algebra, Statistical Signal Analysis, Optimization Techniques, Engineering Statistics, Advanced Probability and Random Processes for Engineers.
Signal Processing	Digital Signal Processing, Recent Topics in Analytical Signal Processing.
Image Processing	Image Processing, Computer Vision, Digital Image Processing of Remotely Sensed Data.
Machine Learning	Foundations of Machine Learning, Deep Learning - Theory and Practice.
Computer Science	Digital Logic Design, Operating Systems, Data Structure, Computer Architecture.

Extracurricular

Reading	Novels, Short stories, Popular science books.
Interests	Astrophysics, Special and General Relativity, Topology, Differential Geometry.
Administrator	Vision and Image Processing Lab, Department of EE, IIT Bombay (2018 – 2022).
Organiser	Department of ETCE alumni meet (SANJOG '13) at Jadavpur University.

References

- **Subhasis Chaudhuri**, Director of IIT Bombay & K. N. Bajaj Chair Professor of Electrical Engineering, IIT Bombay. sc@ee.iitb.ac.in
- **Parag Chaudhuri**, Professor of Computer Science and Engineering, IIT Bombay. paragc@cse.iitb.ac.in
- **Abhishek Gupta**, Assistant Professor of Mechanical Engineering, IIT Bombay. abhi.gupta@iitb.ac.in