Avirup Mandal, Ph.D.

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Research Interest

Computer Graphics & Geometry Processing, Physically-based Simulation, Applied Differential Geometry, Haptics, Extended Reality (XR), Neural Rendering

Work Experience

2024 – Present ◇ **IIT Palakkad**, Palakkad, India.
Assistant Professor, Computer Science and Engineering.

2023 – 24 ◇ **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.

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. (Dual M.Tech. + Ph.D.), Electrical Engineering, CGPA: 9.33/10.0.
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**, Burdwan, WB, India.
Higher Secondary, Science, Grade: 90%.

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

Research Articles

Journals

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. *Interactive Physics-Based Virtual Sculpting with Haptic Feedback*. Computer Graphics and Interactive Techniques. 2022. [*Conference version appeared in ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games - I3D*].
3. **A. Mandal**, P. Chaudhuri, and S. Chaudhuri. *A Volume Preserving Mean Curvature Flow with Singularities*. [*Under preparation*].

Conferences

1. **A. Mandal**, P. Chaudhuri, and S. Chaudhuri. *Galerkin Enhanced Graph-based FEM for Interactive Fracture and Sculpting Applications*. International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications - GRAPP. Porto, Portugal. February 2025. [Best Paper Award Finalist].
2. **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.

3. **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.

4. **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*]. [Best Paper Award Finalist].

5. **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. [*Names in alphabetical order*].

Posters

1. **A. Mandal**, P. Chaudhuri, and S. Chaudhuri. *Artist Controlled Fracture Design Using Impurity Maps*. SIGGRAPH Posters. Vancouver, BC, Canada. August 2022. [ACM Student Research Competition Semi-Finalist].

2. **A. Mandal**, P. Chaudhuri, and S. Chaudhuri. *Scalable Visual Simulation of Ductile and Brittle Fracture*. SIGGRAPH Posters. Virtual event. August 2021. [Selected for Technical Paper Oral Session presentation].

Academic Research Projects

I am broadly interested in developing *fast*, *efficient* and *robust* algorithms for ***physics-based simulation***, ***simulation of natural phenomena*** and ***geometry processing***. 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.

Graph Neural Network to Simulate Complex Physics

- Developed a GNN model on TensorFlow to learn physics-based deformation for 2D & 3D mesh models.
- Leveraging GNNs enhances scalability over traditional mesh-based simulation, enabling quicker and more precise rendering, thereby facilitating the exploration of intricate physical phenomena.

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.
◇ **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.
API/Library ◇ OpenGL, CUDA, OpenHaptics, TensorFlow, PyTorch, Keras.
Tools ◇ MATLAB, Houdini, LaTeX, 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

Available on Request