Avirup Mandal, Ph.D.

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Areas of Interest

Computer Graphics & Vision, Physically-based Animation, Signal Processing, Extended Reality (XR), Haptics, Geometry, Machine Learning, Neural Rendering

Education

2018 – 23 ◇ **Ph.D.**, EE, IIT Bombay, Mumbai, India. CGPA: 9.33/10.0.
2016 – 18 ◇ **M.Tech.**, EE, IIT Bombay, Mumbai, India. CGPA: 9.48/10.0.
2011 – 15 ◇ **B.E.**, ECE, Jadavpur University, Kolkata, India. CGPA: 9.03/10.0.

Work Experience

2023 – Present ◇ **Research Associate**, EE, IIT Bombay, Mumbai, India.
2014 ◇ **Research Intern**, ECE, ISI, Kolkata, India.

Skills

Coding ◇ C++, C, Python, OpenGL, CUDA, OpenHaptics, LaTeX.
ML/DL Framework ◇ TensorFlow, PyTorch, Keras.
Tools ◇ MATLAB, Houdini, Visual Studio, Eclipse, Android Studio, MeshLab, Git.
Web Dev ◇ HTML, CSS.

Projects

Graph-based/Random 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 by 50x.
- Successfully solved the long-standing challenge of the dependence simulation runtime on the number of cracks.
- Extended graph-based FEM to random probabilistic damage mechanics to simulate fracture in impure materials.
- Designed an interactive framework to control the propagation of fracture patterns using C++ & OpenGL.

Galerkin Enhanced Graph-based FEM for Virtual Sculpting with Haptic Feedback

- Extended graph-based FEM using Galerkin Multigrid method to build an interactive, real-time virtual sculpting framework with appropriate haptic feedback using C++, OpenGL & OpenHaptics.
- 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 Solid Objects Immersed in Fluid

- Simulated water flow around a solid immersed object using a Lagrangian approach of Navier-Stokes equation with Smooth Particle Hydrodynamics using C++, OpenGL & OpenHaptics.
- Proper haptic feedback force for both the fluid and immersed solid is calculated and faithfully rendered.

Graph Neural Network for Physics-based Mesh Simulation

- 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.

Object structure and motion recovery from optical flow and shading

- Implemented two algorithms in Python to recover object structure and motion from shading & optical flow.
- Studied the performance regarding noise level, texture information, and regularization factor.

Implementation of Multi-layer Perceptron

- Implemented multi-layer neural network with backpropagation using only basic libraries of Python.
- Proper feature engineering techniques are applied to normalize the raw data and achieve 76% accuracy.

Publications/Patents

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. *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**, P. Chaudhuri, and S. Chaudhuri. *Artist Controlled Fracture Design Using Impurity Maps*. SIGGRAPH Posters. Vancouver, BC, Canada. August 2022.
5. **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.
6. **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).
7. **A. Mandal**, P. Chaudhuri, and S. Chaudhuri. *Scalable Visual Simulation of Ductile and Brittle Fracture*. SIGGRAPH Posters. Virtual event. August 2021.
8. **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.
9. 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.

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.
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*.

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.
Vision ◇ Image Processing, Computer Vision, Digital Image Processing of Remotely Sensed Data.
Machine Learning ◇ Foundations of Machine Learning, Deep Learning - Theory and Practice.

Extracurricular

Administrator ◇ Vision and Image Processing Lab, Department of EE, IIT Bombay (2018 – 2022).
TA ◇ Teaching Assistant for six courses, Department of EE, IIT Bombay (2016 – 2022).
Organiser ◇ Department of ETCE alumni meet (SANJOG '13) at Jadavpur University.
Hobbies ◇ Reading novels, short stories, popular science books & Watching crickets.