Shrey Jayeshbhai Patel

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Education

University of Maryland, College Park — Aug 2023 - Present
Ph.D. in Computer Science — (4/4)

Indian Institute of Technology, Delhi — July 2019 - June 2023
B. Tech. in Computer Science and Engineering — (9.41/10)

Research Interests

Computational Physics, Physics-based Simulation, Differentiable Physics, Computer Graphics

Research Experience

GAMMA Lab, University of Maryland College Park — August 2023 - Present
Graduate Research Assistant — **Advisor:** Prof. Ming Lin

- Working on differentiable strong two-way coupling and applications in control or inverse problems
- Proposed a novel method for unified handling of sub-grid and larger rigid bodies on coarse grids

Graphics and Vision Group, CSE Dept., IIT Delhi — August 2022 - June 2023
Undergraduate Student Researcher — **Advisors:** Prof. Rahul Narain, Prof. Prem Kalra

- Developed a simulation for a neurosurgery called Endoscopic Third Ventriculostomy(ETV) for virtual training of surgeons, in collaboration with All India Institute of Medical Sciences(AIIMS) Delhi, India
- Developed a fluid simulator to study strong two-way coupling between fluids and rigid bodies of different scales

Industry Experience

Quadeye Securities LLP — June 2022 - July 2022
Systems Intern

- Worked on automated program verification and static analysis using LLVM/Clang
- Designed clang-tidy checks using abstract syntax tree(AST) traversal for refactoring codebase
- Used clang static analyzer using control flow graphs for automated detection of bugs and vulnerabilities

Projects

Fluid Simulator

- Fluid dynamics based on Navier-Stokes' equation on domain discretized into staggered grids. Solution using operator splitting strategy in which the equation is divided into advection, pressure solve and time integration
- Rigid body dynamics and collision handling using ReactPhysics3D and Box2D
- Interactions between fluid and rigid bodies using variational interpretation of pressure

Membrane Simulation for Virtual Surgery — GitHub

- Designed the membrane mesh as a half-edge data structure for efficient query/update during remeshing
- Mapped the mesh to a mass-spring system for simulating the dynamics of the mesh
- Implemented fast collision handling and fracture dynamics, for interactivity with a surgical instrument

Ray Tracing — Standard, Monte-Carlo

- Standard variant uses the Phong illumination model to calculate specular, diffuse and ambient light components
- Monte-Carlo variant calculates incoming radiance values recursively using the rendering equation, which is solved using Monte-Carlo integration. Sample efficiency improved by importance sampling and Russian Roulette

MIPS ISA Simulator with DRAM Memory GitHub

– Developed a simulator to parse and execute MIPS assembly language instructions using registers and cache
– Designed a memory request manager with multicore support to efficiently reschedule instructions
– Enhanced by non-blocking memory, forwarding and optimizing buffer updates and writebacks

Automated Theorem Prover for First Order Logic GitHub

– Developed SML code to parse, type-check and evaluate propositions of first-order logic
– Modelled theorems in FOL as conjunctive normal forms(CNF) and stored them as tableaus in dot format
– Theorems are proved/disproved by depth first traversal on tableaus, using symbol tables for storing variables

CoviWars: A COVID-19 themed game GitHub

– Designed from scratch, with multiplayer support using sockets and custom message passing
– Includes a custom interface, random dynamic mazes, variety of enemies, powerups and status effects
– Designed custom variants of Djikstra's algorithm for maze construction and controlling enemy intelligence.

Quadcopter Drone Modelling GitHub

– Hierarchical modelling using directed graphs and transforms like translation, rotation, scaling
– Modes: drone view and vhird person View using viewing and projection transformations
– Control: interactive maneuvering or along predefined path given as bezier curves or B-Splines

Scene Walkthrough using Multi-Pass Rendering GitHub

– Environment created using skybox and billboarding and illuminated by time-of-day rendering
– Scene created using custom/imported models layered with textures: shadow mapping for shadows, normal mapping for embossing, displacement mapping for deformities and texture blending

Coursework

Scientific Computing(A+), Differentiable Programming Fall 2023
Computer Graphics, Digital Image Analysis, Logic for CS July 2019 - June 2023
(in addition to core CS and Mathematics)

Technical Skills

Programming Languages C/C++, MATLAB, Python, Java, SML, GLSL, Dot
Libraries/Frameworks OpenGL, Eigen, Unity, LLVM/Clang, OpenMP, OpenCV

Achievements

IIT Delhi Semester Merit Award 2019-20
All India Rank 74, JEE Advanced 2019
Kishore Vaigyanik Protsahan Yojana(KVPY) Fellowship, IISc Bangalore 2019
Top 1% Award in National Standard Examinations: Physics, Chemistry & Astronomy 2018-19
National Talent Search Examination(NTSE) Scholarship, Govt. of India 2017