# Optimization of CPU & GPU in Physics Engines

By: Justin Nguyen

# TABLE OF CONTENTS

# What are CPUs?

- A CPU (Central Processing Unit) is the primary component of a computer that performs most of the processing.

- The CPU executes instructions from software and applications, processes data, runs applications, and manage system operations.

- Every action you perform on a computer whether opening a file, browsing the web, or running software is processed by the CPU.

- Functions of a CPU
  - FETCH
  - DECODE
  - EXECUTE
  - STORE

# What are GPUs?

- A GPU (Graphic Processing Unit) is a specialized processor designed to handle graphics rendering.

- Initially developed just for rendering images, videos, and animations, but now are widely used in applications like gaming, artificial intelligences, and scientific computations.

- Functions of a GPU
  - Rendering Graphics
  - Parallel Processing
  - Video Editing and Rendering
  - Data Processing & Scientific Computing

# Physics Engines

- Physic Engines are software component that simulates physical interactions in a virtual environment.

- Typically used in video games, simulations, animations, and scientific computing to create realistic movements, collisions, and forces.

- Physic Engines Task
  - Collision Detection & Response
  - Rigid Body Dynamics
  - Soft Body Dynamics
  - Ragdoll Physics
  - Fluid & Particle Simulation
  - Vehicle Physics

# Optimization using CPUs and GPUs

- CPU Optimization is responsible for managing physics calculations, updating object states, and handling interactions.
  - Prioritize CPU power for rigid bodies (cars, walls) while delegating soft bodies (cloth, fluids) to the GPU.

- GPU Optimization is designed for massive parallelism, making it ideal for particle effects, fluid dynamics, and soft-body simulations.
  - Ideal for debris, explosions, cloth, smoke, and liquid simulations.
  - Often used in AI physics simulations and real time destruction mechanics.

# Effect on Gaming Industries

- Optimizing CPUs and GPUs in physics engines enhances the performance, realism, and scalability of video games.

- Efficient use of these processors allows for more complex physics simulations, smoother gameplay, and improved visual fidelity.

- Enhance Game Realism
  - Realistic Collisions & Interactions
  - Seamless Open Worlds

- Performance Improvement & Smooth Gameplay
  - Efficient Parallel Processing
  - Reduced Lag & Frame Drops

# Conclusion: Potential Future

- CPU and GPU performance will play a crucial role in achieving more realistic simulations while maintaining high efficiency.

- Physics Learning will include AI models predicting physics behaviors, reducing the need for real time calculations.

- As hardware and software continue evolving, physics simulations will become more realistic, efficient, and scalable, pushing the boundaries of gaming, VR, AI training, and scientific modeling.

# Sources

D. Both, "The central processing unit (CPU): Its components and functionality," *Red Hat Blog*, Jul. 2020
redhat.com

E. Sperling, "New Approaches For Processor Architectures," *SemiEngineering*, Aug. 2021
semiengineering.com

NVIDIA Blog, "CPU vs GPU: What's the Difference?" (K. Krewell, updated)
blogs.nvidia.com

ASUS Tech Blog, "Discrete vs Integrated GPU – Which to Choose," Aug. 2023
asus.com

NVIDIA, Ampere GA102 GPU Architecture Whitepaper, 2020
nvidia.com

Wikipedia, "Physics engine – Definition and usage"
en.wikipedia.org

SegaRetro, "Havok – physics engine used in 600+ games," 2013
segaretro.org

Wikipedia, "Hardware acceleration of physics (GPGPU)"
en.wikipedia.org

M. Humphries, "Nvidia Announces PhysX 5.0," *PCMag*, Dec. 2019
pcmag.com

IndustryWeek, "Product Development 2025: AI and Simulation," Oct. 2023
industryweek.com

Genesis Engine (MIT/Columbia U.), "High-Performance GPU Physics for AI," Dec. 2022
genesis-embodied-ai.github.io

NVIDIA Developer (T. Harada et al.), *GPU Gems 3*, "Physics Simulation on GPUs," 2007
developer.nvidia.com

THANK YOU !