

# Tony Yiding Tian

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## EDUCATION

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**University of Pennsylvania - School of Engineering and Applied Sciences** Philadelphia, PA  
*B.S.E. in Computer Engineering, M.S.E. in Computer Graphics and Game Technology* May 2027

- GPA 3.74 — Relevant Courses: GPU Programming, Advanced Rendering, Interactive Computer Graphics, Operating Systems Design & Implementation, Data Structure & Algorithm, Embedded Systems, Electrical Circuit

## EXPERIENCE

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**Linux Kernel Policies Research Assistant - PURM Scholar** May 2025 – Present  
*Learning Directed Operating System (LDOS), Prof. Sebastian Angel* Philadelphia, PA

- Selected as Penn Undergraduate Research Mentorship (PURM) 2025 Scholar, conducting advanced research in distributed systems and kernel optimization under Prof. Sebastian Angel
- Developed eBPF-based kernel monitoring infrastructure collecting real-time TCP networking metrics retrieved from 5 crucial kernel tcp functions of tcp\_v4\_rcv, v4\_connect, state\_process, congestion\_control, and cubic
- Engineered high-performance data analysis pipeline processing 10,000+ TCP state transitions per second, identifying critical performance bottlenecks in kernel networking policies and congestion control algorithms
- Architected and contributed 2000+ lines of C and Python code to open-source [KernMLOps repository](#), implementing tcp kernel probing infrastructure used by 15+ researchers
- Presented research findings on TCP optimization to distributed systems lab, leading to 25% improvement in network throughput for target applications

**Product Development Researcher & UX Designer** Jan 2025 – May 2025  
*YesTech Corporation - Best Friends Network Social Platform* Remote

- Led user-centric product development team of 6 for startup's flagship social media application targeting Gen-Z demographic with 10,000+ beta users
- Architected and designed "Friendship Portal" core feature enabling real-time mood sharing between connected users, driving 40% increase in daily active engagement
- Conducted comprehensive user research including A/B testing across 500+ users, survey design and analysis, and usability studies resulting in 3 major feature iterations
- Collaborated directly with mobile development team to implement data-driven UI/UX improvements, reducing user onboarding time by 35% through iterative design optimization
- Established quality assurance protocols for mobile app testing across iOS and Android platforms, identifying and documenting 50+ critical bugs pre-release

**Guest Service Attendant** May 2024 – Aug 2025  
*Residential and Hospitality Services, University of Pennsylvania* Philadelphia, PA

- Managed large-scale residential operations supporting 1000+ high school students during summer programs, implementing streamlined check-in processes that reduced average wait time by 45%
- Coordinated resource allocation and inventory management for essential residential supplies (temporary credentials, equipment carts, linens), optimizing distribution efficiency by 30%
- Provided technical customer support and troubleshooting for residents including minors, maintaining 95% customer satisfaction rating through effective communication and problem-solving
- Collaborated with facilities management team to resolve technical issues across multiple building systems, reducing average incident response time from 30 to 15 minutes

**Beta Test Engineer & Quality Assurance Analyst** Dec 2022 – Oct 2023  
*miHoYo - Genshin Impact (AAA Mobile Gaming)* Remote

- Selected as exclusive beta tester for Genshin Impact, a \$4B+ revenue mobile game with 60M+ monthly active users, participating in pre-release testing cycles every 6 weeks
- Conducted comprehensive quality assurance testing for 10+ character releases, each generating \$1M+ in revenue, ensuring gameplay balance and identifying critical performance issues before public launch
- Performed systematic testing of open-world gameplay mechanics including combat systems, puzzle design, and performance optimization across multiple mobile platforms (iOS, Windows)
- Documented and reported 100+ gameplay bugs and performance issues through structured testing protocols, contributing to 15% reduction in post-launch critical bugs
- Provided detailed feedback on character design, combat mechanics, and user experience, influencing design decisions for characters with combined revenue exceeding \$10M

**MatForge - Advanced Material Rendering System** | *Vulkan 1.3, Slang, C++*

Nov 2025 – Dec 2025

- Architected production-quality GPU path tracer implementing four SIGGRAPH papers (2023-2024) in unified Vulkan ray tracing pipeline, contributing 2,400+ lines of C++ and Slang shader code for sampling and geometry systems
- Implemented Quad-Optimized Low-Discrepancy Sequences (QOLDS) from SIGGRAPH 2024, engineering base-3 Sobol' generator with Owen scrambling across 47 dimensions, achieving +2.57 dB PSNR and 44.7% MSE reduction vs PCG sampling at 512 SPP with 1% performance overhead
- Developed RMIP (Rectangular MinMax Image Pyramid) intersection shader from SIGGRAPH Asia 2023, enabling tessellation-free displacement mapping through hierarchical texture-space ray traversal with custom Vulkan intersection shaders
- Engineered automated convergence analysis framework generating statistical benchmarks across sampling configurations, validating rendering quality improvements through PSNR/SSIM metrics and CSV-based visualization pipeline
- Integrated techniques into complete Monte Carlo path tracing pipeline supporting glTF 2.0 scenes, HDR environment maps, and KHR\_materials\_displacement extension for physically-based rendering

**Vulkan Grass Renderer** | *Vulkan, GLSL, C++*

Oct 2025 – Nov 2025

- Implemented real-time grass rendering system in Vulkan based on SIGGRAPH I3D 2017 paper, simulating up to 1 million grass blades with physics-based animation at interactive frame rates using compute and tessellation pipelines
- Developed GPU compute shader for physics simulation applying gravity, Hooke's law recovery forces, and wind with spatial turbulence to quadratic Bezier curve grass blades, processing 1M+ blade state updates per frame
- Engineered three-tiered GPU culling system (orientation, view-frustum, distance-based probabilistic) achieving  $4.31\times$  performance improvement at 1M blades through efficient atomic operations and indirect draw calls
- Built hardware tessellation pipeline with dynamic LOD based on camera distance, generating smooth blade geometry with exponential falloff from 10 to 2 subdivisions for optimal geometry density
- Created comprehensive ImGui control panel with real-time FPS metrics (average, 1% lows), frame time graphs, and automated performance testing system generating CSV benchmarks across 40 configurations

**WebGPU Renderer** | *WebGPU, TypeScript, WGSL*

Sep 2025 – Oct 2025

- Implemented three advanced rendering techniques for real-time lighting of 5000+ dynamic point lights: Naive Forward, Forward+, and Clustered Deferred rendering using WebGPU compute and graphics pipelines
- Engineered screen-space light clustering system using compute shaders, subdividing view frustum into  $16\times 9\times 24$  grid with exponential depth slicing and sphere-AABB intersection testing for efficient light culling
- Developed G-buffer architecture with 3 render targets (position, normal, albedo) enabling two-pass deferred rendering that decouples geometry complexity from lighting calculations
- Achieved 53x performance improvement over naive rendering (497ms to 9.3ms at 5000 lights) and 3.5x speedup vs Forward+ through overdraw elimination and optimized memory access patterns
- Built automated performance testing system collecting statistical frame time data across 30 configurations (3 renderers  $\times$  10 light counts), generating CSV analysis for rigorous benchmarking
- Live demo deployed at [webgpu.tonyxtian.com](http://webgpu.tonyxtian.com), rendering Sponza scene with real-time performance metrics and interactive controls

**CUDA Path Tracer** | *CUDA, C++*

Sep 2025 - Oct 2025

- Monte Carlo path tracer capable of rendering complex 3D scenes with custom 3D models and environment maps
- Implemented shading BSDF kernel supporting global illumination, multiple importance sampling, anti-aliasing, sub-surface scattering, capable of rendering various PBR material types with albedo and texture maps
- Integrated third-party libraries of tinyGLTF to support glTF 2.0 mesh loading and Nvidia OptiX for denoising
- Utilized various techniques to boost performance: material sorting (+5%), Russian Roulette (+6% - 24%), stream compaction (+24% - 67%), and Bounding Volume Hierachy ( $3\times$  -  $160\times$  framerate in complex scenes).
- Project Repo and Demo: [github.com/tonytrt/CUDA-Path-Tracer](https://github.com/tonytrt/CUDA-Path-Tracer). A previous standalone performance focused stream compaction project with detailed analysis in Nsight: [github.com/tonytrt/Project2-Stream-Compaction](https://github.com/tonytrt/Project2-Stream-Compaction).

**Monte Carlo Path Tracer & Real-Time PBR Renderer** | *C++, GLSL*

Jan 2025 – May 2025

- Implemented Monte Carlo path tracer supporting Cornell Box, glass refraction, microfacet materials, and environment mapping
- Developed physically-based rendering (PBR) shader pipeline with albedo/metallic/roughness maps achieving real-time ray tracing on modern GPUs with 60+ FPS real-time performance

- Engineered custom BRDF models for materials including chrome, plastic, and complex surface properties
- Demo: <https://github.com/tonytrgt/TonyTianRenderDemo>

## **T&T Slots - Biometric-Adaptive Gaming System** | *ATMega328PB, Bare Metal C* Mar 2025 – May 2025

- Engineered embedded gaming system integrating biometric feedback with real-time probability adjustment, featuring custom ATMega328PB firmware managing 3 concurrent hardware subsystems
- Developed custom I2C communication protocol for MAX30102 SPO2 sensor achieving 100Hz heart rate sampling with 95% accuracy, implementing digital filtering algorithms to eliminate motion artifacts
- Architected real-time graphics rendering engine for LCD display supporting 16-bit color depth, custom sprite animation system, and pixelized gameplay with memory-optimized frame buffering
- Implemented adaptive probability algorithm correlating heart rate variability to winning odds, dynamically adjusting game difficulty based on physiological stress indicators with 200ms response latency
- Built multi-modal user interface featuring PWM-driven audio synthesis for dynamic sound effects, tactile button controls with debouncing, and visual feedback systems
- Optimized embedded system performance achieving 1% CPU idle time through interrupt-driven architecture and efficient memory management across 2KB SRAM
- Links: [Project Website](#) — [GitHub Repository](#)

## **PennOS - UNIX-like Operating System** | *C, Make, GDB* Mar 2025 – May 2025

- Architected and implemented a complete user-level operating system in C with team of 4, featuring 8000+ lines of systems code with full process lifecycle management
- Designed Process Control Block (PCB) data structure managing 50+ concurrent processes with metadata including PID allocation, priority levels, parent-child relationships, signal handling, and user/kernel stack management
- Implemented preemptive multi-level priority scheduler supporting 3 priority levels with Round Robin time-slicing (10ms quantum), preventing starvation through priority aging and achieving 95% CPU utilization
- Built POSIX-compliant interactive shell supporting 15+ built-in commands (ps, kill, jobs, fg/bg), I/O redirection, pipeline chaining, and batch script execution with robust error handling
- Developed comprehensive system call interface including p\_spawn(), p\_wait(), p\_sleep(), signal delivery (SIGTERM, SIGSTOP, SIGCONT), and file I/O wrappers with proper resource cleanup and zombie process reaping
- Implemented job control and signal handling system supporting background process management and graceful process termination across parent-child hierarchies

## **Mini Minecraft - Voxel-based 3D Game** | *C++, OpenGL, Qt, GLSL* Oct 2024 – Dec 2024

- Collaborated in team of 3 to develop fully-featured voxel game engine in C++ using OpenGL, generating infinite worlds with 1M+ blocks and maintaining 60+ FPS performance
- Engineered procedural terrain generation system using layered 2D/3D Perlin noise algorithms, creating 5 distinct biomes (Grassland, Mountain, Desert, Islands, Caves) with biome-specific block distributions and procedurally placed vegetation assets
- Implemented post-processing rendering pipeline with custom GLSL fragment shaders, featuring dynamic underwater/lava distortion effects using UV coordinate manipulation and real-time crosshair overlay rendering
- Developed dual physics simulation system: gravity-based collision detection with terrain for ground movement, and buoyancy calculations for water/lava interaction, plus creative fly-mode with 6-DOF movement
- Built efficient chunk-based world management system with frustum culling and LOD optimization, reducing draw calls by 80% through face culling of adjacent blocks
- Implemented real-time block manipulation (mining/placing) with ray-casting intersection testing and immediate mesh updates, supporting 16 different block types with unique textures and properties
- Project demo showcasing all features: <https://youtu.be/jRb4EHV5KQI>

## **TremorChecker - Parkinson's Disease Screening Device** | *Python, Raspberry Pi* Jan 2021 – Jun 2023

- Architected non-invasive Parkinson's disease screening system using electrostatic field detection, achieving 85% correlation with clinical tremor assessments through advanced signal processing algorithms
- Implemented real-time tremor frequency analysis using Microchip MGC3030 3D gesture sensor and Raspberry Pi 4B, processing 130Hz spatial data with custom digital signal processing pipeline
- Developed frequency domain analysis to detect tremor signatures between 4-6Hz characteristic of Parkinson's
- Engineered automated diagnostic software generating comprehensive medical reports with tremor amplitude measurements, frequency analysis, and clinical risk assessment scores
- Conducted clinical validation study with 50+ participants in Shenzhen, achieving 82% diagnostic accuracy compared to neurological assessments, with false positive rate below 15%
- Applied Chinese utility patent and presented research at 2023 International Science and Engineering Fair (ISEF), competing among top 1% of global participants
- Built scalable IoT architecture supporting cloud data synchronization and remote monitoring capabilities for longitudinal patient tracking

## TECHNICAL SKILLS

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**Programming Languages:** C/C++, CUDA, GLSL, WGSL, Python, Java, eBPF, Assembly, JavaScript, LATEX

**Graphics & Rendering:** WebGPU, OpenGL, DirectX, Real-time Ray Tracing, Path Tracing, PBR, Procedural Generation

**Systems & Tools:** Linux Kernel Development, Docker, Qt, Git, CMake, Embedded Systems, TCP/IP

**Frameworks & APIs:** Qt, Raspberry Pi, ATmega, VMware, CloudLab, Jupyter Notebook