Shivansh Singh

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Education

University of Toronto | *BASc - Electrical & Computer Engineering* Graduated April 2026
- **Minors:** Artificial Intelligence Engineering | Robotics & Mechatronics
- **Relevant Coursework:** Computer Security (ECE568), Algorithms & Data Structures (ECE345), Operating Systems (ECE344), Machine Learning (ECE421, CSC384, APS360), Software Design & Communication (ECE297)

Technical Skills

Programming: Modern C++ (17/20/23), Python, TypeScript/JavaScript (React, Node.js), Go, SQL (PostgreSQL), Java, C (bare-metal), x86/ARM assembly
Systems & Architecture: Distributed Systems, Lock-Free Concurrency, Real-Time / Embedded, Microservices, API Design (REST, gRPC), Zero-Copy Data Paths, SIMD (AVX-512)
Robotics, Controls & ML: ROS2, PX4, Simulink, PID / closed-loop control, Inverse Kinematics, Visual Servoing, OpenCV, HITL/SITL Simulation, PyTorch, CUDA, OpenVINO, YOLOv5, GANs
Hardware: STM32, Arduino, Raspberry Pi, PCB Design, FPGA, UART/BLE, Servo & Motor Control, 3D Printing
Tools & Infrastructure: Docker, Git, CI/CD, AWS (EC2, S3), Prometheus, Grafana, Linux, Valgrind, GDB, Intel VTune

Work Experience

Software Engineering Intern, Robotics | *Ribbit (Autonomous Cargo Aircraft — NRC search-and-rescue mission)* Sep. 2024 – Aug. 2025
- Engineered real-time C++17 service layers using zero-copy data pathing and lock-free ring buffers, sustaining sub-100ms deterministic message-processing cycles.
- Wrote embedded drivers for safety-critical sensors/actuators with template metaprogramming for zero-overhead hardware abstraction.
- Built the X-Plane 11 simulation bridge for hardware- and software-in-the-loop (HITL/SITL) testing of the full flight stack (see Projects).
- Integrated flight-software modules across state estimation and control into the autonomy pipeline; multi-threaded RF audio streaming with custom buffer management that eliminated jitter over low-bandwidth radio.
- System-level telemetry monitoring (Prometheus, Grafana) for incident response and observability; test strategy + integration tests that surfaced issues on the ground, before flight.

Robotics Intern | *Roboprenr* May 2023 – Aug. 2023
- Built a voice-interactive pseudo-humanoid robot from zero: 3D-printed chassis + custom PCBs wiring sensors, servos (PCA9685), and IMU to a Raspberry Pi 4.
- ROS2 Humble on embedded Linux for modular control; OpenCV vision in C++ and PyTorch face-recognition models.

Teams & Leadership

Software Lead - UAV Multicopter | *UofT Aerospace Team (UTAT)* Sep. 2025 – Apr. 2026
- Architected a resilient, event-driven IPC framework in Modern C++ for autonomous flight nodes — fault-tolerant crash resilience and asynchronous state synchronization across mission-critical cycles.
- PX4 flight control for multi-copter/fixed-wing VTOL mode transitions; closed-loop attitude + rate controllers in Simulink with PID gain tuning from flight-log analysis.
- Defined the test strategy and integration suite for flight-node protocols, reducing field-failure rates.

Software Developer - Deep Learning Acceleration | *aUToronto (UofT Self-Driving Team)* Sep. 2023 – Apr. 2024
- Refactored latency-critical perception pipelines from Python to Modern C++ ROS2 nodes, eliminating GIL constraints — 2×+ throughput.
- Profiled with Intel VTune and Valgrind to fix cache misses and heap bottlenecks — ∼5× faster inference via memory-efficient ops, ∼25% lower CPU at peak load.
- CUDA-accelerated inference on vehicle-grade GPUs; Dockerized CV pipelines (OpenVINO quantization) on live vehicle hardware.

Project Manager - Autonomous SUMO Robot | *UTRA (UofT Robotics Association)* Sep. 2022 – Apr. 2023
- Led the sub-team through design, build, and competition — mechanical/electrical/software: opponent and edge detection, motor control, match strategy.

Robotic Arm Team - Inverse Kinematics | *RSX (Robotics for Space Exploration)* Sep. 2021 – Apr. 2022
- Inverse kinematics for a space-robotics manipulator — target poses to joint configurations, collision-aware.

Additional Involvement | *UTHT (Hyperloop) & UTFO (Freelancers Organization)* 2022 – 2023
- UTHT — Electronics & Firmware: Arduino firmware and bring-up for the pod test-track sensing/control electronics. UTFO — Web Developer: React front-end development for the organization's platform and client projects.

Projects

Autonomous Robotic Service Dog (Capstone, Lead Architect) [Repo] [Demos] | *ROS2, C++, OpenCV, IK* 2025 – 2026
- Led the system architecture for an 8-DOF quadruped that follows and monitors patients — distributed ROS2 stack integrating perception, planning, and control with custom QoS profiles for deterministic multi-node communication.
- Built a closed-loop visual-servoing pipeline (OpenCV state estimates → velocity commands) enabling adaptive real-time human tracking; end-to-end person-following demonstrated on the physical quadruped.
- Developed a 3-DOF inverse-kinematics solver for task-space leg actuation; froze the hip joint in the final build to run 2 active DOF per leg.

X-Plane 11 Simulation Bridge (at Ribbit) | *C++, HITL/SITL, ROS2, Sensor Simulation* 2024 – 2025
- Bridged X-Plane 11's flight-dynamics engine to the autonomy stack — simulated state into the same interfaces the real aircraft uses; custom serialization, sensor-to-world coordinate mapping.
- Switchable HITL/SITL modes for end-to-end validation — integration bugs caught on the ground, not in the air.

Rescue Ranger [Repo] [Devpost] | *C++, OpenCV, Node.js, AWS (EC2, S3), React, Arduino* Jan. 2023
- Built a first-place autonomous search-and-rescue rover (1st of 150+ teams, UofTHacks X) in 24 hours: 3D-printed chassis, Arduino, C++ obstacle avoidance, and OpenCV survivor identification.
- Node.js REST backend on AWS EC2 streaming live rover telemetry (media in S3), powering a real-time React + Google Maps dashboard.

Velox-LOB: Sub-Microsecond Matching Engine | *C++20, Lock-Free, AVX-512 SIMD* Jan. 2026 – Present
- Limit order book sustaining 1M+ order updates/sec — Data-Oriented Design for L1 cache-hit maximization; custom fixed-size block-pool allocator eliminating heap-fragmentation spikes.
- Lock-free single-producer/single-consumer queue via `std::atomic`; AVX-512 SIMD price-level updates for ∼4× lower matching latency.

Aether-Flow: Distributed Agentic-Inference Engine | *C++23, Go, gRPC, PyTorch* 2026 – Present
- C++23 execution engine orchestrating agentic workflows across decoupled VLM/LLM services; async gRPC streaming backend in Go with a custom lock-free priority queue — dynamic batching for ∼40% higher hardware utilization.

Plants vs. Zombies — Bare-Metal ARM Engine [Repo] | *C++, Software Rasterizer* 2023
- Full PvZ clone rendered straight to a memory-mapped framebuffer on an ARM SoC — hand-written rasterizer, sprite blitting with masking, collision detection, and manual frame pacing; zero graphics libraries.

Bird Animation Model (GAN Video Synthesis) [Repo] | *PyTorch, YOLOv5, CUDA* 2023
- YOLOv5 pipeline extracting bird features from 18,000+ real images; CNN features feeding a GAN that synthesizes animated flight sequences — ∼3× faster training via CUDA parallelization.

Black-Scholes Quant Engine | *C++, AVX-512 SIMD, CRTP, Monte Carlo* 2024 – 2025
- Options pricing + Monte Carlo with SIMD-vectorized Greeks (Delta/Gamma/Vega, ∼6× speedup); CRTP static dispatch eliminating virtual-call overhead in the hot kernel.

Additional Projects 2022 – 2026
- **KUKA KR6 Arm** (2025): 6-DOF — DH kinematics, FK/IK, jerk-limited trajectories (Simulink). **STM32 BLE Rover** (2024): bare-metal C — obstacle avoidance + BLE camera streaming (<500 ms), UART, FPGA, assembly.
- **TourGuide Pro** (ECE297, 2023): multithreaded C++ OpenStreetMap engine — Dijkstra/A*, ∼200 ms queries. **Security Exploits** (ECE568, 2024): buffer overflows; XSS, SSRF, RCE, prototype pollution on CTF-style targets.
- **Accent Ace** (HackTheNorth 2023) [Devpost]: PyTorch/torchaudio pronunciation coach. **Project Jerome** (MakeUofT 2022) [Devpost]: wearable obstacle + gas-hazard detection for the visually impaired.
- **PacBot** (UTRA, 2023): autonomous Pac-Man AI. **Impact** (CIV300, 2023): 2D serious game, packaged for Android. **VS Code Extension** (2025): streaming AI feedback in-editor. **Daisy + Odysseus** (2026): personal OS — knowledge graph + autonomous research agent.

Extracurriculars

Hackathons: UofTHacks X 1st Place, UTEK 2nd Place, HackTheNorth 2023 [Devpost], NSBEHacks [Devpost]

Varsity Athlete: UofT Wrestling & Rowing; MMA/BJJ bronze medallist (Canadian nationals); former national-level swimmer (India). 15+ hrs/week competitive training alongside full-time engineering.