Mohamed Waiel Shikfa

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Portfolio • GitHub

Education

Carnegie Mellon University (CMU) **Doha, Qatar**
B.Sc. Computer Science, Concentration in Computer Systems, GPA: 4.00/4.00 *2023–2027*

Scholarship: TAFAWQ Merit Scholarship, awarded to one student per cohort.

Honors & awards: Andrew Carnegie Society Scholar (1 of 40 across CMU, 1 of 2 at CMU-Q); Qatar Campus Scholar (1 of 4); Dean's List, every completed semester; Outstanding Academic Achievement Award (expected); College Honors (expected); University Honors (expected).

Awards & Achievements

1st Place: Meeting of the Minds, Early Research, In-Person Stream (MOTM) *2026*
1st Place: Pizza & Programming Contest (Advanced Track) *2026*
1st Place: Qatar Student Association Adassa Photo Competition *2024*
1st Place: YouthMobile Qatar Competition (national) *2018*
2nd Place: Qatar Collegiate Programming Contest (QCPC) *2024*
2nd Place: Apprenticeship Competition (Business Development) *2024*
Eco-Campus: Earned Scotty Green Stamps for contributions to campus sustainability *2023*
Participant: QCRI Hackathon (2023), Africa & Arab Collegiate Programming Championship (2024), NSA Codebreaker Challenge (2024–25), QSTP Hackathon (2026).

Research Interests

Design and control of robotic mechanisms and actuators; modular multi-robot systems; physics-based simulation and experiments; active perception and state estimation for autonomous systems.

Research Experience

Undergraduate Researcher, Carnegie Mellon University in Qatar *2025–Present*

Task-Oriented Simulation and Planning for Modular Multi-UAV Systems

Senior Honors Thesis; advisers: Dr. Ryan Riley and Dr. Gianni Di Caro *Fall 2026–Present*

- **Research question:** Studying how payloads, attachment geometry, available thrust, and physical interactions shape modular UAV configurations and coordinated flight. *(in progress)*
- **Simulation framework:** Extended PyBullet and MuJoCo environments through a unified Python interface; parameterized module geometry, mass, inertia, connections, and scenarios.
- **Assembly control:** Implemented approach trajectories, idealized rigid docking, and assembly flight control for planar and 3D structures; added trajectory-tracking and thrust-loss scenarios.
- **Multi-module dynamics:** Modeled heterogeneous modules and studied downwash, control allocation, and simulator behavior during assembly and flight.
- **Task-to-flight planning:** Extending the framework toward an integrated pipeline from payload and attachment selection through configuration, allocation, assembly, and coordinated flight. *(in progress)*
- **Force-informed planning:** Adding Newton–Euler force and moment requirements and per-module control under downwash to support physically informed configuration planning. *(in progress)*

Research Experience (continued)

Active Vertical Perception and Navigation for Greenhouse Robots

Adviser: Dr. Gianni Di Caro *Fall 2026–Present*

- **Sensing platform:** Designed and procured a Jackal-mounted 1.5 m lift with two gimbal-stabilized cameras; mechanical assembly and commissioning are underway. *(in progress)*
- **Simulation test bed:** Built a Docker-based ROS 2/Gazebo greenhouse with uneven terrain, wheel slip, crop rows, lift and gimbal dynamics, cameras, lidar, IMU, and wheel odometry.
- **Mission control:** Coordinated base motion, camera orientation, and sensing height; integrated Nav2 planning and tracking for multi-height inspection missions.
- **Evaluation tools:** Built visualization tools and repeatable test scenarios for sensor streams, transforms, robot state, odometry error, and map quality.
- **Localization and mapping:** Developing sensor-based estimation with wheel odometry and IMU data and lidar correction to replace the simulator-pose baseline. *(in progress)*
- **Autonomous patrol:** Extending the system to build a map, accept a user-sketched route, and respond to dynamic obstacles. *(in progress)*
- **Coverage study:** Investigating how sensing height, crop occlusion, terrain motion, and localization error affect inspection coverage and reliability. *(in progress)*

Compact NdFeB Electropermanent Magnets for Robotic Actuation

Adviser: Dr. Ryan Riley; literature review *Spring 2026–Present*

- **Switchable actuator:** Developed compact NdFeB pulse-switching hardware to address Magnobots' magnetic-interface limitations and enable latching, linear actuation, and rotary actuation.
- **Coils and controls:** Designed wound-coil modules and pulse-driver electronics; integrated microcontroller control and demonstrated magnetic switching.
- **Physics-based models:** Built coupled Python/ngspice simulations for hysteresis, forces and torques, coil fields, eddy currents, and circuit transients.
- **Pulse driver:** Built a capacitor-discharge driver (780 μF bank charged to 400 V; 62.4 J) and 18-layer copper-strip coil; estimated 1.7–2.0 kA peak current at about 0.1 Ω.
- **Design studies:** Compared coercivity, winding geometry, voltage, current, temperature, and switching behavior through parameter sweeps and model comparisons.
- **Force fixture:** Designed a load-cell stand with screw-driven 0–25 mm spacing, alignment fixtures, and configurable sensor mounts.
- **Field logging:** Designed indexed Hall-probe fixtures for axial flux measurements and built a 40 kHz logger for pulse and field recordings.
- **Experimental validation:** Refining force, field, and switching-repeatability measurements and preparing the work for publication. *(in progress)*

Magnobots – 3D Modular Self-Reconfigurable Robots

Adviser: Dr. Ryan Riley *Fall 2025–Spring 2026*

- **Robot concept:** Investigated magnetic latching and repulsion-driven rolling for three-dimensional connection and reconfiguration.
- **Geometry and prototypes:** Explored rhombicuboctahedral shells and connectors; examined interface spacing, stacking stability, magnet orientation, and structural mass.
- **Design finding:** Used simulation, fabrication, and bench tests to diagnose weak connections, identifying magnet performance as a bottleneck that motivated the NdFeB project.
- **Recognition:** Received the top Early Research Award in the in-person stream at Meeting of the Minds 2026.

Professional Experience

Carnegie Mellon University **Doha, Qatar**
Course Assistant / Lead Course Assistant *2024–Present*

15-150: Principles of Functional Programming

- Promoted to Lead Course Assistant for 15-150.
- Developed two original lab packages for hands-on practice with functional programming concepts.
- Led recitations, mentored students individually, and supported assessment and grading.

15-251: Great Ideas in Theoretical Computer Science

- Initiated a dedicated Course Material Developer role for 15-251.
- Authored and typeset original problem sets to reinforce theoretical computer science concepts.

15-112: Fundamentals of Programming and Computer Science

- **Course arcade:** Coordinated with students to deploy their games on the course arcade after learning its operation from the instructor.
- **Handheld console:** Optimized the graphics library for a purchased, low-cost handheld console; built setup and porting scripts to help students develop and run their course games on the device.
- **CMU Graphics sound:** Rewrote the Python library's sound engine for concurrent playback and simpler file handling.
- **CMU Graphics fixes:** Contributed resize, test, and documentation improvements and proposed image-loading and validation changes.

Other courses

- **Course support:** Assisted with 15-122 Principles of Imperative Computation, 15-210 Parallel and Sequential Data Structures and Algorithms, and 80-210 Logic and Proofs.
- **Teaching and assessment:** Led problem-solving sessions and individual mentoring; graded assignments, quizzes, and exams across programming, algorithms, and proof-based courses.

OpenInfra Foundation (OpenStack) **Remote**
Software Engineering Intern *Summer 2024*

- Collaborated in a student team on four merged OpenStack SDK changes extending Ironic's bare-metal provisioning interfaces.
- **Node history:** Contributed a dedicated history resource and proxy interfaces to list a node's history and retrieve individual events (922610).
- **Virtual media:** Contributed attachment and detachment interfaces at resource and proxy levels, including API-version handling and unit and functional tests (921957).
- **Virtual networking:** Contributed VIF attachment using port or port-group identifiers, including mutually exclusive argument checks and request-payload updates (921890).
- **Firmware inventory:** Contributed resource and proxy interfaces to list node firmware components, with tests and release documentation (922591).
- Used Linux, command-line tools, version control, and automated testing throughout development and upstream review. The four changes merged between July 2024 and November 2026.

Savest (QSTP) **Doha, Qatar**
Media Production Intern *Winter 2023*

- Produced a 3D promotional video translating Savest's product concept into animated scenes; handled scene development, animation, editing, and production coordination.

Technical Skills

Spoken languages: English, French, Arabic (fluent); Spanish (intermediate).

Programming languages: Python/MicroPython, C/C++, Java, Rust, SML, Bash, JavaScript, HTML/CSS, x86-64.

Development tools: VS Code, Make, CMake, GDB, Maven, Gradle, Jupyter, LaTeX, Claude Code, Codex.

Robotics: ROS 2, Nav2, Gazebo, MuJoCo, PyBullet; Linux/Unix, Docker, Git.

Electronics & fabrication: KiCad, ngspice, Arduino, Raspberry Pi Pico, 3D printing, circuit design.

Cloud & data: AWS, Azure, Google Cloud, Terraform.

Scientific computing: NumPy, SciPy, pandas, Matplotlib.

Media & design: Blender, Shotcut, Audacity; 3D animation, video editing, and audio production.

Selected Projects

Systems & Networking (coursework)

- **Peer-to-Peer File Transfer (team):** Co-developed a BitTorrent-style system over UDP with peer discovery, parallel chunk downloads, integrity checks, retransmission, and congestion control (C).
- **Adaptive Video Streaming (team):** Co-developed a streaming proxy with throughput estimation, adaptive bitrate selection, DNS-based server selection, and network-emulation tests (C, Python).
- **Distributed Filesystem:** Implemented remote method invocation, naming and storage services, hierarchical read/write locking, and demand-driven file replication (Java).
- **Dynamic Memory Allocator:** Implemented a 64-bit allocator with segregated free lists, bounded best-fit search, splitting, and adjacent-block coalescing; used trace analysis to tune size classes (C).

Embedded Systems

- **Physical Pong Arcade (team coursework):** Built a physical two-player Pong game with stepper motors, player controls, goal sensors, a score display, and sound; programmed a Raspberry Pi Pico in bare-metal Rust to coordinate motion, input, goal detection, and scoring.

Games & Interactive Experiences

- **The Forest Is on Fire!:** Completed an independent firefighting game with spreading-fire mechanics, difficulty levels, and Electron packaging (JavaScript, HTML/CSS); preparing the Steam store page for a planned public release.
- **PassTheGame:** Created a collaborative game-development challenge in which club members extend a shared Pygame project through branches and pull requests.
- **Salem's Adventure:** Built an animated interactive story for the CMU-Q arcade exploring language and identity through an alternate-history journey (Python).

Others

- **Dim3 (team coursework):** Built a 3D data pipeline for mesh conversion and cleanup, voxel, point-cloud, and graph representations, and web-based inspection; explored descriptor-based SVM classification (Python, Blender).
- **Cofactor Expansion Experiment:** Implemented recursive determinant calculation in SML, Python, and C; logged recursive calls to study time and space complexity across matrix sizes.

Leadership & Community

Student Leadership

Open CMUQ Club *Fall 2024–Present*
President. Managed campus open-source projects and organized events engaging more than 40 students at a time to encourage collaborative software contributions.

Game Development Club *Fall 2024–Present*
Executive Team. Developed games for club game jams and shared game development techniques through community workshops.

Computing Club *Spring 2024*
Executive Team. Helped organize Marhaba Tartan, Bits & Bytes, and the club's Tarnival booth; promoted events to encourage student participation.

Media & Community Communication

MSA Club *Spring 2026*
Media Team. Produced promotional videos and digital media for major events; contributed to web platforms for club operations and community outreach.

Jadwal Club *Spring 2026*
Media Volunteer. Filmed and edited promotional videos highlighting campus events and club initiatives.

Outreach & Service

CMUQ Admissions & Student Affairs *Volunteering*
Student Ambassador & Volunteer. Represented the student body at Early Decision dinners, orientation, and Experience CMUQ Day; volunteered at graduation ceremonies.

Mind Craft Alpha *Volunteering*
Workshop Coordinator. Led hands-on computer science workshops for K–12 students.

LifeLines / Reboot the Earth Hackathons *Volunteering*
Organizer. Co-organized campus hackathons, coordinating event planning and logistics and supporting participating teams.