

Hironmoy Roy Rudra

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PROFILE

Computer Science undergraduate at BRAC University building the infrastructure behind robotics research: simulation environments for Isaac Sim and Unreal Engine 5/Cosys-AirSim, in-vehicle capture and annotation pipelines for a multimodal driving dataset, a scored evaluation campaign, benchmark tooling, and a pinned, checksum-verified setup script that fails unless it reproduces the reported run. Work spans ROS 2 autonomy stacks (C++, Python), event-camera synthesis and a multi-seed training suite, backed by test suites (289 tests in hifi-environment-builder), licence gates and per-file provenance.

SELECTED PUBLICATIONS

- **Matched Controls for Probe-Based LoRA Rank Allocation: A Negative Result for One Allocator under a Rank-Coupled Initialization.** *Under review, Transactions on Machine Learning Research (submitted 2026) (first author).* Compares TSDLoRA with a budget-matched uniform-rank control, LoRA and GoRA over five seeds on eight commonsense tasks, three decoders and 11 of 24 GLUE cells; TSDLoRA trails the control in 26 of 35 cells.
- **DhakaSense: A Multimodal Driving Dataset and Benchmark for Dense, Heterogeneous Traffic in Dhaka.** *Under review, IEEE ICRA 2027 (submitted 2026) (second author).* Presents 14 h 35 min of synchronized LiDAR, stereo-depth, six-camera and GNSS/INS driving data over 175 Dhaka scenes, labelled semi-automatically across an 8-class taxonomy and benchmarked per traffic-density level.
- **CERTUS: Certified Terrain Traversal Under Sensing Uncertainty, with Certification-Driven Active Perception.** *In preparation, target IEEE/RSJ IROS 2027 (first author).* Gates traversal on step, slope and clearance with a distribution-free (Cantelli) margin, predicts which depth sensor can certify which rover, and resolves blocked cells by active perception; validated in Isaac Sim before deployment on a real rover.
- **COVE-Sim: counterfactual, recipient-specific communication for event-camera UAV teams (working title).** *In preparation, target IROS 2027 (CoRL 2027 fallback) (first author).* Decides what each event-camera UAV tells which teammate from the counterfactual value of a message to that recipient's task loss, giving the first collaborative-perception system with an event-derived shared representation; simulation study in Cosys-AirSim.
- **COVE multi-UAV hazard detection and avoidance dataset (working title).** *In preparation, target NeurIPS 2027 Datasets & Benchmarks track.* Covers five industrial environment families (warehouse, factory, construction, port, mine) with seeded layouts, exact label geometry and QC gates, hazards at rule-breaking speeds, and event and RGB capture in Cosys-AirSim.

EXPERIENCE

BRACU Mongol-Tori (University Mars Rover Team)

Dhaka, Bangladesh

University Project Team – multiple roles, ranked 8th at University Rover Challenge 2025

Nov 2023 – Present

- **Co-Advisor (Nov 2025 – Present):** Direct technical strategy for the European Rover Challenge build. Mentor undergraduate engineers on autonomous navigation, perception, ROS 2 architecture, and sim-to-real validation, and push the team to write up competition work to publication standards.
- **Sub-Team Lead, Autonomous (Sep 2024 – Aug 2025):** Led the autonomy sub-team. Built and deployed the autonomy stack, SLAM pipeline, and path-planning algorithms for the rover. Ran the autonomous missions on-site at the University Rover Challenge in Utah and managed live telemetry during competition runs.
- **Control Systems Engineer (Feb 2024 – Aug 2024):** Wrote the ROS 2 communication and control architecture from scratch. Implemented inverse kinematics for a 3-DOF arm using ArUco markers and an OpenCV pipeline. Worked on camera calibration for the rover's stereo and RGB feeds.
- **Contributor (Nov 2023 – Feb 2024):** Studied rover control on Arduino and Raspberry Pi, and assessed the feasibility of moving the rover stack onto ROS.

Kibo Robot Programming Challenge, 6th Edition

Dhaka, Bangladesh

6th Place, National Round, JAXA – Computer Vision and Autonomous Sign Detection

Aug 2025 – Feb 2026

- Placed 6th in the national round with a real-time CV pipeline for autonomous sign detection in JAXA's microgravity simulator.
- Wrote real-time detection and classification for visual markers, tuned the CV models for speed and accuracy under simulator constraints, and connected the perception module to the navigation stack for autonomous targeting.

First Global Challenge (FGC) Team Bangladesh

Dhaka, Bangladesh

Technical Mentor – national robotics team

Sep 2024 – Feb 2025

- Spent six months training the national team on programming, problem decomposition, logic building, and competition strategy.
- Built an end-to-end rice leaf disease detection pipeline in PyTorch and optimized inference with TensorRT for high-speed edge deployment on the team's robot.

ROBO hobby

Dhaka, Bangladesh

AI Engineer – edge computing for agriculture

Oct 2024 – Jan 2025

- Built a Raspberry Pi pest detection system in TensorFlow Lite for common crop pests, with reasonable accuracy in real field tests.
- Owned the full ML pipeline: dataset collection and labeling, model training, post-training quantization, and on-device inference.

SELECTED PROJECTS

- **hifi-environment-builder (Oct 2026):** Wrote a Python toolkit (**hifienv**) and Claude Code skill that build label-correct, sensor-clean, licence-clean, reproducible simulation environments for Unreal Engine 5/Cosys-AirSim and Isaac Sim 6 (USD). Fetches CC0/CC-BY PBR materials from Poly Haven, ambientCG and MatSynth with per-file provenance (source, licence, sha256), builds GLB kits headless in Blender, generates seeded layouts, imports into Unreal or writes collider and visual USD, and gates every property: licence allowlist, label parity, null tests, 1 mm collider parity; 289 tests, MIT.

- **CERTUS navigation stack: uncertainty-aware terrain traversal for rovers** (*Sep 2026 – Present*): Built the sim-first research stack behind CERTUS: a terrain pipeline from ZED 2i stereo depth through `elevation_mapping_cupy` to slope, roughness and uncertainty layers, with TOPP-RA (cvxpy) velocity profiles whose limits vary along the path; Isaac Sim 6.0.1 scenes for Clearpath Husky, Jackal and Warthog (URDF to USD) and a ROS 2 Jazzy distrobox container. Wrote an idempotent, staged `setup.sh` that fetches every non-source dependency at a pinned version checked by MD5, sha256 or commit, and a `verify` stage that re-runs the tests and a headless Husky drive and fails unless it reproduces the reported run.
- **BARN Challenge 2027 preparation** (*Jul 2026 – Aug 2026*): Built a classical navigation stack in C++ on ROS 2 Jazzy for a Clearpath Jackal with 2-D LiDAR: log-odds occupancy grid with Euclidean distance transform, two-phase Dijkstra and lattice A*, elastic-band reference, sequentially-linearised MPC solved as a QP with OSQP at 30 Hz, swept-footprint safety shield and backtracking recovery. Scripted a scored campaign over the BARN 2026 public suite (50 worlds $\times$ 10 trials, captured manifest, two metric reports) and wrote a nine-chapter tutorial and a seven-demo interactive companion site.
- **DhakaSense capture and annotation stack** (*Jul 2026 – Sep 2026*): Built the in-vehicle recording stack for a multimodal Dhaka driving dataset: supervisor and watchdog over ZED SVO2, RealSense and chunked-audio recorders, an SBG Ellipse-D INS as master clock, optical-clock sync validation, dual-copy SHA-256 offload and QC reports. Wrote a licence-free PPK chain (UBX to RINEX, RTKLIB), a CVAT label generator, and a remote export orchestrator that runs the nuScenes exporter over NFS, attaches PPK-enriched ego poses with fix status and sigmas, and seals exports with BLAKE2b manifests and a ledger.
- **evs-bench (private repository)** (*Jul 2026 – Sep 2026*): Built Python benchmark tooling for event-based detection of high-speed targets: a dataset contract with validator and QC reports, corrected ESIM event synthesis (persistent per-pixel reference levels, log-intensity interpolation, refractory period) pinned by analytic unit tests, class-agnostic RGB and event YOLO11 baselines, a dt-aware Kalman/SORT tracker, and a time-to-first-detection metric with k -consecutive confirmation and oracle reference curves. Added AirSim fly-and-record capture that replays a logged trajectory through a stepped 2 ms pipeline for 500 Hz output; 57 tests, MIT.
- **PEFT multi-seed retraining suite (TSDLoRA, LoRA, AdaLoRA)** (*2026*): Built the three-stage pipeline behind the thesis experiments: Optuna/TPE hyperparameter search for TSDLoRA, multi-seed retraining of 3 methods $\times$ 3 backbones $\times$ 8 GLUE tasks (72 combinations, 5 seeds each) through a CLI or a web portal, and an analysis stage that produces mean $\pm$ std tables, single-signal ablations (entropy, gradient and rollout-only allocation) and Wilcoxon tests. Baselines use the `peft` LoRA and AdaLoRA implementations with adapters on the Q/K/V and attention-output projections.

TECHNICAL SKILLS

- **Languages:** Python (advanced), C/C++, C#, JavaScript, TypeScript, SQL, Bash
- **Robotics and simulation:** ROS 2; Isaac Sim, Gazebo, Webots, PyBullet, MuJoCo; CARLA, Unreal Engine 5/Cosys-AirSim, Unity; path planning, TOPP-RA time-parameterisation (cvxpy), model predictive control (OSQP), inverse kinematics, control systems design, `elevation_mapping_cupy`, sensor integration and calibration
- **Deep learning and CV:** PyTorch (advanced), TensorFlow, Keras, OpenCV, YOLO Ultralytics models, SAM, Tesseract OCR, classical computer vision; Hugging Face Transformers, LoRA, `peft`, Optuna, Scikit-learn, Reinforcement Learning (DQN, PPO)
- **Data, MLOps and reproducibility:** Pandas, NumPy, feature engineering, data augmentation; Docker, distrobox, Git/GitHub, CI/CD, Weights & Biases, model quantization
- **Embedded, edge and sensors:** Arduino, Raspberry Pi, ESP32, STM32; TensorRT; ZED 2i stereo, Livox Mid-360 LiDAR
- **Web, tooling and CAD:** Flask, FastAPI, REST API design, React Native (Expo Go), Tailwind CSS, Laravel, MySQL, MongoDB, SQLite; pybind11, GUI development (PyQt, Tkinter), Linux (Ubuntu, Raspbian), Jupyter notebooks; Fusion 360, OnShape, Blender (basic)

HONORS AND AWARDS

- 8th Place, University Rover Challenge 2025 – The Mars Society, Hanksville, Utah, USA (Jun 2025).
- 21st Place, University Rover Challenge 2024 – The Mars Society, Hanksville, Utah, USA (Jun 2024).
- 6th Place, National Round, Kibo Robot Programming Challenge 2025 – JAXA, Tokyo, Japan (Feb 2026).

EDUCATION

BRAC University

BSc in Computer Science, CGPA 3.65/4.00

Dhaka, Bangladesh

Sep 2022 – Jan 2027 (expected)

- **Research interests:** robotics, autonomous systems, high-fidelity simulation, perception, IoT.
- **Honors:** VC's List for Academic Excellence (4 semesters); Dean's List for Academic Excellence (3 semesters).

National College of Education

Higher Secondary Certificate, Science group

Narsingdi, Bangladesh

2019 – 2021