

Hironmoy Roy Rudra

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PROFILE

Final-year Computer Science undergraduate at BRAC University, building and deploying ROS 2 rover autonomy stacks. Wrote planning and control layers in C++ and Python: sequentially-linearised MPC solved as a QP at 30 Hz, TOPP-RA velocity profiles, artificial-potential-field and bidirectional hybrid A* planners. Takes robots from ZED 2i stereo depth and 2-D/3-D LiDAR through Isaac Sim, Gazebo and a Unity digital twin to hardware; ran BRACU Mongol-Tori's autonomous missions at the University Rover Challenge 2025 (8th place).

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 2023 – 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.

Robotics Club of BRAC University

Dhaka, Bangladesh

Student Instructor – ROS and physics simulation

Oct 2025 – Nov 2025

- Taught fundamental and intermediate ROS topics and physics simulation in Gazebo and Webots to undergraduate club members.
- Helped students debug code, structure their workspaces, and turn rough ideas into running simulated robot projects.

PROJECTS

- **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 × 10 trials, captured manifest, two metric reports) and wrote a nine-chapter tutorial and a seven-demo interactive companion site.
- **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.
- **Closed-loop rocker-differential rover simulation – Rudra-roy/rocker-loop-sim (Sep 2026):** Built the closed kinematic loop of a rocker-differential rover from Fusion 360 CAD in PyBullet and Gazebo Classic (ROS 2 Humble): a URDF tree plus point-to-point constraints in PyBullet, native ball joints in Gazebo, whose world is Apollo 15 terrain with seeded rocks. Verified loop closure to 0.003 mm (PyBullet) and 0.05 mm (Gazebo) driving on 16° slopes, found dead points at −21.5° and +40° of rocker travel, and recommended ±15° hard stops. Compared skid steering with ±90° wheel steering.
- **BMHS path planner – Rudra-roy/BHMS-Kinematics-aware-path-planner (2026):** Wrote a bidirectional multi-heuristic hybrid A* planner for Ackermann and differential-drive vehicles that grows forward and backward trees from motion primitives, guided by two obstacle-aware 2-D Dijkstra heuristics computed in parallel; the C++17 core (`pybind11`) achieves a 100x+ speedup over native Python implementations. Simplifies paths with clearance-aware Bresenham line-of-sight checks and smooths Ackermann paths with quadratic Bézier curves that respect the minimum turning radius. Ported the core to an experimental ROS 2 Humble C++ package exposing `ComputePathToPose` and `FollowPath` actions.
- **Unity digital twin and ROS 2 autonomy workspace for BRACU Mongol-Tori – bracu-mongoltori/simple_robot_ws (Dec 2025 – Present):** Built a digital twin of the Mars rover in Unity with a MuJoCo physics backend connected to ROS 2: rocker-bogie suspension from URDF joints and custom mesh collisions, a replicated sensor suite, and synthetic data for SLAM and LiDAR-GNSS fusion tests on simulated planetary terrain. Built the ROS 2 workspace that is the rover's autonomy backend and tied its control pipeline to the twin for software-in-the-loop testing, with modular path-planning and kinematics nodes to validate edge cases before hardware deployment.

- **3D LiDAR map-based topographical path planner** (*Aug 2025*): Wrote a path planner based on artificial potential fields for safe autonomous waypoint traversal. Reads raw LiDAR point clouds to estimate terrain slope and isolate high-risk zones in real time. Outperformed BFS, DFS, Dijkstra, hill climbing and conditional A* on traversal efficiency and route safety on rough surfaces by using continuous spatial heuristics rather than discrete graph search.

TECHNICAL SKILLS

- **ROS 2 and middleware:** ROS 2 (Jazzy, Humble), Nav2, URDF and USD robot descriptions, launch files, pybind11 C++/Python bindings, distrobox and Docker containers, Linux (Ubuntu, Raspbian), Git/GitHub, CI/CD
- **Planning and control:** Model predictive control (sequentially-linearised QP, OSQP), TOPP-RA time-parameterisation (cvxpy), artificial potential fields, hybrid A* (bidirectional, multi-heuristic), lattice A*, Dijkstra, elastic band, Bézier smoothing, inverse kinematics, control systems design, reinforcement learning (DQN, PPO)
- **Perception and SLAM:** `elevation_mapping`, `cupy` terrain layers from stereo depth, occupancy grids and distance transforms, OpenCV, YOLO Ultralytics models, ArUco pose estimation, camera calibration, LiDAR point-cloud slope estimation, SLAM and LiDAR-GNSS fusion, Kalman/SORT tracking, PyTorch, SAM, classical computer vision
- **Simulation:** Isaac Sim, Gazebo, Webots, PyBullet, MuJoCo, Unity, Unreal Engine 5/Cosys-AirSim, CARLA; CAD in Fusion 360, OnShape, Blender (basic)
- **Hardware and embedded:** ZED 2i stereo camera, RealSense depth camera, Livox Mid-360 LiDAR, SBG Ellipse-D INS, Arduino, Raspberry Pi, ESP32, STM32; sensor integration and calibration; edge inference with TensorRT and TensorFlow Lite
- **Languages:** Python (advanced), C/C++ (C++17), C#, Bash, SQL, JavaScript, TypeScript

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).

PUBLICATIONS AND MANUSCRIPTS

- **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.
- **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.
- **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.

EDUCATION

BRAC University	Dhaka, Bangladesh
<i>BSc in Computer Science, CGPA 3.65/4.00</i>	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	Narsingdi, Bangladesh
<i>Higher Secondary Certificate, Science group</i>	2019 – 2021