FoMo: A Proposal for a Multi-Season Dataset for Robot Navigation in Forêt Montmorency

Matěj Boxan,[1] Alexander Krawciw,[2] Effie Daum,[1] Xinyuan Qiao,[2] Sven Lilge,[2] Timothy D. Barfoot,[2] and François Pomerleau[1]

[1] Northern Robotics Laboratory, Université Laval, Quebec City, Canada
[2] University of Toronto Robotics Institute, Toronto, Canada

Context & Motivations

- Recent years have seen a noticeable growth of mobile robots venturing into unstructured environments [1].
- Development of robotic algorithms often relies on open source datasets that serve as an essential benchmarking tool [2, 3].
- We join this effort with a proposal for a multi-season, multi-modal dataset recorded in a boreal forest, the largest biome on Earth.
- The main intended use of the dataset is the evaluation of 3D odometry and metric localization, with plans for a public leaderboard similar to [3].

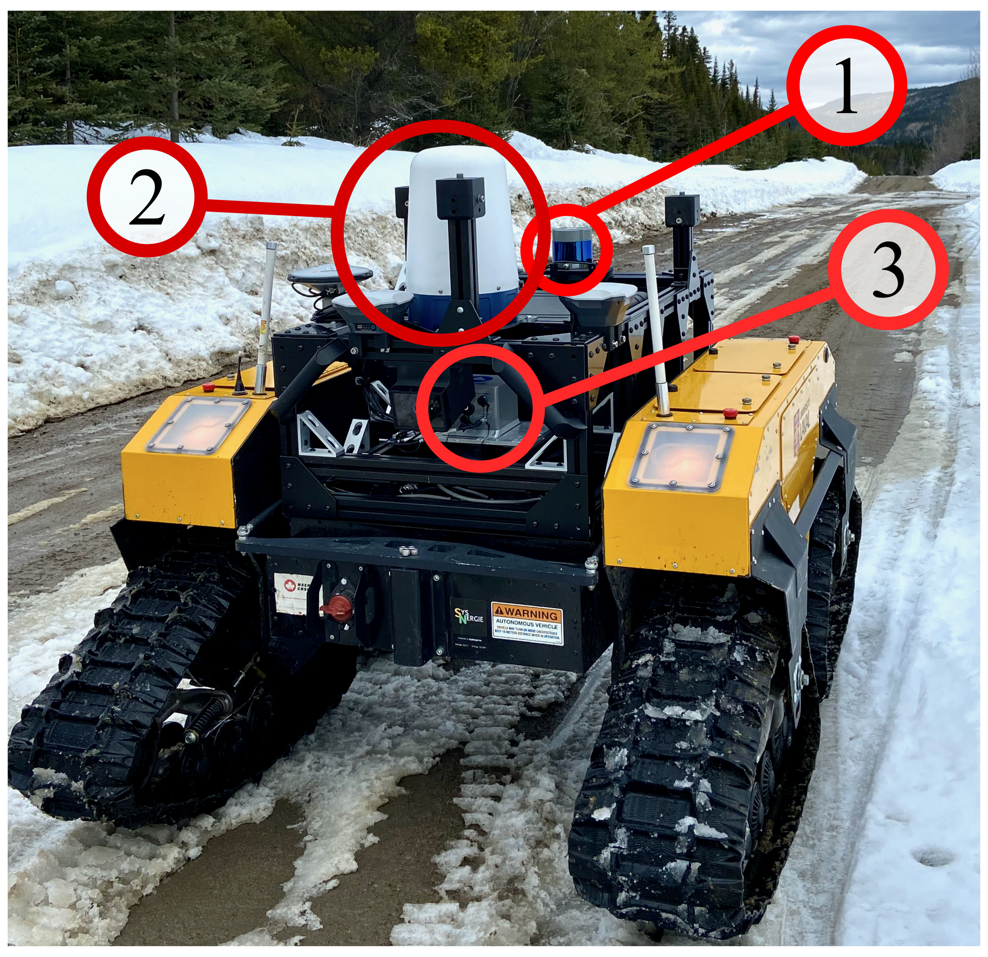

Figure 1: The data acquisition platform in the Montmorency Forest, Quebec, Canada, where the planned data recording will take place. The platform can navigate through diverse terrain, including deep snow, supporting the multi-seasonal nature of the proposed dataset. Marked in red circles are the main sensor modalities: (1) lidar, (2) radar, (3) navigation-grade IMU. Additionally, the robot is equipped with two cameras and other sensors.

Platform and Sensors

- The acquisition platform is an Uncrewed Ground Vehicle (UGV), depicted in Figure 1, specifically a Clearpath Robotics Warthog fitted with four tracks.
- We custom-built sensor frame containing a lidar, two cameras, a radar, three IMUs, and two pressure sensors as shown in Figure 2.
- Facing forward, the robot integrates a RoboSense RS-32 lidar and ZED X stereo camera, while its rear features a Navtech CIR-304H radar and an industrial Basler ace2 wish Fisheye Lens.
- The dataset will feature diverse IMU data sources, provided by an XSens MTi-10 2A8G4 and a VectorNav VN100 Micro-Electromechanical Systems (MEMS) IMUs.
- Additionally, our sensor platform also contains an Atlans-C navigation grade Inertial Navigation System (INS), accompanied by a Septentrio Global Navigation Satellite System (GNSS) receiver.
- For establishing Ground Truth (GT), precise GNSS position is acquired with four Emlid ReachRS+ receivers, with one designated as a static reference station and the remaining three mounted on the UGV.

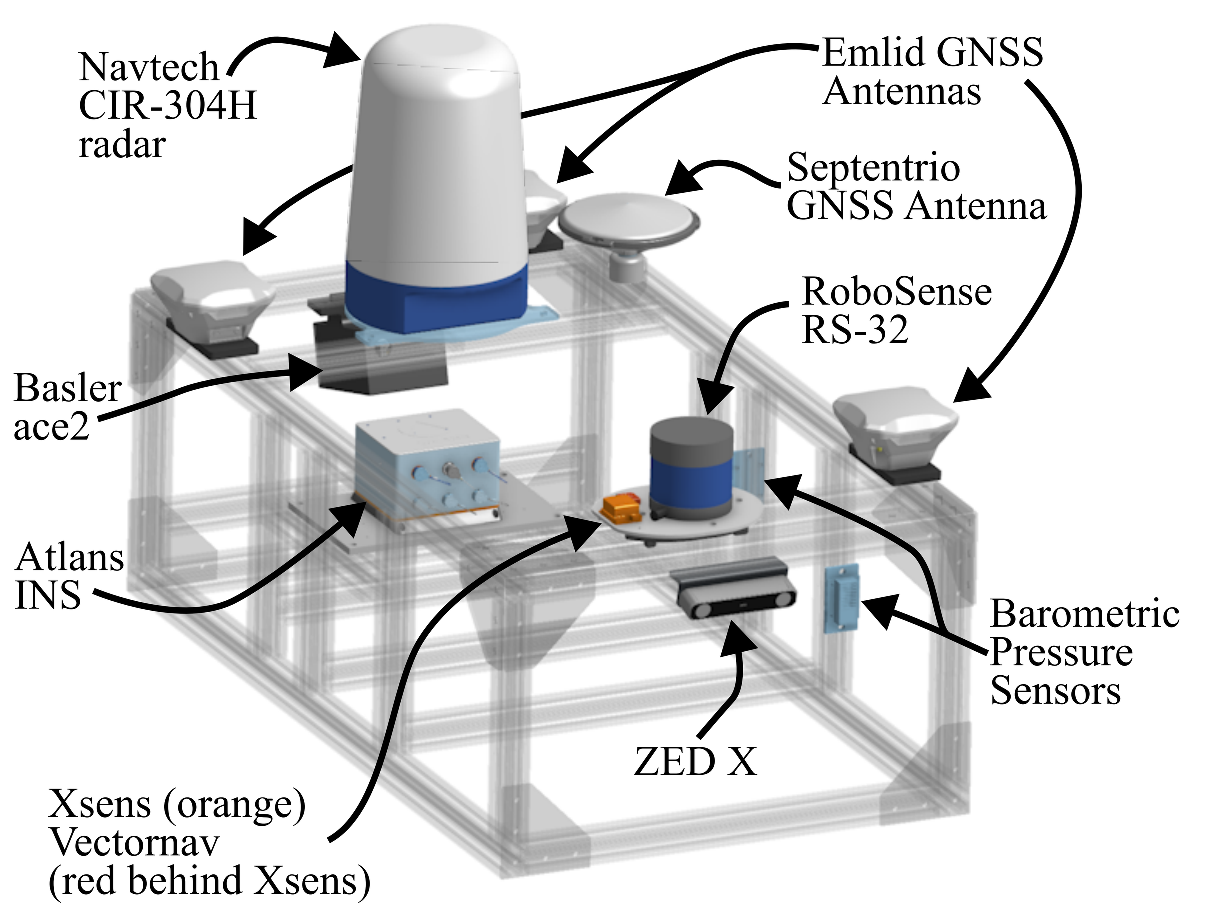

Figure 2: Rendering of the CAD of the sensor frame, mounted on the UGV. A lidar, a radar, two cameras, two barometric pressure sensors, three IMUs, and four GNSS antennas are attached to the frame.

The FoMo Dataset

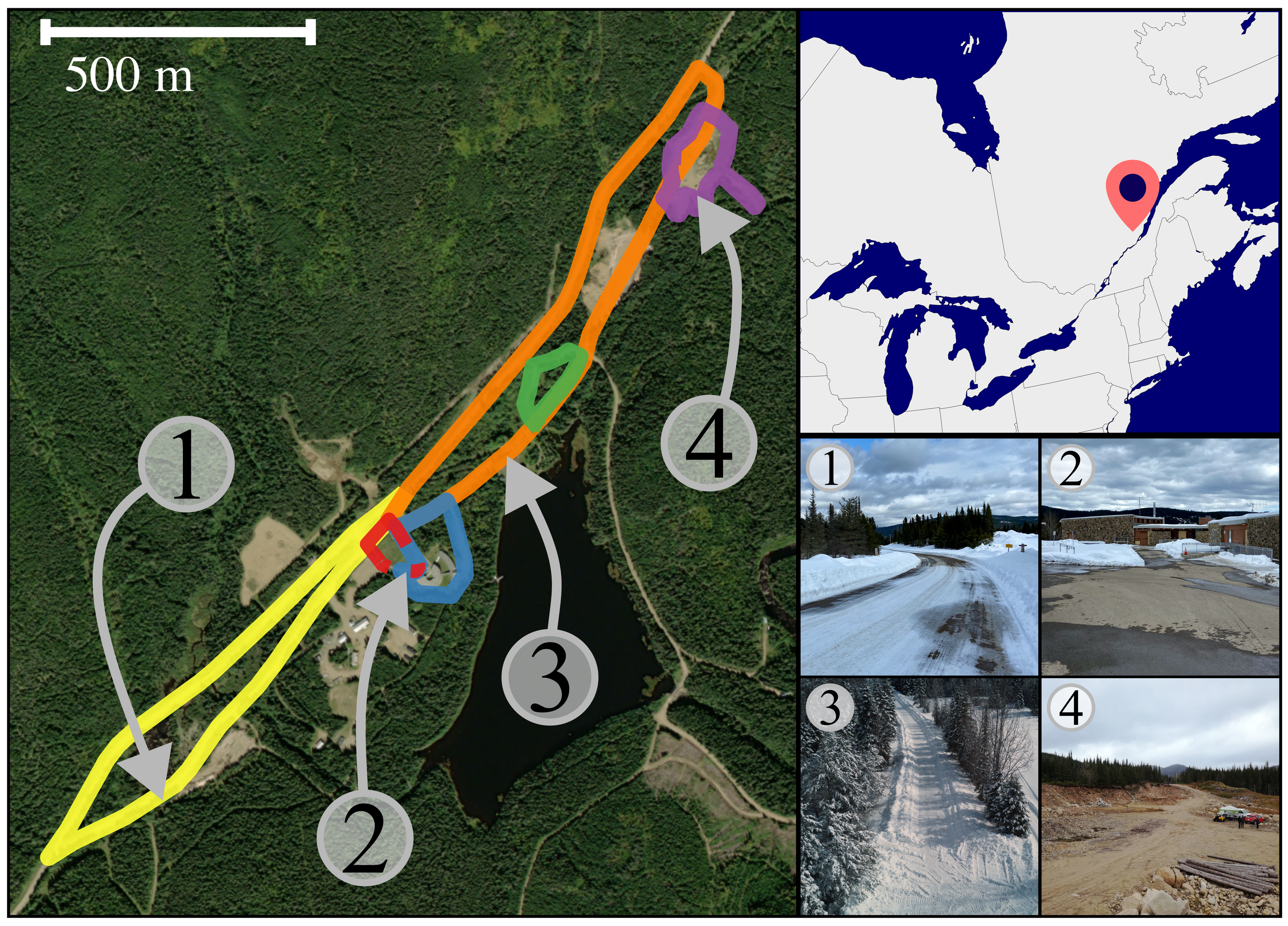

Figure 3: Satellite image of the Montmorency Forest, our data collection area, located in Quebec, Canada. The six proposed trajectories, overlaying the satellite image, have a combined length of 6 km. In bottom-right, we highlight images from the data collection site.

- Data will be collected in the Montmorency Forest located 70 km north of Quebec City, Canada.
- A total of 900 mm of rainfall and 600 cm of snowfall is recorded each year, with snow accumulation reaching up to 200 cm in open areas.
- We propose six trajectories with varying length and difficulty, shown in Figure 3. In total, the described routes cover 6 km, which leads to the expected 42 km of the total length of the dataset.
- In addition to the data captured by the onboard sensors, the dataset will contain meteorological data (e.g., temperature, humidity, pressure) from a weather station with a refresh rate of 1 min.
- Given the impracticality of integrating GT maps into the dataset, we prioritize the inclusion of precise GT poses. These will be acquired using our four GNSS receivers with a Post Processed Kinematic (PPK) method.

Time synchronization and Spatial calibration

- A IEEE1588 Precision Time Protocol (PTP) is employed to synchronize clocks between the grandmaster computer and individual sensors.
- The computer is directly connected to a GNSS receiver and maintains the most accurate time using the satellites' atomic clock.
- All initial spatial calibration estimates are determined from the mounting positions of the sensors in its Computer Aided Design (CAD) model shown in Figure 2.

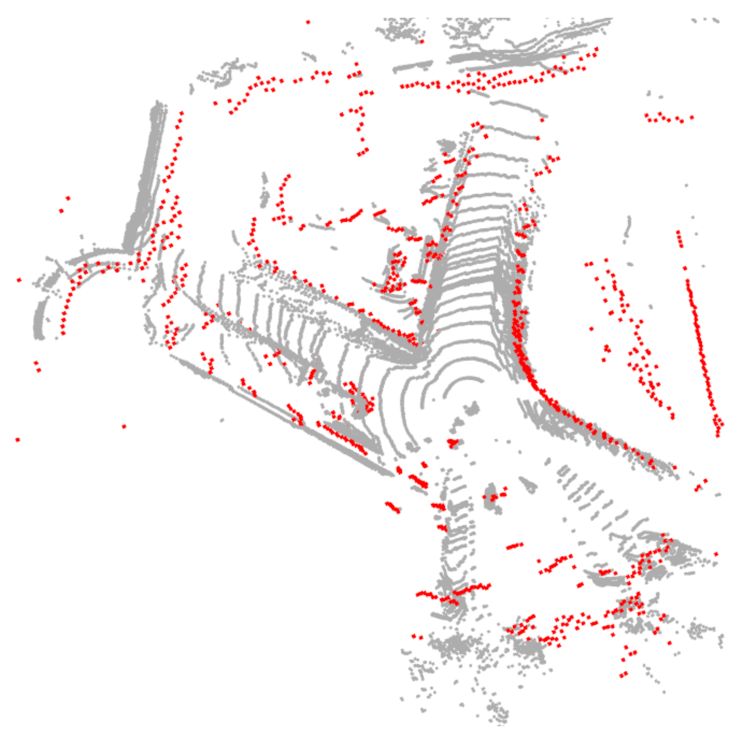

Figure 4: Lidar point cloud (grey) calibrated against extracted radar point cloud (red) using CACFAR extractor.

- Our calibration target, also used for the intrinsic calibration of the Basler ace2 camera, is a chessboard 765 mm wide and 1000 mm tall.
- To allow for a wide range of movements needed for the calibration, the sensor frame is lifted with a crane and manipulated manually to excite all axes of the IMUs.

Acknowledgments & References

This research was supported by the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Fonds de recherche du Québec (FRQNT) through the grant 2023-NOVA-326877 HUNTER (Highlight the Unexpected with Navigation Through Extreme Regions).

[1] Robin Schmid et al. Self-Supervised Traversability Prediction by Learning to Reconstruct Safe Terrain. In *2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pages 12419–12425, 2022.

[2] Samuel Triest et al. TartanDrive: A Large-Scale Dataset for Learning Off-Road Dynamics Models. In *2022 International Conference on Robotics and Automation (ICRA)*, pages 2546–2552, 2022.

[3] Keenan Burnett et al. Boreas: A multi-season autonomous driving dataset. *The International Journal of Robotics Research*, 42(1-2):33–42, 2023.

{matej.boxan, francois.pomerleau}@norlab.ulaval.ca