The Lunar Rover Mini:

Towards a Versatile, Open-Source Mobile Robotic Platform for Educational and Experimental Purposes

Sam Bekkers
Dr. –Ing. Armin Wedler

German Aerospace Center (DLR)
Institute for Robotics and Mechatronics (RMC)

Motivation

In-house DLR systems

✓ *Modular software framework*

✗ *Expensive & complicated hardware*

✗ *Low availability*

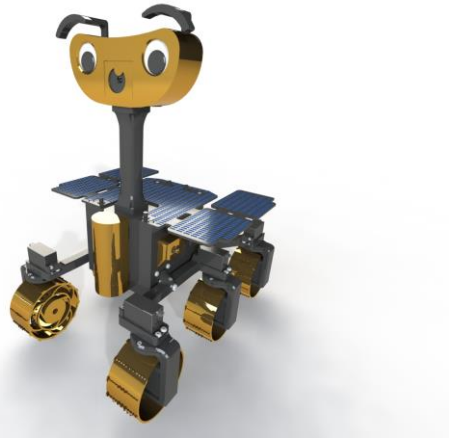
Lightweight Rover Unit (LRU), DLR [1]

Comparable projects to LRM

✗ *Limited development potential*

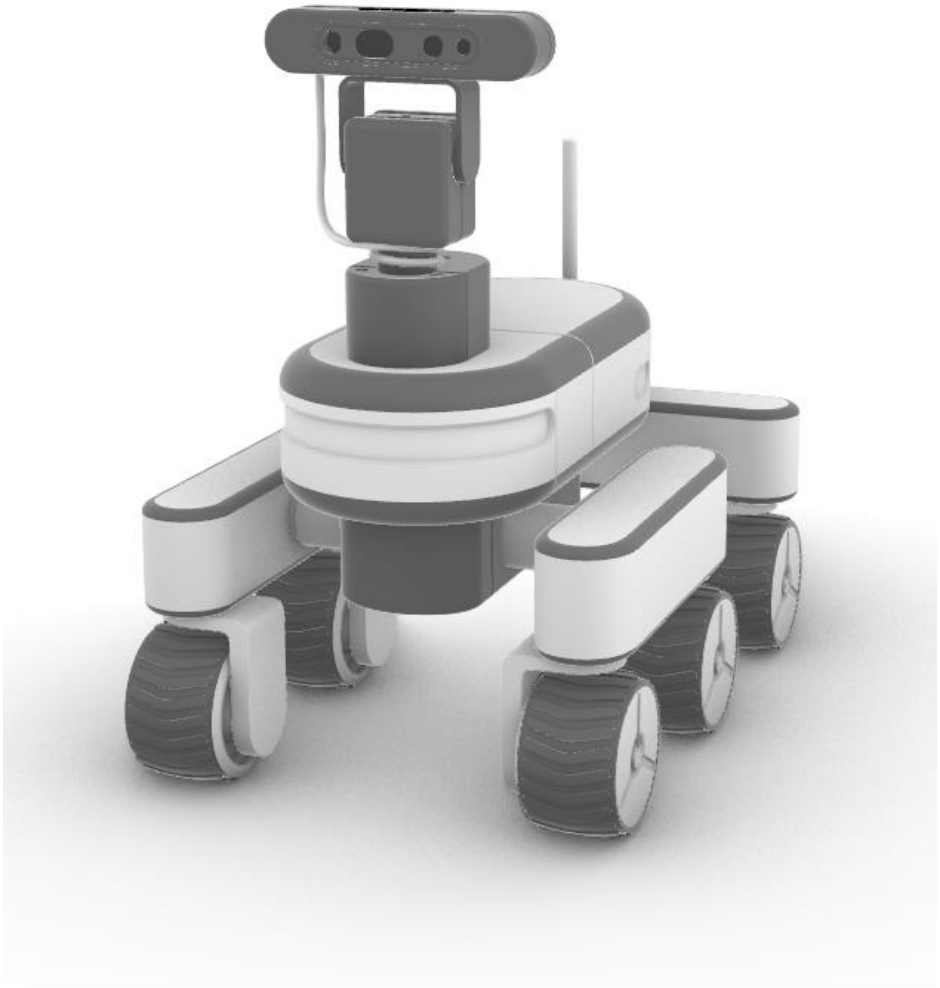
✓ *Low-cost & manageable hardware*

✓ *Easily reproducible*



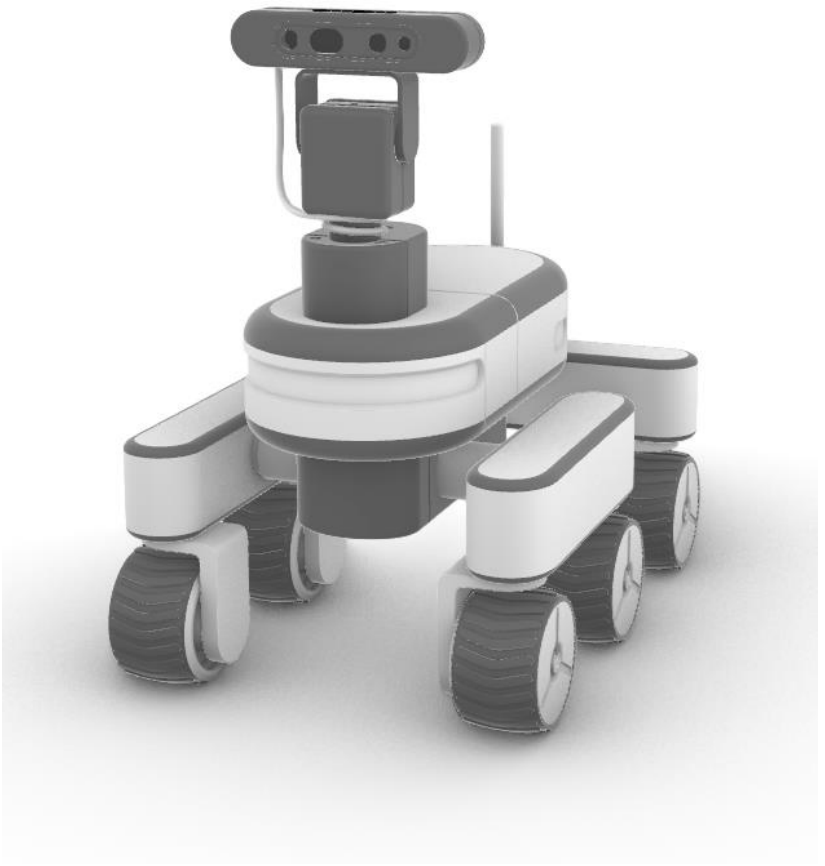
ExoMy, ESA [2]

The Lunar Rover Mini



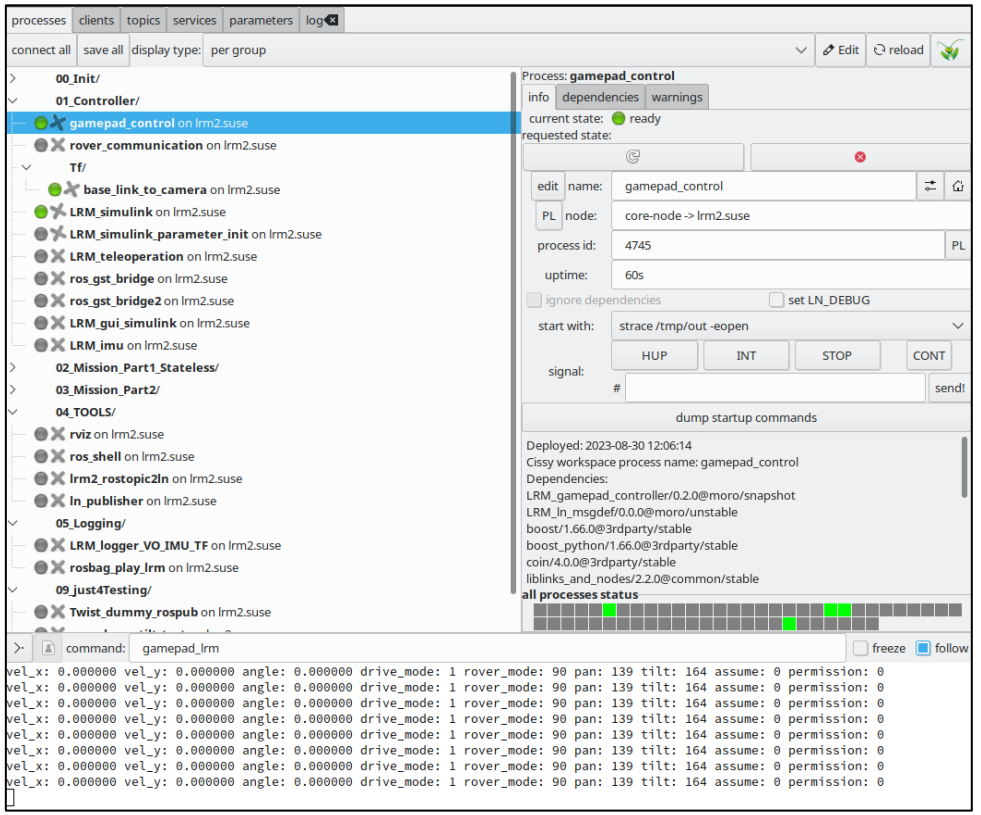
The Lunar Rover Mini | Hardware Overview

- **Dimensions:** 36 x 26 x 39 cm *(L x W x H)*
- **Low-cost assembly:** ~ €2000,-
- **On-Board-Computer:** Intel NUC (i7)
  OpenSuse Leap 15.4 OS
- **Perception:** RealSense D435i
  RGBD camera + IMU
- **Power:** 14,9V LiPo battery
- **Communication:** WiFi



The Lunar Rover Mini | Software Overview

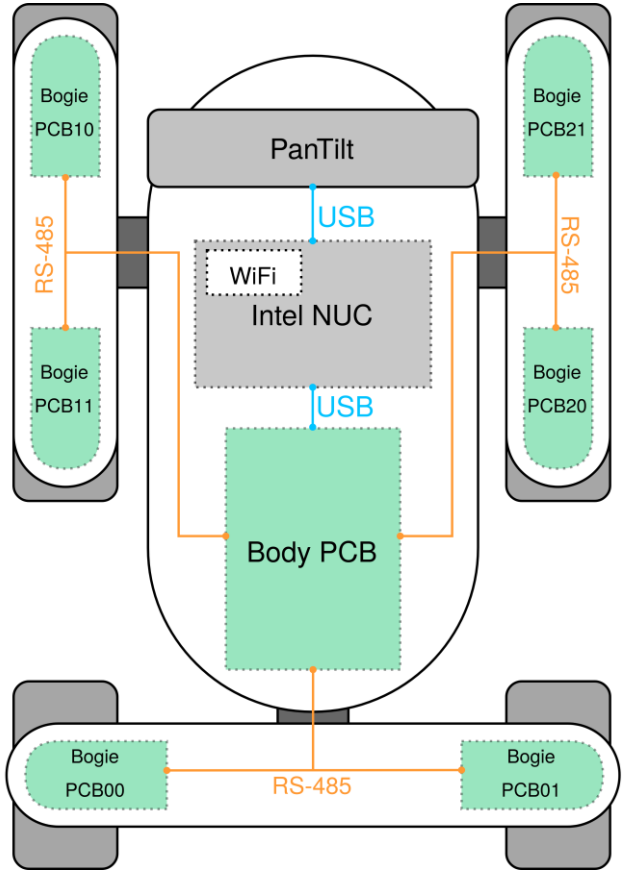
- Links-and-Nodes (LN)
  - *Gamepad Control*
  - *Low level communication*
  - *Simulink motion control*
- ROS Melodic
  - *RTABmap SLAM*
  - *RMC Auto-Navigation*
- RAFCON[6] (future)
  - *High-level mission planning*



LN-manager

The Lunar Rover Mini | Electronics

- Intel NUC
  - *Runs software framework*
  - *Collects perception measurements*
- Body PCB
  - *Manages communication to actuators*
  - *Collects actuator measurements*
- Bogie PCB's control wheel actuators
  - *Low-level PID control*
  - *Steering angle measurement*



System Components Overview

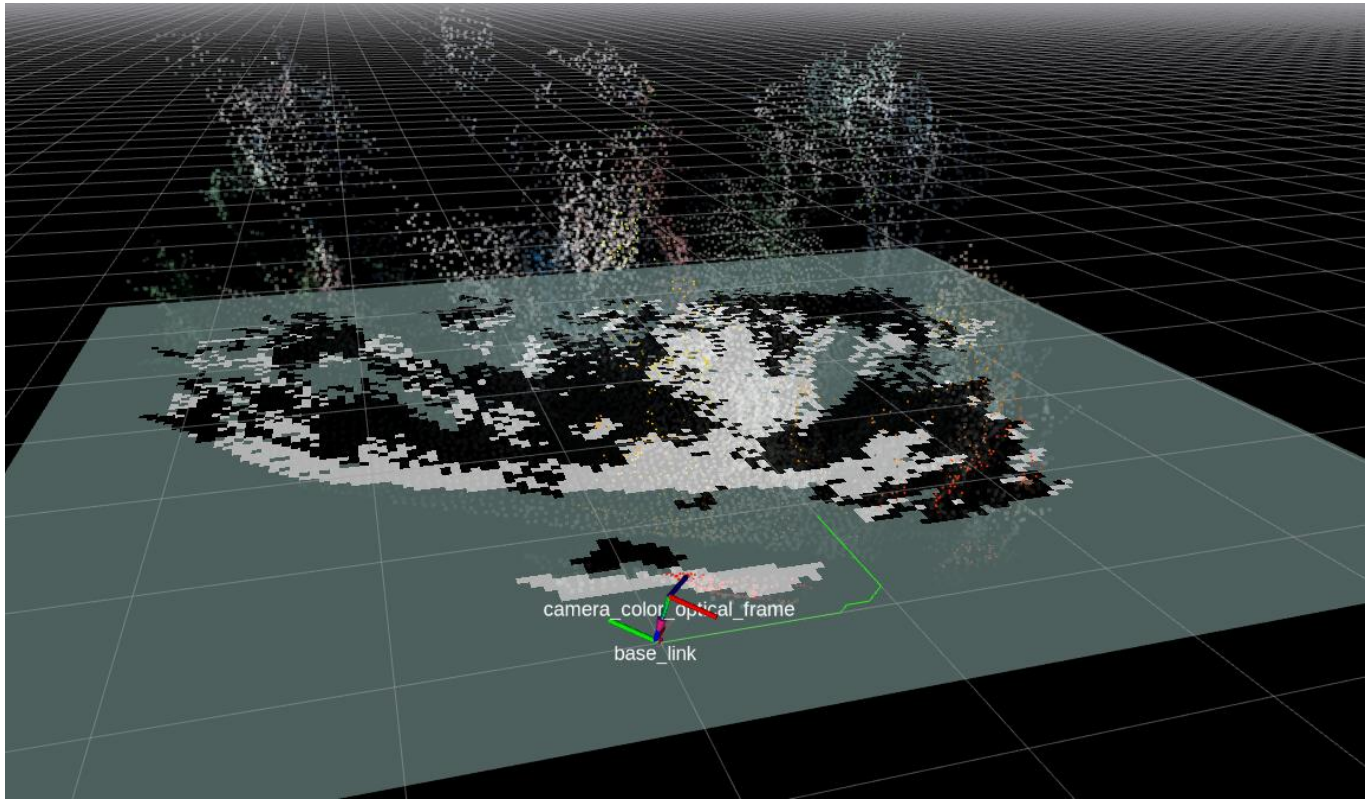
The Lunar Rover Mini | Component Availability

Category	Name	Available	Notes
Hardware	Intel NUC (i7)	✓	On Board Computer
	Intel RealSense D435i	✓	RGBD camera + IMU
	Body PCB	✗	Communication manager
	Bogie PCB	✗	Steer and drive control
	Faulhaber 2619 006 SR	✓	Wheel actuators
	Hitec HS-422 Deluxe	✓	Pan-Tilt actuator
Navigation	RealSense tools	✓	Camera driver, depth sensing
	RTABmap	✓	SLAM framework
	RM-Autonav	✗	Internal tool for autonomous navigation
Infrastructure	Links-and-Nodes	✓	Platform-agnostic process manager
	ROS Melocid	✓	Robot middleware
	RAFCON	✓	State Machine graphical Interface
	Cissy	✗	Internal CI/CD manager

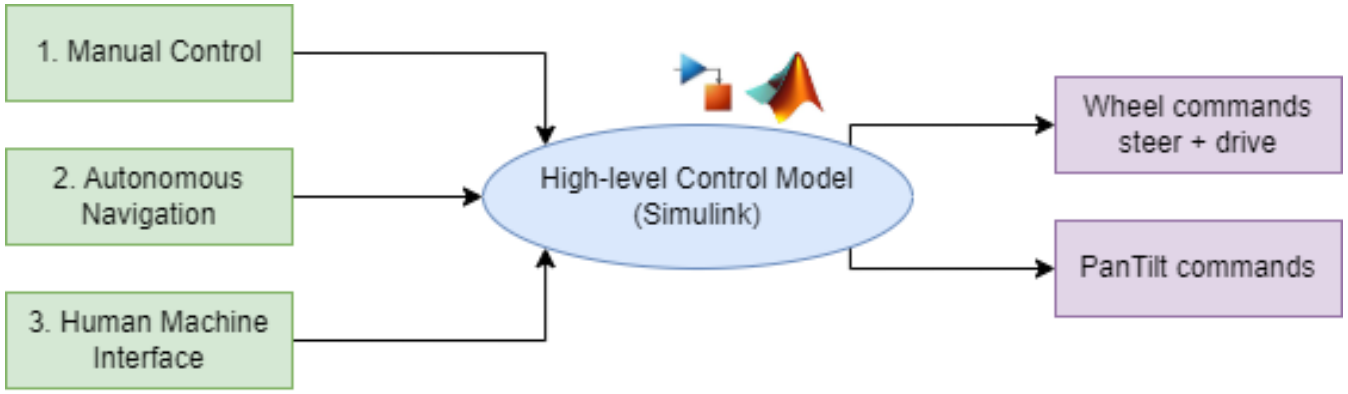
✗ = *not yet available, but foreseen in the near future to be released*

✗ = *not available, but can be substituted by other open-source components*

Operations and Control

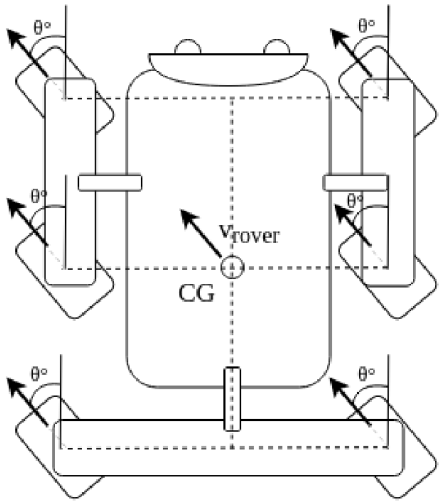


Operations and Control | High-level control

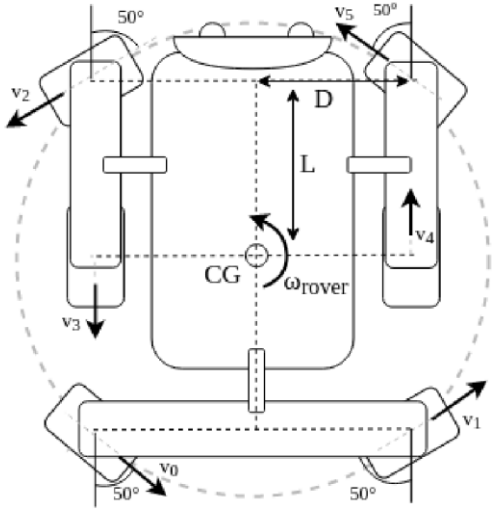


Operations and Control | Driving modes

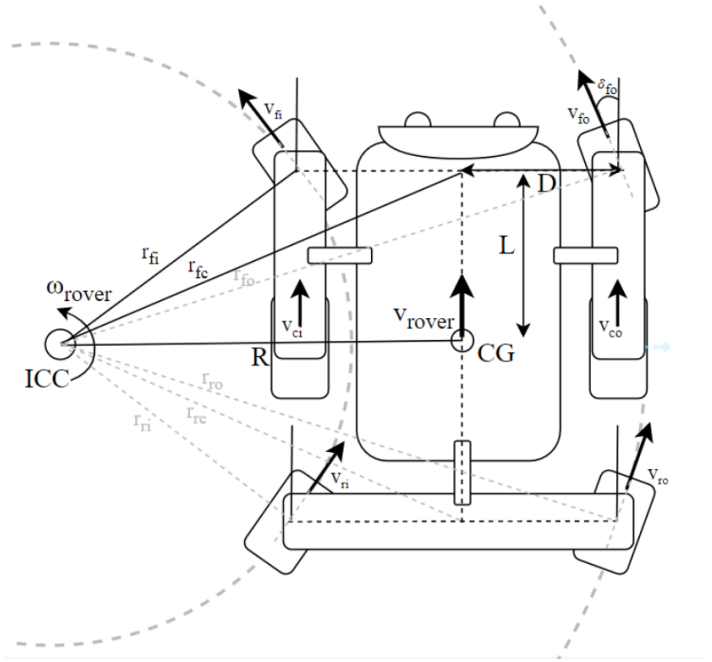
Crabwalk mode



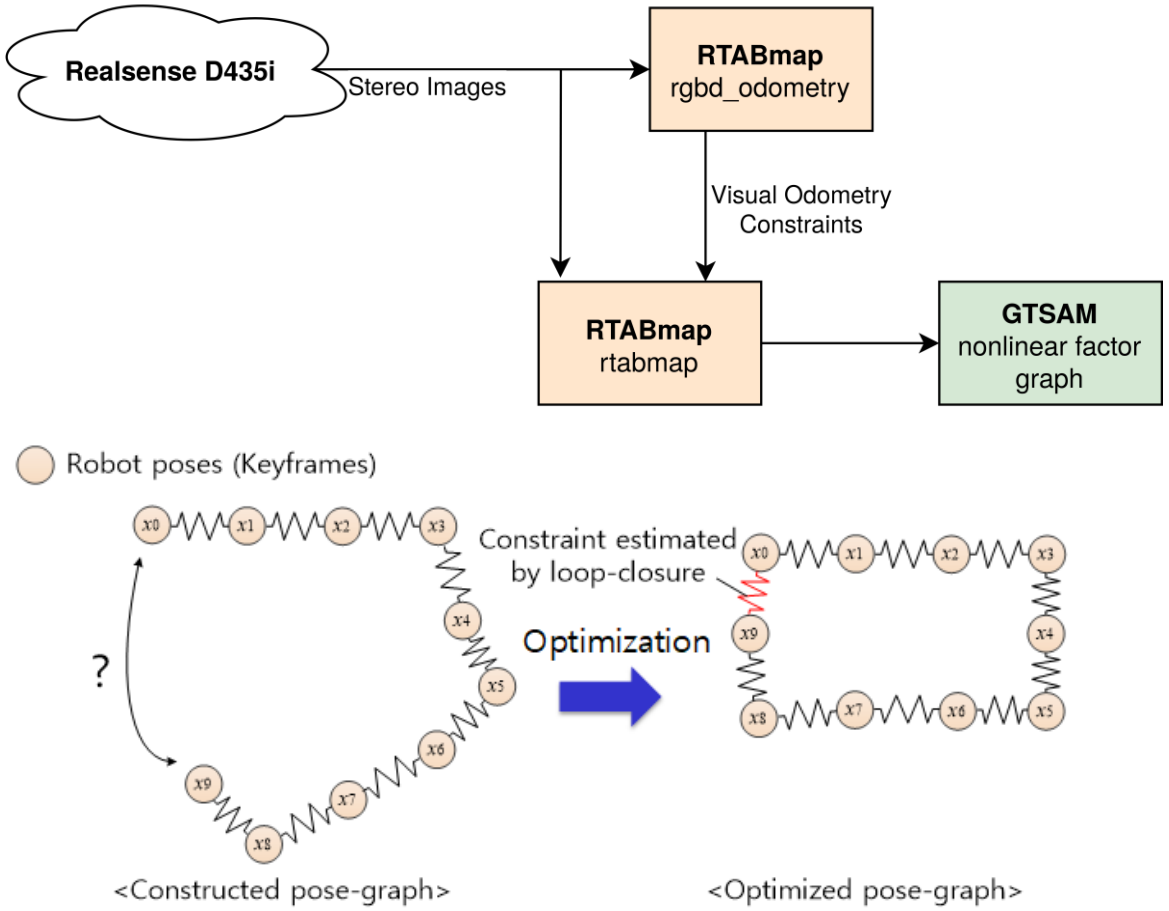
Rotation mode



Ackermann Steering mode



Operations and Control | Localisation and Mapping

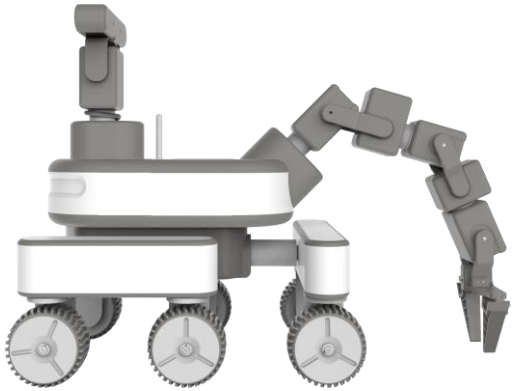


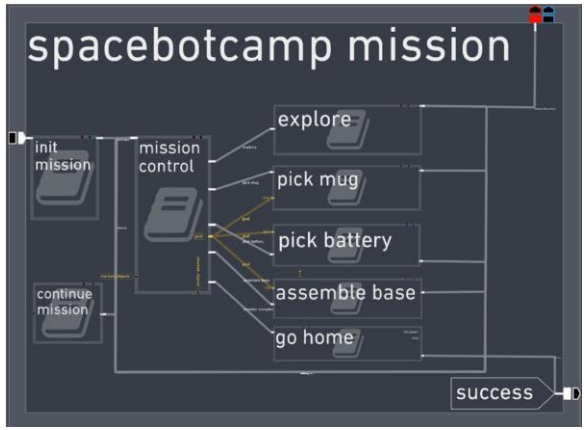
Pose Graph optimisation with loop closures [3]

Developments

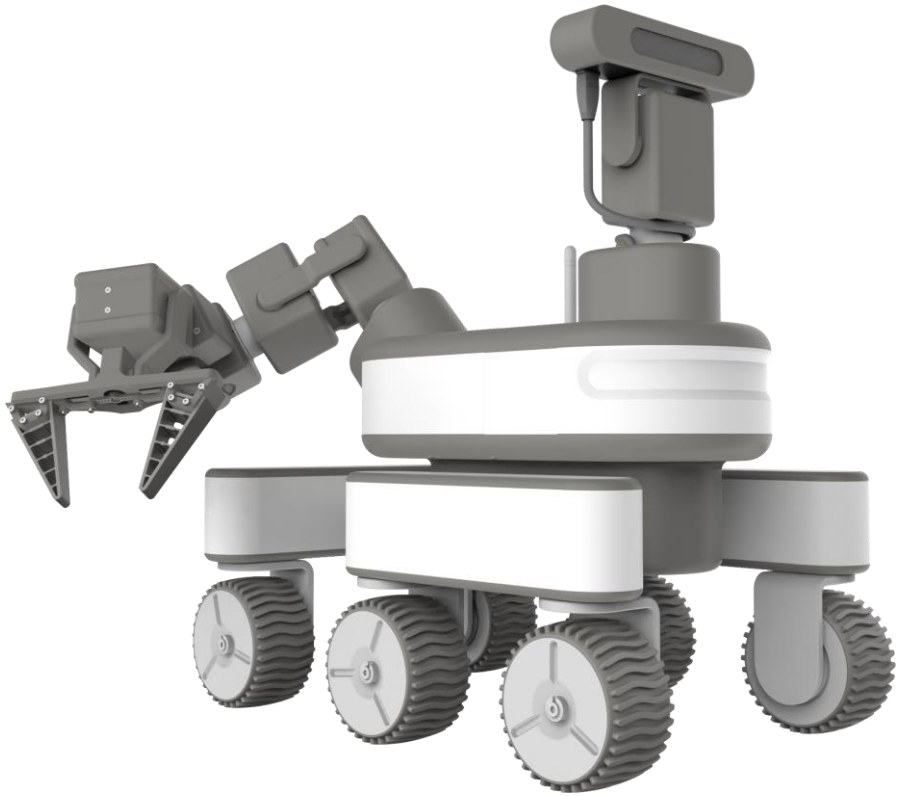
Developments | Robotic Arm

- *Designing a robotic arm for environment manipulation*



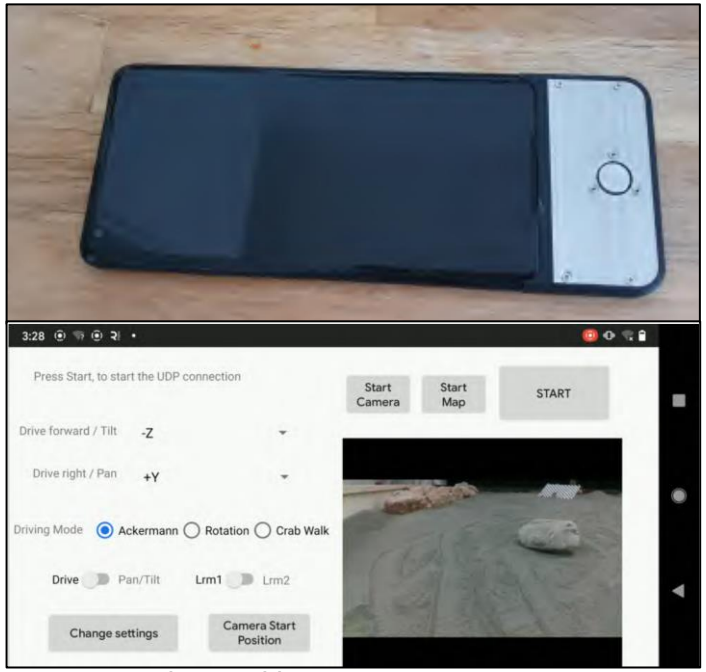


RAFCON Mission planning [1]



Developments | Human Machine Interface

- *Development of a human machine interface on a smartphone*

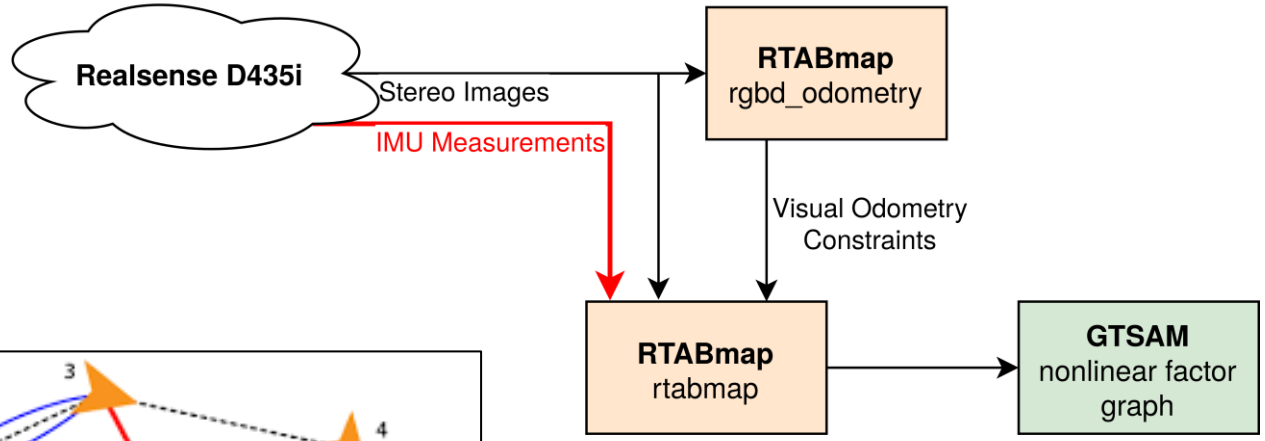


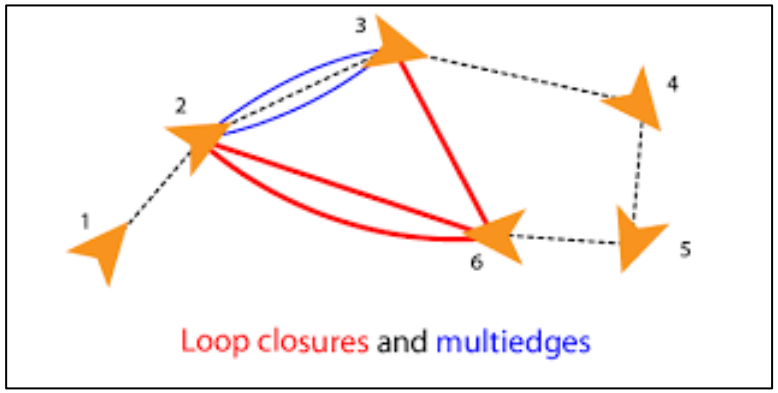
Top: smartphone with 6DoF SpaceMouse
Bottom: control app for manual operation

SHERP, DLR [5]

Developments | Sensor Fusion for SLAM

- *Increasing the accuracy of SLAM by incorporating IMU measurements*



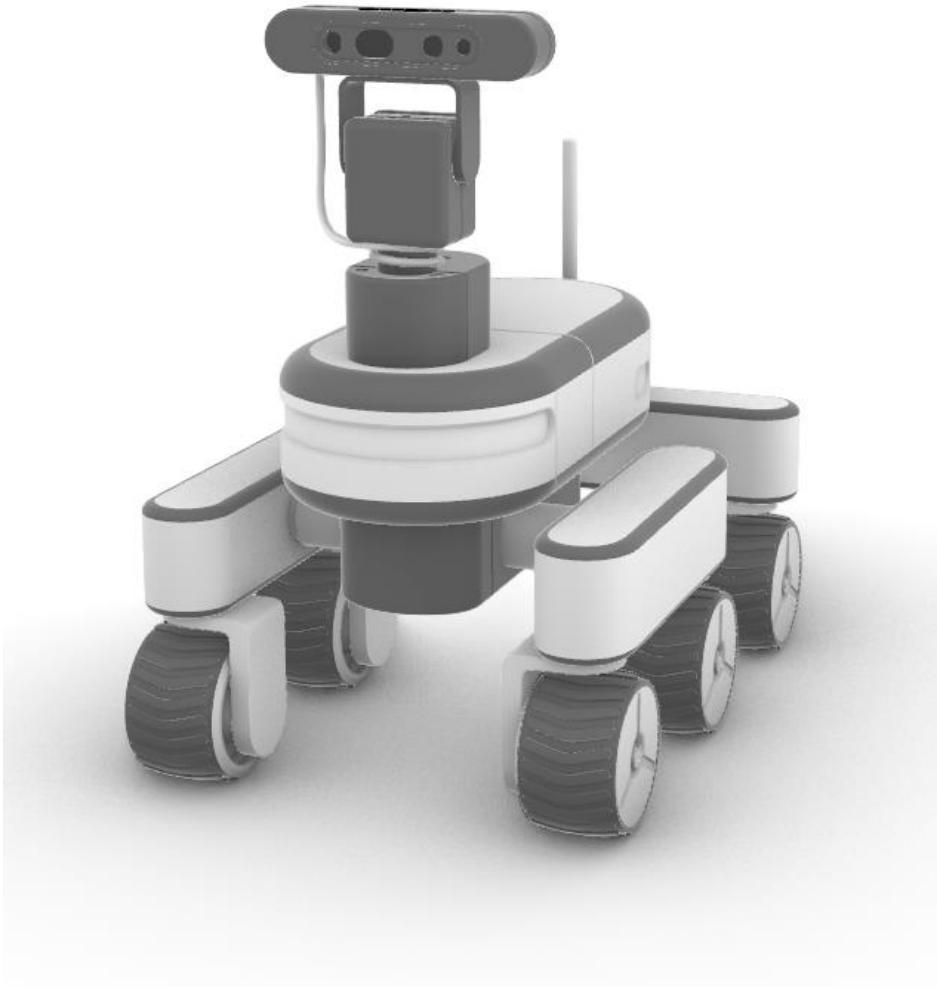


IMU measurements as additional edge in pose graph [4]

Conclusion

Software testing and development platform:

1. *High-end modular RMC software framework*
2. *Low-cost and in the future accessible to all*



References

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