NOBLEO technology
Autonomous Intelligent Systems

Full_coverage_path_planner
&
Tracking_pid

ROSIN: Experiences and outcomes

ROS industrial

ROSin

NOBLEO technology
Autonomous Intelligent Systems

About

- Nobleo: consulting & projects in high-tech
  - Robotics, mechatronics, embedded SW, computer vision
  - ASML, NXP, Bosch Rexroth, Ultimaker, Heineken
-
- Loy van Beek (loy.van.beek@nobleo.nl)
  - At Nobleo since 2015, Nobleo Projects since 2018
  - RoboCup@Home with TechUnited Eindhoven since 2011

NOBLEO
powering innovation

Full coverage path planning

- Needed for cleaning, painting, inspection, …
- No FCPPs available in ROS-Industrial
  - Auburn University's automow?
    - 7 years since last commit
    - No docs, written for a competition
    - Vector represented maps
    - In Python, using Shapely library

NOBLEO technology
Autonomous Intelligent Systems

Full coverage path planning

- ROSIN, stage 1: Minimal Viable Product
  - Requirements:
    - Map: known OccupancyGrid
    - Dynamic Obstacles: handled by local planner
  - Nobleo developed a global planner & local planner to accurately follow global path
    - Most work done by colleagues:
      - Yury Brodskiy: algorithm implementation
      - Michiel Franke: controller
    - My work: refactoring, MoveBase-plugins & testing

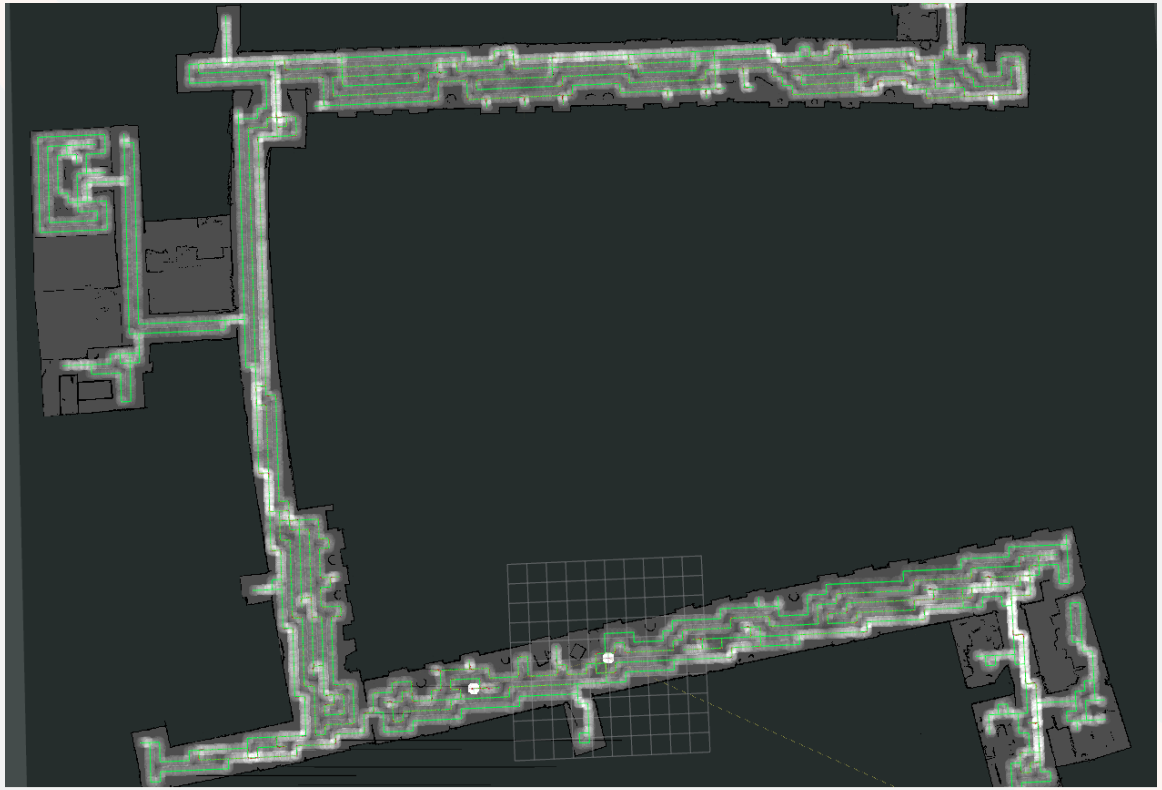
NOBLEO technology
Autonomous Intelligent Systems

Full coverage path planning

- Backtracking Spiral Algorithm
  - Enrique González et al.
- Map is discretized by coverage tool size
- Core separated from ROS
  - Easier testing
  - Easier port to ROS 2 later
- Wrapped as nav_core::BaseGlobalPlanner
  - Goal is ignored, serves as trigger only

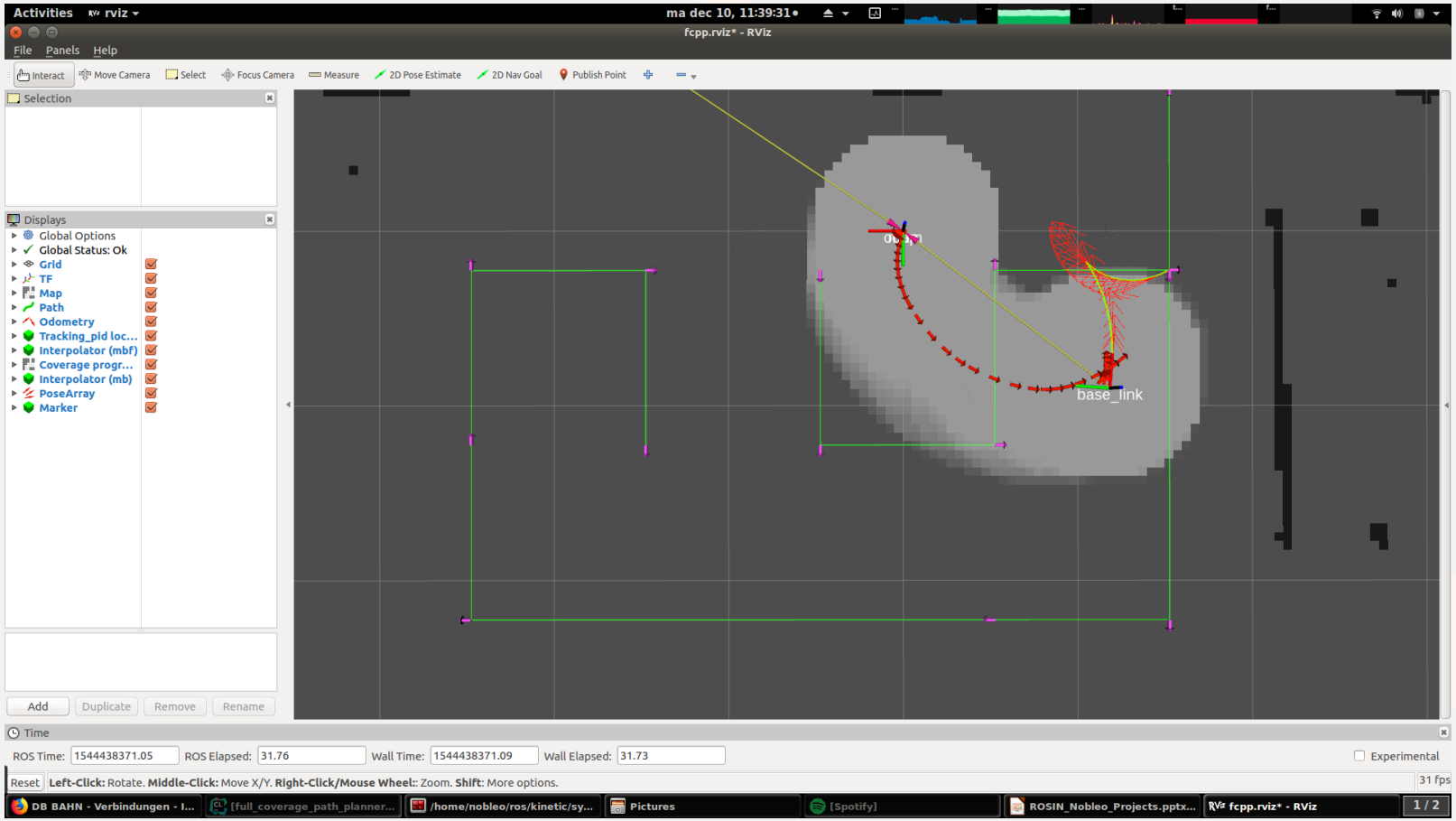
NOBLEO
powering innovation

Full coverage path planning



Tracking_pid

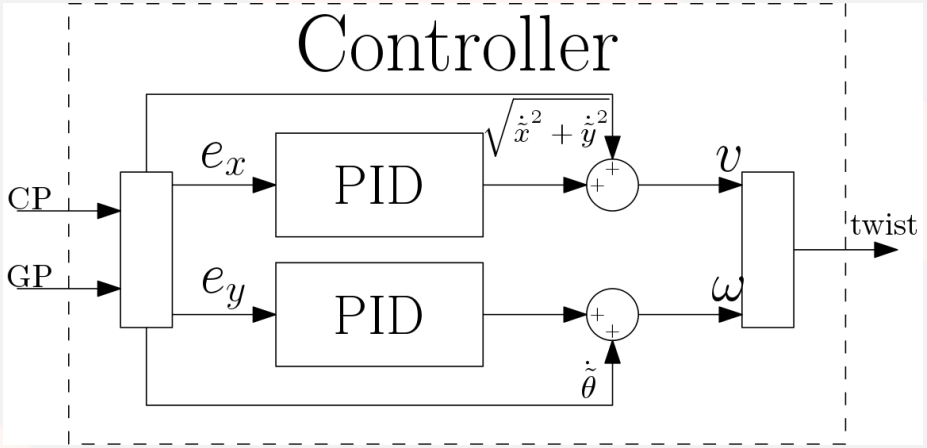
- Local planners take shortcuts on coverage paths
-



NOBLEO technology
Autonomous Intelligent Systems

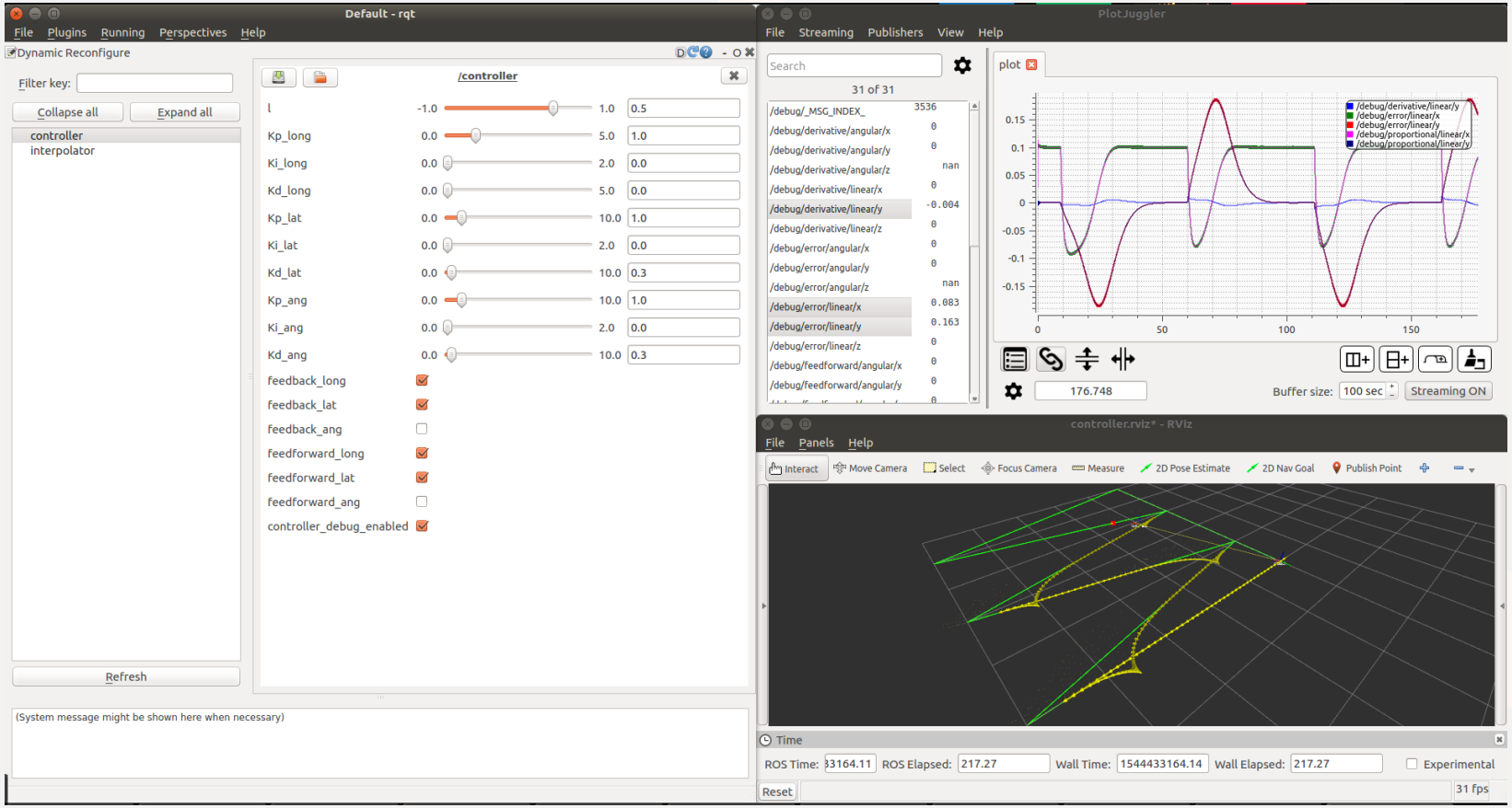
Tracking_pid

- Accurately follow path, reproducable
  - Do not deviate from path!
  - Pause for obstacles
  - Do not go to end ASAP!
  - PID controller on X and Y error
- wrt. carrot moving at fixed speed
- nav_core::BaseLocalPlanner, core ROS-independent



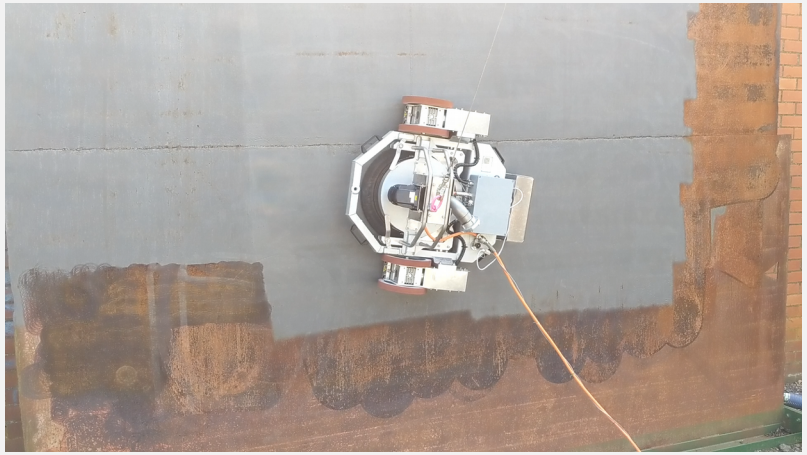
Tracking_pid

- Tuning via dynamic_reconfigure
- Debug intermediate P, I, D outputs

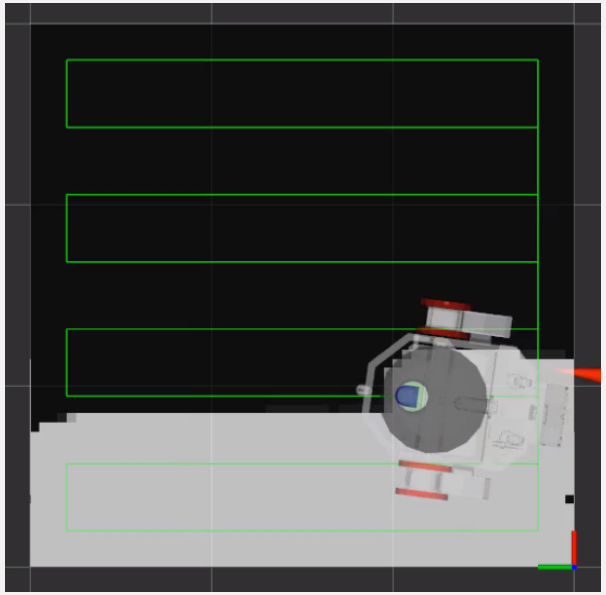


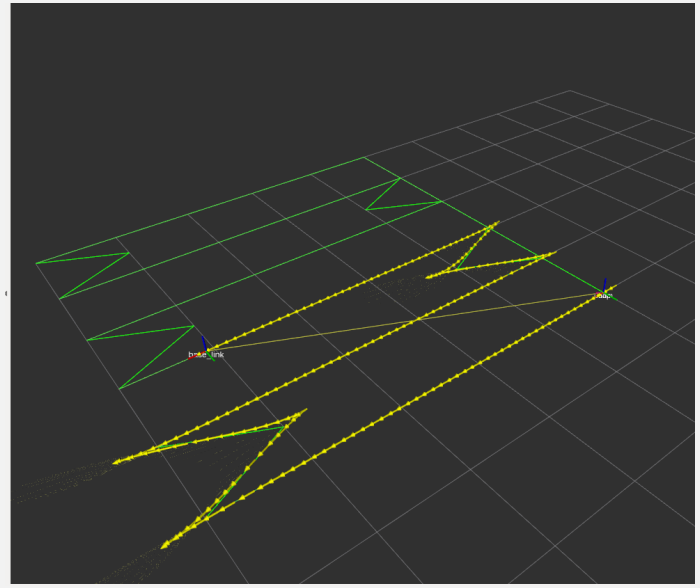
Applications

- Wall cleaning https://youtu.be/4dMjt_Pj4og
-



Tracking_pid compensates for wheel shear by rotating robot

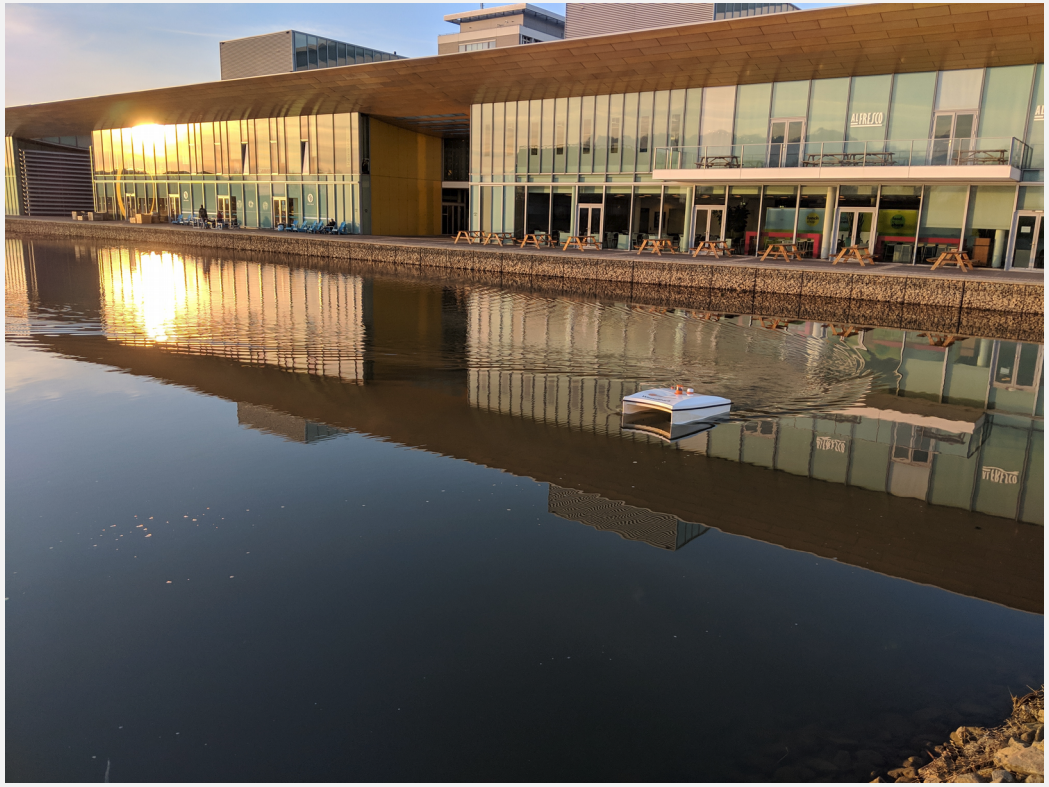




NOBLEO technology
Autonomous Intelligent Systems

Applications

Autonomous Harbor Cleaning: RanMarine WasteShark
- Tracking_pid as virtual anchor



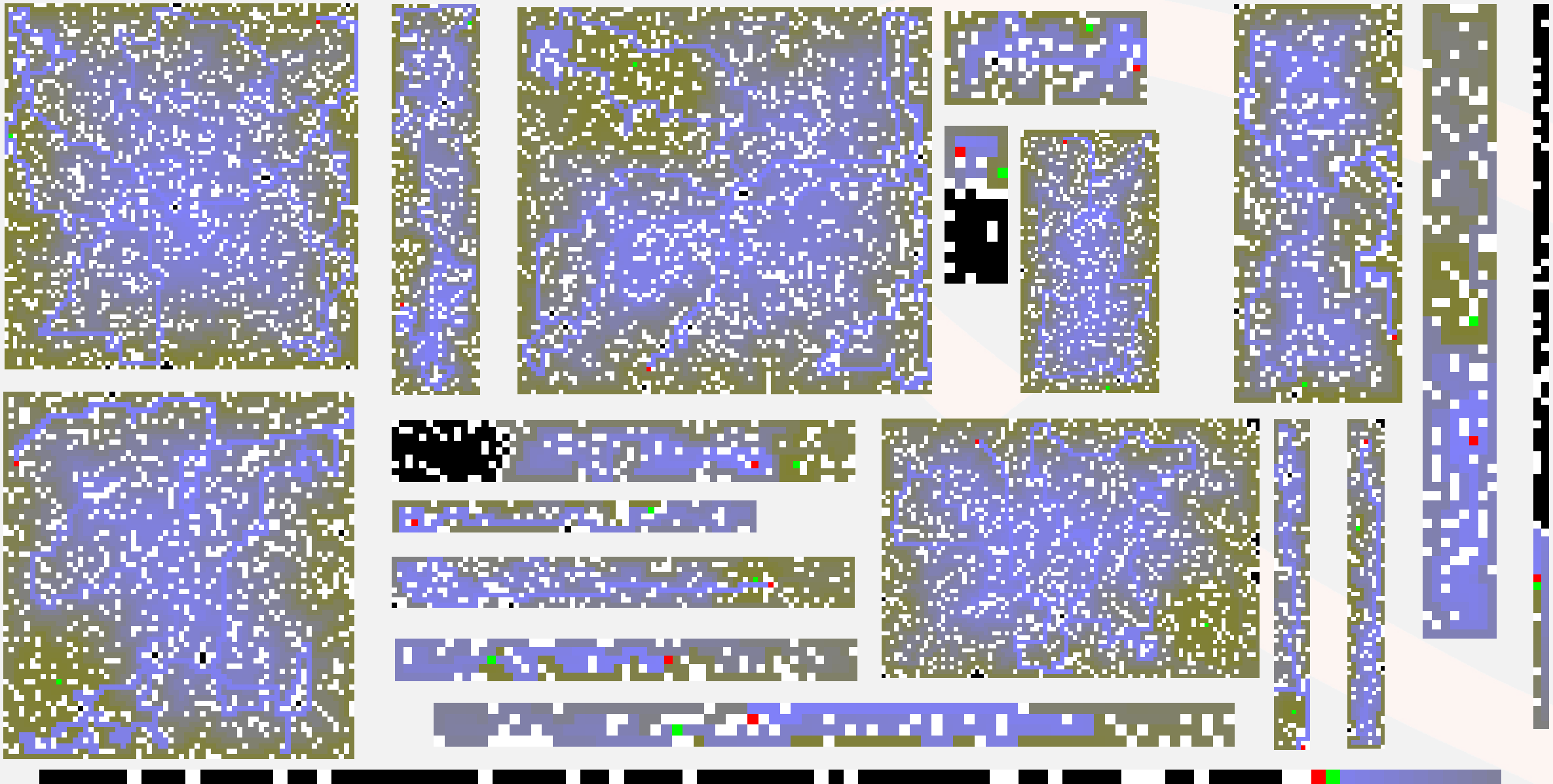
Testing

- Refactored original code for test-ability
  - ROS-independent parts separated
- Testing
  - Unittests with GTest
  - Coverage algorithm is tested against 1000 random maps
    - Expected result: determined by OpenCV FloodFill
  - Tests run in BitBucket with ROS-Industrial CI
    - PR accepted to make script provided for BitBucket executable: `100644 → 100755`

NOBLEO technology

Autonomous Intelligent Systems

Testing



Conclusion

- Great initiative
  - Requires to make in-house SW more generic, thorough
- TODO beyond MVP
  - Adhere to vehicle constraints
  - Different coverage algorithms
  - Property-based testing
    - Generate more test-cases
    - E.g. use CppQuickCheck/QuickCheck++/RapidCheck