# Simulation of Autonomous Exploration and Mapping on SPOT

## Student

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**Objective:** Simulation is a key element in the testing of mobile robots as it mitigates the risk of damaging the physical system and allows agile development cycles by reducing the workload in the field. The simulation requires a robot model of the physical system, a control model of the software and a simulation environment.

The goal of this work is to assemble and test the required parts for simulation in order to interface with a ROS network. This is achieved with the support of Boston Dynamics, as part of their simulator beta program.

**Approach / Technology:** Three fundamental functionalities for mobile robots are selected and integrated into a ROS network to test the environment. In a first step, Spot's vision system is used to generate a map of its surroundings. A real-time appearance-based mapping algorithm is chosen for this task, which assembles a map from spatial measurements and knowledge about movement between measurements.
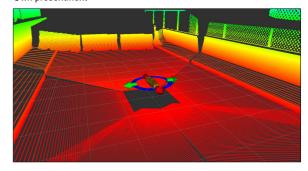
The map provided by the RTAB mapper is then used for navigation and used by the path planner. With live information about the robot's surroundings (camera stream), the robot can approach a global goal while also avoiding obstacles on a local scale.

At last, the goal used for navigation is selected by a frontier-based exploring algorithm. It detects open ends on the map (i.e. frontiers) and chooses the optimal frontier as a navigation goal. The robot is thereby autonomous in its exploration and mapping.
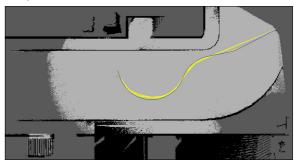
**Result:** During testing of the software on the physical system, the strengths and weaknesses of the simulator were detected. Strengths are clearly se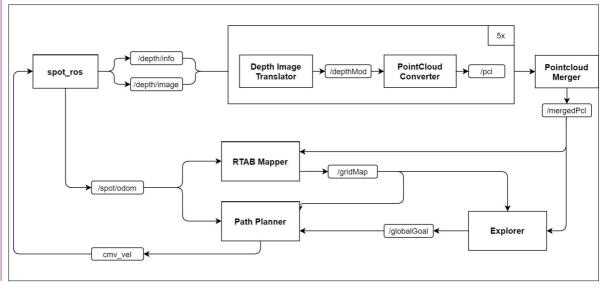en in the fact, that the interfacing of software packages works as expected from the start. Weaknesses are detected in the accuracy of the modelled sensors, their data and the movement. These factors are a key difficulty in mobile robotics and the simplifications made make field testing non-circumventable to assess the functionality of the system.

**Spots surroundings measured as pointcloud generated by the simulated stereo vision system**
Own presentment



**Grid map generated by the RTAB mapper, showing open areas (grey), obstacles (black) and the path taken (blue, yellow)**
Own presentment



**Configuration of the ROS network needed for autonomous exploration**
Own presentment

## Examiner
**Prof. Dr. Dejan Šeatović**

## Subject Area
**Mechatronics and Automation**