SS 2019-2020, SMT-CSE, DISAL-SP138 Project Summary

3D Odor Distribution Mapping in Simulation

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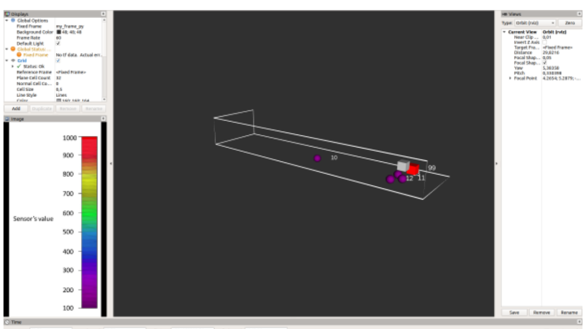
Odor distribution mapping (ODM) aims at mapping the odor field that contains chemical substances. It has been widely applied in many critical situations, such as detecting oil spills, gas leaks and rescuing earthquake buries. Odor mapping can be achieved by either trained animals or mobile robots, mounted with sensitive sensors. Compared with trained animals, robotic system for ODM could have many advantages.

This project addresses the task of implementing an Odor Distribution Mapping (ODM) algorithm, using a simulated quadrotor, to have a 3D monitoring of a confined environment.

First step was to propose a modified version of the 3D Dynamic visualization tool visualization developed in a previous project in order to display the data collected from the drone and the DISAL static sensors in the Webots simulation.

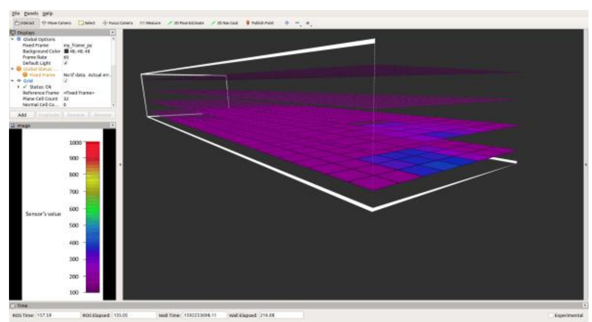


Main interface of the 3D visualization tool after drone integration

Then, 3 ODM algorithms (2D Gaussian Regression, 2D Kernel DM+V and 3D Kernel DM+V/W) were implemented on the quadrotor. The goal of these algorithms is to create, in an online fashion, a grid map of the odor concentration distribution in the room. The first 2 algorithms are based on a 2D approach. The volume of the room is divided into a certain number of 2D planes. These algorithms are applied to each 2D plane in order to obtain a 3D mapping of the odor. However, this implementation does not consider the interaction between the different planes. By way of comparison, a statistical 3D algorithm has also been implemented to take into account this interaction.

Additionally, a dynamic mapping visualization tool has been developed using RVIZ and aims to display the map created by the algorithms while running the simulation.

All the implementations are ROS based, which aims to simplify the transition to real experiments.



Partial grid map from a run of 1min40 obtained with the 2D Gaussian Regression algorithm

Table 4.2: RMSE values for algorithms

	Gaussian Regression	**2D Kernel DM+V**
RMSE	$8.97\text{x}10^{-2}$	$8.55\ \text{x}10^{-2}$

The main challenge lies on the computational cost of these algorithms. Indeed, the strategy followed in this project is to compute the map while moving the drone, which ensures that the plume is minimally impacted by the propellers. However, this approach relies on the speed of computation. This issue must be taken in consideration for further work.

Finally, this work represents a good baseline for further research on ODM in a simulation. Future work should focus on implementing more advance ODM algorithms and a path planning strategy to improve the mapping strategy.