An Open Source Framework for Simulating Mobile Robotics Olfaction

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MOTIVATION

Gas leak localization, drug finding, explosive search or detection of fires at early stages are some of the many potential applications claimed for mobile robots equipped with an electronic nose (e-nose). Indeed, these applications present ideal scenarios where a mobile robot equipped with the capabilities of identifying different volatile organic compounds and providing their respective concentrations would be of great help. Nevertheless, and despite the increase of attention paid by the research community to the field, current olfaction robot prototypes are still far of accomplishing such goals.

The main reason behind the impossibility of real robots to tackle such applications lies in the complex gas dispersion mechanisms dominated by turbulent advection [1] and influenced by temperature, pressure, airflows and even the own robot movement. This strongly limits the possibility of deriving a ground truth (GT) representation of the gas distribution in the environment, making difficult to validate new algorithms or to compare different proposals aiming at the same objective. For the same reason, real experiments usually employ complex setups with the intention of controlling, as much as possible, the dispersion of volatiles (generation of plumes with fans, shutting doors and windows to reduce airflows, etc.), but even then the results cannot be completely validated because of the lack of information about the real state of the gas dispersion.

In this work we present a simulation framework for mobile robotics olfaction which provides the necessary mechanisms for efficiently testing and validating algorithms related, but not limited to, gas distribution mapping (GDM) and gas source localization (GSL). The main advantages of this simulation framework are:

- A ground-truth of the gas dispersion at each instant of time, a fundamental requisite for validating the tested algorithm.
- Repeatability is easily achieved and so comparing different algorithms.
- It helps tuning parameters and finding bugs in the development stages of new algorithms, without the need of tedious and time-consuming real experiments.
- It allows testing an algorithm under different environmental conditions (strong airflows, turbulences, plumes, etc).

In summary, this simulation framework can be seen as a useful tool for developing and comparing state-of-the-art olfaction algorithms.

OVERVIEW

The proposed framework is a C++ application consisting of a number of modules built using the Mobile Robot Programming Toolkit (MRPT) [2] and integrated into the Open Mobile Robotics Arquitecture (OpenMora) [3]. The diagram in Figure 1 describes the main blocks of the framework, while Figure 2 depicts a snapshot of the 3D display in a GDM simulation.

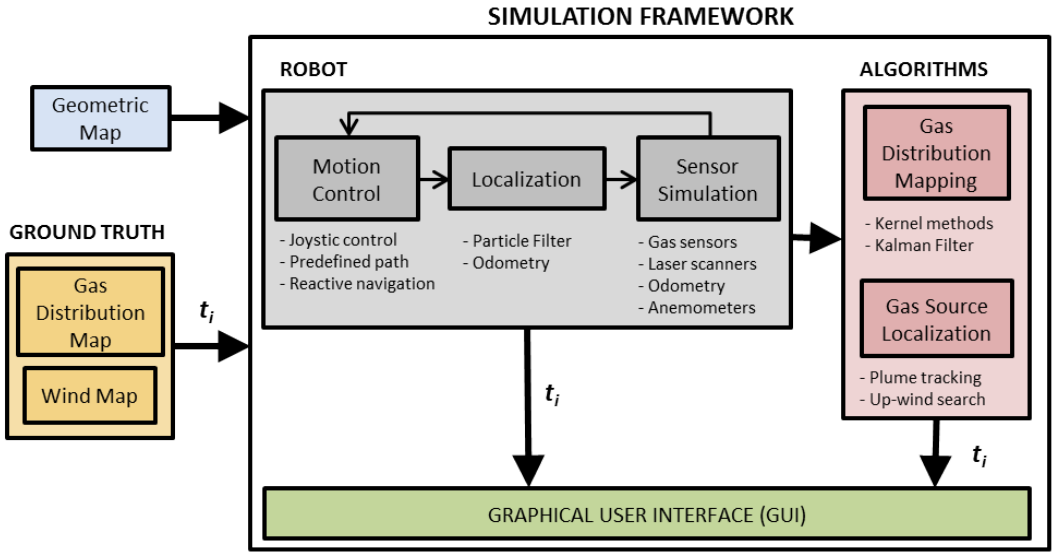

Figure 1. Block diagram of the simulation framework. The ground truth maps (left) can be updated at each iteration, allowing the simulation of gas dispersion.

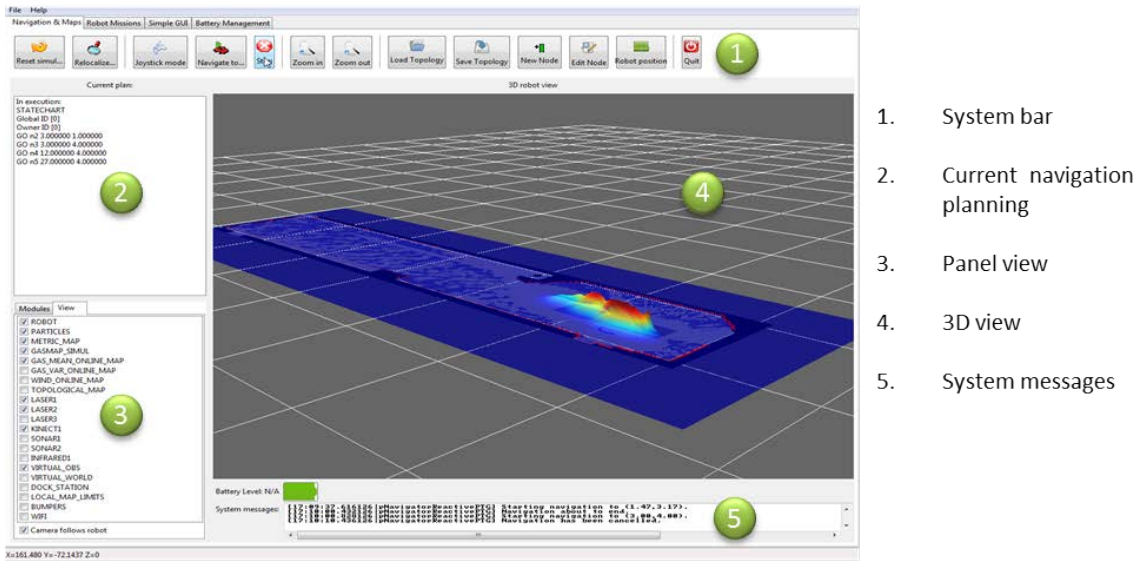

Figure 2. Snapshot of the Graphical User Interface.

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