Odor Source Localization with a Drone in a Realistic Environment

Quentin Golay

Professor : Alcherio Martinoli
Assistant(s) : Faezeh Rahbar, Ali Marjovi

Odor source localization has many applications in the domains of safety, security or environment, where critical situations due to airborne chemicals can happen. Research on robotic systems and algorithms addressing this particular task have been conducted at DISAL in the last years, but mainly in a wind tunnel environment with strictly controlled airflows. These conditions are not representative of real-life applications and a new setup had to be developed.

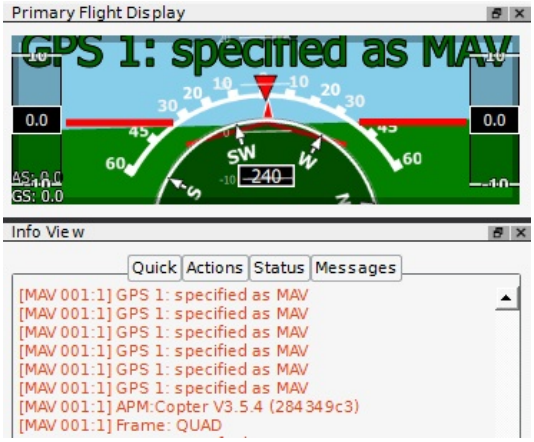
The following report focuses on the design of a new mobile sensing system based on a quadrotor. Using an already existing wireless sensor node, it is aiming to extend the localization of odor sources to realistic environments by enabling the mapping of gas concentrations in 3D. A specific algorithm could then be employed to locate the emitting source in an empty room.

The new system is to be implemented in the flying arena facilities of DISAL, where a motion capture system provides an accurate position of objects in space. Relying on this external attitude estimation, the drone should be able to fly indoor autonomously or according to user commands.

The first step of the project was to select a model of quadrotor. The AscTec Hummingbird had been in use for several years already and, in addition to being expensive, it is getting obsolete. After a comparative study, the Erle-Copter was chosen in replacement. This Linux-based quadrotor is way cheaper and relies on a Raspberry Pi with an extension board that contains all necessary sensors. It is also integrated with the Robotic Operating System (ROS) and is compatible with opensource flight controller softwares.

The integration with the motion capture system was done in two consecutive steps. Firstly, the position estimation is retrieved over a Wi-Fi network thanks to a dedicated ROS node. It has then to be integrated into the flight controller so that the system knows its position in the flying arena. The main idea explored is the faking of a GPS signal, as if the drone was receiving position information from a real physical device. This emulation is done thanks to different modules of the ArduPilot (APM) flight controller software and other opensource libraries, such as MAVLink and mavros.

Unfortunately, difficulties and critical errors were encountered when updating the necessary mavros packages. In the end, the quadrotor was able to recognize the fake GPS signal, but it is still lacking the position data. Once the faulty module is upgraded, the quadrotor could be used with standard flight modes of APM and perform stable indoor flights or navigate to specified waypoints.



APM flight controller recognizing the fake GPS type.

Regarding the wireless sensor node, it is sending its readings over the network to a server running on the drone. The server is coded in Java for the moment, but it should be adapted in order to communicate with the ROS environment as well.

Next steps would be to finish the integration of the Erle-Copter with the motion capture system, either by managing to update mavros or by coding a ROS node that mimics the same behavior. Then an odor source localizing algorithm could be implemented as an additional ROS node, using both the external position estimation and the gas concentrations.