Towards 3D Gas Source Localization in Realistic Indoor Environments using Micro Aerial Vehicles

Wanting Jin

Professor : Alcherio Martinoli
Assistant(s) : Chiara Ercolani

Replacing humans with robots for Gas Source Localization (GSL) tasks under hazardous scenarios has critical realistic meaning. Thanks to the agility and rapidity, and relatively low disturbance on the plume of Micro Aerial Vehicle (MAV) in 3D navigation, a possible extension of research interest from 2D to 3D, is currently studied at DISAL. This project will focus on enabling experimental work to be carried out in a more realistic environment, using the same flying platform employed at DISAL for 3D GSL, namely a Crazyflie miniature quadrotor. Flying a MAV in a more realistic environment requires a good localization system. In this project, two localization systems available at DISAL will be explored and compared.

Customized light-weight and durable makers and final maker configuration of Crazyflie

Firstly, a development environment based on ROS-Webots co-simulation framework is set up to facilitate the validation of the Crazyflie strategy in simulation.

Secondly, an experimental setup for the Crazyflie to use localization system of Motion Capture System (Mocap) and Ultra-Wide Band (UWB) in the Jordils Flying Arena (JFA). Due to the different camera configurations and space volume of the JFA with the wind tunnel, the recommended marker used for JFA is with a radius of 10mm, which exceeds the payload limit of the Crazyflie. As a result, a series of customized markers have been made, such as scooping the original marker inside, 3D printing and coating a foamball with reflective tape and fixing it on a soft stand. Besides, a UWB system with eight anchor sensors was set up in FAJ accordingly to the recommended configuration of Bitcraze

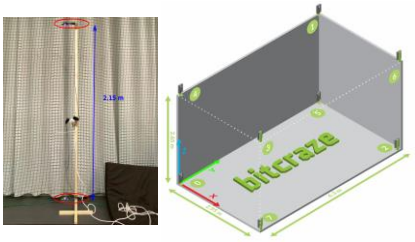
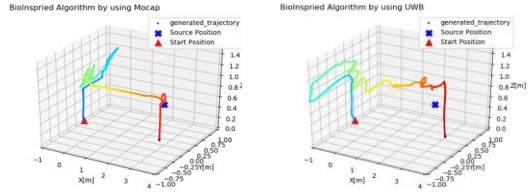


Illustration of the UWB system setup in the JFA

Finally, an existing bio-inspired algorithm for GSL was ported from the wind tunnel to the flying arena of Jordils. The time limit is too constrained to set up the gas source in Jordils and the gas sensor on the Crazyflie. Alternatively, we used simulated gas source and gas detection data from the Webots. The experiment results are as follows:



Real experiment result of bio-inspired alogorithm with simulated odor detection by using Mocap and UWB

By using both localization technologies, the Crazyflie could finish the GSL task and land successfully. Nevertheless, due to the comparably noisy nature of UWB, the trajectory by using UWB is jerky, and the final descending point has a significant estimation error in the z direction. The same conclusion could be drawn that the UWB system is sufficient for the GSL task using Crazyflie, even though the trajectory is comparably not smooth and may lead to some random detours. However, a more accurate localization system will have a significant effect on the performance of the system.