# Odor Mapping with a Crazyflie and Static Sensor Nodes

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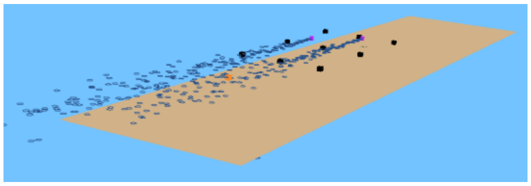
Odor Distribution Mapping (ODM) using a quadcopter has many applications, such as finding the source of a gas leak or monitoring levels of dangerous gasses. However, it faces some challenges such as the lack of consistent information and the limited flight time.

To address these issues, research has been made towards including data from static sensor nodes into the mapping algorithm and in the informative path planning (IPP) strategy.

For this purpose, I implemented a simulation in Webots gathering a Crazyflie micro aerial vehicle and a grid of static sensor nodes, using for some parts controllers already developed in previous projects.



*View of the created Webots world*

The mapping is done using the 3D Kernel DM+V/W algorithm, which divides the space unifomly into cubic cells and weights the impact the measurements taken have on each of them using a Gaussian Kernel, shaped according to the wind direction, the latter being computed using a wind sensor added for this simulation.

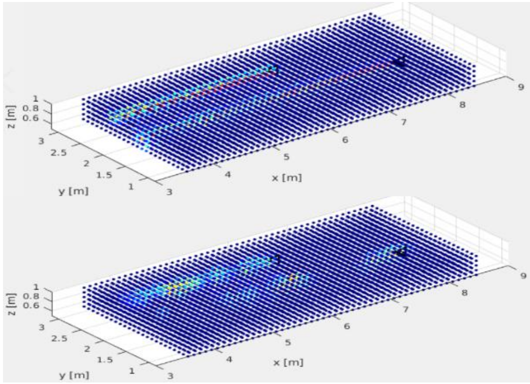
The next step was to adapt the parameters of the algorithm, such as the cutoff radius of the Kernel, to the chosen envrionment, the nature of the odor source as well as the presence of measurements coming from static odor sensor nodes.

The performance was tested using a 3D lawnmower motion for the drone. The motion crossed the axis perpendicular to the plume (y) every 5 cells.


*3D lawnmower motion*

The RMSE was measured using as reference the data obtained by making the Crazyflie stop at each cell and take an averaged measurement.

Then, actual IPP strategies were tested. These tried to maximize entropy, relative entropy (KLD) while the last one relied on relative entropy, odor concentration level and number of cells update (KLD+). The flight time was limited to 4.5 min.




*Reference (top) and map obtained with KLD+ (bottom)*

| Strategy | RMSE | Coverage | Plume cov. |
|---|---|---|---|
| Entropy | 0.048 | 20.8% | 23.9% |
| KLD | 0.041 | 43.8% | 48.5% |
| KLD+ | 0.040 | 34.7% | 62.8% |
| *Lawnmower** | *0.019* | *100%* | *100%* |

The results show that the relative entropy is better to capture the odor distribution in this setup. The KLD has the highest total coverage but captures the plume only partly. This is due to the fact that it resulted in the drone polling towards the different static sensor nodes.

The KLD+ strategy, which relied also on the odor concentration was able to remain longer in the plume, getting a slightly better RMSE (0.04). As a comparison the lawnmower (*no flight time limit) had a RMSE of 0.019.

To conclude, including static sensor nodes enabled to find a quite effective IPP strategy to map the odor within a restricted time. Future improvement would consist in finding a way to generate less shaky trajectories to be able to make the most of the limited flight time.