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Evaluating an odor source localization algorithm in different environmental conditions

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Odor localization can have many real world applications such as: chemical leak detections, search and rescue missions, inspections, environmental monitoring, mine detections, etc.

Many different control strategies have been explored such as bio-inspired, probabilistic and swarm/formation based algorithms. All of these algorithms vary a lot from each other in the way the odor source is localized, but they all have one common point: their success rate is highly dependent on the environment.

This project is a continuation of the work of Soares et al. [1] and of Giezendanner [2]. Soares et al. developed and implemented a 2D graph-based odor-source localization technique, then Giezendanner extended the algorithm in 3D using a “flying” robot.
The goal of this project is to improve Giezendanner’s algorithm by improving the behavior of the flying robot, update the code from using a Khepera 3 for the flying robot to the newer Khepera 4 robots, adjust the gains in the algorithm to obtain a more robust odor localization and finally test the code in different environment conditions to see its effect on the success rate of the algorithm.

The algorithm works by calculating 3 velocity vectors which are then combined in a weighted sum to calculate a final velocity which is then sent to the robot. The three vectors are the formation control vector, the upwind movement vector & the plume centering vector.

To obtain better behavior for the flying robot, the plume centering vector was removed and the different gains used to calculate the formation control vector had to be adjusted accordingly.

Finally, experiments were run while changing the weights in the sum used to calculate the final velocity vector. It was observed that increasing the weight of the plume centering vector helped the robots locate the source much quicker and even localize it in cases where it failed before. But the side effect of privileging plume centering was that the dynamical formation feature disappears and if the odor plume is too small, the robot flock tends to oscillate around the plume, which reduces the energy efficiency of the algorithm.

[1] J. M. Soares, A. P. Aguiar, A. M. Pascoal et A. Martinoli, «A Graph-Based Formation Algorithm for Odor Plume Tracing.,» 12th International Symposium on Distributed Autonomous Robotic Systems (DARS). No. EPFL-CONF-203439, 2014.

[2] J. Giezendanner, «3D Graph-Based Formation Odor Source Localization,» Semester project EPFL, Lausanne, 2015.