Developing a Bio-Inspired 3-D Odor Source Localization

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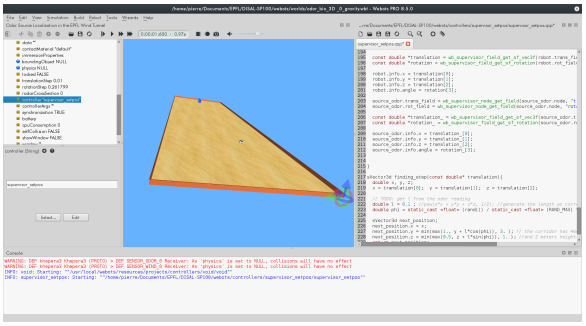
Being able to automatically locate the source of an odor plume has been an area of research since the first robot to be able to do so in 1991, and is still an issue for the 21st century. From the two major approaches considered: stochastic and bio-inspired, the later was considered for the present study.

Animals behaviors in odor plumes has been widely studied. They use odors for life important matters such as finding food or mating partners, in competition with each other. Successful bio-inspired algorithms were demonstrated in 2 dimensions. However in 3D, previous studies of our knowledge had to rely on using plumes with either a perfect conic shape, or continuous plumes (no patchiness), which are not realistic plume models. Being able to use a realistic odor plume generator developed at EPFL, I designed a 3D odor localization algorithm, and wrote the corresponding controller in C.

Tests were conducted in simulations of a real world experiment at DISAL's wind tunnel, with the software Webots which is also originated from EPFL.



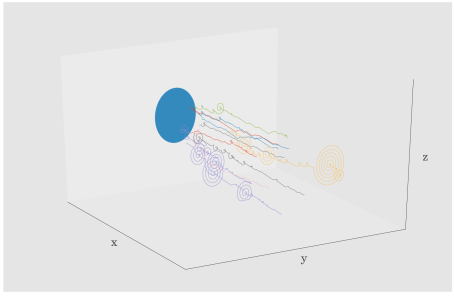
Interface of Webots, at the start of a simulation

The wind and odor sensors necessary to the algorithm are mounted on a Khepera3 robot, itself mounted on a 3D Cartesian traversing system able to move this ground robot in 3 dimensions. The Webots software not being aware of the traversing system, we had to develop a novel approach to move the simulated Khepera in 3D, that would emulate the traversing system's operating.

While previous studies focused solely on going up the plume, I also proposed and implemented a way of finding it a first time, from a randomized initial position.

The parameters used by the different phases of the algorithm are studied and discussed.

Since source identification is a whole new problem by itself, the algorithm's goal was only to approach the odor source at a reasonable distance. We chose this distance as just enough to be able to identify the source in the future. Therefore, the fitness tests that allowed us to assert the validity of a given parameter are defined on the robot's final position's distance to the odor source.



Trajectories of the robot in a few random runs, without the plume finding phase for visibility. The blue circle is the target.

While I tested the algorithm in looser conditions, for instance in larger wind tunnels or with an artificial noise added to key values, I also proposed software improvements and further testing, that could verify the algorithm's potential. Finally, I proposed a different algorithm to go up the plume, which can be easily implemented in simulations. The controller is indeed very modular and different behaviors can be easily implemented by modifying one function at the time.