Developing a Probabilistic Algorithm for Finding Odor Sources in 3-D

Julian Ruddick

Professor : Alcherio Martinoli
Assistant(s) : Ali Marjovi and Fazeh Rahbar

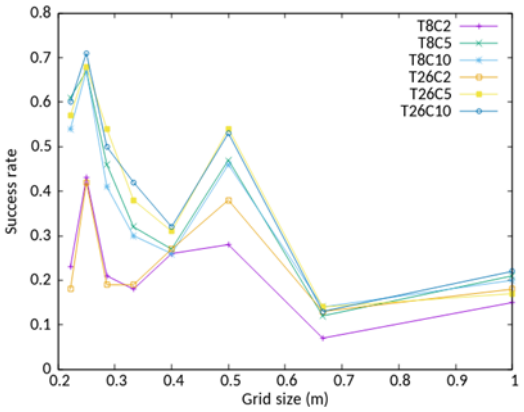
Unlike sound and light, locating the source of an odor is a difficult task for a human. This is why we use sniffer dogs to locate certain odor sources. Since around the 1990s, research has been made to replace these sniffer dogs by robots to locate gas leaks, bombs or drugs. Different odor source localization algorithms have been developed for this purpose. Some simply move towards the highest odor concentration others replicate the behavior of animals such as moths. This project aim was to port an existing 2D probabilistic odor source localization algorithm to 3D. In the first part of the project, I ported the algorithm successfully in Webots and tested what parameters of the algorithm influenced the finding of the source. In a second time I tested some of the environmental factors in the DISAL wind-tunnel and in Webots with similar conditions.

Picture of the robot in the wind-tunnel

The algorithm works by moving the robot at each step to the place that will give the most information of where the source is. To evaluate this, the robot has a concentration model of the odor plume. The algorithm uses this model to build a probability map of where the source could be with every concentration measurement. The amount of information the robot has on the location of the source is defined by the entropy of the probability map. The lower the entropy, the more information the robot has on where the source is. Therefore at every step, the algorithm will evaluate what move would yields the lowest entropy. This process is repeated over and over until the robot finds the source.

To modify the algorithm from 2D to 3D I changed the plume model to fit the Webots and the wind-tunnel 3D plume. I also changed the move strategies of robot and added cases on which the robot estimates it has found the source and can stop searching.

Different parameters of the algorithm were tested in Webots, these parameters were the grid size of the probability map (precision of the probability map) the number of concentration ranges used to evaluate the expected entropy of a move and the number of possible moves for the robot. The main conclusion of these tests were that a higher precision of the probability map increases the success rate of the algorithm. Also two unexpected peaks at 0.5 and 0.25 meter grid size seem to infer that there still is a problem with the plume model or the algorithm.



Success rate for the different parameters

The environmental tests made in the wind-tunnel and Webots showed that the algorithm was very successful when run with the same wind speed that was used to build the plume model but much less successful when run in an environment with lower wind speed.

Overall the algorithm was successfully ported to 3D. Although the algorithm is not working perfectly for the moment, tracks for improvement have been given.