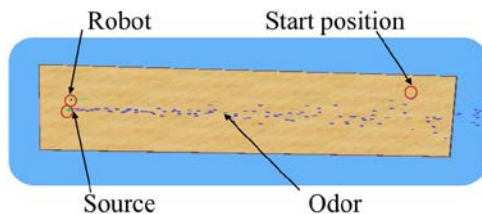


Particle Filter Algorithm for Odor Source Localization

Vincent Demotz

Professor : Alcherio Martinoli
Assistant(s) : Faezeh Rahbar, Ali Marjovi

The purpose of odor source localization is to find the unknown location of a source of volatile chemical. The robotic odor source localization is the heuristic to use a mobile robot for such goal. In an outdoor environment, the particles spread out in the air and are pushed away by the wind. The particles form a plume of the odor, with the higher concentration of odor particles at the location of the source. Robotic odor source localization is the process of finding this plume, follow it to the source, and declare the geographical location of the source.



Main interface of the Webots Simulation

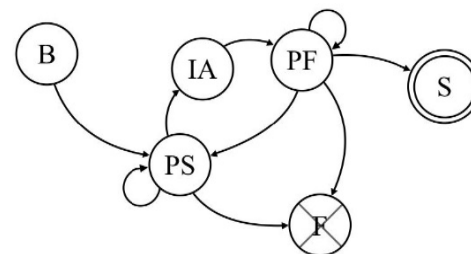
This work extends a previously implemented method based on a probabilistic algorithm. This probabilistic algorithm creates a map of possible location of the source and makes moves until the locations converge to the same physical point. The method is a strong and well-studied starting point, but is subject to higher failure ratio when noise in the plume is introduced. The goal of this work is to extend this base algorithm and improve its robustness and speed.

For the extension purpose, the base method is merged with a deterministic method called surge spiral [2], which is slow but robust. To decide which method to use at which moment, a finite state automata (FSA) is created, with a transition manager.

For this purpose, several simulations are conducted in (ii). The specific simulation setup is presented in The goal is to identify the base results and the potential bottlenecks to improve. These simulations showed that the base algorithm is not resilient to noise, even if it performs really well under idle conditions. The

main problem of the base algorithm is "plume loss", id est a movement outside the odor plume and inability to retrieve it. Once the robot is outside the plume, it moves randomly until it hits a wall or the simulation time threshold is reached. In any of the simulation, the robot was able to retake over a plume loss. Nevertheless, the average direction of the robot is in the direction of the source from the starting point, with a mean distance of 2.4 meters. To deal with this problem, this work propose to switch to surge spiral after a plume loss.

Once the plume is found again with the spiraling, the probabilistic algorithm is cleaned and started again. Since the probabilistic algorithm moves in the correct direction, successive call of the algorithm allows the robot to quickly move to the source with a high success rate.



Finite State Automata for Odor Source Localization. B: Begin state, PS: Plume Search state, IA: Initialization Algorithm state, PF: Plume Following state, F: Failure state, S: Success state

After the merging of the two methods, and the addition of the FSA, the performances in noisy situations are improved until the success rate reach 100% in a realistic environment, and for a consequent number of simulations. The performances of the algorithm are studied in an increasingly noisy environment, until the robot is unable to find its way to the source anymore.

All the work has been conducted in simulation environment, but still realistic. The Webots simulator is a good and efficient tool to build algorithm that can be deployed in real situations.