The problem of odor source localization has been extensively studied from early 1990s. But most of the previous works focus on chemical odor source localization. However, in many situations, such as burning some materials, the source does not release a chemical substance but rather airborne particles. These particles are often odorless and common chemical sensors are not able to sense them. Therefore, solving the particle source localization problems means substantially changing the sensing technology and in turn adapting the related localization algorithms.

In this work, we first experimentally investigate particle plume sensing and modeling. We use Plantower PMS 7003, a laser-based particle counter to measure the concentration and number of particles of different sizes. Through a refined scan in the wind tunnel, we fitted the measurement data of the sensor to a pseudo-Gaussian plume.

We adapted a state of the art probabilistic algorithm, Infotaxis, to find the source of a particle plume. In the original Infotaxis algorithm, the robot takes measurement at every step and updates the probability map of the source location, then chooses a target with maximum entropy decrease to move to. Since we have multiple measurement channels for particle plumes, we generate multiple probability maps, one per channel. We fuse all the measurements related to different particle sizes into one map. The integrated map represents in this case the weighted sum of all the six original maps, with the reciprocal of the entropy of each map representing the weight of that map in the integrated one.

The method was evaluated in simulation and in a wind tunnel emulating realistic environmental conditions in a repeatable fashion with a Khepera IV robot endowed with PMS 7003 (see the picture on the right). In particular, we have investigated the impact of two environmental parameters - the wind speed and source release rate on the algorithm performance, in order to evaluate the proposed algorithm under different environmental conditions and compare its performance with those of the original Infotaxis directly applied to particle source localization.

The proposed algorithm showed its robustness in many tested conditions. In high wind speed, the algorithm is able to locate the source with less than 2 meters’ error in an 80 m² arena. With the wind speed decreasing, the average error distance would increase to 2.5 m, but it is still good in a large area. The variant based on an integrated probability map is clearly superior to a naive use of the Infotaxis algorithm leveraging a map based on one of the six available sensing modalities. The shortcoming of the proposed algorithm (similar to the original Infotaxis) is its dependence on accurate robot localization, and prior knowledge of the plume model.