Recent advances in chemical sensor technology have achieved sensitivities comparable to a dog's nose. One application of such sensors is the search for sources of odor or other chemical traces.

Airborne molecules are mainly transported by advective flows (wind). The small eddies (little turbulences) in this flow create complicated and unpredictable concentration patterns, which make the search for odor sources challenging. Simple gradient-ascent techniques fail to give satisfying results, even in simple environments.

**Algorithms**

With single-robot systems, bio-inspired odor source localization algorithms for airborne particles, such as zig-zagging and spiral surge, have been proven to work.

The search for sources can be accelerated by using multi-robot systems. A main goal of this project is to find out how collaboration and communication between a team of robots can enhance odor source localization, and to develop distributed algorithms that exploit the intrinsic advantages of the multi-robot systems.

**Experiments with an Odor Sniffing Khepera 3 Robot**

We are using a Khepera 3 robot (K-Team SA, Yverdon) which we equipped with an odor sensor (ethanol) and a wind direction sensor. Air is actively sniffed with a small pump, which resembles the olfactory system of animals.

Dogs are known for their outstanding sense of smell. Because of this, they are deployed for tracing explosives, drugs and other substances, or for searching for human bodies in disaster areas and avalanches. Dogs and rats, which have an excellent nose as well, are also used for humanitarian demining.

The best chemicals sensors available nowadays achieve a sensitivity of a dog's nose for specific target molecules. In many of the above mentioned applications, the dog could therefore in the future be replaced by robots.

**Realistic Plume Simulation**

In addition to the experiments with real robots, we perform simulations on the computer. The complex flow of airborne particles is not easy to simulate on the computer. To achieve realistic results in environments with obstacles, we coupled a finite element simulator (OpenFOAM) with a robotic simulator (Webots).

**Applications**

Odor source localization algorithms could replace dogs and rats in many applications, such as humanitarian demining or search and rescue operations in disaster areas or on avalanches. They could also be used to enhance security on airports or country borders, to detect pipe leaks in industrial plants or to track offensive smells in the environment.

Whereas training dogs is lengthy and expensive, programming and calibrating robots is far easier. Robots can be built in masses within short time and are immediately available after production. In addition, mobile robots can be used regardless of their mood or sleepiness. (Dogs need a rest after a couple of hours.) Hence, mobile robots would be a relatively cheap alternative to dogs.

More information: http://swis.epfl.ch