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Odour Mapping Under Strong Backgrounds With a Metal Oxide Sensor Array

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Abstract. This work describes the data from navigation experiments with the mobile robot, equipped with the sensor array of three MOX gas sensors. Performed four series of measurements aim to explore the capabilities of sensor array to build the odour map with one or two odour sources in the wind tunnel space. It was demonstrated that the method based on Independent Component Analysis (ICA) is able to discriminate two odour sources, that in future can be used in the surge-and-cast robot navigation algorithm.

Keywords: gas sensor, sensor array, odour localization
PACS: 07.07.Df

METHODS AND RESULTS

This text describes the data from an initial set of navigation experiments in the scope of the Bio-ICT European project NEUROCHEM. The acquisition system was composed of two segments, a robotic platform developed in SPECS at UPF and an embedded computer running a custom GNU/Linux distribution developed within the project by UPC (Fig. 1, left panel). The embedded computer held a Metal Oxide gas sensor array (TGS262010, TGS260010 and TGS2810 varieties) with a total autonomy of 1.5 hours. The system was placed in a wind tunnel facility in UPF in order to characterize the response of the metal oxide sensor array under the presence of one odour source jointly with a strong background. The compounds used were Ethanol (as background), Acetone and Ammonia at 5%, 11% and 20% dilution in water, respectively. These compounds were diffused in the wind tunnel with help of an ultrasound diffuser at two separate locations (Fig. 1, right panel). Four series of measurements were performed aiming to explore the capabilities of the sensor array in constructing the odour map in presence of a strong background under a controlled environment. Data pre-processing included correction of a certain time delay in sensor response in respect to the robot position in the tunnel and de-noising through a low-pass filter. A separation method based on Independent Component Analysis (ICA) was applied to the sensor data in order to decorrelate the signal form the two sources. ICA assumes a model of mixing,

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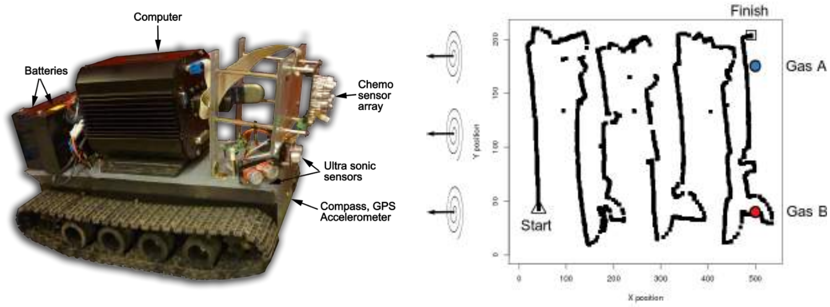

FIGURE 1. *Left panel:* In the robotic platform, the embedded computer takes control of the mobile motor, chemosensor board and other sensors by running the custom OS image, proper software and iqr. *Right panel:* The experimental set up of the tunnel. Two odour sources of Gases A and B are placed on the right side, the ventilators are on the left side and produce the plume from right to left.

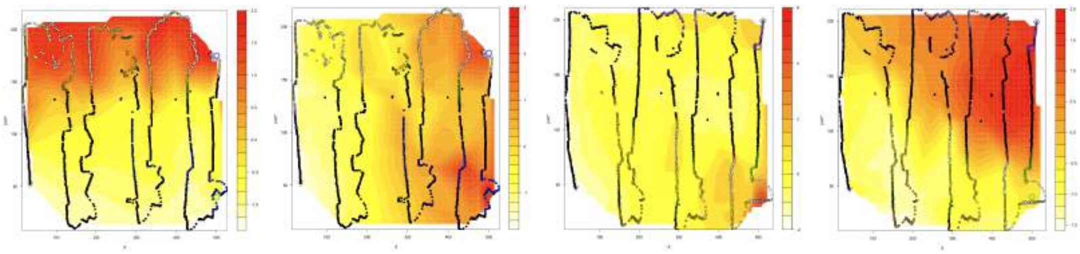

FIGURE 2. *Left panel:* The odour map of Ethanol 5% (bottom right corner) and Ammonia 20% (top right corner) reconstructed from the first and the second components of ICA performed on sensor readings. *Right panel:* The odour map of Ethanol 5% (bottom right corner) and Ammonia 20% (top right corner) reconstructed from the first and the second components of ICA performed on sensor readings.

$$x = As \tag{1}$$

where the sources $s = [s_1, s_2, ..., s_m]'$ are mutually independent random variables, and A is an unknown invertible mixing matrix. This algorithm finds a matrix W such that the output

$$y = Wx \tag{2}$$

is a good estimate of the sources s. Pearson variant of ICA finds y through a Mutual Information minimization process [1]. Results of Pearson ICA are able to decorrelate the two odour sources as seen in Fig. 2 for two combinations of gases. Ethanol can be considered as a very strong background as metal oxide sensors are very sensitive to this compound. automatic determination of the number of components present in the tunnel and the application of the Neurochem platform in surge-and-cast behavioral models.

REFERENCES

1. Karvanen, and Koivunen, *Signal Processing* **82**, 663–673 (2002).