ipNOSE: A portable volatile analyzer based on embedded technology for intensive computation and time dependent signal processing.

A Perera[*1], R Gutierrez-Osuna[2], S Marco[1]
[1]Dept. d'Electrònica, Universitat de Barcelona
[2]Computer Science Dept., Wright State University

Abstract[+]

Most electronic noses need a computer and special software in order to analyze data from sensors. In the case of portable electronic noses, most of them are operated by microcontrollers with limited data storage (usually feature vectors) and simple signal processing capabilities. Here we suggest the integration of a small form factor computer inside the electronic nose. This concept allows us to easily perform temperature modulation over metal oxide sensors, remote connectivity under TCP/IP networking, large data storage and complex signal processing.

1 Introduction.

The number of sensors to include in the system is an important parameter. This number may be large in order to have varied chemical information to handle different applications. An alternative approach to large sensor arrays is to perform temperature modulation over tin oxide sensors. Setting the sensor to different temperatures is somehow equivalent to have a continuous number of sensors with different selectivity [1-2]. This solution is not very convenient for portable systems, as they need large memory allocation for each channel time vector. The feature extraction is more complex than in isothermal DC measurements, requiring more computational load.

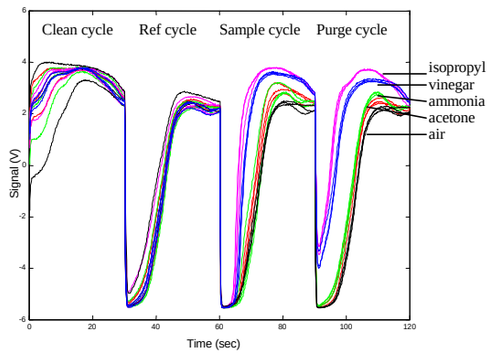


Figure 1 Slow ramp heating profile

The WSUB electronic nose was designed to be a versatile portable chemical vapor analyzer with direct temperature modulation, large database storage and modular signal processing

2 Instrument

The system was developed as collaboration between Wright State University and Universitat de Barcelona, and is composed of four to twelve different tin oxide FIS sensors. The packages of these sensors are very small. Their internal structure based on micro-bead provides fast thermal response allowing relatively fast temperature modulation. The electronics can hold various commercial sensors like FIS, FIGARO, MICROSENS, MICS or CAPTEUR via configuration jumpers.

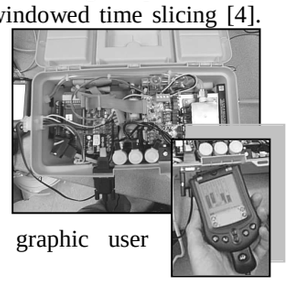
A computer is embedded in the nose in a PC/104[3] specification that defines compact size self-stacking modules (3.6 x 3.8 in). An open source UNIX-clone Operating system (GNU/Linux) was elected because of the availability of the sources, which allows the developer to customize the operating system to the size needed by the hardware. Arbitrary heating profiles can be applied directly to the sensors or even be calculated in real time as function of pattern recognition code.
In figure 1 an example of four dilutions plus air can be seen. These dilutions gave approximately the same DC response to the sensors.

3 Application fields

As designed, this system is a versatile portable chemical vapor analyzer. It can be used to acquire large amounts of data on the field to be analyzed in the lab or characterized in real time. All data is stored in MATLAB or OCTAVE compatible-files to allow easy plotting and processing off-nose. Modularity, software compatibility and portability allow users to test algorithms and acquire data when vapor/odor samples cannot be taken to the laboratory. Users could program their own code for signal processing, compile it using standard *gcc* and download it to the nose. The whole system can be remotely operated via TCP/IP under client/server structure, so remote or even distributed sensing can be performed over the Internet. This could be useful when quality control is needed at many points in the manufacture chain and data analysis needs to be centralized in one computer. Long duration and stability test can also be easily automated using standard Unix scheduling commands (like *cron* or *at*). The user could even receive an e-mail from the nose when samples are getting out of spec.

4 Further work

Many aspects of the nose need to be completed. First step is to improve the very basic signal processing available in the system. While basic feature extraction, LDA and K-NN are implemented, more sophisticated algorithms will be implemented. With special emphasis to advanced feature extraction over time signals provided by temperature modulation, like windowed time slicing [4]. On the other side is necessary to build a user interface. Until now the control of the analyzer has been done via Ethernet in the lab or connecting from a PDA (Palm Pilot) via serial port outside the laboratory. Work for a graphic user interface is in progress.



5 References

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* aperera@el.ub.es

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