Spatio-temporal Description of Air Quality with Mobile and Static Arrays of MOS Sensors

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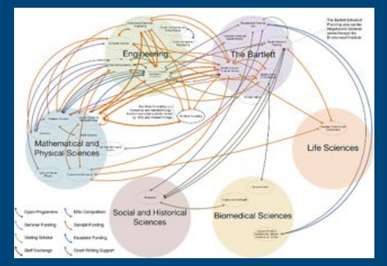


About this Group

A variety of air pollutants have known harmful effects on human health and the environment. The London Air Quality Network is made of 160 continuous monitoring sites. However, in urban settings, the concentrations of these pollutants can vary dramatically. Hence, some streets layouts with corresponding trace may lead to unsustainable local levels of concentrations.

We have teamed up researchers from statistical science, chemistry and computer science departments to develop new science in pollution monitoring and modeling with pervasive sensing technologies. The areas we work on include:-

•State of Art Gas Sensors – we evaluate the performance and limitation of commonly used electrochemical gas sensors for pervasive applications

•Metal Oxide Sensors (MOS) – we research into the latest advance in MOS technology and the suitability of the sensors for portable applications

•Wireless Sensor Network (WSN) – we research into the hardware and software aspects of the technology

•Pollution modeling – we investigate new technique for pollution modeling using fine-grain, mobile sensor data provided by WSN

Sensor Module

Several commercial Carbon Monoxide (CO) electrochemical sensors (Figure 1) were evaluated to see if they are suitable to detect the range of street-level pollution level. The calibration looks at their sensitivity (Figure 2) towards the gas and the response time (Figure 3). The bigger sensors tends to have better sensitivity and quicker response time.

Figure 1

The performance of electrochemical sensors are satisfactory regarding their sensitivity and power consumption. However, they have relatively short life time, typically 1-2 years. The sensors degrade over the period, which suggest re-calibration and re-deployment. MOS sensors can potentially be a better option for pervasive sensing.

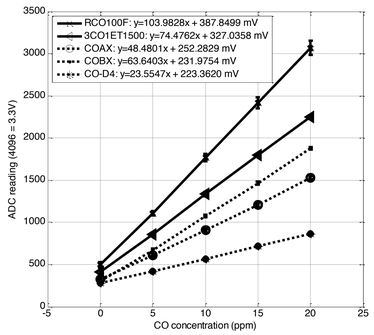


Figure 2

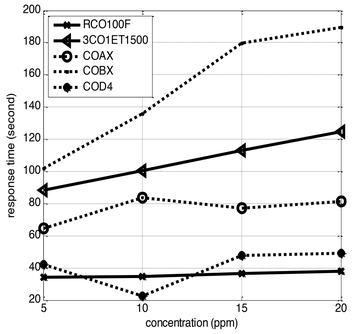


Figure 3

Bracelet Hardware Platform

Bracelet is the flexible, portable, modular hardware platform developed by the Computer Science department for pervasive sensing applications. Different modules, including procesors, radio modules, GPS modules, sensors, interface boards, external memory modules can be mixed and matched, tailored for the application. Bracelet v1 (Figure 4) uses SPI communication bus between the modules. Bracelet v2 (Figure 5) uses I2C buses and allows for more modules to be attached to the platform.

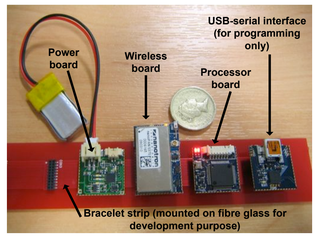


Figure 4

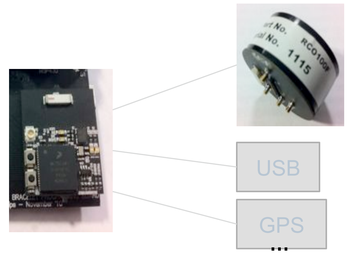


Figure 5

Calibration

The gas sensors with their sensor modules must be calibrated (Figure 6) individually before deployment. Ideally, they should be calibrated against environmental factors including temperature and humidity.

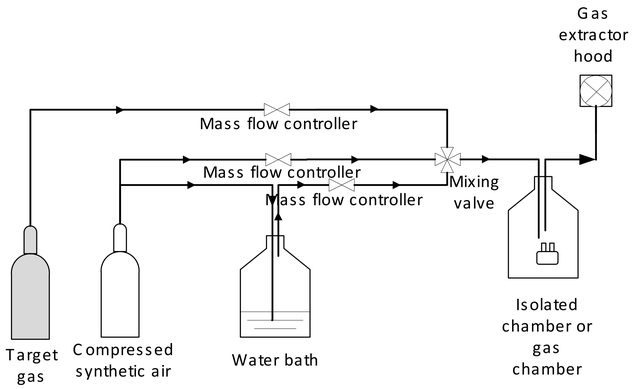


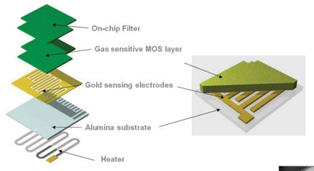
Figure 6

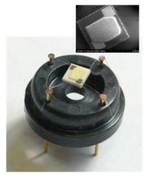
Metal Oxide Sensors

Research in MOS sensors involves doping the sensors with substrate (Zeolite) to improve selectivity towards the target gas. It has the following competitive edges over electrochemical sensors:-

•MOS sensors have long life time, typically >10 years.

•MOS sensors are very small (the sensor and heater track are 1mmx1mm), good for portable application.





Implementation and Data Analysis

A small lab trial with 5 sensor nodes (2 with CO sensors) and 1 base station (sink). The sensor nodes take readings at regular interval and send the information back to the base station wirelessly. The base station display the information to the user. (Figure 7)

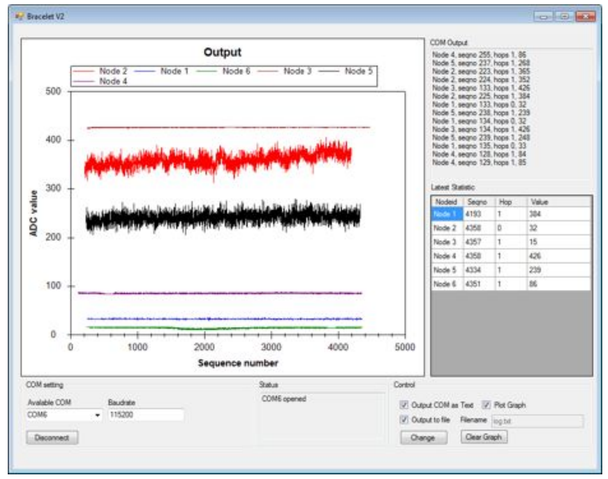


Figure 7

The Environmental Fluid Mechanics group at the Department of Civil, Environmental and Geomatic engineering (CEGE) is our collaborator on the implementation and data collection aspects of the project.

Future Work

We have demonstrate the use of portable gas sensor units for pervasive pollution monitoring application. In the near future,

• Deploy 20 sensor units in a street-canyon environment in London to collect fine-grain temporal-spatial data.

• Research and develop the use of MOS sensor in pervasive monitoring.

• Use the data collected to develop new technique for pollution modeling.

• Investigate other similar application domains for the techniques developed.

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