Participatory Air Pollution Monitoring Using Smartphones

ETH Eidgenössische Technische Hochschule Zürich
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TIK Technische Informatik und Kommunikationsnetze
Computer Engineering and Networks Laboratory

Goals

Increase public awareness of urban air pollution
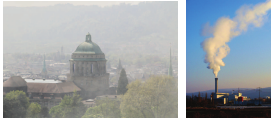
Air pollution in the city of Zurich

Involve general public into environmental monitoring

Participants of a flash mob

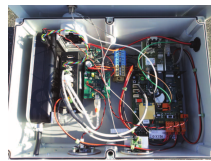**Improve** temporal and spatial resolution of current air pollution maps

Ozone concentration levels

Autonomous Sensing

Data collection using mobile sensor nodes on top of trams:

• Sensors: O$_3$, CO, and PM

• Localization: GPS

• Communication: GSM and WLAN

• Processing: Gumstix

Provides initial coverage of the area of interest

Sensor box with low-cost sensors

Five sensor boxes on top of trams

Participatory Sensing

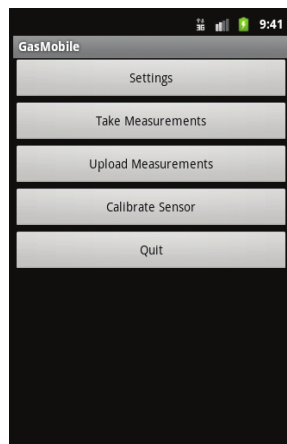Data collection using off-the-shelf smartphones:

• Sensors: O$_3$ and CO

• Localization: GPS
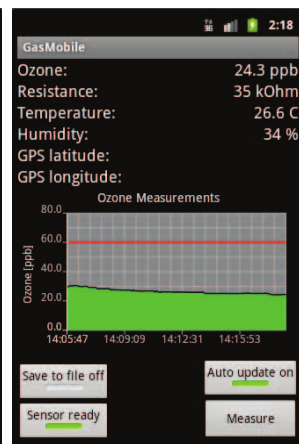
• Communication: GSM and WLAN

• Processing: Smartphone
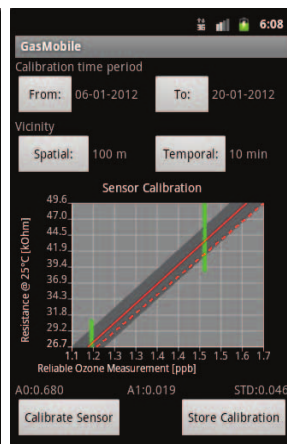
The average citizen senses the air she breathes

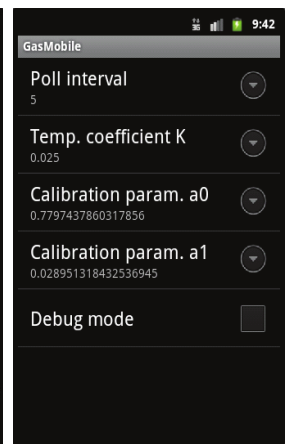*Low-cost ozone sensor connected to a HTC Hero*

Main menu
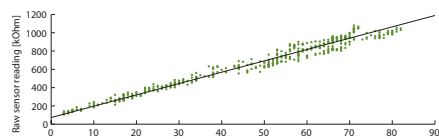

Sensing

Calibration

Settings

Ozone Sensor
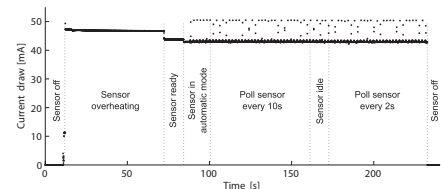
Tin dioxide ozone sensor:

• Resistance of the tin dioxide (SNO$_2$) layer depends on the ozone concentration

• Sensing range betwee 0 ppb and 200 ppb

Ozone sensor

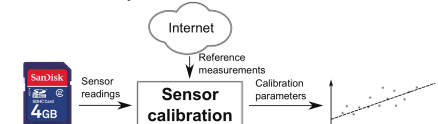*Response curve is quasi-linear with respect to the ozone concentration*

Current draw of the ozone sensor over time

Support High Data Quality

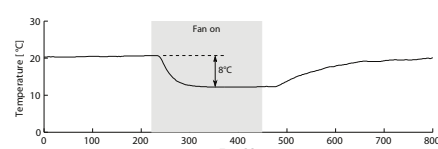Users must assume a certain data quality:

• Assistance in sensor calibration

• Advice when to perform measurements depending on motion speed

Calibration procedure:

Measurements near a reference station are used to update calibration

Effect of mobility on sensor readings:

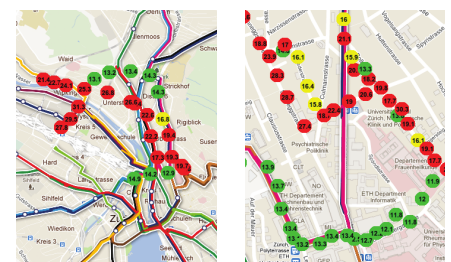*Air flow generated by a fan influences the on-board temperature*

• The temperature drop induces a maximum error of 14%

Measurement Campaign

Air pollution monitoring in an urban area:

• Ozone sensor mounted on a bicycle

• Sampling inverval of 5 seconds, in total more than 2,500 measurements in Zurich

Ozone pollution maps with high spatial resolution:

Overview

Close-up view

• The measurement error is on average 2.74 ppb when compared to high-quality stations