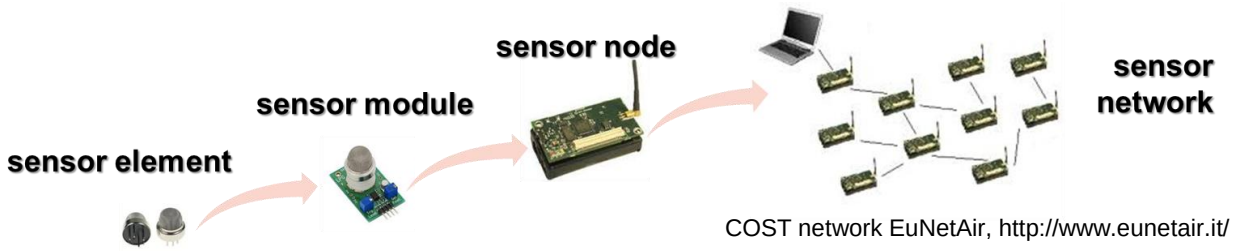
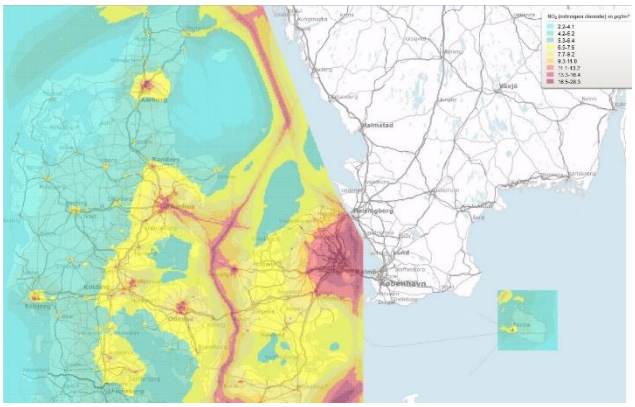
International training course

Low-cost Environmental Monitoring – from sensor principles to novel services



COST network EuNetAir, http://www.eunetair.it/

3S GmbH, http://www.3s-ing.de



http://lpdv-en.spatialsuite.dk

April 9-10, 2019 - Berlin - Germany

Bundesanstalt für Materialforschung und -prüfung (BAM)

Branch Adlershof

Building 8.05, Richard-Willstätter-Straße 11, 12489 Berlin

Organized by:

UNIVERSITÄT DES SAARLANDES

AARHUS UNIVERSITY

ARISTOTLE UNIVERSITY OF THESSALONIKI

EURICE EUROPEAN RESEARCH AND PROJECT OFFICE GMBH

BAM Bundesanstalt für Materialforschung und -prüfung

Purpose and background

Environmental monitoring today is based on fixed measurement stations containing sophisticated analytical equipment to achieve a high data quality. However, due to the high cost for investment and maintenance only a limited number of pollutants (typ. CO, NO_x, SO_2, ozone, PM10, PM2.5, BTX, tVOC) are monitored at very few locations. Furthermore, not only is the spatial resolution limited but temporal resolution is coarse, with measurements typically providing hourly values at best. Thus, the fundamental information available on air quality (AQ) today does not meet the demands of many citizens or the requirements of **advanced environmental information (EI) services** and **city infrastructure management**. The current status does not reflect the increasing needs for well monitored 'smart cities', requiring e.g. real-time traffic management, identification of clean 'green' areas and routes in cities, specific information for children, elderly or citizens affected by certain pollutants or allergens, temporal air quality profiles for optimisation of ventilation strategies for improved indoor air quality, and, last but not least, for educating citizens about their local environment and the impact of their everyday life habits to their quality of life.

Novel low-cost sensor technologies are poised to support a paradigm shift by allowing ubiquitous ambient pollution monitoring with high spatiotemporal resolution available at every person´s fingertips – either through environmental information websites backed by stationary and mobile sensor networks or quite literally with **sensor technology being integrated into mobile devices and supported by Internet of Things (IoT) technologies**. The availability of such sensor data cultivates a fertile environment for the development of novel information services addressing personalised citizen needs as well as city planning and management and environmental decision making requirements. The seminar will provide an overview over the state-of-the-art in environmental monitoring today and over sensor and modelling technologies for low-cost ubiquitous monitoring as well as indicate novel EI service characteristics and future markets based on these technologies.

Seminar benefits

Participants will learn about the main aspects of air pollution, its effects and associated costs as well as the **current status of environmental monitoring technologies** with their pros and cons.

Then, an **overview over modern low-cost sensor principles**, operating modes and data evaluation strategies as well as **characterization and calibration** is given with clear indications on advantages and limitations compared to existing monitoring stations. **Examples** will be given for **various benchmark applications** covering different fixed and mobile, especially drone-based, sensor solutions for pollution and odour monitoring.

Finally, participants will learn how these sensor solutions can be utilized to develop **novel environmental services** for municipalities, companies and citizens. The potential for **citizen science solutions** will be discussed as well as service design principles and market penetration potentials.

Who should attend?

The seminar **addresses** a wide range of **participants from industry and municipalities**, e.g., sensor companies providing solutions for environmental monitoring, developers and operators of existing monitoring stations to learn about new sensor technologies, network providers and app developers offering new applications and advanced services, **municipality representatives** interested in green city solutions as well as **citizen initiatives** aiming at improved air quality information. The seminar also provides **contacts for future R&D collaborations** in this field.

Scientific instructors

Environmental monitoring
Prof. Ole Hertel
Department of Environmental Science
Aarhus University
Roskilde - Denmark
oh@envs.au.dk

Smart sensor systems
Prof. Andreas Schütze
Lab for Measurement Technology
Saarland University
Saarbrücken - Germany
schuetze@lmt.uni-saarland.de

Data modelling & services
Prof. Kostas Karatzas
Environmental Informatics Research Group
Aristotle University
Thessaloniki - Greece
kkara@eng.auth.gr

Day 1 – Tuesday, April 9, 2019

12:30 **Welcome, introduction and goal of the seminar**, A. Schütze, O. Hertel, K. Karatzas

- Environmental monitoring today and tomorrow
- Smart and green cities: how and why?
- Overview and goal of the seminar

13:00 **Introduction to air pollution**, O. Hertel

- Pollutants: gases and particles
- Atmospheric chemistry
- Health effects and external costs of Air Pollution
- Atmospheric particles – physical and chemical properties, sources and sinks
- Needs and requirements for monitoring and assessment

14:00 – 14:30 coffee break

14:30 **Gas sensor function principles**, A. Schütze

- IR absorption
- Electrochemical cells
- Semiconductor gas sensors
- Field effect devices
- Mass sensitive devices
- Examples from nanotechnology and materials development

15:30 **Application example: Microsensor technologies for Air Quality Monitoring**
S. Raible (ams Sensor Solutions Germany GmbH) - *tbc*

- Microsensor technology
- Microsensor integration with ASIC for readout and evaluation
- Microsensors for smartphone integration

16:00 – 16:30 coffee break

16:30 **State of the art in environmental monitoring**, O. Hertel

- Basic considerations on data quality and temporal resolution
- Offline measurement systems (passive samples, diffusion tubes)
- Online measurement systems for CO, NO_x, SO_2, ozone
- Measurement systems for particles (PM10, PM 2.5, UFP)
- Characterization of particles: pollen monitoring for allergic rhinitis (hay fever) warning

17:30 **Application example: AQ monitoring around Heathrow airport using low-cost sensors**
A. Schütze, O. Hertel, K. Karatzas

- Background and motivation
- Sensor nodes and installation
- Data processing and in-network calibration
- Results and lessons learned

End approx. 18:00

19:30 dinner and get-together: **Restaurant tbd**

Day 2 – Wednesday, April 10, 2019

9:00 **Microsensor developments for particulate matter**, O. Hertel, A. Schütze

- Physical parameters of particulate matter (particle number/mass/surface area)
- Current knowledge on health relevance of these parameters
- Newest developments of miniature versions of particle sensors
- Expected future needs and importance of such developments

9:45 **Gas sensor characterization and calibration**, A. Schütze, C. Tiebe (BAM)

- The 3S: Sensitivity, Selectivity and Stability
- Sensor drift, aging and poisoning
- Gas mixing systems for laboratory and field calibration
- Measurement uncertainty for sensor calibration
- Traceable calibration of gas sensor systems

10:45 – 11:15 coffee break

11:15 **Multi-sensor systems (aka „electronic noses“)**, A. Schütze

- Motivation for multi-sensor systems, basic concepts and typical solutions
- Advantages and drawbacks of multi-sensor systems
- „Virtual multi-sensors“: obtaining multi-dimensional data from a single sensor element
- Multi-sensor signal processing and data fusion

12:00 **Gas sensors in your smartphone: potential applications**, K. Karatzas

- Indoor Air Quality (tVOC and specific hazardous VOCs)
- Breath alcohol monitoring
- Personal safety: CO and fire alarm
- Further application potential and service deployment

Lunch break (approx. 12.30 – 13.30)

13:30 **Sensor deployment and networks: general considerations**, A. Schütze, K. Karatzas

- Fixed monitoring stations
- Mobile monitoring stations (on trams, buses, cars)
- Personal mobile monitoring systems
- Sensors on flying platforms
- Homogeneous and heterogeneous network

14:00 **Application example: Outdoor odour nuisance monitoring**
W. Reimringer (3S Sensors, Signal Processing, Systems GmbH)

- Background and motivation
- Sensor nodes and installation
- Citizen network as odour reference
- Results and lessons learned

14:45 **Application example: Mobile robot olfaction with flying platforms**, P. P. Neumann (BAM)

- Background and motivation
- Gas-sensitive aerial robots at BAM
- “Sensorless” wind vector estimation with copter-based flying platforms
- Examples: Gas source localization and gas distribution mapping with gas-sensitive aerial robots
- Results and lessons learned

15:30 – 16:00 coffee break

16:00 **Air pollution modelling**, O. Hertel, K. Karatzas

- Plume models, urban scale and CFD
- Street pollution modelling and human exposure assessment
- Hot spots, indoor and outdoor exposure patterns
- Examples of refined AQ level estimation based on data fusion and AQ modelling
- Regional scale to long-range transport air pollution modelling – processes, methodologies, examples

16:45 **From AQ data to personalized Quality of Life information services**, K. Karatzas

- Computational intelligence (CI) methods for environmental sensor data investigation and modelling
- Using low-cost monitoring networks for personalized information
- Design principles of EI services for mobile devices
- Examples for Quality-of-Life services: green routes through cities
- Synergies with personal health monitoring sensors
- The business perspective

17:45: **Wrap-up and final discussion**, K. Karatzas, O. Hertel, A. Schütze

18:00 end of the seminar

A step further? Participate in the Workshop

Setting standards for low cost Air Quality sensors

Thursday, April 11, 2019 - @ BAM in Berlin

further information: www.lmt.uni-saarland.de/setting-standards

Registration

I hereby register for the international training course “Low-cost Environmental Monitoring – from sensor principles to novel services”, Berlin, April 9-10, 2019

For online registration please go to netmon.eurice.de

Name: _____

Institution: _____

E-mail address: _____

Phone: _____

Mailing address: _____

City incl. postal code: _____

Country: _____

Date, place: _____ Signature: _____

NetMon seminar organisation:

Date and place:

April 9-10, 2019, Bundesanstalt für Materialforschung und -prüfung (BAM), Branch Adlershof, Richard-Willstätter-Straße 11, 12489 Berlin, Germany

Organisers:

Saarland University, Aarhus University, Aristotle University in co-operation with Eurice GmbH + BAM

Seminar material:

All participants will receive the course material (presentation slides) plus supporting material in printed and electronic form.

Participation fee:

1.090 € plus VAT covering participation fee, course material, coffee and soft drinks during breaks, dinner April 9 and lunch April 10. Participation is limited to 20 participants.

Early bird registration until February 28, 2019: 890 €

Invoice:

After registration, participants will receive an invoice and confirmation of their participation.

Cancellation (all values plus VAT):

… until February 28: 190 € cancellation fee
… after February 28: 545 € (50% of participation fee)
… after March 22: no refunds

Replacement by another participant from the same institution is possible.

Please send your registration to:

E-mail: registration@netmon.eurice.eu

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66123 Saarbrücken
Germany