



Gas Detection and Source Localization

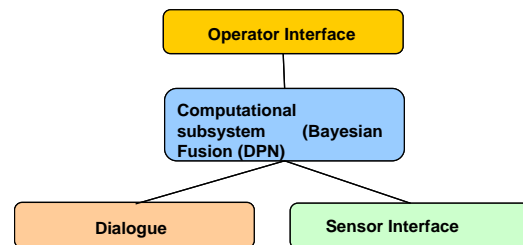
The main objective of the DIADEM project is to create an ICT system for collaborative situation assessment and decision making that supports effective protection of the population and the environment against chemical hazards in industrial areas.

Early detection of harmful gases and determination of possible sources is a crucial capability in environmental management. However, in the targeted domains networks of calibrated chemical sensors with adequate coverage and density are not available. Instead, the estimation must be based on observations of simple sensors as well as reports from field inspectors and people complaining about unusual smells and health symptoms. Detection and localization based on such heterogeneous information requires significant expertise and processing capabilities. In the state of the art approaches, the communication and processing are carried out by humans. As noted by experts, often only a small fraction of the relevant information is exploited due to communication and processing bottlenecks. We present a solution which supports automated information acquisition, detection and source localization.

Distributed Gas Detection System (DGDS)

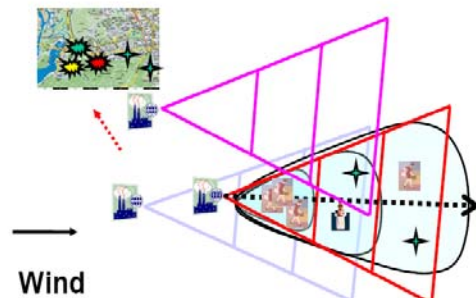
DGDS is a novel solution which supports automated detection of annoying and dangerous gaseous substances by combining complementary approaches: (i) automated querying of complainers, (ii) efficient processing of sensor data, complaints, and information from field inspectors and (iii) automated dissemination of the detection results via advanced user interfaces. In this way, we can obtain and process up to 3 times more complaints than the current state of the art approaches, without requiring extra work from experts in the control room and field inspectors. In addition, arbitrary chemical sensors can easily be incorporated, which can further improve responsiveness and reliability of the detection and source localization. DGDS consists of complementary subsystems:

- Computational subsystem that allows detection and localization by combining observations originating from citizens, field inspectors and multiple sensors of different types and quality.
- Dialogue subsystem supports efficient communication with users. It exploits existing communication infrastructure, such as GSM, landlines and Internet.
- Sensor interface subsystem that supports easy incorporation of arbitrary chemical sensors (plug&play).
- Operator interface which supports clear representation of the detection results.



Robust and Efficient Computation

The computational subsystem can continuously analyze sensor outputs and complaints. It reacts to sensor signals or complaints that are likely to be caused by the presence of some gas. Given the wind direction, the system develops hypotheses, each corresponding to a potential source. Each hypothesis is associated with an estimated area in which the pollution source could have an impact. In the simplest case this is a cone, whose vertex represents the location of a potential source. Observations obtained within the area are relevant for the confirmation or rejection of the hypotheses.



The hypotheses are ranked according to the likelihood of the potential sources, using heterogeneous observations.

The likelihood is determined with the help of Distributed Perception Networks framework [1], a novel approach to decentralized Bayesian information fusion. This approach supports distributed information processing and simple addition of new information sources, such as static and mobile sensors.

Designing and evaluating interfaces to facilitate the dialogue between experts and the public

Due to the lack of adequate sensory networks, the DGDS solution depends on the information provided by citizens and professionals. Therefore, we investigated and evaluated user interfaces that facilitate reporting on human-based olfactory perception, support incident management and increase the quality of interaction between users/citizens and a system for environmental monitoring. In particular, we investigated:

- Quick and reliable acquisition of information on smell from people considering circumstances (e.g. distress).
- Establishing and sustaining a close relationship between the dialogue agent requesting smell descriptions and the people that live and work in the area.
- Communication between experts facilitating environmental management.

To address these issues, user studies testing several information acquisition strategies and interfaces were performed. We investigated in a survey experiment whether mobile agents should adapt to users' affective states [2]. Results demonstrated that offering substantive information to sad users increases compliance to systems' advice. In emergency settings people are likely to experience negative emotions and adherence to safety instructions is crucial. Therefore, adapting instructions to users' affective state is highly relevant and could potentially save lives. Furthermore, we performed experiments investigating how best to establish and sustain the delicate relationship between users and the (mobile) environmental monitoring system. For instance, we performed a user study to test the effects of socially expressive and empathic system behavior [3]. Participants performed a search task in a crisis context while being interrupted by a location-aware agent that both provided and requested information. Results show that socially expressive behaviour did not increase compliance to requests; instead it reduced trust in provided information and compliance showing that careful use of social adaptations is crucial.

Interfaces to facilitating collaboration

Based on a thorough contextual analysis of tools and methods used at the environmental monitoring agency DCMR we designed and implemented a prototype interface of a browser-based geographical information system that can be connected to other DIADEM components and allows for information visualization and sharing between experts to facilitate source detection of environmental incidents.



Key Contributors

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Project

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References

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