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FRAUNHOFER INSTITUTE FOR PHYSICAL MEASUREMENT TECHNIQUES IPM

1 *Networked sensors allow a fast overview of the situation in emergencies. In other fields of application, they open up new capabilities for efficient monitoring.*

2 *»Sensor nodes« measure various parameters directly at the hazard point and communicate with each other.*

NETWORKED SENSOR SYSTEMS FOR DECENTRALIZED MONITORING

Networking is one of the future trends in the field of sensor systems. Smart sensors equipped with radio and location units are today increasingly able to measure ambient parameters and exchange this information with each other. These autonomous, distributed microsystems can be used in various ways, such as in the fields of food logistics, agriculture, building or disaster management.

New monitoring quality

A new monitoring and documentation quality is offered in such applications by combining measuring techniques and data fusion. Networked sensors today already measure simple parameters such as temperature or humidity. They are also being upgraded for complex measurement tasks, such as measurement of gases for example, to an increasing extent. Fraunhofer IPM is developing special gas sensors for integration in sensor networks against the backdrop of many years of experience in the field of developing and manufacturing miniaturized sensors and systems for gas measuring technology. The demands made on such sensors are stringent: they must be sensitive, energy-efficient and above all robust.

Example scenario: disaster management

Fraunhofer IPM tested the capabilities of wireless networking of sensors in a joint project with other Fraunhofer Institutes using the example of a disaster scenario. Various sensors and mobile air and land robots were developed in order to be able to respond quickly and efficiently in emergencies. These are intended to take the place of rescue workers for inspecting the terrain and provide fast and comprehensive reconnaissance of the disaster environment by situation-dependent, wireless ad-hoc networking with each other.

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3

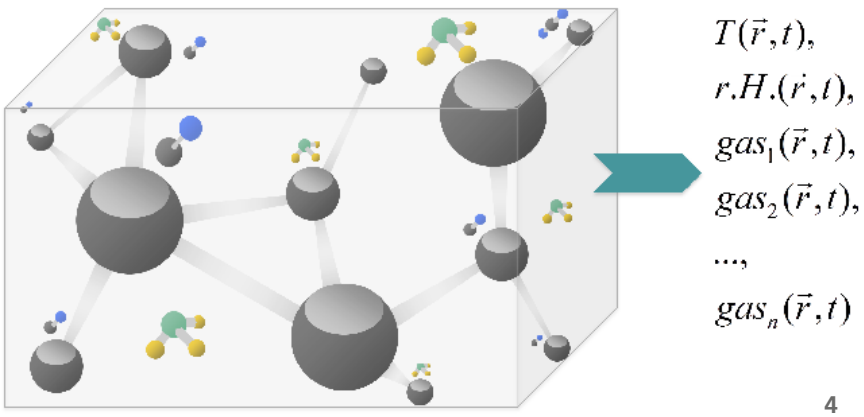
»Sensor nodes« forecast propagation of gases

Special »sensor nodes« have been developed at Fraunhofer IPM, which are, in the first instance, designed for interior spaces such as chemical production facilities. The spheres, which are around the size of tennis balls, are equipped with various types of sensors. Mobile robots initially scatter the spheres roughly over the disaster region. The sensors measure gases such as ammonia and carbon monoxide, in addition to temperature and humidity as well, and transmit the measured values to a central unit. The measurement data allows initial conclusions to be drawn as regards toxic gases, hazardous chemicals or possible fire hazards, thus protecting rescue workers against possible hazards. The objective is to generate superior information, such as localization and intensity of the gas source, from the single measurements by way of data fusion. Mathematical models form the basis for this process.

A location unit, based on ultrasound time-of-flight measurement combined with a compass, is installed in every sensor node. This way, the sensors are able localize their position in relation to each other and exchange with each other information on the measured ambient parameters by radio. In an outdoor scenario, GPS technology can be used for localization. The sensor network merges the data of the individual sensors on the basis of the collective intelligence principle and links it together to form an evaluation so as to produce a space-resolved representation of the hazard sources in the affected area. Having received the information, the incident command managers can coordinate how to proceed. The concept is being tested on the basis of a realistically staged emergency on a testing ground belonging to the German »Technisches Hilfswerk« disaster relief organization.

Economical and energy-efficient sensors

A sensor network for use in emergencies must be as low-cost as possible: this is because the larger the area, the more sensors are required, and the sensors cannot always be retrieved after rescue work is over. Consequently, for these operations, Fraunhofer IPM is developing best-price-sensors which are not only cheap to produce but which also have low energy consumption and which thus allow longer or repeated operation. This process combines gas sensor systems and electronics in compact microsystems (MEMS, MOEMS). As regards sensor technology, Fraunhofer IPM primarily uses semiconductor gas sensors, colorimetric sensors and photoacoustic sensors. A combination of various sensors provides an informative picture of the hazard situation.



4

3 In an emergency, »sensor nodes« signal merged measurement data to the incident command management.

4 Space-resolved measurement data is generated from the sensor network.