

Graphic: Emschergenossenschaft



Photo: Andreas Lander



FRAUNHOFER INSTITUTE FOR FACTORY OPERATION AND AUTOMATION IFF



Selected by the Emschergenossenschaft as the general contractor, the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg is developing these unique inspection and cleaning systems.

The subsystems in overview:

- Sensor and measuring systems that inspect pipe condition above and below the water line
- Multi-sensor system that exactly positions inspection systems in the sewer line
- Sewer cleaning system that removes deposits
- Carrier system (robot) that moves and positions sensor and measuring systems or sewer cleaning equipment throughout the sewer
- Media supply system and infrastructure to operate the systems (media: power, high-pressure water, data communication, etc.) at distances of over 600 m between entry shafts
- Data processing and fusion to visualize sensor data and types of damage (and even compare current sensor data with prior inspections)

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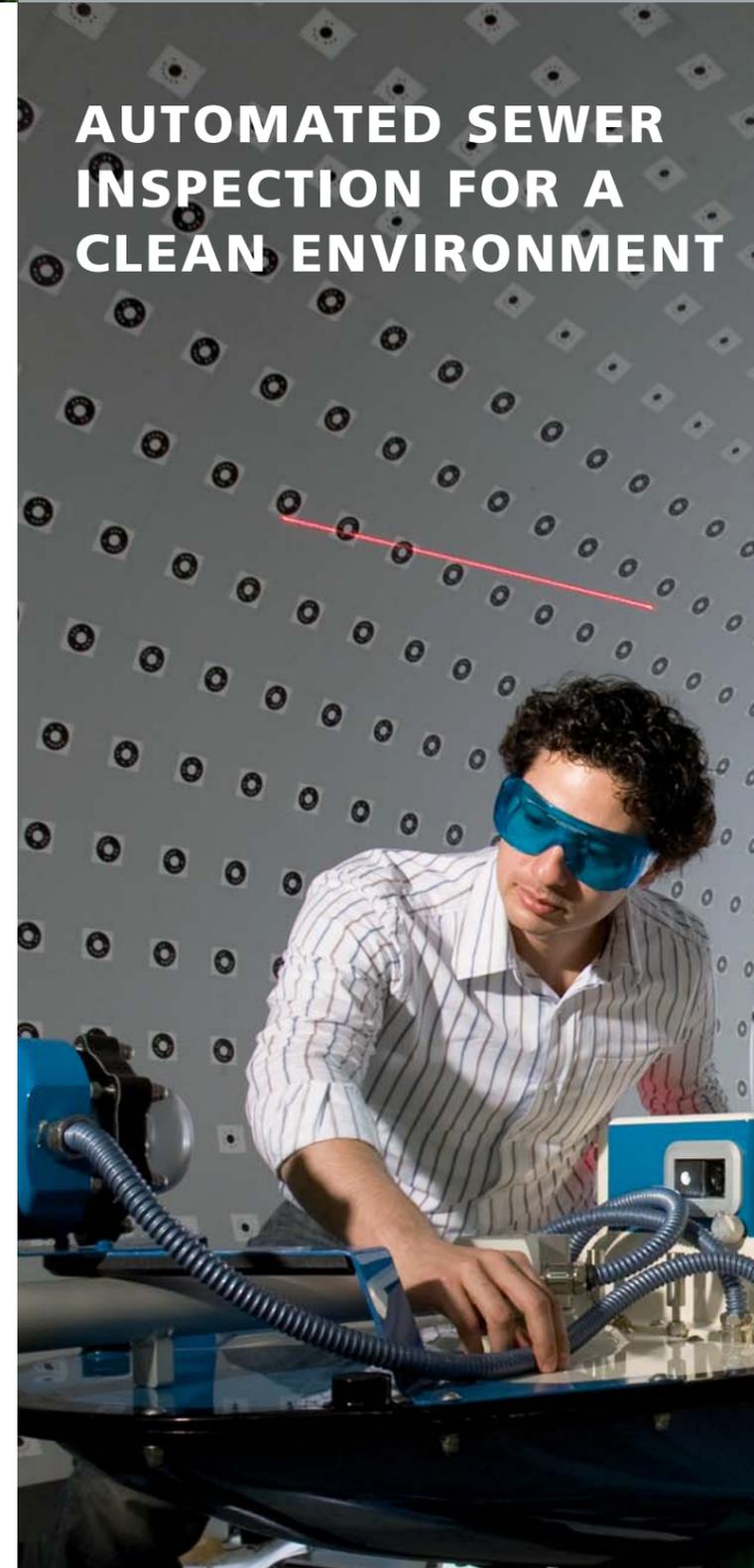
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# AUTOMATED SEWER INSPECTION FOR A CLEAN ENVIRONMENT



## ROBOTS FOR A CLEAN EMSCHER

The Emschergenossenschaft has been planning to modernize its existing above ground sewer system since 1990. In the future, subterranean sewers will drain off sewage so that clean water flows in the river Emscher again.

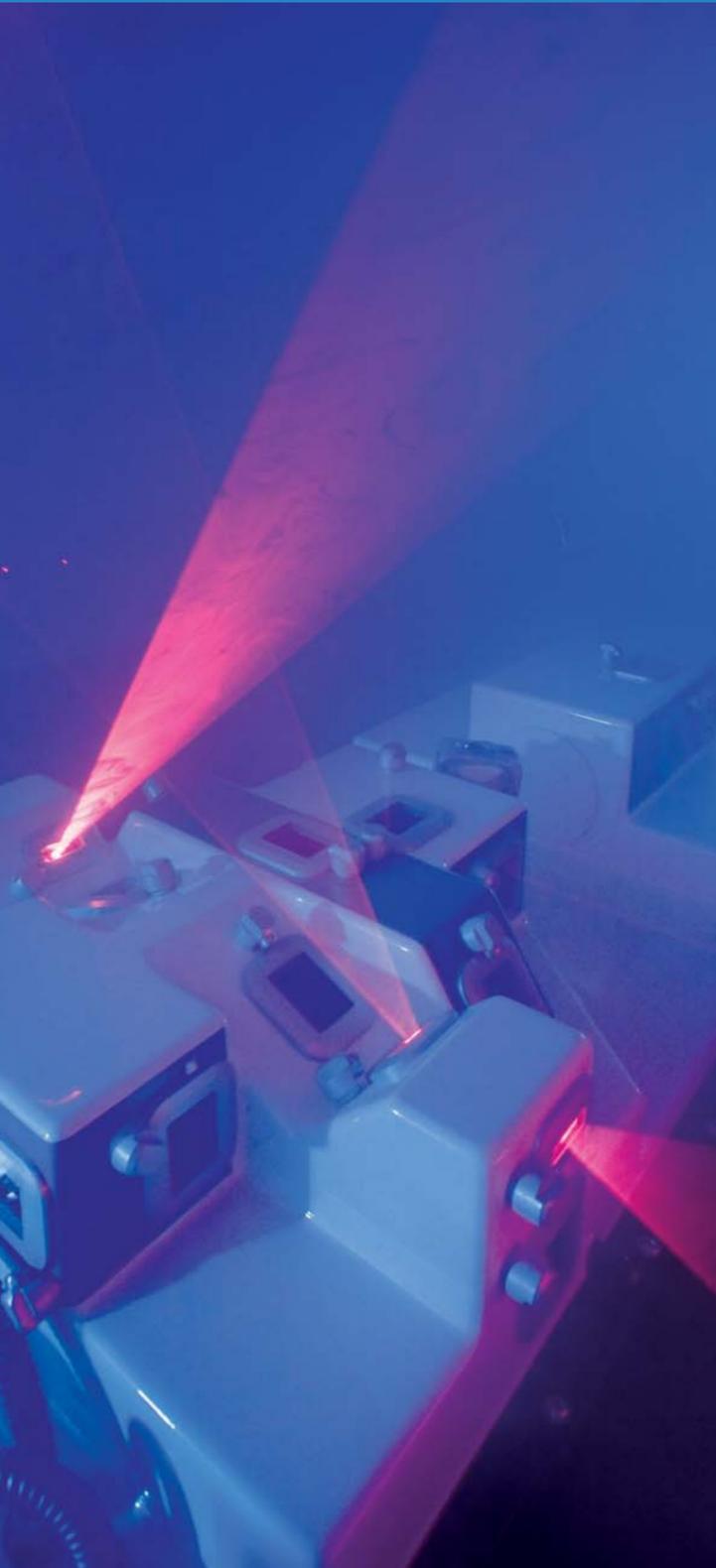
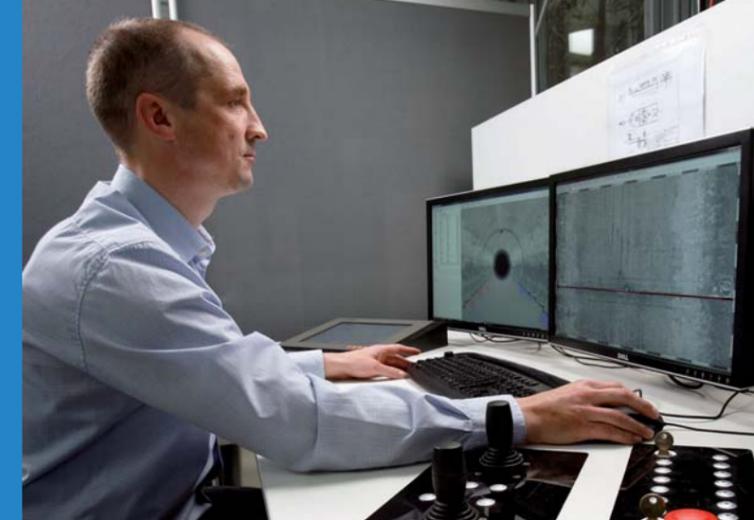
The Emscher sewer system is presently the largest residential water management project in Europe and the heart of future sewage disposal in the Ruhr region. Its completion is scheduled for 2017.

The Emscher sewer system has predominantly been planned as a continuously filled, one pipe-system in non-stop operation. Consequently, conventional walk-through inspection is impossible.

One-pipe sewer inspection and cleaning and the resultant savings are only possible with special robotic systems.

The automated sewer inspection system must reliably detect the following types of damage:

- Corrosion
- Mechanical wear
- Inhibition of flow (obstacles, deposits, incrustations)
- Deviation of position (horizontal, vertical, axial displacement)
- Cracks
- Leaks



## DAMAGE DETECTION SYSTEM

### For Rapid Preinspection

In the first stage, the damage detection system travels through the sewer to preinspect it. The floating system autonomously maintains a centered course, even in curves. The innovative software architecture visualizes the data from several cameras, light-sectioning sensors and ultrasonic scanners based on inclination, inertial and laser range sensors as a highly resolved 3-D reconstruction of the sewer. Intelligent processing of inspection data helps operators detect and classify damage. Redundant sensors facilitate reliable inspection even under the most adverse conditions in the sewer.

The damage detection system is equipped with various sensor systems:

- Intelligent multi-camera system that detects cracks, evaluates corrosion in the gas space and measures joints
- Ultrasonic scanner that detects mechanical wear, deposits and obstacles in the water space
- Video cameras that detect infiltration in the gas space

## CLEANING SYSTEM

### For Intensive Cleaning

The cleaning system removes deposits and cleans the sewer wall with effective high-pressure water equipment. Newly developed, fully automated kinematics with an integrated water supply and safety features serve as the universal carrier for all types of high-pressure cleaning technologies and enable cleaning the gas and water spaces separately in automatic mode.

The cleaning system operates with various components:

- Nozzle bank with various surface cleaning jets that cleans the gas space
- Underwater ejector jet that elevates the shear stresses in the sewer line and accelerates the entire flow of wastewater
- Pivoting video camera with zoom function and underwater 3-D ultrasonic scanner that checks the cleaning effect

## DAMAGE MEASURING SYSTEM

### For Exact Inspection

In the third stage, the damage measuring system maps the condition of the sewer in detail.

Intelligent processing of data from camera images automatically notifies operators of suspected cracks. Joint width is also determined from the camera images. A 3-D ultrasonic scanner in the water space precisely measures pipe geometry and thus deposits, obstructions and mechanical wear.

To detect cracks and infiltrations below the water line, our experts have developed three different measuring systems for use in sewers and combined them in a sensor cluster:

- Ultrasonic echo time measurement
- Optical crack detection employing a "diving bell" patented by the Fraunhofer IFF
- Differential temperature measurement system patented by the Fraunhofer IFF that detects even the minutest quantities of infiltrating groundwater

## CONTROL AND EVALUATION SOFTWARE

### For User-friendly Data Processing

All inspection systems are provided with sophisticated data processing software. This makes the system user friendly for operators and enables them to fully examine and analyze the results of inspection quickly. For the first time, operators have a clear, user-friendly evaluation software at their disposal, which visualizes all relevant data.

IT solutions for a wide variety of problems:

- Distributed sensor data capture and processing
- Heterogeneous subsystem integration
- Signal analysis and pattern recognition
- Control systems
- Image processing
- Geometry scanning and automatic measurement
- Concepts for the integration of real-time and non-real-time components
- Highly precise position sensing
- Data visualization
- Teleoperation
- Inspection data management