



# SmokeBot

## SmokeBot

**Mobile Robots with Novel Environmental Sensors  
for Inspection of Disaster Sites with Low Visibility**



**oass**  
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Institut für Feuerwehr- und  
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Feuerwehr Dortmund

Stadt Dortmund  
Feuerwehr





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**Mobile Robots with Novel Environmental Sensors  
for Inspection of Disaster Sites with Low Visibility**



H2020 RIA (Grant Agreement Number: 645101)

Jan 1, 2015 – Jun 30, 2018 (42m)

Requested Grant: 3,817,418€

6 partners (ORU, LUH, FHR, TAUR, WARW, FDDO)

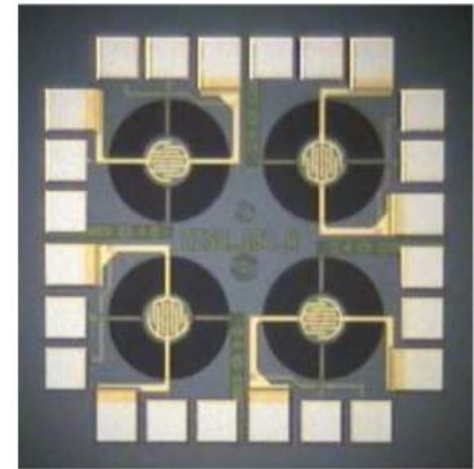


## ■ Step changes in robotics abilities and technologies?

- Sensor development / Perception Ability
  - » Development of high-resolution radar camera



- » Development of high-bandwidth gas sensors (MOX and polymer sensors)

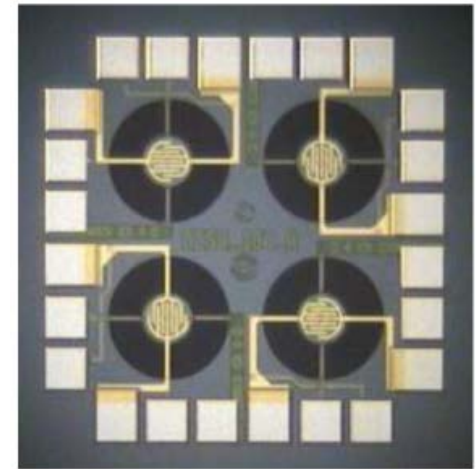
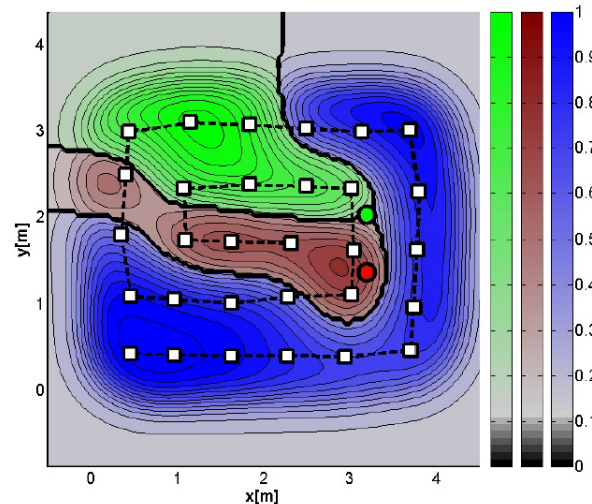


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- Sensor development / Perception Ability
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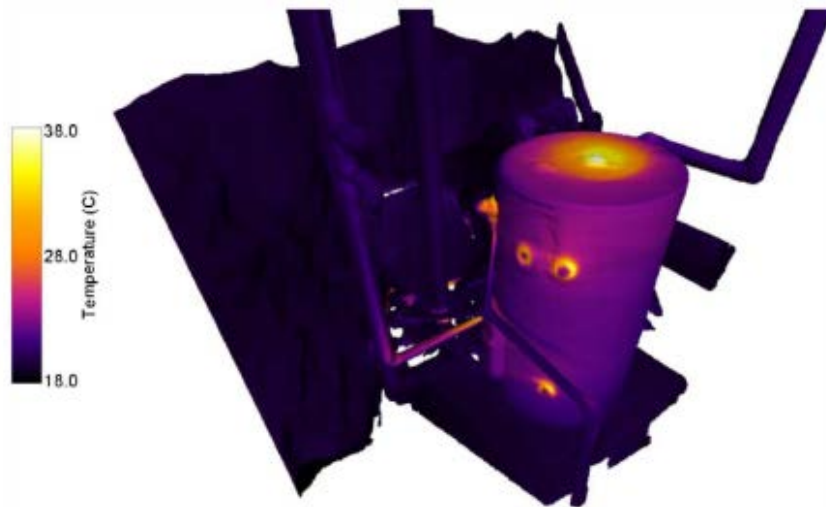


- » Development of high-bandwidth gas sensors (MOX and polymer sensors)
  - Multi-modal gas distribution mapping and gas source localization



## ■ Step changes in robotics abilities and technologies?

- Sensor development / Perception Ability
  - » Development of high-resolution radar camera
  - » Development of high-bandwidth gas sensors (MOX and polymer sensors)
- Perception under Low Visibility Conditions / Perception Ability
  - » Fusion of different sensor modalities for robust perception (graceful degradation of perception accuracy with more restricted visibility)
  - » Sensor fusion for navigation using radar camera, thermal camera and LIDAR







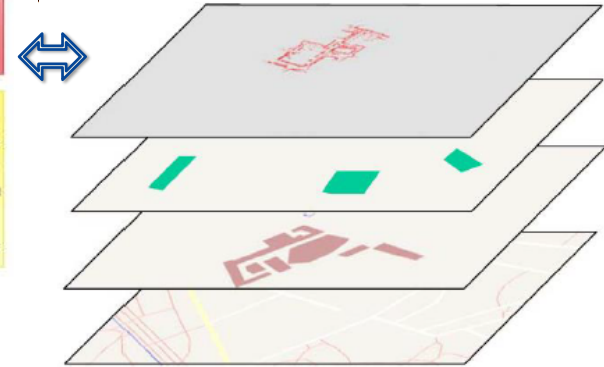
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  - » → **RGT-V** unit: **R**adar, **G**as sensors, **T**hermal Camera, "normal" **V**ision



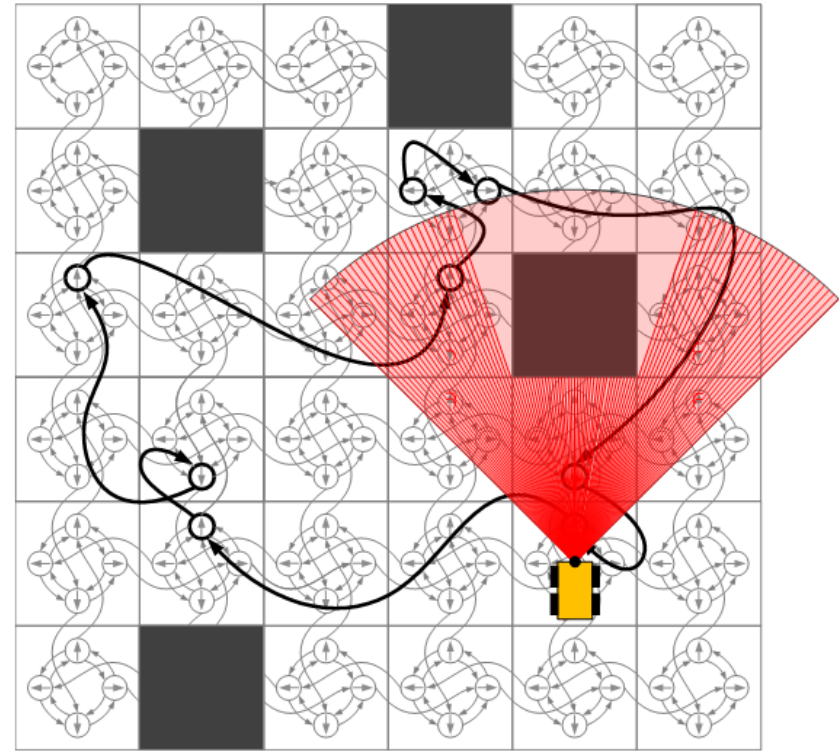
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- Sensor development / Perception
  - » Development of high-resolution
  - » Development of high-bandwidth
- Perception under Low Visibility
  - » Fusion of different sensor modalities (graceful degradation of perception)
  - » Sensor fusion for navigation
- Reasoning and Scene Analysis / Cognitive Abilities
  - » High-level situation and threat analysis (multi-modal data → hazard detection + prediction in disaster scenarios)



## ■ Step changes in robotics ability

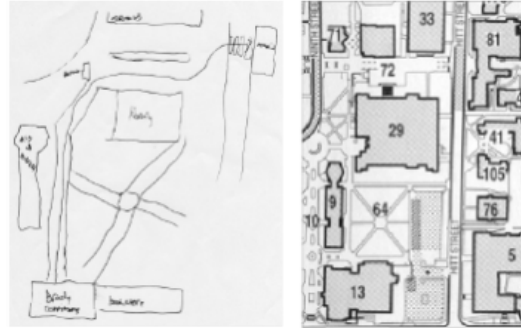
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  - » Development of high-resolution radar
  - » Development of high-bandwidth gas sensors
- Perception under Low Visibility Conditions
  - » Fusion of different sensor modalities for robust perception (graceful degradation of perception accuracy)
  - » Sensor fusion for navigation using radar
- Reasoning and Scene Analysis / Communication
  - » High-level situation and threat analysis (multi-modal data → hazard detection)
- Interleaving Perception and Action / Autonomy
  - » Return procedures after communication loss
  - » Trajectory planning for optimal sensor positioning





## ■ Step changes in robotics a

- Sensor development / Perception
  - » Development of high-resolution
  - » Development of high-bandwidth
- Perception under Low Visibility
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- Interleaving Perception and ACTION / Autonomy
  - » Return procedures after communication loss
  - » Trajectory planning for optimal sensor positioning
- SmokeBot Platform / Dependability
  - » Increased thermal and mechanical robustness of robot platform
  - » Improved interface to SmokeBot platform



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## ■ Step changes in robotics abilities and technologies?

- Sensor development / Perception Ability
  - » Development of high-resolution radar camera
  - » Development of high-bandwidth gas sensors (MOX and polymer sensors)
- Perception under low visibility conditions / Perception Ability
  - » Fusion of different sensor modalities for robust perception (graceful degradation of perception accuracy with more restricted visibility)
  - » Sensor fusion for navigation using radar camera and LIDAR
- Reasoning and scene analysis / Cognitive Abilities
  - » High-level situation and threat analysis (multi-modal data → hazard detection + prediction in disaster scenarios)
- Interleaving perception and action / Autonomy
  - » Return procedures after communication loss
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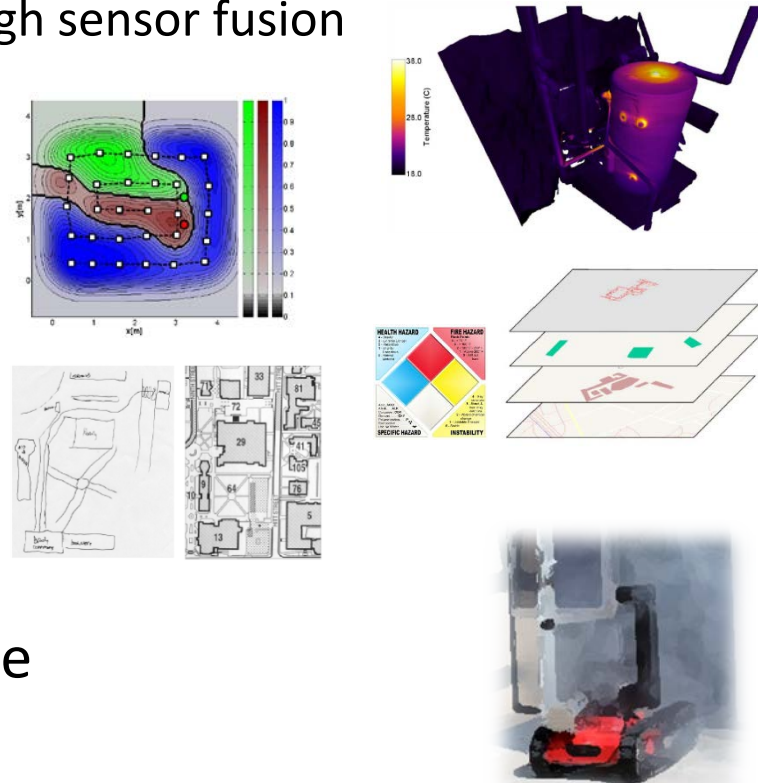


## ■ Step changes in robotics abilities and technologies?

- Sensor development Step Change 1: Improved ability to handle low visibility conditions
  - » Development of high-resolution radar camera
  - » Development of high-bandwidth gas sensors (MOX and polymer sensors)
- Perception under low visibility Step Change 2: Improved means for environmental monitoring
  - » Fusion of different sensor modalities for robust perception (graceful degradation of perception accuracy with more restricted visibility)
  - » Sensor fusion for navigation using radar camera and LIDAR
- Reasoning and scenario understanding Step Change 3: Low Visibility Explorer prototype for fire brigades
  - » High-level situation and threat analysis (multi-modal data → hazard detection + prediction in disaster scenarios)
- Interleaving perception and action / Autonomy
  - » Return procedures after communication loss
  - » Trajectory planning for optimal sensor positioning
- SmokeBot Platform / Dependability
  - » Increased thermal and mechanical robustness of robot platform
  - » Improved interface to SmokeBot platform

## ■ The SmokeBot Approach

- Sensor Unit for low visibility conditions (RGT-V sensor unit)
  - » **RGT-V** unit: **R**adar, **G**as sensors, **T**hermal Camera, "normal" **V**ision
- Perception and cognitive abilities for low visibility scenarios
  - » High-Resolution environment model through sensor fusion
  - » Thermal camera perception
  - » Multi-modal gas distribution mapping and gas source localization
  - » General disaster information model
  - » Sensor planning and self-preservation
  - » Sketch maps for navigation and human-robot communication
- Low Visibility Explorer Robot prototype





## ■ Civil Robots for safety/post-disaster management

- Development of **Low Visibility Explorer Robot** to support fire brigades in search and rescue operations in low visibility scenarios (tunnel fires, terrorist attacks, nuclear catastrophes, ...)
- Hardware and software to deal with **low visibility conditions**, e.g. dust, fog and heavy rains (also in other application domains)
- Improvement of inexpensive and sensitive gas sensors (**gas sensors for mobile robots** and OSS environmental monitoring)







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