Towards an Autonomous Assistant for Miners, Surveyors and Planners
01/10/2013 Unterbreizbach – Mine Accident

• Regular blasting in a salt mine cracked liquid CO₂
• 40 Mm³ CO₂ flooded the mine in 5 minutes with supersonic velocity
• Area was labelled as safe by human concerns
• Seven miners trapped in the mine, four could be rescued

• No human fault or technical malfunction, no chance to prevent?

How can human life be saved in such a situation?
Groundhog (USA 2006) – Pioneer

- Mapped three abandoned mines (2002 - 2005)
- Equipped with laser range sensing, on-board computing, gas and sinkage sensors
- Autonomous exploration
- Custom-built by Carnegie Mellon University (CMU)

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Motivation – Related Work – Robot – Capabilities – Future Work

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CSIRO (Australia 2014) – 3D Mobile Mapping

- In total 17 km were mapped
- Full 3D model based on laser scans and Inertial Measurement Unit (IMU)
- Model was geo-referenced to survey data
- Robust, reliable, accurate method

CSIRO (Australia 2014) – 3D Mobile Mapping

State of the Art

<table>
<thead>
<tr>
<th>Groundhog</th>
<th>CSIRO</th>
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- Mobility
- Monitoring
- Mapping, 3D – Modelling
- Autonomy
- Reproducibility
- Reliability
- Manipulation task – active interaction
Alexander – Mobile Underground Robot
Alexander – Mobile Underground Robot

- Clearpath Robotics platform: *Husky*
- Stereo camera system
- RGB-D cameras
- Laser range finder
- Environmental sensors
- Max. payload: **75 kg**

<table>
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<tr>
<th>Speed</th>
<th>Battery</th>
<th>Weight</th>
<th>Size</th>
<th>Task</th>
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<tbody>
<tr>
<td>1.0 m/s</td>
<td>24 V 20Ah</td>
<td>~ 65 kg</td>
<td>0.99x0.67x0.39 m</td>
<td>Discover</td>
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1st Level – Reiche Zeche (Freiberg, Germany)
1st Level – Reiche Zeche (Freiberg, Germany)
1st Level – Reiche Zeche (Freiberg, Germany)

Depth: 149 m | Educational and Research Mine | Active Ventilation | Round-trip: 450 m
Mapping, Monitoring, Reconstruction
Mapping, Monitoring, Reconstruction
Mapping, Monitoring, Reconstruction
Mapping, Monitoring, Reconstruction
Application – Cave Automated Virtual Environment (CAVE)

"experience situations as they would be on-site"
**Conclusion**

- Mobility
- Monitoring
- Mapping, modelling
- Autonomy
- Reproducibility
- Reliability
- Manipulation task

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<th>Alexander</th>
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Mining-RoX – Mobile Robots in Underground Mining

S Grehl, M Donner, M Ferber, A Dietze, H Mischo and B Jung

Steve.Grehl@informatik.tu-freiberg.de

Thank you for your attention
Different Tasks, Different Concepts

Julius

- Long-term usage
- Active manipulation
- XRF measurements
- Sample extraction
Different Tasks, Different Concepts

Elisabeth

- Clearpath platform: *Kingfisher*
- Unmanned water vehicle
- Image capturing
3D Reconstruction
Motivation – Related Work – Robot – **Capabilities** – Future Work
Technical Specifications: CAVE

- 25 Full HD projectors
- 6 ATI R9 (6GB) und 6 GTX 285 (1 GB)
- 50 MegaPixel