Robot Assisted
Urban Search and Rescue (USAR)
motivation

• to what extent can robotic platforms and sensors aid rescuers in collapsed USAR (man-made) scenarios?
  • other disaster areas (mine rescue, wildfire …) not covered

• lessons learnt from past disaster interventions

• overview of current robot, sensor and state-of-the-art propositions
  • the practical and the wacky ones!
  • the industrial and the more academic ones
urban search and rescue
• navigate unstructured & hazardous environments

• become aware of disaster site
  • size up incident

• locate survivors

• main task is “search”
  • not shoring or victim extrication
role of mobile robots in USAR

- aid in reconnaissance and confined space traversal
- rescuer protection
  - mitigate unknown hazards
- victim id
- decrease response time, increase survival rate
  - generally no single-robot solution but multi-agent

- overall, challenging integration problem of
  - locomotion
  - perception
  - mapping
  - localization
research problems

• locomotion
  • wheels, legs, tracks, UAV, snake …

• sensing, localization and mapping
  • LADAR, sonar, GPS, vision, IR, IMU, gas sensors …
  • 3D SLAM

• heterogeneous multi-agent co-ordination

• easy deployability + full task automation

• interaction issues robot-rescuers: HRI

• learning
robots for USAR - early days

• first known actual use of robots for USAR: World Trade Center disaster on 9/11/2001
  • still at its infancy

• robots were employed in (www.crasar.org)
  • searching for victims
  • searching for paths through rubble that would be quicker to excavate
  • structural inspection
  • detection of hazardous materials
deployed robots at the WTC disaster
WTC: where robots were during rescue phase

- tethered tele-op robots used in 6 drops
- No survivors found. 2% (10) of victims found by robots

(courtesy of crasar.org)
robots were employed because …

- could go deeper than traditional search equipment
  - robots 5-20 meters into the interior of rubble pile
  - ~ 2 meters for a camera mounted on pole

- could enter a void space too small for a human or search dog

- could enter a place still on fire or posing great risk of structural collapse

- quite importantly: were readily accepted by the rescue community.
  - yet all teleop due to same user acceptance issues (amongst others)
many lessons learnt

- information fed back by robot is most important
- voids will be searched by persons if possible
- It’s not about navigating over rubble but getting into the interior
- man-packable
- teams of 2 people/robot best
### Robot Assisted USAR – EMC’08

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#### Size Robot vs. Size Void

(see [www.crasar.org](http://www.crasar.org) for more details on taxonomy)

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<th>Semi-Structured</th>
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**Shoebox sized**
- Tethered
- *Esp. good for vertical*

**Carry-on sized**
- Wireless
- *Most climb stairs*

**Lawnmower sized**
- Wireless
- *May have arm, Can do rapid hazmat*

**EOD bomb squad**
- Shoring, extrication
wonderful creations for disaster area robot locomotion
more on robot locomotion
multitude of sensors available
sensors to the aid: sensor fusion
sensor fusion (cont)
• researchers – emergency workers – industry cooperation
  key for suitable emergency response development
• information sharing
• standards for training – NIST RoboCup Rescue

Fire brigade (rescue/USAR section) training site, Adelaide

NIST Rescue arena
conclusions

- Robots have potential to become accepted successful rescue tools such as dogs
  - feries/rescue workers already generally tech-savvy
- Reconnaissance, confined-space, victim location are already achievable with today’s robots and sensors
- No current “one-size fits all” rescue robot solution
  - wide size/capabilities/robustness/objectives
- Despite advances in sensors (hardware, fusion…), still not sufficiently adequate to fully exploit all surrounding information
- Additional “intelligent” capabilities necessary to make the move into rescue departments:
  - clever autonomous navigation, object id within a context, better HRI, multi-agent (robot/rescuer) coordination
- Cost needs to come down significantly for wide-spread usage and deployment