Safety, Security and Rescue Robots
I. General Idea

II. Approach Threat
   - Bomb Disposal
   - Firefighting In Tunnels

III. Search Victims
   - Snake Like Robot
   - Active Scope
   - Shape Shifting Robot
   - Search Balls
   - Micro Hopping Robots

IV. Gather Information
   - Unmanned Aircraft
   - ROBHAZ-DT3
   - Mapping with Kurt3D

V. Other
   - Special Guest
I. General Idea

The Idea Behind Rescue Robots

- To find survivors quickly is urgent
  - In general a victim buried under rubble survives 72 hours
- Rescue missions in disaster areas are dangerous

- Robots may give great support in these topics:
  - to help rescuers find more survivors
  - to ensure more security to rescuers
  - to carry out operations in hostile environments
- But: Robots are never meant to work alone
- They will always be a part of rescue teams
II. Approach Threat

General

- Active approach of the Threat
- Autonomously or human-guided actions against the threat
- Used for fast and/or save access to the threat

II. Approach Threat

- Bomb Disposal
- Firefighting In Tunnels
II. Approach Threat

Bomb Disposal - the intrepid

- Very popular robots
  - Often used in films
  - Object of many reportages
  - Often in use
    - Like in an incident at an US army base where radioactive material was involved

- High precision
  - They need to interact with small electronic parts

- Various models
II. Approach Threat

**Example: Mark V-A1**

- Very robust, "All-Terrain"-Platform
- Features:
  - Color surveillance and arm camera
  - Tool mounts on torso
  - Continuous rotate gripper
  - Arm got 7 degrees of freedom
  - 2-way-audio: speakers and micro
  - Power Supply: 24VDC - Two 65 amp-hr 12VDC
II. Approach Threat

Firefighting In Tunnels - keep cool

- Intervention of firemen is limited
- Prompt Intervention is crucial
- Idea of a firefighting robot:
  - Inspired on Robogat
    - Fixed on a monorail
    - Monorail used for locomotion and water supply
    - Vehicle carry an arm with firefighting devices
II. Approach Threat

Firefighting In Tunnels - keep cool

- Rail for movement and supply
  - The vehicle moves freely on the rail and connects to specific point for water.

- Technical Specifications:
  - Size: 8m (l) x 0.7m (w) x 0.6m (h)
  - Weight: 1200kg (1700kg connected)
  - Mobility: 22 wheels → up to 80km/h
  - Firefighting device: 2 pumps, range: 6-50m, flowrate: 30L/sec
  - Sensors: Thermal camera, temperature sensor, pyrometer, gas chromatographs
  - Battery: 18 Pbs (7.7 missions) 62 Li-ion (3.5 missions)
III. Search Victims

General

- Search for victims is time consuming and difficult
- Victims need quick help to survive
- Search inside rubble is impossible to human
- Trained dogs are not always or just few available
- Even dogs are getting tired...

III. Search Victims

- Snake Like Robot
- Active Scope
- Shape Shifting Robot
- Search Balls
- Micro Hopping Robots
III. Search Victims

Snake Like Modular Robot – flexibility!

- May move on almost every terrain
- Good capabilities of climbing obstacles
- Modularity provides good flexibility
- Possible reassemble after damage
Active Scope – the scary one

- Locomotion through ciliary vibration drive mechanism

- Prototype specifications:
  - Core element: industrial video scope
  - Motors: 24 vibrating motors on 300mm interval
  - Sensor: CCD Camera
  - Weight: 7.1 kg
  - Speed: 46.7 mm/s

- Turning becomes possible
  - With a wall 180° with a space of 60mm x 160mm
  - On open space it needs 1m
  - Climbes a bump of 200mm
III. Search Victims

Shape-Shifting-Robot – next up: T-1000

- One simple module developed
- The modules are linked with arms
- Uses a tracked design
- 3 DC Motors for each module
  - 2 for yaw and pitch joints and one for the track
- The shown prototype uses three modules
  - Each got a processor – the performing controller
  - Middle one carries the centralized controller
  - All performing controllers are linked via a single serial bus (CAN)
III. Search Victims

Shape-Shifting-Robot – next up: T-1000

- **Ability to metaform in three shapes:**
  - Line, triangle, row
  - Each one good for specific situations

<table>
<thead>
<tr>
<th>Action</th>
<th>Line</th>
<th>Triangle</th>
<th>Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>climb slope</td>
<td>up to 25°</td>
<td>up to 25°</td>
<td>up to 30°</td>
</tr>
<tr>
<td>pass through trench</td>
<td>450 mm</td>
<td>300 mm</td>
<td>10 mm</td>
</tr>
<tr>
<td>climb stairs</td>
<td>30°/100 mm</td>
<td>30°/120 mm</td>
<td>30°/10 mm</td>
</tr>
<tr>
<td>Pass hole</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>climb obstacle</td>
<td>270 mm</td>
<td>210 mm</td>
<td>0</td>
</tr>
<tr>
<td>climb over debris</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
III. Search Victims

Shape-Shifting-Robot – next up: T-1000
III. Search Victims

Search Balls – going down

- No real robots but small sensor units
- Small Search Balls are equipped with:
  - Wireless camera
  - LED’s for light
  - Radio receiver for communications

Specifications:

- 2 types: 1 with 3 fixed, 1 with 2 rotating cams

<table>
<thead>
<tr>
<th>Type</th>
<th>3 fixed</th>
<th>2 rotating</th>
</tr>
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<tbody>
<tr>
<td>Sphere</td>
<td>100mm</td>
<td>100mm</td>
</tr>
<tr>
<td>Camera</td>
<td>The Me</td>
<td>The Me</td>
</tr>
<tr>
<td>LED</td>
<td>4 per cam</td>
<td>3 per cam</td>
</tr>
<tr>
<td>Motor</td>
<td>-</td>
<td>1 DC Motor (0.17W)</td>
</tr>
<tr>
<td>Radio</td>
<td>1 receiver</td>
<td>1 receiver</td>
</tr>
<tr>
<td>Battery</td>
<td>Li-polymer</td>
<td>NiMH</td>
</tr>
</tbody>
</table>
III. Search Victims

Micro Hopping Robot – shake it!

- Very small robot with simple locomotive capabilities
- Simple design results in a low price robot
- Advantages are:
  - Very small (ca. 25mm x 25mm x 25mm)
  - Low cost (< 10 $)
  - Self contained electricity
  - Sensor devices
  - On-board-controll logic for navigation
  - Up to 5.5 h of operation time
  - Provides rescuers with survivor location signal
Micro Hopping Robot – shake it!

**Construction:**
- 2 flat micro DC vibration motors
- Motors and control electronics are centered on a metal sheet
- Metalsheet, button and batteries are implemented onto a 1 cubic inch skeleton frame
- 2 infrared/thermal sensors are placed on each side
- A steel wire is attached around the robot
III. Search Victims

Micro Hopping Robot – shake it!

**Locomotion principle:**

- The rotation of the motor causes the robot to be lifted and thrust forward
- Current motor can be altered to turn
- A simple logic switches the current according to signal intensity
- The wire is for stability and to ensure the right positioning and contact to ground
- Speed was measured up to 60 mm/s
- Locomotion algorithm is simple:
  - No signal: go straight
  - Left or right signal: turn left or right
III. Search Victims

Micro Hopping Robot – shake it!

Detection capabilities:

2.5m

5m

10m
Conclusion & Opinion:

- Micro Hopping Robots are able to
  - Survive a drop in the rumble
  - Detect victims
  - Approach victims
- Produceable at very low cost
  - A very large number of robots may be used (100s to 1000s)
  - Wide area search in rumble is possible
- They may be a good part in rescue teams
- A Russian proverb says: 
  "Quantity has a Quality all of its own"
IV. Gather Information

General

- In hazardous or hostile environment it's good to know where you are

- Having information about the terrain or of the position of danger or victims means half the job done

- Gather information is a time consuming and sometimes dangerous job

IV. Gather Information

- Unmanned Aircraft
- ROBHAZ-DT3
- Mapping with Kurt3D
IV. Gather Information

Unmanned Aircraft – independent bird

- Surveillance and observation of hostile or wide areas
- As example: unmanned two bladed helicopter

  Specifications:
  - Rotor: 1.6m diameter, ca. 1800 RPM
  - Weighth: 9kg
  - Sensors: Gyro (average 0.06 degrees/sec, total ±300 deg/sec)
    GPS (accuracy ca. 10m)
    Magnetoresistive sensor
    Camera
  - Avionic include CPU, sensors and actuators to control the flight
IV. Gather Information

Unmanned Aircraft – independent bird

- Ground Controll System (GCS)
  - Receives data and image through several antennas

- Human-Robot-Interface
  - Real time image
  - Rebuild of aircraft attitude
  - Digital map & waypoints
  - Virtual instruments

- Avionic is moved by waypoints
- GCS uses a tracking system for the antennas
Kurt3D – the eye

- Kurt3D maps his environment – in 3D!
  - Having a reliable map of dangerous or hazardous areas makes the job much easier
- Localises 6 degrees of freedom
  - x,y,z axis and roll, yaw and pitch angles
  - Uses one 2D scanner rotating on a vertical axis with a servo
  - Uses HAYAI-Algorithm + noise reduction
- Communicates over TCP/IP
- May even identify victims
Kurt3D – the eye

- **Specifications:**
  - Size: 45cm(l) x 33cm(w) x 26(47)cm height
  - Weight: 15.6 kg (22.6kg)
  - Power: Two 90W motors for 6 wheels
    - Scanner 17W
    - Servo 0.85W
    - 2 Logitech Quickcam 4000 + Light
  - Batteries: 28 NiMH for wheels → 4h
    - 20 NiMH for scanner → 5h
    - 8 NiMH for light
  - System: Intel-Centrino-1400MHz
    - 768MB-RAM
    - Linux operation system
IV. Gather Information

ROBHAZ-DT3 – the winner

- Simple and compact double-track mechanism
- Consists of three parts
  - Front body, rear body, passive joint for connection
  - There's no actuator for the joint! It's really passive!
- May mount specific equipments
  - Such as water disruptor, manipulator or sensors
  - For rescue missions is suggested:
    - 2D-Laser-Scanner, non-contact temperatur and CO₂ sensors
IV. Gather Information

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### IV. Gather Information

**Specifications:**

- **Size:** 740mm(w) x 470mm(h) x 290mm(l)
- **Weight:** 39kg
- **Speed:**
  - 0.7 m/sec (2.5 km/h)
  - 2.7 m/sec (10 km/h)
- **Joint limit:** +10° ~ -30°
- **Battery:** Lithium-polimer
- **Time of operation:** 1h

**ROBHAZ-DT3 – the winner**

[Diagram of ROBHAZ-DT3]
V. Other

Wall – E – the one and only

- Rescues the earth with sorting trash and finding a plant
- Selfrecharging with solar
- Selfrepairing
  - Takes parts of other, broken Wall-E units
- Social connections
  - Cockroach
  - Eva

Waste Allocation Load Lifer - Earth-Class
Thanks

Thanks for listening

References


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Stand: 22.11.2008

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