# Urban Search and Rescue

- After major disasters or attacks often the rescue teams work in dangerous and unknown environments to save lives and to recover the damage.

- Assessing the situation correctly plays a key role during these operations.

- Success of search and rescue as well as recovery strategies require reliable information, good organization and efficient use of resources.

- Reliable information is hard to acquire when infrastructure (communications, roads, hospitals) damage is high.

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Disasters and Attacks

- Earthquakes
- Hurricanes
- Tsunami
- Terrorist Attacks
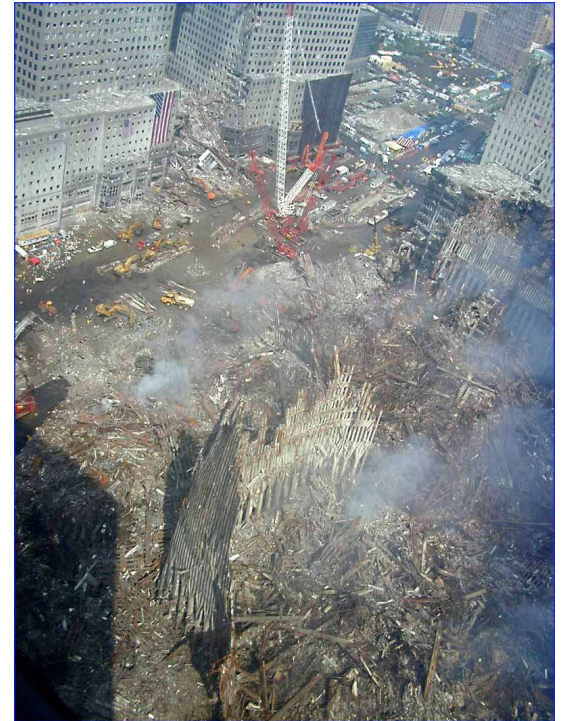
Problems faced during rescue operations

- Limited time: According to statistics, most of the victims were rescued during the first 72 hours after an earthquake. Time may vary but response time is important in all types of disasters.

- Hostile environment: Disasters may initiate fires, building collapses and other incidents which may comprimise the security of people in the area.

- Most of the decisions must be made with incomplete information. These may include:
    - Location of the victims
    - Reliability of existing Infrastructure: Roads, communication infrastructure etc.

Can Robots help?

- Technologically, yes. Although the robotics research is still premature to develop fully autonomous robots, teleoperated robots were used in several disasters so far.
  - Virginia mine explosion (article in the web site)
  - Hurricane Katrina
  - World Trade Center

- According to William "Red" Whittaker, team leader who won 2nd and 3rd place in DARPA Grand Challenge 2005, technology is there but more money and commitment is needed to use robots in disaster areas.

Rescue Robots (1)
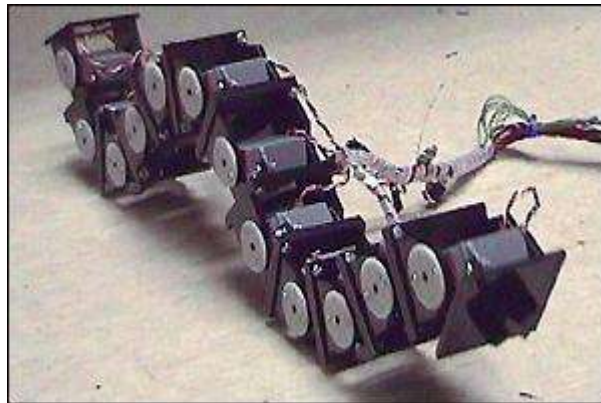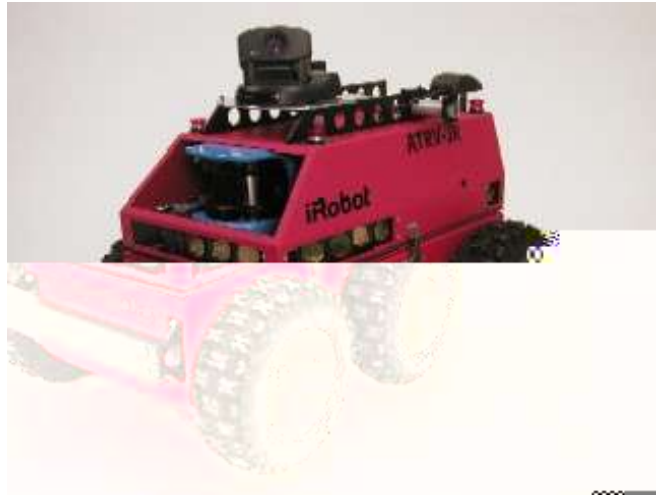
Rescue Robots (2)

Potential uses of robots in rescue efforts

- Utilization in risky and dangerous tasks.

- Locating victims

- Mapping of the disaster area

- Surveillance of the environment for fires, potential gas leaks and structural changes.

- Carrying water, food, medicine, oxygen etc. to victims before they can be reached.

Utilizing robots in USAR - Problems

- State of the research is still in it's infancy. Robots are not fully autonomous and most of the current rescue robots cannot be used without considerable training.

- Using multiple robots, in theory, will increase the efficiency of tasks. However, cooperation between robots becomes an issue.

- Hybrid rescue teams with human assistance seems to be a good approach but requires an interaction mechanism between humans and robots.

Research on Rescue Robots

- Low level robotic functions: perception, locomotion

- Path Planning

- Mapping and Localization

- Multi-Robot Coordination, task and resource allocation

- Human Robot Interaction

- Others…

RoboCup

- Academic initiative to promote research in Robotics and Artificial Intelligence.

- Long term goals provide public apeal and formidable challenge.

- Provides a common platform where scientists and engineers compare their results and benefit from each others experience.

- Consists of three main leagues:
    - Soccer *(Humanoid, mid-size, small-size, 4-legged, simulation)*
    - Rescue *(Simulation, USAR, USARSim)*
    - Junior *(Soccer, Rescue, Dance)*

RoboCup Rescue Simulation

- Objective is to provide a platform which would enable to work on high level interaction and coordination mechanisms among large number of agents.

- A part of a city where an earthquake is simulated causing fires, building collapses with trapped victims. Environment is dynamic and communication is noisy.
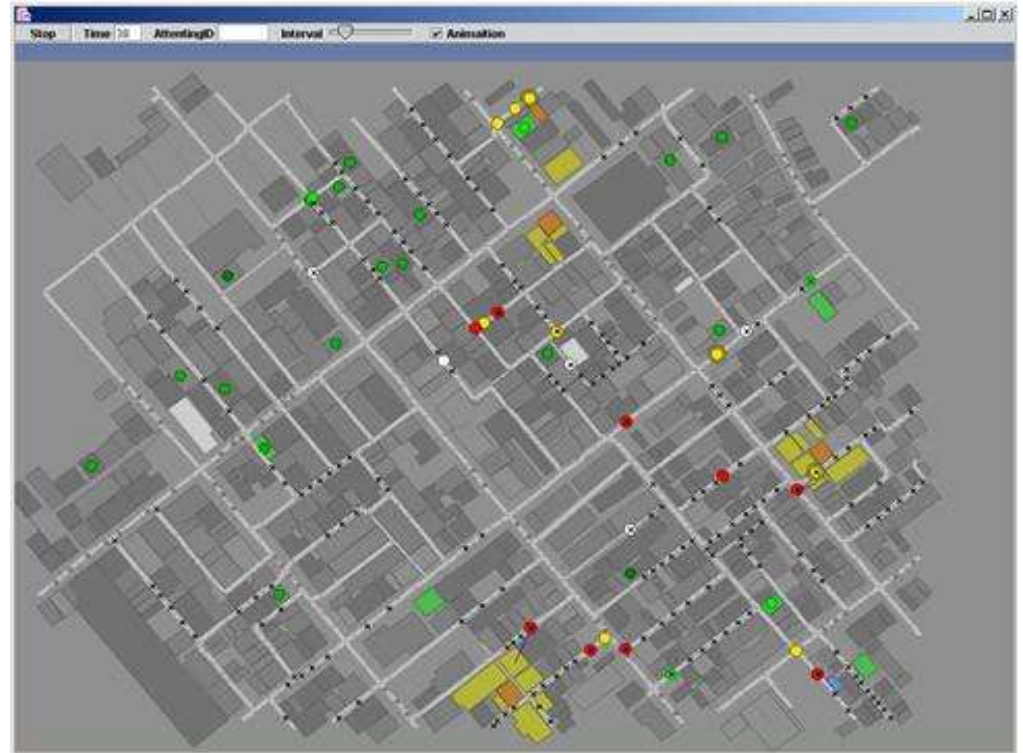
The rectangles represent the buildings (gray: intact, yellow: in fire). The cercles represent agents: FireBrigade (red), PoliceForce (yellow), AmbulanceTeam (white) and Civilians (green).

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RoboCup USAR

- Objective is to develop robots that would search and locate victims in a cluttered area. Mostly, focuses on developing or improving low level robot capabilities such as perception and motion.

- An arena in a large room is designed for competitions, containing obstacles, stairs and test dummies for victims.


Robots performing search and rescue tasks in confined arena, built to represent similar problems in a disaster environment.

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RoboCup USAR Simulation

- Objective is to provide a intermediary between USAR and city level simulation.

- Built on Unreal Tournament game engine, robots and arenas are modeled for testing programs. It is suitable for researchers with limited means to afford expensive equipment.

Real and simulated robots (left) and arenas (right)
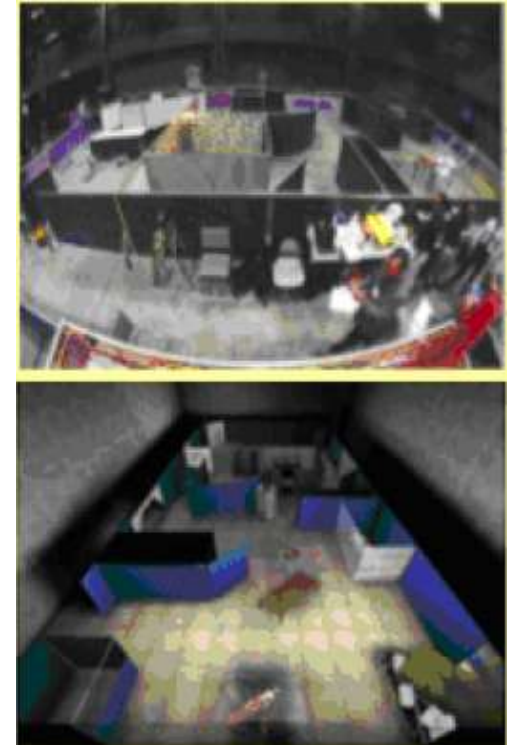
RoboCup Junior Rescue

- A project-oriented educational initiative designed to introduce RoboCup to high schools and undergraduates.

- Engages robots to identify victims quickly and accurately within re-created disaster scenarios, varying in complexity from line-following on a flat surface to negotiating paths through obstacles on uneven terrain.

Robocup Junior Rescue event in CUNY-GC 2006.

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Individual Assessment

- Write a report about an article of your choice. A suitable article would be on one of the below topics:
  - The potential usage or method descriptions about how robots can be used in disaster sites.
  - General information about a rescue robot or a class of rescue robots.

- Your report should contain:
  - One page summary of an article, including your opinions.
  - Name of the article and a reference to it. If your article is not online you should attach a copy of it to your report.

- NO HANDWRITING! Report should be either send via email or printed out.