

# Search and Rescue

CISC1003



<https://www.youtube.com/watch?v=mz9sMor67IU>

<https://www.israelrescuecoalition.org/israel-search-and-rescue-units/>

# Urban Search and Rescue

- After major disasters/attacks, rescue teams face challenges:
  - 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.



# Urban Search and Rescue

- Success of search and rescue, 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.



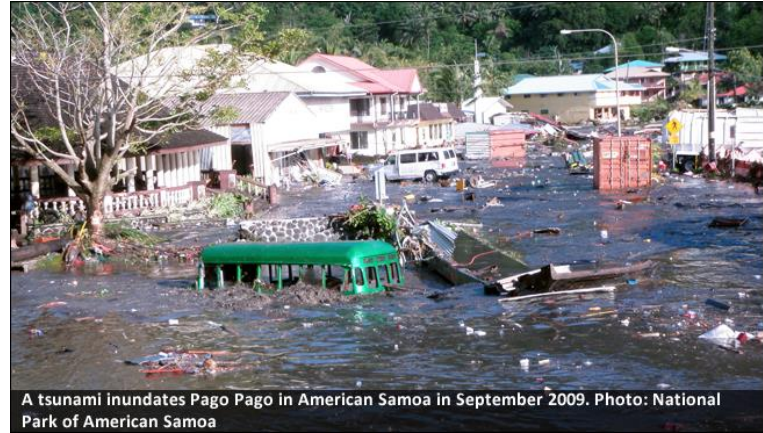
# Disasters and Attacks

- Earthquakes
- Hurricanes
- Tsunami
- Terrorist Attacks





# Disasters and Attacks



A tsunami inundates Pago Pago in American Samoa in September 2009. Photo: National Park of American Samoa



<https://www.nbcnews.com/news/world/mexico-earthquake-death-toll-climbs-rescuers-race-find-survivors-rubble-n803301>

# Problems faced during rescue operations

- Time constraints (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
  - May compromise the security of people in the area.



# Problems faced during rescue operations

- 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
  - Hurricane Katrina
  - World Trade Center





# Can Robots help?

- Technology is there but more money and commitment is needed to use robots in disaster areas.
  - According to William “Red” Whittaker, team leader who won 2<sup>nd</sup> and 3<sup>rd</sup> place in DARPA Grand Challenge 2005,



# The U.S. Navy reveals robot cicadas that could soon be dropped in swarms over hurricanes and other natural disasters to monitor conditions

- The U.S. Navy is testing tiny robot drones that fly in swarms to collect data
- At \$250 each, they are disposable and dropped from the sky in bunches
- First stacked together, they break apart and fly to individual GPS coordinates

By [SAGE LAZZARO FOR DAILYMAL.COM](#)

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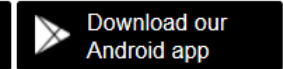
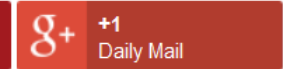
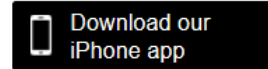
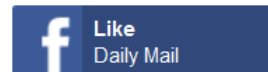


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The U.S. Navy is testing tiny robot drones that fly in swarms like cicadas to collect data.

The CICADs - or 'close-in covert autonomous disposable aircrafts' - are designed to be cheap enough that a bunch can be dropped simultaneously from the sky and even into storm conditions like hurricanes.

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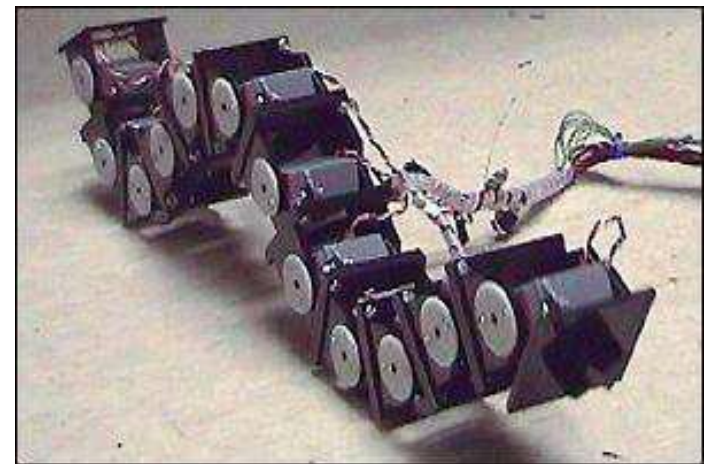


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# Rescue Robots



\*<https://www.popsci.com/technology/article/2011-03/six-robots-could-shape-future-earthquake-search-and-rescue#page-4>

\*<https://spectrum.ieee.org/automaton/robotics/industrial-robots/japan-earthquake-more-robots-to-the-rescue>

# Dallas Police Used Bomb-Armed Robot To Kill Active Shooter

"We saw no other option but to use our bomb robot and place a device on its extension for it to detonate where the suspect was."



By Eric Limer Jul 8, 2016

A Portland police robot removes a device in a trash can used in a robbery in April 2016

Getty + Portland Press Herald



Police used a bomb-defusal robot [armed with an explosive](#) to kill an active shooter taking part in a coordinated attack that left five police officers dead in Dallas, Texas on Friday.

Dallas Police Chief David Brown [explained the situation in a press conference](#) after the fact, saying:



# Robots help in disasters

- Robots Detonating Bombs:



- <http://www.gettyimages.com/detail/news-photo/ultra-orthodox-jews-watch-as-an-israeli-police-robot-news-photo/671095#ultraorthodox-jews-watch-as-an-israeli-police-robot-carries-a-mobile-picture-id671095>
- <https://www.dreamstime.com/editorial-stock-image-military-police-robot-used-to-safely-move-detonate-bombs-beer-sheva-israel-november-mines-enters-vehicle-image62763099>



# Robots' potential uses in rescue efforts

- Utilization in risky and dangerous tasks.
- Locating victims
- Mapping of the disaster area



[https://www.army.mil/article/48456/robots\\_to\\_rescue\\_wounded\\_on\\_battlefield](https://www.army.mil/article/48456/robots_to_rescue_wounded_on_battlefield)

<https://www.youtube.com/watch?v=mz9sMor67IU>

<http://www.allonrobots.com/rescue-robots.html>

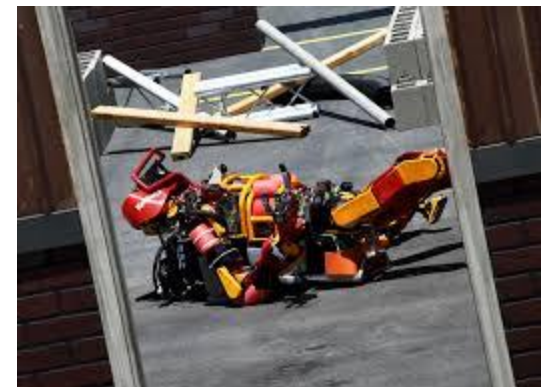
# Robots' potential uses in rescue efforts

- 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 Urban Search and Rescue (USAR) - Problems

- State of the research is still in relative infancy.
  - Robots are not fully autonomous
  - Most of the current rescue robots cannot be used without considerable training.



# Utilizing robots in Urban Search and Rescue (USAR) - Problems

- Using multiple robots will increase efficiency of tasks.
  - In theory
  - However, cooperation between robots becomes an issue
- Hybrid rescue teams with human assistance seems to be a good approach
  - Requires interaction mechanism between humans and robots.



<https://cacm.acm.org/magazines/2013/3/161193-exploration-and-mapping-with-autonomous-robot-teams/abstract>

<http://www.giannidicaro.com/robotics.html>

# 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.
  - Holds an annual international competition
  - Through appealing but formidable challenges.
- Provides a common platform where scientists and engineers compare their results
  - Benefit from each others experience.



# RoboCup



- Consists of three main leagues:
  - Soccer: “Robot Soccer World Cup”
    - *Humanoid, mid-size, small-size, 4-legged, simulation*
  - Rescue: RoboCupRescue
    - *Simulation, USAR, USARSim*
  - Junior: “RoboCupJunior”
    - *Soccer, Rescue, Dance*

# RoboCup Videos



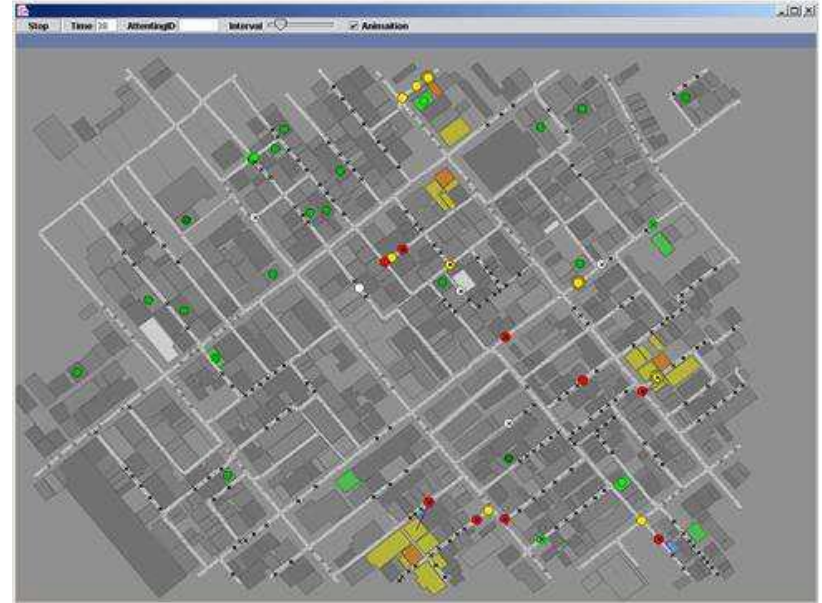
- Soccer league
- Junior Rescue:
- Rescue league:
  - <https://www.youtube.com/watch?v=8AOID93y0nw>
  - <https://www.youtube.com/watch?v=IAAZwQVFYRk>

# RoboCup Rescue Simulation

- Objective:
  - Provide a platform to work on high level interaction and coordination mechanisms
  - Among large number of agents.
- Environment:
  - A part of a city where an earthquake is simulated
    - Causing fires, building collapses with trapped victims.
  - Environment is dynamic, communication is noisy

# RoboCup Rescue Simulation

- The rectangles represent the buildings:
  - gray: intact
  - yellow: on fire
- The circles represent agents:
  - Fire Brigade (red),
  - Police Force (yellow)
  - Ambulance Team (white)
  - Civilians (green)
- 3D simulation:
  - [3D Simulation](http://miners.cs.umn.edu/)





# RoboCup USAR

- Objective:
  - 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.

# RoboCup USAR

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

# RoboCup USAR



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

# RoboCup USAR Simulation

- Objective is to provide an intermediary between USAR and city level simulation.
- Built on Unreal Tournament game engine
  - Robots and arenas are modeled for testing programs.
  - Suitable for researchers with limited means to afford expensive equipment.

# 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 recreated disaster scenarios
  - Varying in complexity
    - line following on a flat surface, negotiating paths through obstacles on uneven terrain, etc.



# RoboCup Junior Rescue



Robocup Junior Rescue event in CUNY-GC 2006

# Homework: 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:
  - A of an article, including your opinions – up to three pages.
  - 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.

