

# Search and Rescue

CISC1003



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

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

# Search and Rescue

- Search and Rescue Robots

# 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.

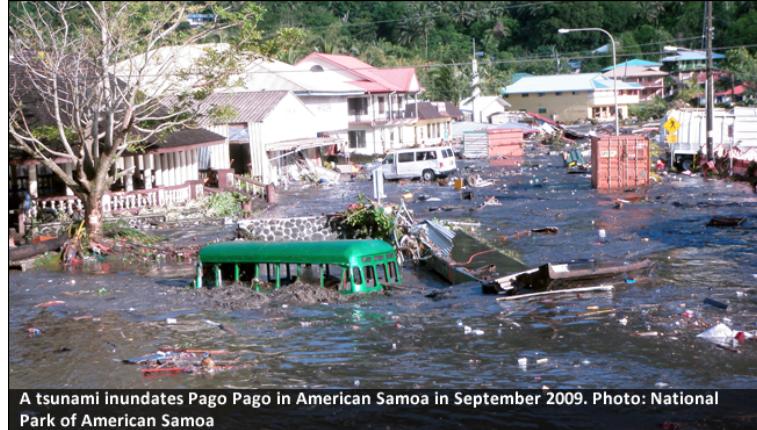


# Disasters and Attacks

- Earthquakes
- Hurricanes
- Tsunami
- Terrorist Attacks



# Disasters and Attacks



<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



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

# 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 3rd 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 DAILYMALCOM

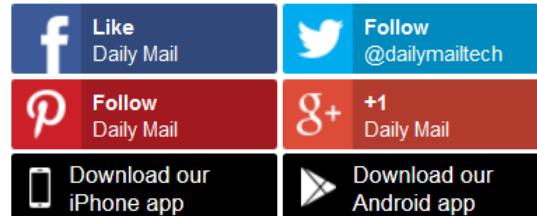
PUBLISHED: 17:44 EDT, 28 July 2017 | UPDATED: 18:06 EDT, 28 July 2017



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.

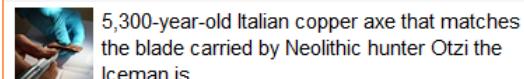
Site  Web  Enter your search



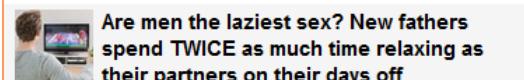
### Today's headlines



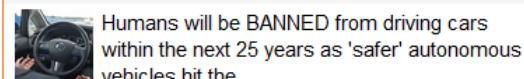
Stunning belt decorations made from coal and encrusted with jade and coral are found on 2,200-year-old...



5,300-year-old Italian copper axe that matches the blade carried by Neolithic hunter Otzi the Iceman is...



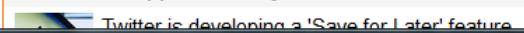
Are men the laziest sex? New fathers spend TWICE as much time relaxing as their partners on their days off



Humans will be BANNED from driving cars within the next 25 years as 'safer' autonomous vehicles hit the...

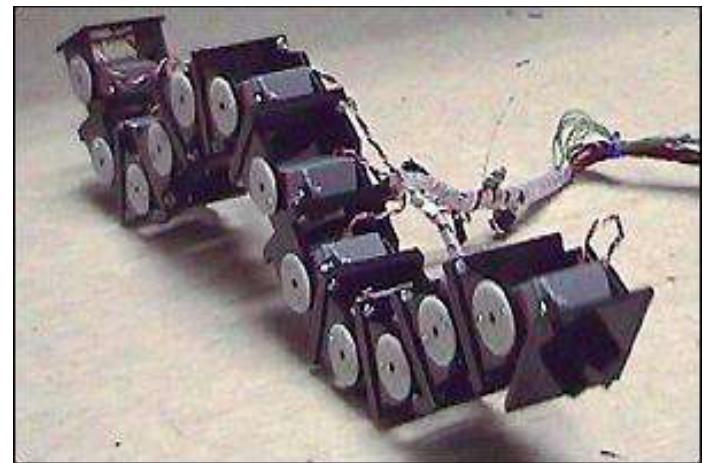


Viewers blast Mark Zuckerberg for 'exploiting disaster' by using Facebook's VR app to virtually tour...



Twitter is developing a 'Save for later' feature

# 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-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>

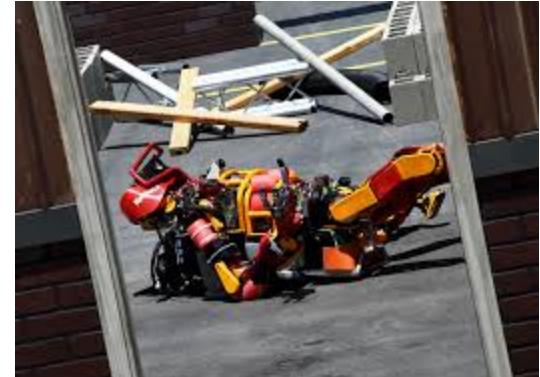
# Robots' potential uses in rescue efforts

- 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.



<http://robohub.org/robots-to-the-rescue/>

<https://www.wired.com/2015/06/stop-laughing-clumsy-humanoid-robots>

# 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

RoboCup  
LEIPZIG GERMANY 2016  
30 JUNE to 4 JULY



- 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

RoboCup  
LEIPZIG GERMANY 2016  
30 JUNE to 4 JULY



- 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



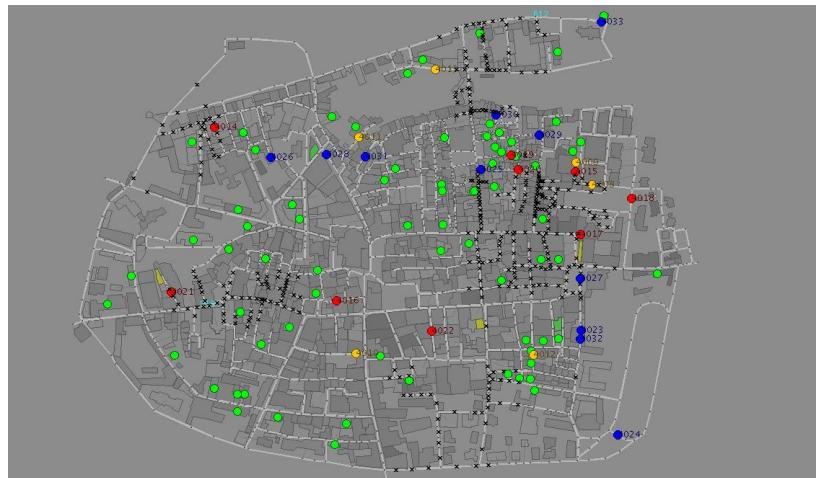
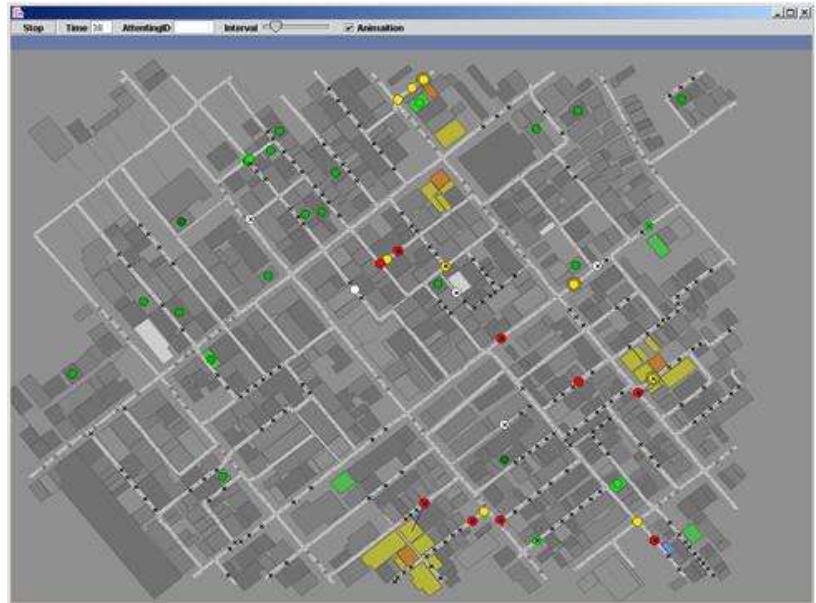
- Soccer league
- Junior Rescue:
- Rescue league:
  - [https://www.youtube.com/watch?v=8AOID93y0n  
w](https://www.youtube.com/watch?v=8AOID93y0nw)
  - [https://www.youtube.com/watch?v=IAAZwQVFYR  
k](https://www.youtube.com/watch?v=IAAZwQVFYRk)

# 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](#)



# 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 copy 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.

**QUESTIONS**