

CAP6671 Intelligent Systems

Lecture 11:

Robocup Rescue

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Schedule: T & Th 9:00-10:15am

Location: HEC 302

Office Hours (in HEC 232):

T & Th 10:30am-12

Research Issues

Research Issues

- Autonomy
- Coordinating multiple robots
- Mobility (climbing ramps, obstacles)
- Perception
 - Fusing multiple types of sensors
- Heterogeneous capabilities
- Human-robot interaction

Competition Environment



Zones



RoboCup Rescue

**RoboCup Rescue Robot League
Regional Qualifying Arena**
(10M x 7.5M WITH 1.2M WIDE HALLWAYS)

NIST

YELLOW SECTION
FLOORING: PITCH & ROLL RAMPS (10°)
OBSTACLE: RANDOM MAZE
VICTIMS: DIRECTIONAL BOXES
(SCORED BY AUTONOMOUS ROBOTS ONLY)

ORANGE SECTION
FLOORING: PITCH & ROLL RAMPS (15°)
FLOORING: HALF CUBIC STEPFIELDS
OBSTACLE: CONFINED SPACES
VICTIMS: BOXES WITH HOLES

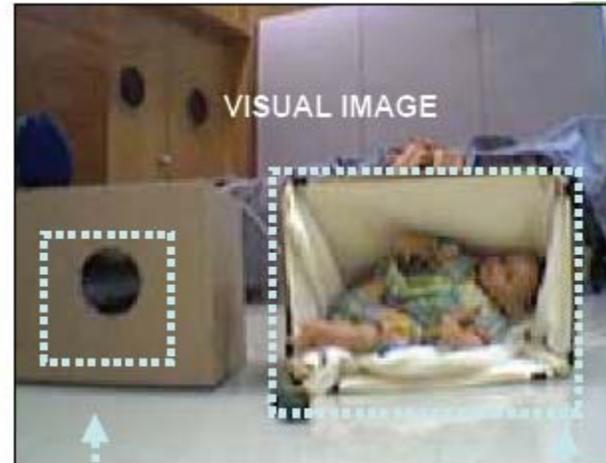
RED SECTION
FLOORING: FULL CUBIC (RED) STEPFIELDS
OBSTACLE: INCLINED PLANE (45° WITH CARPET)
OBSTACLE: STEPS WITH PIPES (20CM)
OBSTACLE: STAIRS (40°, 20CM RISERS)
VICTIMS: DIRECTIONAL BOXES



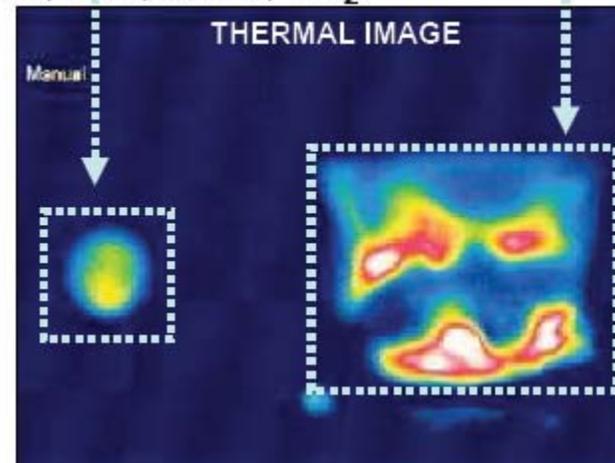
Obstacles



Victims



Signs of life: form, motion, heat, sound, CO₂



Details

- 15/20/25 minute missions
- Teams are allowed one operator during the mission
- Start point is in the yellow arena with all robots facing same direction
- Yellow arena victims can be scored only by robots with autonomous navigation and victim ID
- Teleoperated robots can only score orange or red arena victims
- Robots can be fixed at start point with loss of victims, maps, and time
- Awards:
 - Autonomy: find most yellow arena victims
 - Mobility: find most red arena victims

Results

- 17 of 20 participating teams performed missions representing AUS, DEU, IRN, JPN, MEX, SWE, THA, USA.
- ***CHAMPIONSHIP AWARDS: MIXED INITIATIVE MISSIONS***
- *Teams with the highest cumulative scores from 7-10 missions receive 1st, 2nd, 3rd place awards*
- 1st: INDEPENDENT, KING MONGKUT'S INST. OF TECH. BANGKOK, THAILAND
- 2nd: PELICAN UNITED, CHIBA INSTITUTE OF TECH. & TOHOKU UNIV., JAPAN
- 3rd: CEO MISSION, UNIV. OF THE THAI CHAMBER OF COMMERCE, THAILAND
- ***BEST-IN-CLASS: MOBILITY***
- *Robots that found the most Red Arena victims throughout and scored the most points in mobility missions*
- 1st: PELICAN UNITED, CHIBA INSTITUTE OF TECHNOLOGY, JAPAN
- 2nd: SHINOBI, THE UNIVERSITY OF ELECTRO-COMMUNICATIONS SGI, JAPAN
- 3rd: INDEPENDENT, KING MONGKUT'S INST. OF TECH. BANGKOK, THAILAND
- ***BEST-IN-CLASS: AUTONOMY***
- *Robots that found the most Yellow Arena victims throughout and scored the most points in mapping missions*
- 1st: RESKO, UNIVERSITAT KOBLENZ UND LANDAU, GERMANY
- 2nd: JACOBS RESCUE ROBOT, JACOBS UNIVERSITY BREMEN, GERMANY
- 3rd: RFC UPPSALA, UPPSALA UNIVERSITY, SWEDEN

Winner (KMINTB, Thailand)



Competition Directions

- Encourage autonomous behaviors on all robots
- Manipulation tasks (last victim in each arena)
 - Door opening (push/pull, assorted knobs)
 - Placing items (radio, water)
 - Picking items (sample, ID badge)
- Continue integration with Virtual Robot Competition
- Autonomous behaviors in complex environments
- A bracket of common robot platforms similar to legged league: Rhex, Volksbot, Kenaf
- Centralize repository of data, algorithms, etc.

Virtual Robot Competition



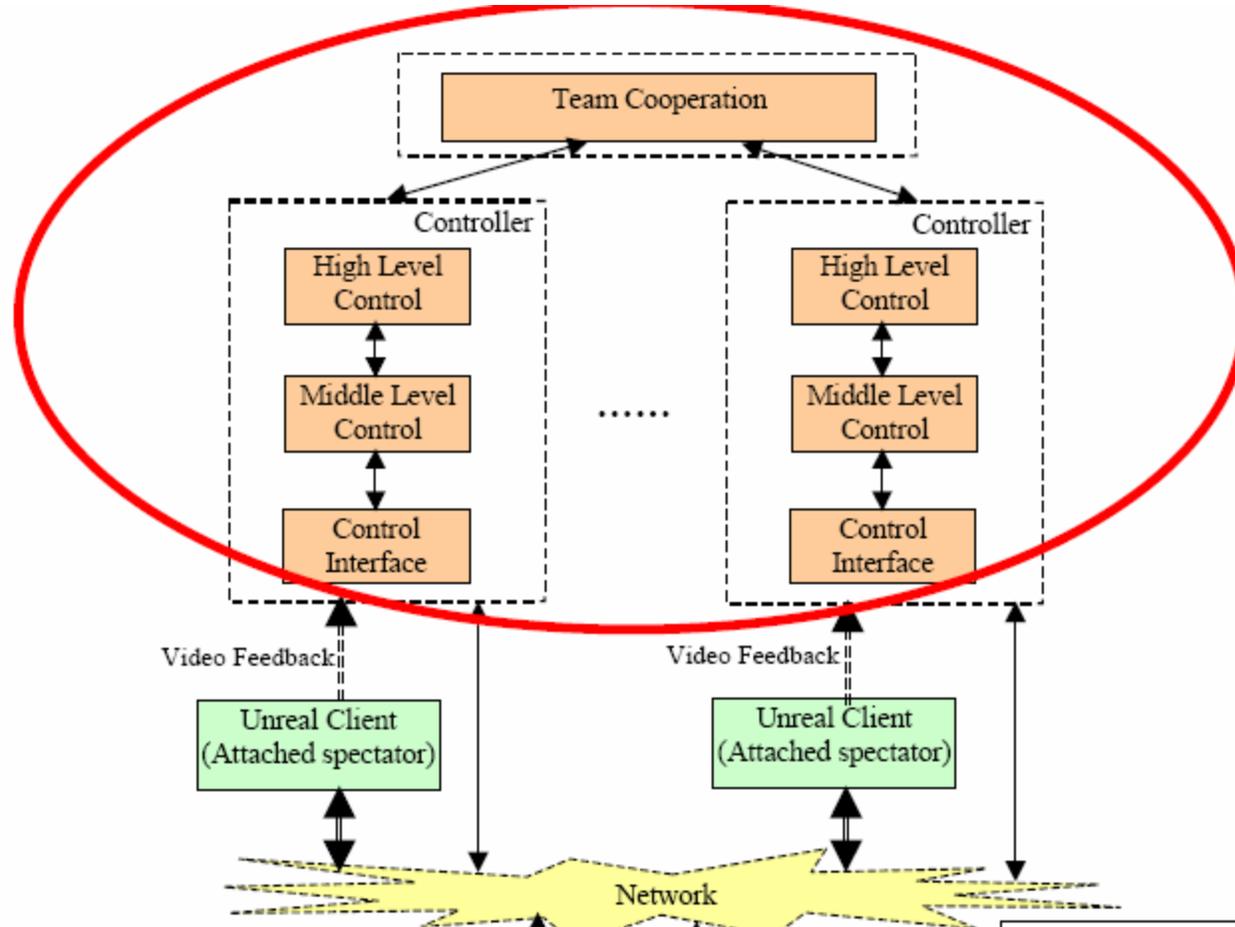
Simulated version of the competition using Unreal Tournament game environment

Simulated robot, sensors, control API and environment are given

Competitors design control code and user interface

<http://sourceforge.net/projects/usarsim>

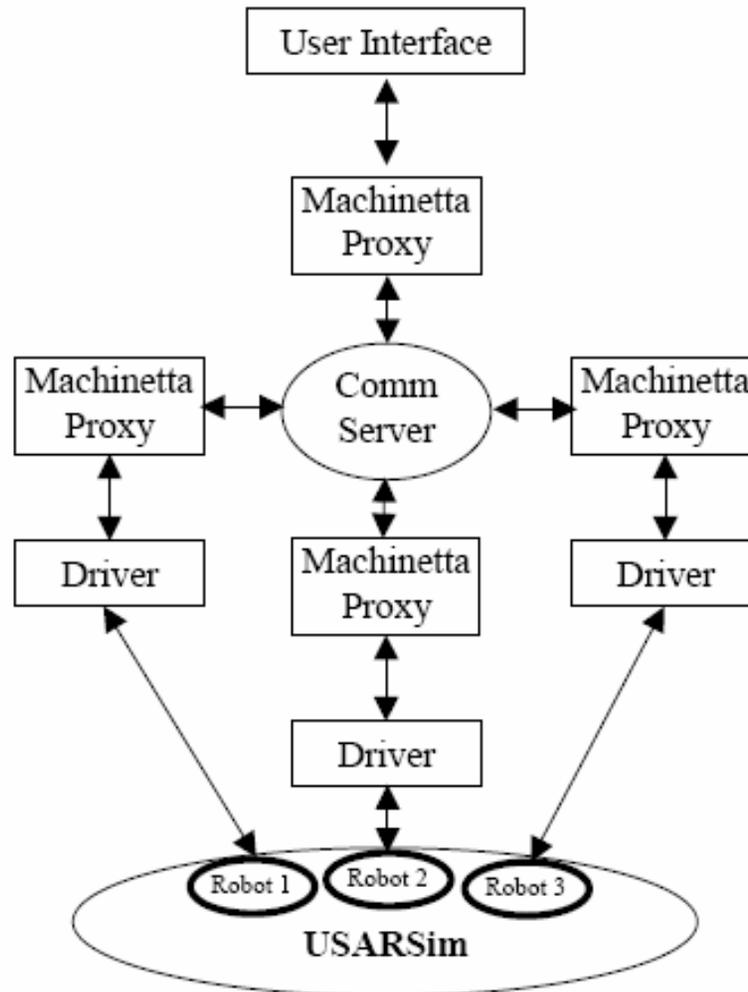
Example Controller



Cooperating Robots for SAR

- What other problems is this work relevant to?

System Architecture



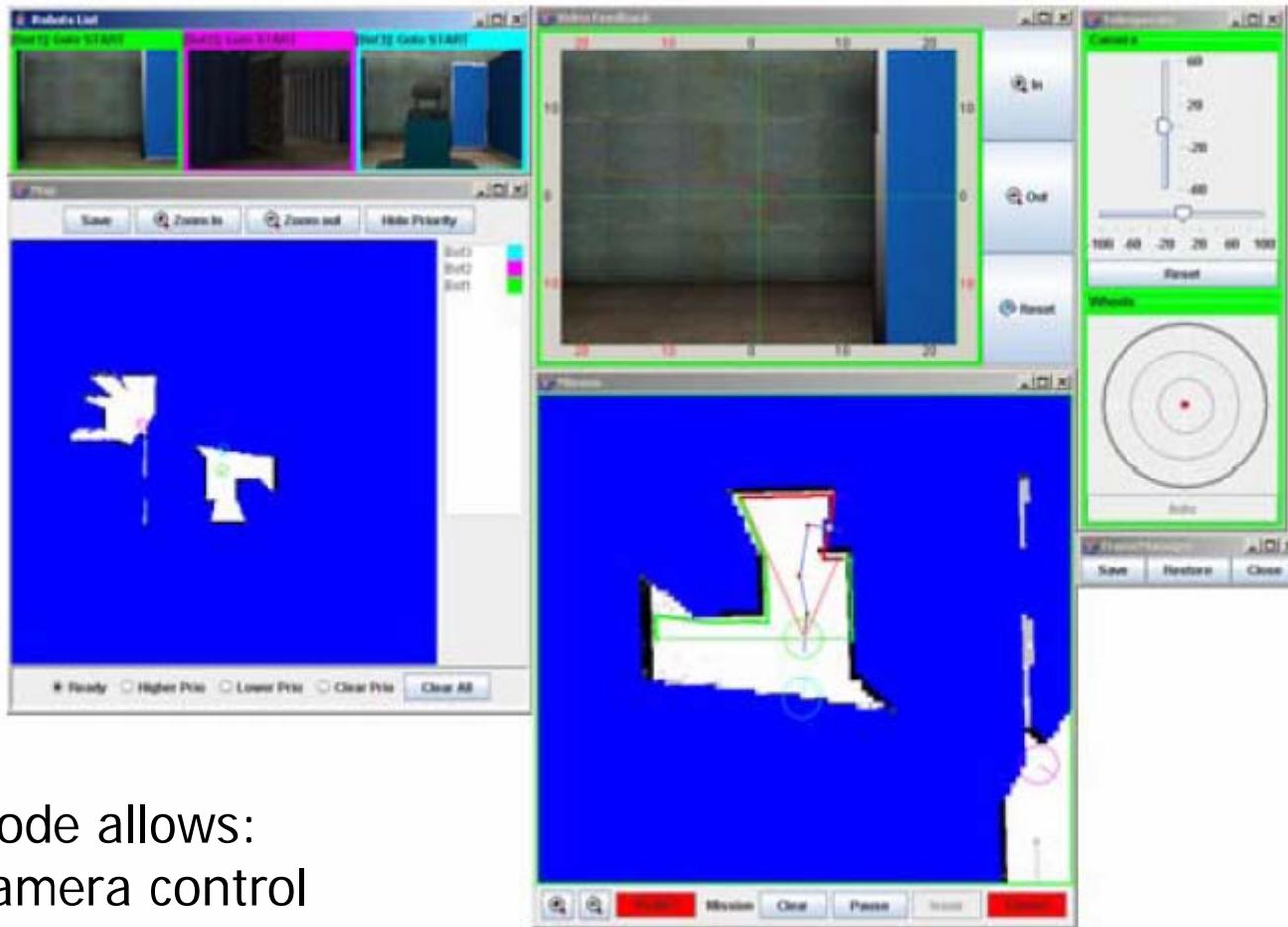
Machinetta provides:

- Coordination
- Adjustable autonomy
- Information fusing
- Role allocation
- Task deconfliction

Team-oriented plans describe plans in terms of:

- Roles
- Constraints between roles

User Interface



Mode allows:
Camera control
Waypoint selection
Teleoperation

Results

- Evaluated:
 - Subjects experience (via questionnaire)
 - Increases in number of victims found
 - Area explored
 - Distribution of attention
- Results:
 - Subjects performance improves under increased autonomy
 - However improvements could be attributed to the path planning and autonomy mechanisms rather than the improved coordination.

References

- S. Balakirsky slides