

Robot Swarms

Command, Control, and Countermeasures

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MITRE Sponsored Research

The logo for the MITRE Technology Program, featuring a stylized graphic of stacked cubes in yellow, orange, and blue to the left of the text.

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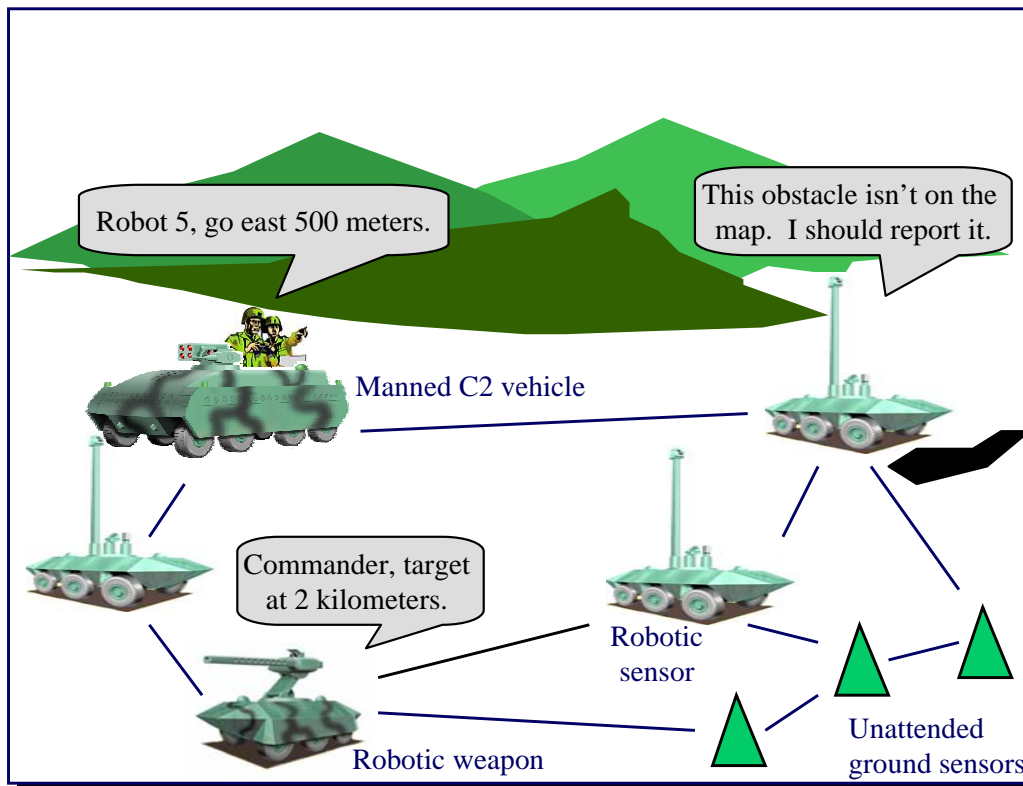
The MITRE logo, consisting of the word "MITRE" in a bold, black, sans-serif font.

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Problem

Enable autonomous systems and humans to work together effectively



Future Combat Systems Cell Concept

Issues for robot teams

- Coordinating teams of robots for reconnaissance
- Human-robot interaction
- Semi-autonomous behaviors for the robots
- Dynamically varying the degree of human supervision

Background


“It shall be a goal of the Armed Forces to achieve the fielding of unmanned, remotely controlled technology such that --

(1) by 2010, one-third of the operational deep strike aircraft of the Armed Forces are unmanned; and

(2) by 2015, one-third of the operational ground combat vehicles of the Armed Forces are unmanned.”

**-- Senate Armed Services Committee Bill S.2549,
National Defense Authorization Act for FY 2001**

**Technology
Transition Targets**

- 
- **Network-Centric Warfare Programs (e.g., FCS)**
 - **Intelligence Programs**
 - **Homeland Security (border security, disaster response)**
 - **DARPA Programs and Military ACTDs**

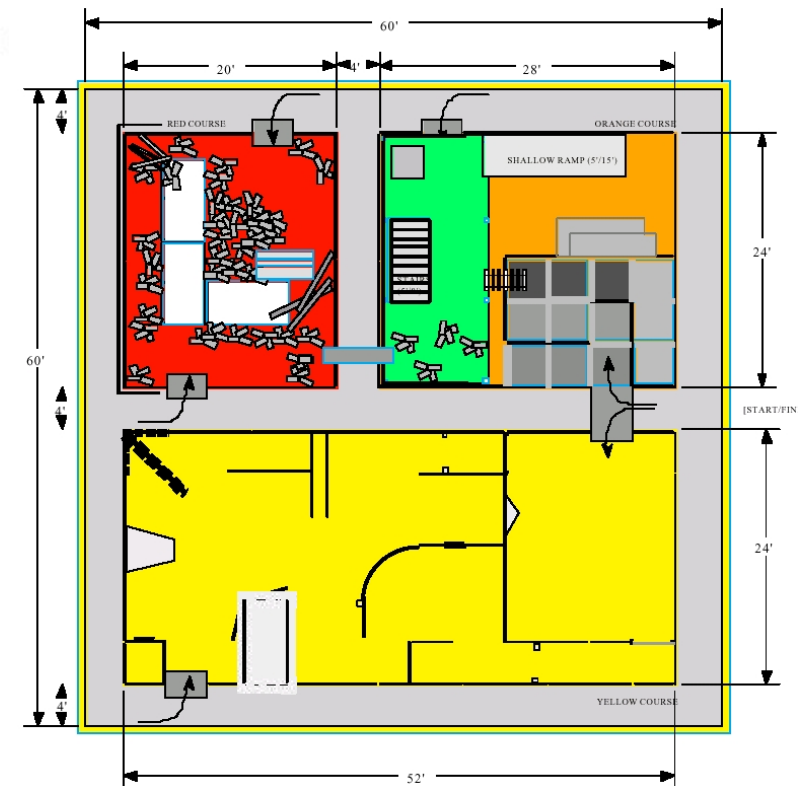
Objective

Demonstrate collaborative human-robot teaming

- Current Testbed: NIST Search & Rescue Test Course
- RoboCup-Rescue and AAI Search & Rescue Competitions

The S&R task fits our broader interest in reconnaissance teams

- Urban recon and target ID
- Building clearing
- Facility security



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Activities

- **Software Development**
 - **Robot Behaviors**
 - **Obstacle Avoidance, Navigation, Mapping, Target Recognition**
 - **Communications**
 - **Data Fusion**
 - **Operator Interface**
 - **Simulator**
- **Sensor Integration**
- **Robot Repairs and Upgrades**
- **Participation in S&R Competitions**

Highlight: Command Interface

The screenshot shows the Robot Command Console (Lo Res) interface. At the top is a toolbar with drawing tools (pen, eraser, rectangle, circle, line, polygon, text, fill color, stroke color, zoom) and map display options (Map Display: Obstacle, Victim, Goal). The main area is the map area, a blue field with a yellow obstacle and a green robot. To the right is the control panel with teleoperation, camera, or autonomous behavior controls, including a dropdown for active robot (Robbie), a stop button, distance and velocity sliders, and a turn angle dial. At the bottom are three robot video windows, each with a dropdown menu and a stop button. The first window shows a closeup of the robot. The second window shows the robot in a hallway. The third window shows the robot in a room. To the right of the video windows is the command history or video closeup panel, which displays a list of commands and their results.

drawing tools

map display options

map area

control panel

teleoperation, camera, or autonomous behavior controls

robot video

robot history

command queue

command history or video closeup

```
commander Robbie teleopTurnRel -7
commander Robbie teleopTurnRel 8
commander Robbie teleopTurnRel 73
commander Robbie teleopDist 547
commander Robbie teleopDist -623
commander Robbie panTo -75
commander Robbie tiltTo 80
commander Robbie panTo 42
commander Robbie tiltTo -34
commander Robbie ptzCenter
commander Robbie goto 13300 14460
commander Robbie goto 16640 13800
```

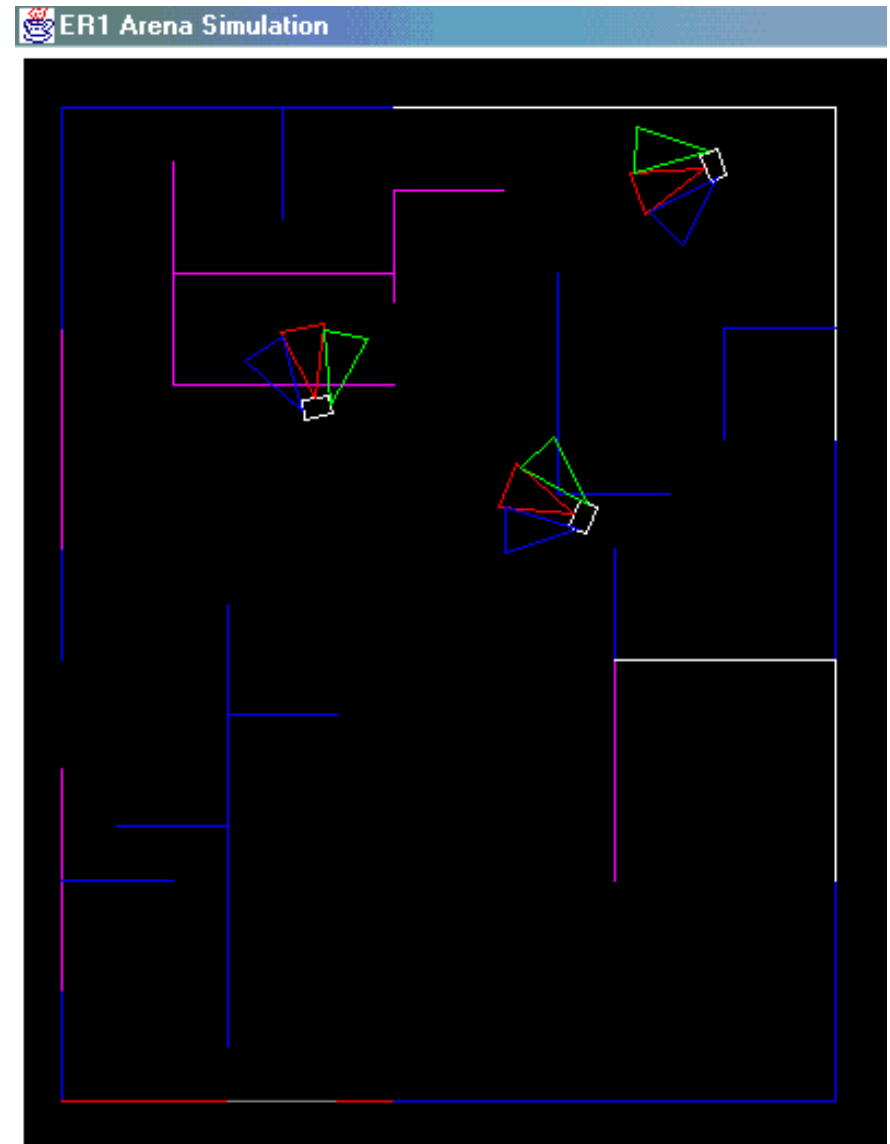
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Highlight:

Physically Realistic Simulator

- Builds on Weatherly/Kuhl project to build a Java simulation framework
- We add
 - Sensors
 - Effectors
 - Behavior-based control



Impacts

- **Extend MITRE's expertise in command and control into the robotics domain**
- **Prepare to meet sponsor needs during the next 10 years**
 - **Future Combat Systems**
 - **Autonomous ground, sea, and air vehicles**
 - **Autonomous teaming and coordination**
 - **Automated reconnaissance**
- **Develop expertise in human-robot interaction**

Future Plans

- Increase robot team size from three (currently) to 10–20
- Revise current interface to support larger team sizes
- Enhance autonomous capabilities so that robots can be effective with 1/10 to 1/20 of the operator's attention
- Integrate smaller, less capable robots with larger, more capable robots
- Explore countermeasures for robotic swarms

