Robotic Technology for USAR

Illah Nourbakhsh
16-899D Lecture Slides
Role of Robotics in USAR

- Lower latency of first entry
  - HAZMAT scheduling, preparation
  - Structural analysis and approval
- Lower very high human risk
  - Increase accessible domain
  - Broaden operating conditions (heat, lack of oxygen)
- Human sensing augmentation
  - Sensing: Infrared imaging, Environmental modeling
  - Force multiplier
Role of Robotics in USAR

- Lower latency of first entry
- Lower human risk
- Human sensing augmentation

*Increase survival chance and outcome for victims, decrease risk exposure and hazards to first responders.*
Barriers to Success

- Effective human-robot interaction
- USAR robot operating system standardization
- Mechatronic robot innovation
- Robot – sensor interfaces
- Systems-level field testing and validation
Barriers to Success

- Effective human-robot interaction
  *Current interfaces: fragile, inefficient and need extensive training*
  - Human factors analysis must be applied to USAR case
  - Iterative interaction design of interfaces
  - This investment has high payoff, imagine 1:6 human:robot

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- Mechatronic robot innovation
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ROBOTS AT GROUND ZERO

Photos courtesy of University of South Florida

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Barriers to Success

- Effective human-robot interaction
- USAR robot operating system standardization
  
  To maximize effectiveness across research efforts, we need standardized integrations of heterogeneous robot platforms.
  
  - Decouple physical robot structure, embedded processing and high-level interaction design
  - USAR O.S. will lower barrier to entry for industry and research partners

- Mechatronic robot innovation
- Robot – sensor interfaces
- Systems-level field testing and validation
Barriers to Success

- Effective human-robot interaction
- USAR robot operating system standardization
- Mechatronic robot innovation
  
  *No single robot design serves all search & rescue needs.*
  
  - Consider USAR robotics as a set of tools dynamically assembled based on real-time demands
  - Robustness and price point: essential to commercial viability

- Robot – sensor interfaces
- Systems-level field testing and validation
Barriers to Success

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  *Retooling existing USAR sensors for robot use.*
  
  - Human-readable sensors must be dual-use
  - Overcome mechanical, electronic and AI obstacles

- Systems-level field testing and validation

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*We must build foundational knowledge rather than individual engineered solutions.*

- Design > Implementation > Testing > Evaluation > Refinement > Dissemination
- Instrumented test facilities, standards and evaluation methodologies are required

Illah Nourbakhsh
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NIST Cooperative Test Facilities
USAR Test Arena Proliferation

FOSTERING COLLABORATION THROUGH STANDARDS

PREVIOUS COMPETITIONS

- AAAI Conference 2000
  AUSTIN, TEXAS, USA
- IJCAI/AAAI Conference 2001
  SEATTLE, WASHINGTON, USA
- RoboCupRescue 2002
  FUKUOKA, JAPAN
- AAAI Conference 2002
  EDMONTON, ALBERTA, CANADA
- American Open 2003
  PENNSYLVANIA, USA
- Japan Open 2003
  NIIGATA, JAPAN
- RoboCupRescue 2003
  PADUA, ITALY
- IJCAI/AAAI Conference 2003
  ACAPULCO, MEXICO

YEAR-ROUND ARENAS

- NIST
  MARYLAND, USA (2000)
- Museum of Emerging Science
  TOKYO, JAPAN (2002)
- Carnegie Mellon University
  PENNSYLVANIA, USA (2003)
- Istituto Superiore Antincendi
  ROME, ITALY (2003)
- University of New Orleans
  LOUISIANA, USA (2004)
- Bremen University
  BREMEN, GERMANY (2004)
- Portugal TBD
  LISBON, PORTUGAL (2004)

2004 COMPETITIONS

- American Open
- German Open
- Japan Open
- RoboCupRescue
  LISBON, PORTUGAL
- AAAI Conference
  CALIFORNIA, USA
Sensor Integration

- USF expertise in first responder sensor needs
- CMU expertise in embedded sensor interfacing electronics and software
- ARC expertise in local reasoning and interpretation
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Mechatronic Robot Innovation

- ARC robot control development
- CMU rapid prototyping facilities

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Simulation and Training

- U. Pitt. / CMU Unreal simulation, chosen for broad dissemination as the NIST standard
- Sensor model characterization: only possible in most realistic possible environments: ARC
- Scorpion EarBot dynamic modeling and neural net – controlled V.O.R. research
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