Robotics: Integrated System Design Fall 2009

Final Project: USAR Updated: Oct. 26th, 2009

Goals

- To design & implement an autonomous search and rescue robot
- To design & implement robot manipulator
- To explore methods of localization.
- To design & implement an algorithm for autonomous navigation

Introduction

An earthquake registering 7.5 on the Richter scale along the New Madrid Fault has caused extensive damage across Missouri, Southern Illinois, and Tennessee. An emergency response team was sent out to search for potential victims in a chemical warehouse near I-255, which has suffered damage in part of its storage facility. It is clear from the rising smoke that a fire has broken out putting some of the flammable chemicals at risk of exploding. Managers at the warehouse have informed the rescue team that at least 3 of their employees are missing and presumed to be trapped in the warehouse. Rescue workers have asked that your Robotic Rescue Team dispatch a robot to help find and possible rescue the trapped employees.

The local rescue workers have provided information about the warehouse that you might find useful for your robot. They have provided a blueprint of the area needed to be searched as well as photos of the facility prior to the earthquake. However, conditions inside are unknown obstacles may be littering the warehouse floor. Your team has been given 15 minutes to search the facility for the employees, move flammable chemicals away from the fire, and possibly transport employees to a helipad to be recused.

Pictures from the 2009 RoboCup Rescue Competition

Team Assignment: Build an Urban Search & Rescue Robot

1. Design & build a robot(s) that can explore an earthquake-damaged building.
2. Your robot will search for victims, each wearing a specific colored uniform, in the warehouse.
3. Upon discovery, your robot should approach the victim as closely as possible and confirm/indicate that the victim has been found; this includes communicating the position of this victim to human operators outside. Have your robot stop, signal a victim is found, display the coordinates, then continue after a button is pushed.
4. Human operators outside will store a grid corresponding to 1 square foot/grid space for each floor tile. The robot should indicate where the victim is on the grid.
5. Your robot should attempt to move victims to the helipad so they can be easily rescured.
6. Like the victims, your robot should also identify canisters of flammable materials and indicate where on the map they are originally placed.
7. Your robot should attempt to move the canisters to a safe zone that the warehouse managers have indicated on the map.
8. Your robot should also identify the room with the fire and communicate this to the Rescue Workers.
9. It is required that the height of your robot not extend above the walls (i.e., virtual ceiling).

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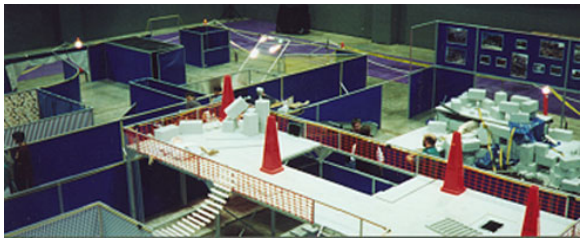


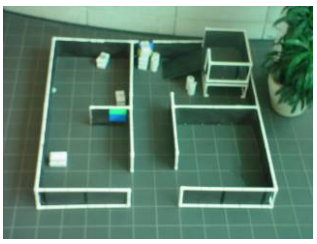
NIST Reference Test Arenas for Autonomous Mobile Robots at the AAAI 2000 in Austin, Texas, USA.

Demonstration

- Each team will have two opportunities to run—one on the December 7th and one on December 9th–with the better of the two counting for the final grade.
- The order of demonstrations will be assigned by lottery.
- Each team will have 10 minutes to conduct the search mission.
- Robots may begin anywhere outside the entrance to the building.
- You may run your robot as many times as you wish during those 10 minutes but only one continuous run will count.
- Two human interventions will be allowed per run that involve repositioning and reorienting the robot; a very limited number of "nudges" are allowed at the discretion of the referee.

The Building

- The building layout will remain fixed; however, the debris field inside may be changed.
- The Rescue Team may use the building layout and any other additional knowledge of the rooms to program a map for the robot to use.



Presentation

- Each team will give a 15 minute, in-class presentation that describes their project. Presentation days are Nov. 30th and Dec. 2nd. Order to be determined by lottery.
- The presentation will consist of no more than six power point slides, and should cover the following aspects of your project: Overall Search Strategy, Mechanical Design, Sensor Suite, and Software Design
- Copies of the slides must be handed in with the project report.

Hand-in

- A lab report describing your team's design including photos of robot components and slides from presentation.
- Team Meeting notes (as described in the General Lab Philosophy)
- A post-mortem write-up that discusses the robot's performance with regard to potential future enhancements. This report should emphasize what went right and what went wrong with the project development, including significant feedback on the effectiveness of the multidisciplinary teamwork, as well as suggestions for how this aspect of the project (and the course) might be improved.
- **Due date**: December 11th.

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Evaluation: 100 points (120 points possible)

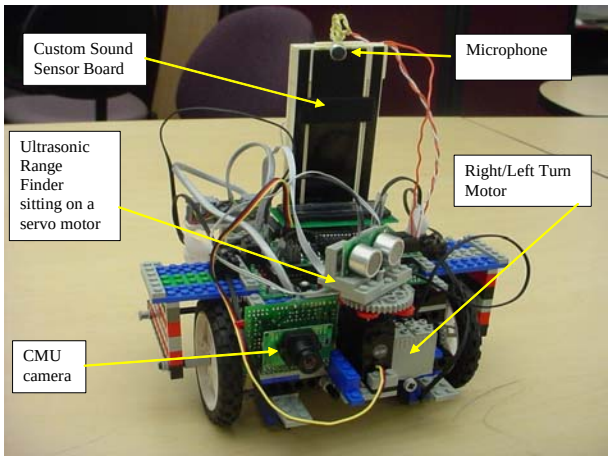
- Identifying a victim: 3 points per victim (9 points possible)
  - A robot's camera must be pointing in the direction of the victim and be approximately one foot away from the victim when it sounds or confirms/indicates the victim is found.
- Indicating a victim on a map within 1 square foot of actual placement: 3 points (9 points possible)
  - False identification of a victim could hamper the human rescue workers' effort or put them at unnecessary risk (this includes pointing in the direction where no victim is or indicating a victim by being further than the one-foot radius): -3 points per false identification over 1-foot.
- Indicating a canister of flammable chemicals on the map within 1 square foot of actual placement: 3 points per canister (12 points possible); - 3 points per false identification over 1-foot.
- Moving a victim to the helipad: 5 points per victim (15 points possible).
- Moving a canister to the safe zone: 5 points per canister (20 points possible).
- Identifying the room with the fire: 5 points.
- Hitting a victim: - 6 points
- Lab Report (1500 word minimum): 20 points
- Post-mortem (600 word minimum): 10 points
- Team Meeting Minutes: 10 points
- Average of peer reviews: 10 points

Extra Credit

- Present a preliminary design and have a design meeting with Scott and Aaron for up to 10 points of extra credit. See separate preliminary design assignment sheet: 10 points.
- Shortest time per points earned: 5 points

Some Resources

- Urban Search and Rescue Competition Website Run by NIST: http://www.isd.mel.nist.gov/projects/USAR/
- Center for Robot Assisted Search and Rescue: http://www.crasar.org/
- Fire-fighting robot: http://www.cooper.edu/~mar/mar.htm
- Using a PID-based Technique For Competitive Odometry and Dead-Reckoning: http://www.seattlerobotics.org/encoder/200108/using_a_pid.html
- CMU Lecture on navigation with additional methods for mapping: http://roboti.cs.siue.edu/classes/integratedsystems/links.html



Robot from 2004 SIUE USAR Competition