Lab 7: USAR – Urban Search and Rescue

Lead TAs:

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Challenge:

Usually, as part of the 16-311 course curriculum, we want teams to have some experience in Urban Search and Rescue. As one of the most well-known universities on the cutting edge of robotics, we create elaborate simulations for USAR in preparations for a possible emergency. However, we've yet to receive a call.

But don't let that change your perspective. This could be the year which everything changes. In preparation for the possible emergency, we've developed the following design requirements and checkpoints.

Teams, we're counting on you to be the heroes this year.

Design Requirements:

Size Restrictions

In order for the robot to be transferred to the disaster zone, the robot **must not exceed** the dimensions below. These dimensions apply to your entire robot, including the vision system.

Width: 7.5"
Depth: 8.5"
Height: 6.0"

The robot may expand past these dimensions once deployed, however conditions might not always permit expansion. Also, your robot may not intentionally jettison any components.

Control Options

All robots shall be **teleoperated** from a remote mission control center consisting of a computer terminal (not provided) and a video monitor (provided). You will be operating your robot via Bluetooth and will not have feedback other than onboard sensor information and/or camera feed. You will be programming this robot in RobotC, and we recommend using the built-in RobotC joystick interface to control your robot.

Various joysticks interface with RobotC (tested):

(1) Logitech F310 Gamepad (recommended & directly interfaces with RobotC)
(2) Xbox 360 Controller
(3) Logitech Extreme 3D Pro Joystick

(4) Logitech Attack 3 Joystick
(4) Keyboard input to control your robot

These peripherals must be found by your team and do not have to be included in your external budget. If you are having trouble finding a controller, ask the TAs.

Sensing

You will be provided with a wireless camera. You should provide your own 9V batteries (not to be included in your budget). Plan on using at least 2-3 batteries throughout the lab. The provided camera must be mounted on your robot, and you must be able to quickly swap cameras.

It is strongly recommended that your robot has onboard lights as lighting conditions may vary. Note that cameras have a very limited field of view; account for this in your design.

Although optional, external non-lego electronics and actuators are permitted as long as they are included in the budget, fit in the size constraints, do not damage the environment, and do not intentionally interfere with other robots.

Additionally, your USAR robot must be able to autonomously deploy (without camera feed) from a random bay inside a “hangar” structure. This process will be very similar to that of lab 6, in that the robot will be placed in a random start location (one of the bays in the hangar) and must use line following, a known map of the hangar, and some method of sensing in order to localize and drive out of the hangar towards the helipad. During this time, your robot will not have a video feed. More details about the layout of the course can be found in the design proposal presentation and in the initial scenario, both released on Piazza.

External Budget

You may use additional parts, within a $50 spending limit of your own money. We are **not** able to reimburse teams. However, any additional parts that you are using **must not** damage the LEGO parts or the NXT brick in any way, or the environment the robot is in. Also they must not interfere with the communications with your robot or other robots during your time in USAR.

You will be responsible for any damages caused by your robot.

Prohibited materials

- Any glue or duct tape (anything that leaves residue) on any materials provided by the class
- Sharp items (glass, blades, spiked treads, drill bits, sawblades)
- Liquids or chemicals (other than sealed batteries)
- Sand or other particulate matter
- Sandpaper and other abrasives

- Any other material that the TAs deem to be damaging to the kits or the course

Performance Expectations

- Ascend and descend stairs of approx 1” rise and 1.5” run
- Ascend and descend ramps of approx 35 degrees
- Drive through narrow hallways and doorways
- Survive a 2’ drop
- Navigate quickly across uneven terrain
- Maneuver over loose rubble
- Capture objects using velcro
- Move loose rubble without using velcro
- Navigate with intermittent camera feed
- Autonomously deploy from a random hangar bay

Evaluation:

Design Proposal: March 15

Your team must submit a design proposal outlining your plans for your USAR robot. You will need to have 3 distinct design candidates. Although we don’t require you to create detailed CAD drawings, you will need to have multiple views of your robot (scanned hand drawings are fine).
The rubric can be found here <insert link>
This evaluation counts as your Homework 8 grade.

Checkpoint: March 22

The rubric can be found here: RUBRIC

In order to pass the check points, your robot must be able to: traverse bumpy terrain, go up/down ramps, go up/down stairs, follow lines, rescue people, survive a drop test, and move quickly.

Not only that, but you must be able to control your robot in tele-operated mode. You will be viewing the robots through a camera and traversing the practice field.
This evaluation counts as your Homework 9 grade.

Demo Day: March 29-30

Mission Briefings: Status unknown. Whereabouts unknown. Contact unknown.
Rescues may occur in typical 3-stage entry. Resources and time are limited, so each stage causes failures and inabilities to deliver all robots. Schedule and evaluation will be announced with mission briefings.
This evaluation counts as your Homework 10 grade.

Advice:

- PRACTICE!!! Driving through a camera is very different than driving when you can see exactly what the robot is doing.
- Be careful with gears! 4 wheel drive is good but can also lock your gears.
- Center of Mass. High center of gravity is bad for climbing. Is the traction on front, center, or rear? Going up the stairs is one issue. Going down is another!
- Try balancing Lego motors, added weights, batteries, etc.
- Protect your camera. Some groups have had video feed issues because they have been too rough with their cameras.
- Camera blind spots – do you need pan or tilt on your camera?
- Visibility. It will be dark, so you'll probably need some way of getting light in.