JHU Robotics Challenge 2015

An engineering competition for students in grades 6 – 12

May 2, 2015
Glass Pavilion
JHU Homewood Campus

Sponsored by:
Johns Hopkins University
Laboratory for Computational Sensing and Robotics
Johns Hopkins Alumni Association
Graduate Representative Organization

Rules version 1.0 (October 9, 2014)

Note for returning participants: Welcome back! There have been some minor changes to the rules for the 2015 edition of the JHU Robotics Challenge. We are exited to see what the competition will bring this year. Good luck building!

Introduction

The purpose of the JHU Robotics Challenge is to complement classroom instruction by providing students with a unique opportunity to enhance classroom skills and knowledge in a fun and competitive environment. This year's competition consists of five separate challenges:

Challenge 1 **Slithering Slalom**
Robots must follow a long, curvy black line on the ground. Obstacles will be placed parallel to the line, which the robot must avoid.

Challenge 2 ***Mystery Maze***
Robots are placed in the Mystery Maze where they must autonomously navigate around corners and multi-way splits in attempts to reach the finish.

Challenge 3 ***Microsurgical Search & Destroy***
Teams of Robotic Eye Surgeons will design and program their robots to find and remove all the "lesions" (cups on large white circles) at various unknown locations in the patient's eye, a 4' x 4' enclosure. Two teams will compete simultaneously to remove the most lesions.

Challenge 4 ***Unleashing the Mad Scientist***
Teams will design an innovative and practical application for their robot beyond the scope of the ideas in the other challenges. They will display a working model of their idea in an oral presentation along with a written report.

Challenge 5 ***So You Think Your Robot Can Dance***
Teams will program an original dance routine for their robot(s). Choreography can include a combination of spins, repeated sequences, and other creative movements.

General Rules

1) Robot programs must be written entirely by the student teams (but may receive input from mentors).
2) Teams may use portions of programs that they have previously written. However, they may not use programs that other people wrote or that were obtained by online resources.
3) Only robots that comply with the "Acceptable Robots" may be used for events 1-3.
4) There may not be more than 3 student members (Grades 6-12) on a team.

Acceptable Robots

This year, there is a specific size limit for each robot competing in Challenges 1-3. This rule supersedes previous restrictions on which robots could be used. For the first three challenges the maximum width and length of the robot is **7.5 inches by 7.5 inches**. Within reason, there is no size limit for challenges 4 and 5.

We are also removing previous restrictions on which sensors can be used. You can now use any sensor compatible with your robot kit.

Suggested robots:
Arduino-based robot: http://www.adafruit.com/blog/2012/03/19/parallax-boebot-robot-for-arduino-kit-video/
Sparki: arcbotics.com/products/sparki/
BoE-Bot: www.parallax.com/product/28832
Other options: www.intorobotics.com/beginner-robotic-kits-arduino-compatible/

We have a set of BoE-bots that can be loaned out for free (with $150 security deposit). If you would like a kit email us at jhurobocomp@gmail.com.

Important Dates

Competition
When: Saturday May 2, 2015
Where: Glass Pavilion, Johns Hopkins Homewood Campus
Registration: https://www.lcsr.jhu.edu/Education/CISSRS/JHRC2015

Training Event
When: Saturday January 24, 2015
Where: Hackerman Hall room B17, Johns Hopkins Homewood Campus
This year we have decided to offer a whole day robotics workshop for teachers, parents and students. The morning session will be focused on the regular BOE-Bot and the afternoon session on the Arduino-based BOE-Bot. You can attend one or both!

In each session, we will talk about how to assemble the robot, how to program frequently used commands to read sensor inputs and to drive the motors. You are also welcome to bring your robots and program them with graduate students in robotics. We can help you debug code and offer some general programming advice. If you are interested in attending this workshop, please **register** on our website:

https://www.lcsr.jhu.edu/Education/CISSRS/JHRC2015

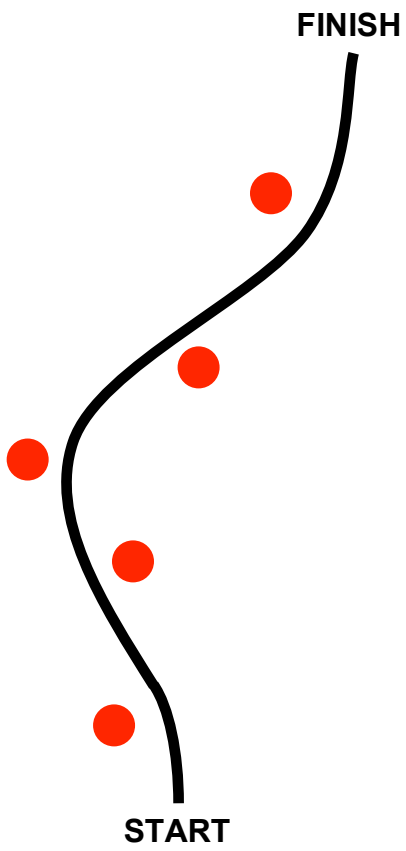
CHALLENGE 1
Slithering Slalom

For this competition, there are two separate courses (one "easy" and one "hard"). The design on each course will not be available beforehand but a representation of a possible course is displayed below. Each course consists of a ¾" thick black line (black electrical tape) which contestants must follow from beginning to end. Alongside the course will be randomly placed Solo cups. Cups will be placed along the course ½" away from the centerline plus half the robot's width. For this competition the contestants will receive **2** scored runs. For each run, the contestant can choose to use either the "easy" or "hard" course. The "easy" course will contain 5 Solo cups and the "hard" course will contain 8 Solo cups. The hard course may have additional difficulties such as sharp turns. For a contestant to complete the run, their robot must remain on the line for the entirety of the course. Note that a variation of the "easy" course will be available for practicing at the event.

Scoring for the competition will be determined as follows:

- Complete the "easy" course – **6 points**
- Complete the "hard" course – **12 points**
- Hit an obstacle (Solo cup) – **(-1 point)**
- Failing to complete the course – (**1 point/ every obstacle passed while still on the line**)

In the event of a tie score, the contestant will repeat the "easy" course without an obstacles and the robot that completes the course the fastest will win.

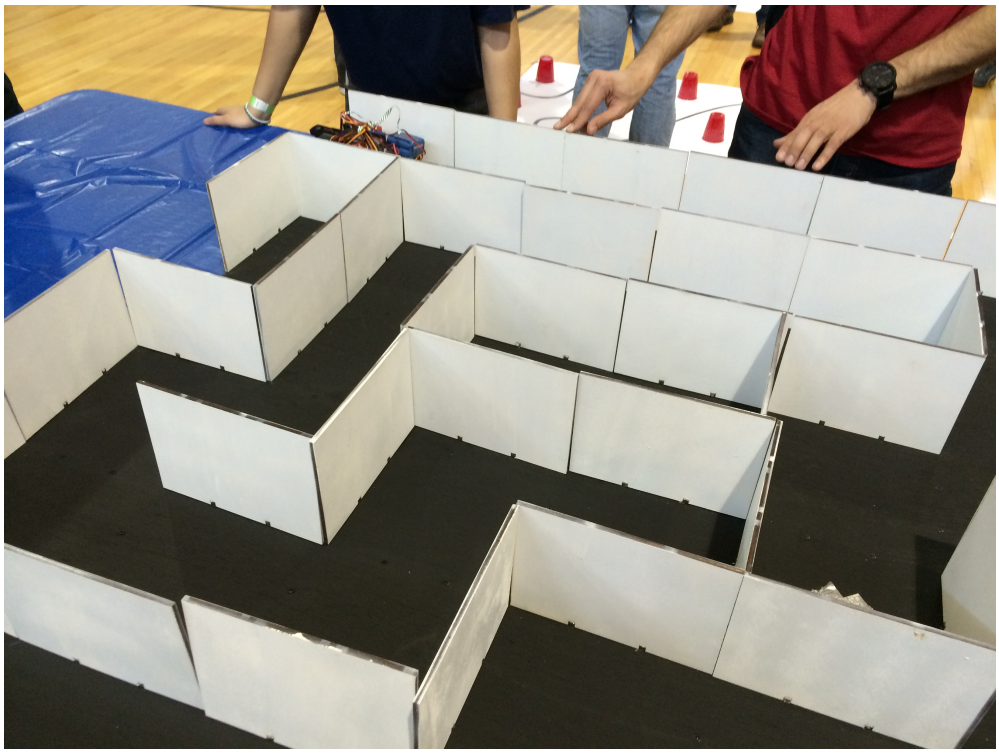


CHALLENGE 2
Mystery Maze

In this challenge, robots must autonomously navigate a maze filled with winding corridors and paths that split off in multiple directions. The layout of this maze will vary throughout the day in increasingly difficult rounds. Passageways will be a minimum of 8 inches and walls will reach at least 6 inches tall. Each turn will be constructed at 90-degree angles. The board will be split up into a grid of equal sized (8" x 8") squares. The walls in the area will be white.

The robots will then be tested on increasingly difficult stages of the course. Only teams that complete the first stage will progress on to subsequent rounds. Teams get up to two attempts per round. Teams will be ranked by the highest stage of the course completed, then by the time required on that stage. First, second, and third place awards will be given.

The 2014 challenge will be more similar to a typical "micro mouse" competition. One key difference is that our arena will be rectangular instead of square.



Example course from the 2014 competition. There will be slight changes to the course but the design will be very similar.

CHALLENGE 3
Microsurgical Search and Destroy Tournament

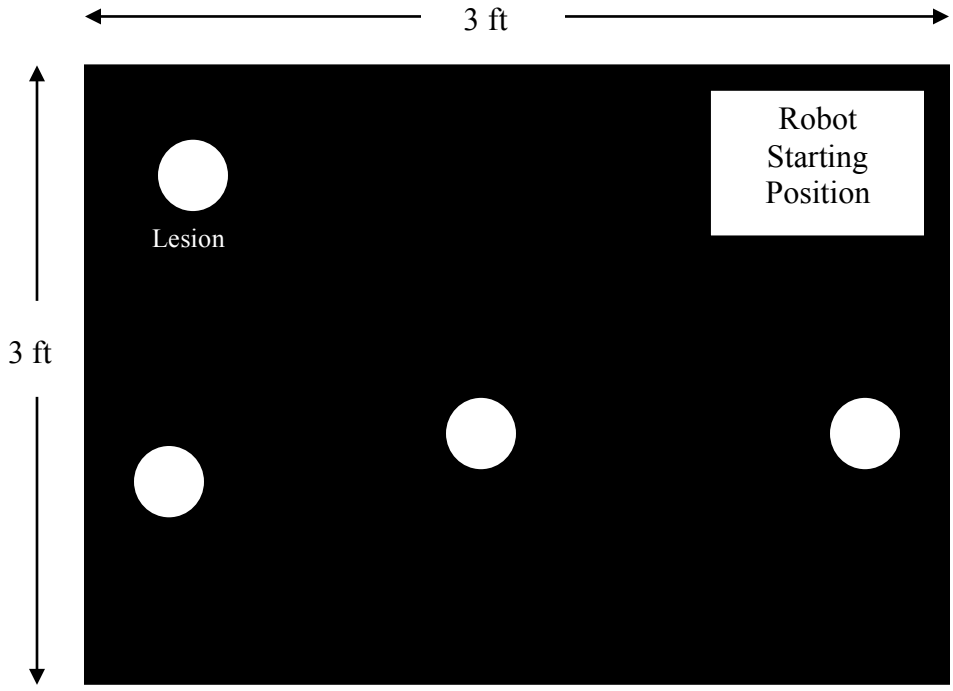
Teams of Robotic Eye Surgeons will design and program their robots to find and remove "lesions" at various unknown locations in the patient's eye. The arena is a 3 foot x 3 foot enclosure with a black surface that has black 4 inch tall walls. The base and walls of the brain are black. Lesions will be represented by will be represented by 2 inch radius **white** circles. The robot will be placed in a random point inside the eye and should be able to detect the corners and sides of the enclosure and to search the entire eye for lesions on its own. Each lesion can only be removed once before it is considered out of play.

The robot will be placed at a randomly picked corner of the brain and several lesions will be placed at various locations in the brain (see figure 2). There will be four lesions in total. The robot should be able to turn whenever it encounters a wall or corner and search the entire enclosure. If a lesion is detected, the robot should signal its presence to the judges. For example, an LED can be flashed or a buzzer sounded. The signal that the team wishes to use must be announced to the judges prior to the competition starting.

When the robot determines that it has finished searching the entire area, it should send a different signal to the judges. For example, the LED can be flashed several times, or the buzzer sounded for longer or a completely different signal used. The robot does not have to end where it began its search. The round is over after **120 seconds**.

The following system will be used to score each entry:
- 25 points for tumors detected within the first 30 seconds.
- 20 points for tumors detected within the next 30 seconds.
- 15 points for tumors detected within the next 30 seconds.
- 10 points for tumors detected within the next 30 seconds.

100 possible points for lesion detection, 100 possible points for style, efficiency and robustness of detection (judge's discretion).



CHALLENGE 4
Unleashing the Mad Scientist (Innovative Use)

This challenge is to design an innovative application for your robot. In addition to the robot kits, additional items may be used. Teams selecting this challenge will present their idea in an oral report and submit a written report. Teams will also demonstrate a working model of their proposal.

Scoring

Product Idea 20 points

Teams will identify a need and develop a solution for that need. Your idea will be scored based on the innovation and practicality of that idea. Teams are encouraged to sufficiently motivate the need for their solution by researching relevant problems and choosing one best addressed with their robot kit.

Product Prototype 30 points

Teams should be prepared to demonstrate their proposal with a working model or prototype. The prototype will be judged on quality of construction, efficiency of operation, reliability, and achievement of design specifications.

Product Oral Report 20 points

Each team will be given up to 10 minutes to make a presentation to the judges and to answer questions. The presentation should cover the design and development of the idea and the scientific principles behind the design. Students are encouraged to present the technical aspects of their project including program code and flow charts. Teams will be judged on their content and presentations. Presentation skills include poise, speaking ability and use of visuals. Students may bring a laptop with a PowerPoint presentation, make a poster, or provide any other documentation. If working on a team, students should describe how they each contributed to the project.

Product Written Report 30 points

Teams must submit a printed written report to compete in this event; teams without a report will receive zero points for this section. The report should include the following items:

Written Report Outline

Title page. Include: (1) name of the challenge, (2) team name and logo, (3) name of school, (4) names of student team members, (5) names of teachers assisting.

Table of Contents. List each section and the page on which it first appears.

Summary (abstract). Give a concise summary of the project.

Body. The body is the main part of the report and can be divided into several sections. Your report should include documentation of the following:

What is the problem that you are trying to solve?
What are the scientific principles behind your design?
Drawings (with titles and labels) and design calculations.
What experiments were conducted and what improvements did you make after testing?
What problems were encountered while building your design?
What were your solutions to those problems?

Conclusions. Describe how successful your project was and what you learned during the project. How can your idea be applied to future projects?

Acknowledgements. List the names of the adults who assisted you in the project with a brief description of what they did. Include a certification, signed by all student team members and adults assisting, stating that:

"We hereby certify that the majority of the ideas, design and work was originated and performed by the students, with limited assistance by adults, as described above."

Bibliography. List all references used including webpages, books or periodicals.

Appendix A. Team Members. Briefly describe how each person contributed to the project.

Appendix B. Project Timeline

Appendix C. Bill of Materials. Provide a list of all materials with costs and how they were obtained. For donated materials, please estimate the cost.

Appendix D. Flow Chart, Drawings and Code. Include program code, a flow chart of the program and any drawings not included in the body of the report.

CHALLENGE 5
So You Think Your Robot Can Dance

Teams will program an original dance routine for their robot. Choreography can include a combination of spins, repeated sequences, and other creative movements. Students are permitted to use any additional components (motors, sensors, etc.) and any robot kit. Multiple robots are also allowed in the dance. Scoring will be based on the robot's performance and the creativity of the dance routine. The robot's dance will be limited to one minute. Here are some examples of actions to include in the dance routine:

- Have your robot sing as it dances
- Add moving arms to your robot
- Have two robots dance together

Be creative and have fun!

The top three routines will be decided by a panel of judges and will be displayed during the awards ceremony. The winner will be chosen by audience choice.