JHU Robo Challenge

An engineering competition for middle and high school students

JHU Homewood Campus
April 30th, 2016

Rules version 1.1 (March 25th, 2016)

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

Introduction

The purpose of the JHU Robo Challenge is to complement classroom instruction by providing students with an opportunity to enhance classroom skills and knowledge in a fun and competitive environment. This competition consists of four 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 past dead-ends in attempts to reach the finish.

Challenge 3 ***Shark Tank***
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.

Challenge 4 ***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.

There will be awards for each challenge as well as for the best code. For more details see the end of this document.

We are excited to see what the competition will bring this year. Good luck!

Note for returning participants: Welcome back! There have been some major changes to the rules for the 2016 edition of the JHU Robo Challenge. Namely:

- Challenges:
  - Search and Destroy has been removed.
  - Slithering Slalom has been updated.
  - Mystery Maze will use a new board and has updated scoring.
  - Shark Tank has replaced the Mad Scientist event.
- We have a parts list for each event for teams can practice at home.
- The award structure has been updated.

All changes from last year are colored in red.

General Rules

1) There can be a maximum of **3 middle/high school students per team**
2) Only robots that comply with the "Acceptable Robots" may be used for the Slithering Slalom and Mystery Maze.
3) Robot programs must be written entirely by the student teams (but may receive input from mentors). **Teams may not use code that other people wrote or that was obtained directly by online resources**. Using pre-made navigation libraries (e.g. line following) is prohibited. Note you may use basic functionality like the "Servo" library for the Arduino. If you have a question about whether or not you can use previous code please send us an email.

Acceptable Robots

This year, there is a specific size limit for each robot competing in the Slithering Slalom and Mystery Maze but not for the Shark Tank or Dance. For these 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 the other challenges. For most challenges the speed of the robot will be a factor in the score.

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/beginn/*er-robotic-kits-arduino-compatible/

We have a set of BoE-bots and Arduino-bots that can be loaned out for free (with $150 security deposit). To get a kit email us at: jhu.robo.comp@gmail.com.

We also have a small fund for helping teams buy additional sensors or robot parts. For example if you need new sensors or actuators we can buy them and let you borrow them for the competition season. If you are interested please contact us at jhu.robo.comp@gmail.com

Important Dates

Please register for each event at https://robochallenge.lcsr.jhu.edu

Competition
When: April 30th, 2016
Where: Glass Pavilion, Johns Hopkins Homewood Campus

Introductory Training Session
When: February 6th, 2016 (1pm-5pm)
Where: Hackerman Hall room B17, Johns Hopkins Homewood Campus
We will have one session that introduces students/teachers/parents to the BoE-bot and Arduino-bot. We will discuss how to assemble the robot, basic electronics, and how to program it using various sensors and motors. You should bring your robot and a laptop to program it.

Advanced Training Session / Help Session
When: March 19th, 2016 (1pm-5pm)
Where: Hackerman Hall room B17, Johns Hopkins Homewood Campus
We will introduce selected advanced topics for programming the robots. The programming components of this session should be relevant regardless of which robot platform you are using (e.g. BoE-Bot, Lego NXT, etc.). In additional graduate students in robotics will be available to answer any questions and debug code.

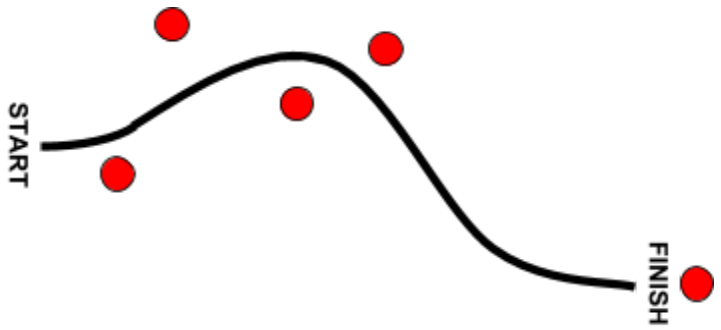
CHALLENGE 1
Slithering Slalom

Contestants must follow the ¾" thick black line from beginning to end as shown in the figure below. There are three courses ("easy", "medium", and "hard"). The design on each course will not be available beforehand. Colored Solo cups will be placed alongside the course. Cups will be placed at a minimum of 4" away from the center of the black line. For this competition the contestants will receive **2** scored runs. For each run, the contestant will choose which of the three courses they want to participate on. The "easy" course will contain 5 Solo cups, the medium course will contain 7 Solo Cups, and the "hard" course will contain 9 Solo cups. The medium and hard courses may have additional difficulties such as sharp turns, and crossing lines. The "hard" course may contain dotted lines and a color inversion where the robot must follow a white line on a black background. For a contestant to complete the run, their robot must remain on the line for the entirety of the course. 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 "medium" course – **9 points**
- Complete the "hard" course – **12 points**
- Hit an obstacle (Solo cup) – **(-1 point)**
- Failing to complete – (**1 point per obstacle passed while still on the line**)

In the event of a tie score, the contestant will repeat the "easy" course without any obstacles and the robot that completes the course the "fastest" will win. To prevent robots with faster motors from having an advantage, the total time will be scaled based on how long it takes for the robot to traverse a short, straight black line.

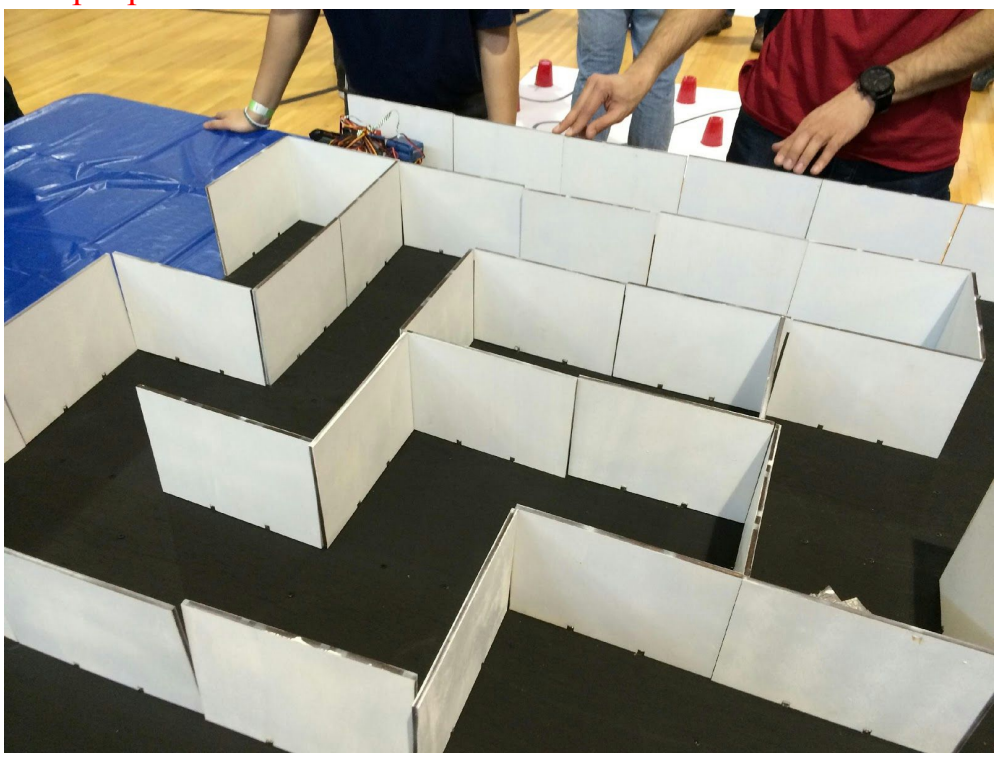


CHALLENGE 2
Mystery Maze

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 apart and walls will reach at least 6 inches tall. The walls in the area will be white and the ground will be black.

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.

In the first round the board will be split up into a grid of equal sized (8" x 8") squares, and each turn will be constructed at a 90-degree angle, and there will be a single path from start to finish. However, in subsequent rounds some walls may be placed at an angle, the distance between walls may vary, and there may be dead ends or multiple paths to the finish.



Example course from the 2014 competition. Note that the course will look different this year but will conceptually be the same.

CHALLENGE 3
Shark Tank

Shark Tank is an open-ended challenge where each team must design and prototype an innovative application for their robot. Some previous examples include creating a miniature prototype prosthetic arm using Lego Mindstorms, an autonomous goalie for a soccer game, and a robot that can draw letters. Each team should demonstrate a working model to a group of judges who will ask questions regarding design, implementation, and the target application.

Scoring

Idea 35 points

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

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.

Oral Presentation 35 points

Each team has up to 10 minutes to present to the judges and answer questions. The presentation should cover the design, development, and scientific principles behind the design. Students are encouraged to present the technical aspects of their project including program code and flowcharts. Teams will be judged on their content and presentations. Students may bring a laptop with a PowerPoint presentation, make a poster, or provide any other documentation.

This challenge is similar to what used to be called Mad Scientist of Innovative Use. Note that teams no longer have to submit a written report.

CHALLENGE 4
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 two minutes. 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.

AWARDS

Challenge awards: Each challenge will have a 1st, 2nd, and 3rd place. The first place team for each will receive a prize (e.g. $25 gift card)

Code awards: We will inspect the code used for each team for the Slalom and Maze events. The code will be scored based on factors like style, complexity, and efficiency as indicated in the code-style rubric. This encourages teams to write their own code as opposed to leveraging pre-made code. A prize will be given out for the best scoring code in these two challenges.

Overall award: There will be an overall winner based on the total number of points that team obtained over all challenges. The score for each event will be normalized so that each challenge is worth the same amount of points.

$$\text{Score} = (\text{Slalom} + \text{Maze} + \text{Shark Tank} + \text{Dance} + \text{Code}) / 5$$

If a team does not participate in a challenge they receive a score of zero. We do not expect that many teams will participate in all 4 challenges.

Note: all prizes will go to the teacher/parents. They may distribute the winnings how they see fit (e.g. to give them to the students or buy more classroom sensors)