Robotic Systems Challenge 2013

An engineering challenge for students in grades 6 – 12

April 27, 2013
Charles Commons Conference Center
JHU Homewood Campus

Sponsored by:

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

Introduction

The purpose of the Robotic Systems Challenge is to complement classroom instruction by providing students with a unique opportunity to apply classroom skills and knowledge in a fun and competitive environment. This year's robotic systems challenge consists of four separate challenges. A short description of each is provided.

Challenge 1 ***Petite Slalom***

Rules of challenge 1 updated!

The Petite Slalom is a course in which competitors robots travel from the starting gate to the finish line while traveling through "gates." The gates are selected from pre-determined points on the rough side of a 3' x 6' section of tempered hardboard. Teams will be able to practice on practice tracks they can construct from provided directions. When they arrive at the competition they will be told which gates they must pass through to get points. The most successful robots will traverse the course correctly and be the fastest to accomplish the route. Since all the points where gates can possibly be placed will be known in advance, teams will be able to program their robot to run segments of the course in preparation. They will then have to join these segments together at the competition to run through the correct gates. There are two categories of this slalom. Category 1 uses the Parallax Boebot and Category 2 is any other robot.

Challenge 2 ***Mystery Course***

Teams will arrive at the competition with no knowledge of what the course will be. The course will be some type of blind course that requires robotic sensors to maneuver. They must come to the challenge equipped with a complete Boebot and the knowledge required to effectively use the sensors provided in the kit. Teams will be given 90 minutes to assemble the sensors on the robot and program the robot. The course will not be available to the competitors during the programming and assembly phase. The students will place their robot in line when they feel they have programmed it successfully. All robots will be tested on progressively more difficult mazes, and will be ranked by time, with the fastest time on the most difficult stage being the winner.

Challenge 3 ***Innovative Use of the Board of Education***

Teams will design an innovative and practical new use for the Basic Stamp Board of Education. They will display a working model of their idea in an oral presentation along with a written report. Teams will be judged on quality of the idea, operation of the prototype, the oral report and the written report. This challenge is designed to be the result of innovation and robotic exploration and is considered the premiere challenge of the day's event.

Challenge 4 ***Search & Destroy (Robotic Brain Tumor Surgery)***

Rules of challenge 4 updated!

Teams of Robotic Brain Tumor Surgeons will design and program their Boebots to find all the "tumors" (large white circles) at various unknown locations in the patient's brain, a 3' x 3' enclosure. The BoeBot will be placed in a random point inside the brain and should be able to detect the corners and sides of the enclosure and to search the entire brain for tumors on its own. When a tumor is found, the robot must signal to the surgeons(possiblty a buzzer or LED). The robot should stop once the entire brain has been searched. Teams will be judged on their robot's ability to find all the tumors, time to complete the search, and efficiency. Bonus points will be awarded for creative signals!

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 other components (motors, sensors, etc.) not included in the Boebot kit. Multiple robots are also allowed to be used in the dance. Scoring will be based on the robot's performance and the creativity of the dance routine.

CHALLENGE 1
Petite Slalom

In the Petite Slalom competitors will program their robot to travel through a slalom course set up on the rough side of a 3' x 6' sheet of tempered hardboard. Robots are programmed to run a designated path through a series of gates.

There are two categories for this competition. In the Boebot category (**Category 1**), only Boebots can be used. The Boebot must be powered only by 4 AA batteries. Information about the Boebot can be found at www.parallax.com. In the open category (**Category 2**) any programmable robot can be used. For example the small robot, available at www.smallrobot.com can be used with a TI83 calculator or a LEGO Mindstorm robot could be used. These robot types are all easily available and can be built and programmed in a relatively short period of time.

Rules

The track consists of a 3 foot by 6 foot piece of tempered hardboard, as shown in figure 1. Robots will run on the rough side of the track. The track is unadorned with sides and the spacing dots are done with a marker. No paint or tape is used, to ensure that the surface provides consistent traction.

Practice tracks can (and should) be produced at your school based on the measurements shown in figure 1. Teams should remember that minor differences in track material and construction are not justifiable cause to argue the outcome of a competition.

Each category will have its own track and the setup of the track may vary between the categories.

A gate consists of a pair of 18 ounce party cups to be used as gate markers. The cups will be placed upside down centered on the dots on the track; the dots are 12 inches apart. One cup will be blue or plain colored and marked with an "L". The other cup will be red or a plain colored and marked with an "R".

Robots must pass forward through the gate with the blue cup on the robot's own left and the red cup on the robot's own right.

One special (optional) gate may be used at the judge's discretion that is considered a reverse gate. The robot must pass through this gate backwards. This gate will be marked with a blue cup with a horizontal strip of masking tape (or a plain cup marked LB) and a red cup with a horizontal strip of masking tape (or a plain cup marked RB). The robot must pass backwards through this gate with blue striped cup on the robot's own left and the red striped cup on the robot's own right.

Dots in the drawing (figure 1) indicate possible positions for gate markers. The dots are centered 12 inches apart. The lower left dot in the figure is at (x,y) coordinate (6 inches, 1 foot). The upper right dot is at (x,y) coordinate (2 ½ feet, 5 feet).

The location of the starting line is shown in figure 1. The robot may start with the axle of the drive wheels on the starting line to achieve a consistent start. The starting line is not a gate.

At the beginning of each round, the judges for each category will choose the location the finish line and up to four gates on the track. The arrangement of gates and finish line will then be revealed to the contestants. The finish line will be 1 foot wide and positioned at one of the four locations abutting the edge of the track. These positions are marked as A,B,C, and D on figure 1.

All teams will begin to program their robots to travel the course. Predetermined sections of code can be used in both categories.

When a team completes their programming they will place their robot into the line (queue). A small bonus score will be given to the first 3 robots in line. Any robot removed from the line must be placed at the end of the line when returning. After 15 minutes for programming, the competition will begin. If any team is not in line when the competition starts, they may continue programming for an additional 15 minutes. After a total of 30 minutes for programming, no more robots will be allowed in line.

After one run the robot may be placed back in line for a second attempt. No changes to programming will be allowed between attempts.

Scoring

Scoring will be based on time. The team with the shortest time including bonuses (deductions) and penalties (additions) will be declared the winner. The time will be the time required to travel from the starting line to the finish line. Time starts on first movement of the robot and ends when the finish line is touched. A maximum of 40.0 seconds will be recorded. After 60.0 seconds, a robot will be removed from the board. Deductions for correct movement and placement in line will be made as follows:

The first 3 robots in line will get a 1 second point bonus (deduction) from their time.

5 seconds will be deducted at each gate if the robot passes through the gate in the right direction without touching a gate marker (cup).

3 seconds will be deducted at each gate the robot passes completely through in the correct direction but touches a gate marker. In this case the gate marker moves but the robot stays between the dots without touching the dots.

1 second will be deducted for each gate the robot partially passes through or the robot passes through in the wrong direction. In this case some of the robot but not the entire robot passes through the gate or the robot goes in the wrong direction.

5 seconds will be deducted for touching the finish line.

There will be a 10 second penalty (addition) for passing through a gate out of order. This penalty is incurred when a robot passes through a gate or touches the finish line without passing through the previous gate. This penalty may not be used to make the time exceed 40.0 seconds for any round.

Each round ends when robots have had at the most two opportunities to run, or as directed by the judge.

The team with the shortest time including deductions and penalties (additions) will be declared the winner.

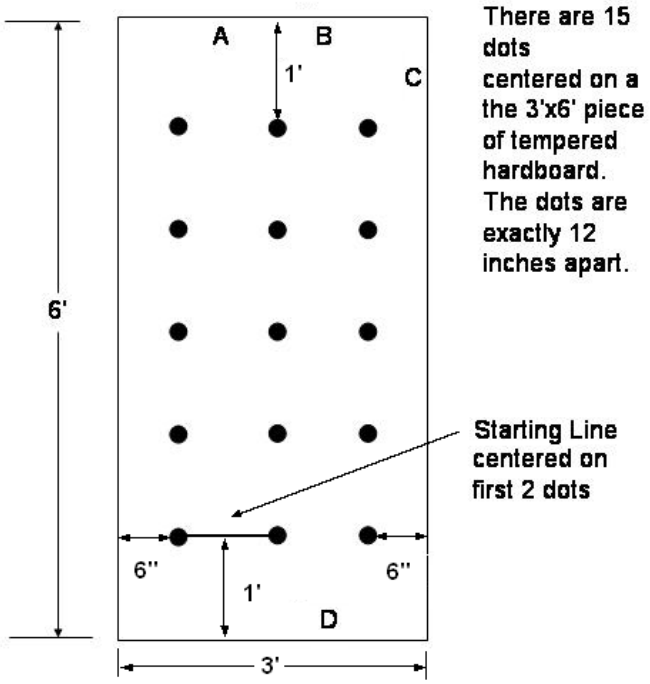

Figure 1 Petite Slalom

Scoring Sheet

Team: _____

Points	**Trial 1**	**Trial 2**
First 3 positions in line: **– 1 point**		
Each gate the robot passes through in the correct direction without touching a gate marker: **– 5 points**		
Each gate the robot passes through in the correct direction but touches a gate marker: **– 3 points**		
Each gate the robot partially passes through (in correct or wrong direction): **– 1 point**		
Robot touches the finish line: **– 5 points**		
Each gate the robot skips or passes out of order: **+ 10 points**		
Total time (seconds):		
Final Score		

CHALLENGE 2
Mystery Course

Teams are encouraged to practice with the sensors available in the Boebot kit prior to arrival at this competition. The stages of the mystery course will be explained upon arrival at the challenge and teams will have 90 minutes to select the appropriate sensor and program their robot. Only after the programming period will the course be revealed. Teams will not be allowed to reprogram their robots after the course is unveiled. The robots will then be tested on increasingly difficult stages of the course. Only those teams that complete the first stage will progress on to the second, and so on. Teams will be ranked by the highest stage of the course completed, then by the time required on that stage.

Teams must arrive at this competition with a good working knowledge of how to program the Boebot and its sensors.

Rules

Teams are restricted to use only the sensors available in the Boebot kit, no other sensors may be used.

Robots must be powered by 4 AA batteries only.

Teams must provide their own computing devices; none will be available for loan. Teams must insure any computer they bring has the proper programming environment.

Teams may not be assisted in programming by any person other than a team member.

Teams may use portions of programs they have previously written.

Many details of the course will be provided at the beginning of the programming period. There will be no other communication between the judges and the competitors except for minor clarification of the details provided. Those clarifications will immediately be made available to all teams participating.

No more than two attempts to maneuver each stage of the course will be made by any team.

Competition will progress in stages of increasing difficulty. The winner will be determined by timing. The team to complete the highest difficulty stage in the shortest time will be declared the winner. There will be a second and third place trophy awarded as well.

The course will be constructed such that all walls are at least 6” high and all passages through which the robots must travel are at least 8” wide.

CHALLENGE 3
Unleashing the Mad Scientist
Innovative Use of the Board of Education

The Board of Education is a parallax product that interfaces a basic stamp processor and can be easily programmed in basic programming language. The board of education is the same logic board that is used on the Boebot robot. This challenge is to design an innovative and practical new application for the basic stamp board of education. The final prototype may use other components from the Boebot kit, but that is not necessary. Teams selecting this challenge will present their idea in an oral report and submit a written report. Teams will also demonstrate a working model their proposal.

Standards

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 significant problems and choosing one best addressed with the Board of Education. The teams are responsible to present their idea in a way that enhances the usefulness, innovation, uniqueness, and need of that idea.

Product Prototype 30 points

Teams should be prepared to demonstrate their proposal with an actual working model (prototype). Teams can show video during their presentation but a working model must be displayed. 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 content (knowledge of the project, organization of the presentation, and completeness of the information) and presentation (poise, speaking ability and visuals). Students may bring a laptop with a PowerPoint presentation.

The three teams with the best score will be asked to present their product during the awards ceremony.

Product Written Report 30 points

Teams must submit a printed written report to compete in this event; teams without a report will be disqualified. The report should include the following items:

Title page. Include the name of the challenge, team name and logo, name of school, names of student team members, names of teachers assisting.

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

Summary (abstract). Must be less than 1 page in length and clearly summarize the project.

Body. The body is the main part of the report and can be divided into several sections. The information that should be included in the body is listed.

An explanation of the reasons behind your design.
An explanation of the scientific principles behind your design.
Drawings (with titles and labels) and design calculations.
An explanation of design testing, and any improvements made after testing.
A description of problems encountered in building your product and your solutions to those problems.

Conclusions. Describe how successful your project was and what did you learn by doing this 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 internet, books and periodicals.

Appendix A. Team Members. List the team members with a short description of how each person contributed to the project.

Appendix B. Scheduling and Accomplishments. Show on a timeline or similar method how you scheduled your project. Include brief records of meetings and work sessions telling how the schedule was managed.

Appendix C. Material Resources. Provide a list of all materials used the cost of the material and how they were obtained. Please provide an estimate of the cost of donated material.

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

CHALLENGE 4
Search and Destroy
Robotic Brain Tumor Surgery

Teams of Robotic Brain Tumor Surgeons will design and program their Boebots to find all the "tumors" (large **white** circles) at various unknown locations in the patient's brain, a 3' x 3' enclosure. The BoeBot will be placed in a random point inside the brain and should be able to detect the corners and sides of the enclosure and to search the entire brain for tumors on its own. When a tumor is found, the robot must signal to the surgeons (possibly a buzzer or LED). The robot should stop once the entire brain has been searched. Teams will be judged on their robot's ability to find all the tumors, time to complete the search, and efficiency. Bonus points will be awarded for creative signals!

Rules

The brain (enclosure) consists of a 3 feet x 3 feet black poster board base with surrounding **black** poster board walls that are 4 inches tall and painted with matt black paint (non-reflective). The base and walls of the brain are black. Tumors will be represented by 2 inch radius **white** circles.

The robot will be placed at a randomly picked corner of the brain and several tumors will be placed at various locations in the brain (see figure 2). There will be four tumors. The robot should be able to turn whenever it encounters a wall or corner and search the entire enclosure. If a tumor 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.

Scoring

The following system will be used to score each entry:

- There are four tumors.
- 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.
- Round is over after 120 seconds.

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

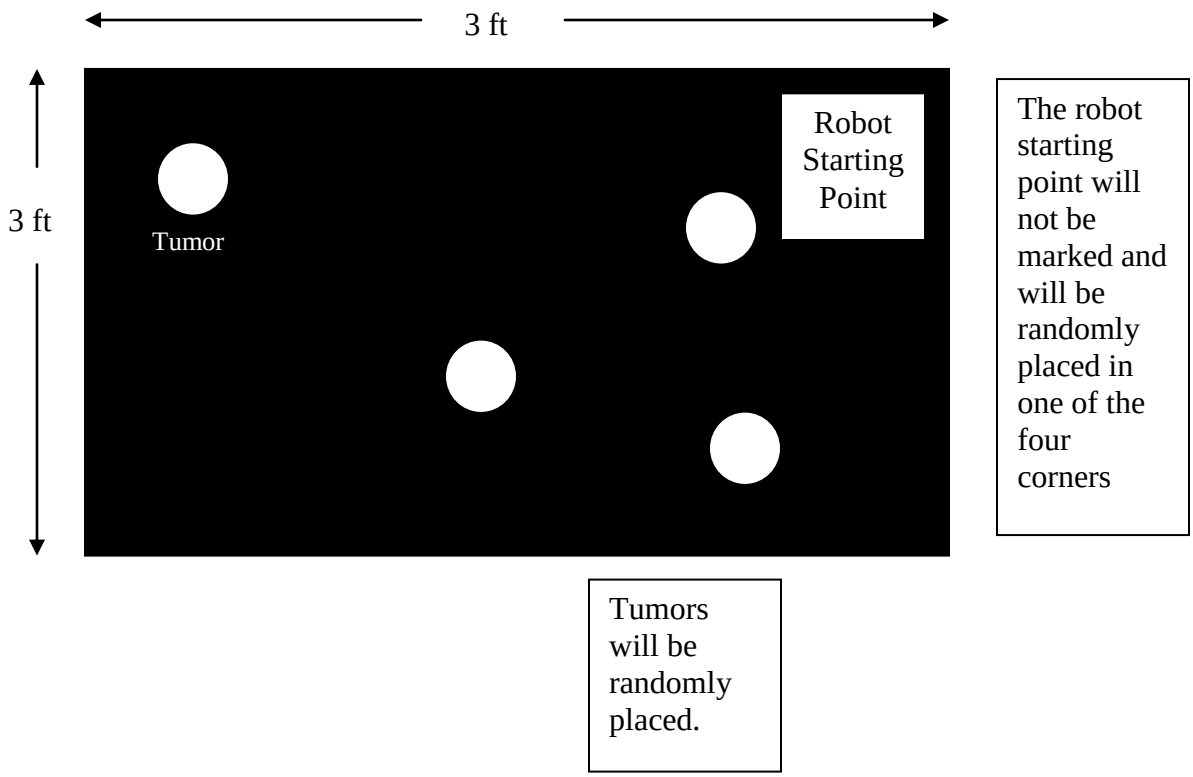

Figure 2 Search and Destroy Brain Layout

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 any additional components (motors, sensors, etc.) and any robot kit. Multiple robots are also allowed to be used 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!