ION Mini-Urban Challenge 2010 Rulebook

Revision 2010.1.3

Sponsored by:

1. General Overview

The Institute of Navigation (ION) announces the 2nd Annual Mini-Urban Challenge sponsored by ION and the Air Force Research Laboratory (AFRL).

The purpose of this competition is to design and operate a "car" using a LEGO Mindstorms kit to successfully navigate through the Mini-Urban Challenge.

Regional Competition locations and dates will be posted on the competition website.

The National Competition will be held June 3-5, 2010 in Dayton, OH. The National Competition will coincide with the 7th Annual ION Robotic Lawn Mower Competition at Siebenthaler's Beaver Valley Garden Center in Beavercreek, OH. Teams competing in the National Competition will view the Lawn Mower Competition on June 5, 2010.

At both the Regional and National Competitions teams will be scored in a variety of categories and the winning team will be selected based on the highest total score. Scoring details are provided in later sections. The top two teams at each Regional Competition will be invited to compete at the National Competition. Awards will be presented to the top two teams at the National Competition.

1.1 General Team Rules

1. Teams may only be comprised of high school students (defined as students enrolled in grades 9-12, and not over the age of 18 as of the date on the team application). Teams are limited to no more than 10 students, though smaller teams are encouraged. The competition will provide travel grants and prizes for up to 5 students per team. Additional students may participate and attend the competition at their own expense.
2. Each team must be supervised by at least one adult (over 18yrs of age) teacher. Only the student component of each team will be eligible for awards. The teacher supervisor will certify that all team members are students of appropriate grade level on the application form.
3. Team mentors are encouraged. Competition staff will work to pair mentors with teams. Mentors may be engineers working in the local area or engineering students attending schools in the local area. Mentors are encouraged to meet with the students and help them with their project. The mentor's role should be limited to guiding problem solving and providing solution examples. The mentor is not to actually build any part of the project or write any of the code being used in the competition.
4. A team area will be provided at the competition with power connections. Teams will be responsible for bringing any equipment they will need the day of the competition.
5. Schools may have more than one entry. Each entry must have their own hardware, developed by each team, and must be documented by a separate application form. Multiple teams may be supervised by the same teacher.

Intention to compete must be received by submitting your application form no later than the application deadline.

6. The Point of Contact for each regional competition is as follows:
   a. Ohio Competition:
      Casey Miller
      Bldg 262 Rm S240
      4375 Chidlaw Rd
      Wright Patterson AFB, OH 45433
      casey@miniurbanchallenge.com
   b. Florida Competition:
      Carrie New
      101 W. Eglin Blvd.
      Bldg 13 Room 213
      Eglin AFB, FL 32580
      carrie@miniurbanchallenge.com
   c. Louisiana Competition:
      GB Cazes
      6220 E. Texas, Bldg D
      Bossier City, LA 71111
      gb.cazes@cyberinnovationcenter.org
   d. Washington DC Competition:
      Rick Buongiovanni
      8551 Rixlew Lane, Suite 360
      Manassas, VA 20109
      rbuongi@ion.org

1.2 Best in Show

The Best in Show Award will be presented to the team that has the most aesthetically pleasing car. Since the definition of "aesthetically pleasing" is subjective you are encouraged to personalize your car however you like. Each team will have the opportunity to explain to the judges why they designed their car they way they did. The judging of this award will be based on two categories, each worth 50% of the total score. The cars will be judged based on their look and feel as well as on their form and function. Each vehicle will be given a grade based on a 5-point scale, for each category.

2. Mini-Urban Challenge

2.1 Overview

The purpose of this competition is to design and operate an autonomous "car" using a LEGO MINDSTORMS kit to successfully navigate through the mini-urban challenge. The teams are placed based on their total scores; 80% of the total score is based on the navigation of the mini-urban challenge; 20% of the total score is based on the presentation given by the team and answers given during informal questioning.

2.2 The Challenge

The challenge is to design a car that can successfully navigate the Mini-Urban Challenge using the provided sensors. The car must enter the city from the designated entry point, travel through the city on the roads, obeying marked speed limits and stop signs. While in the city the car must stop at designated locations. Each team will be given a map of the city indicating the locations of three primary stops and three secondary stops. Teams will be required to visit each of the assigned primary buildings, pull into the parking lot and stop for a minimum of 5 seconds. These stops may be made in any order (i.e. secondary stops may be made prior to primary stops, or alternated, etc.) At each stop teams will be given a designated parking place. Teams may choose to park correctly in the designated parking place for additional points. Once all the stops have been completed the car shall be required to exit the city at the designated exit point (same as the entry point). Each team shall have a maximum of 60 minutes within the LEGO city. This time can be used for practice runs and up to three official runs which will be scored. The judges must be informed before teams begin an official run. Once the 60 minutes within the city have expired, all scoring will stop. The top scoring run will be counted toward the team's composite score. The total time of each scored run will be recorded for tie-breaking purposes.

2.3 Rules & Regulations

2.3.1 Car Design

1. Cars shall be autonomous and unmanned and shall not be remotely controlled during the competition. Remotely controlled includes but is not limited to: commands to reset the car's computer, commands to reinitialize the car, commands to adjust the car's route, etc.
2. Cars shall be built using only the RCX or NXT system. Only one brick may be used per car.
3. Car movement shall be accomplished through direct contact with the competition surface. Power shall only be provided through the battery pack in the RCX or NXT controller.
4. The car motor may not be adjusted in any way.
5. The car will only be built using LEGO components. LEGO parts not included in the LEGO MINDSTORMS kit may be used. Cars may be decorated with non-LEGO components.
6. Only the following sensors may be used:
   a. Black and white light sensor
   b. Color light sensor
   c. Touch sensor

d. Ultrasonic sensor

7. Teams may use more than one of the approved sensors if they choose.
8. The car shall be designed in such a way that a 4x2 LEGO brick will be left exposed at the top of the car so a wireless camera may be attached during the competition.

2.3.2 Driving

1. Car must obey the posted speed limits at all times.
2. Car must not leave the road surface.
3. Car must obey all stop signs, coming to a complete stop before beginning again.

2.3.3 Student Participation

1. During the team's 60 minute competition time within the LEGO city, only students may touch or interact with the car, team computers, hardware or software.
2. Teachers, coaches, parents and spectators must remain outside the marked competition area during the team's 60 minute competition time.
3. Any non-team member interaction with the team's robot, computer, hardware or software during the 60 minute competition time may result in disqualification.

2.4 City Description

Within the city teams will encounter many of the things found in an average American town or city. There are roads, intersections, stop signs, speed limits, and stores. Everything teams will encounter is described in detail below.

2.4.1 Road Surface

The road surface will be at least 20cm wide at all times. A white line, 1/2 in wide, will be drawn down the center of the road with a colored line, 1/2 in wide, on either side (see Figure 2-1). The colored line will be touching the white center line. The car may drive on any portion of the road, and may drive either way on all roads. The car does not have to stay on a "correct" side of the road. The colors used on the road surface will be the same colors as LEGO bricks and will be made using 3M electrical tape. Calibration stations will be available on competition day for each team to make adjustments due to color and lighting.

2.4.2 Intersections

There will be multiple intersections within the city. At all intersections traffic will be required to stop in all directions. Intersections will be marked with a

red stop sign on the right side of the road. There will also be a 1/2 in red stripe across the road at the location of the stop sign. Cars will be required to come to a complete stop before proceeding through the intersection.

2.4.3 Speed Limits

There are multiple roads within this city. In more congested, down-town areas, the roads have a speed limit of 6m/min. This speed limit will be marked along the road using white speed limit signs and will be designated by yellow tape. On more open roads and on the city bypass you will be allowed to go faster. The speed limit of these roads is 10m/min, and will also be marked using white speed limit signs and designated by green tape.

2.4.4 Buildings

To complete the challenge teams are required to stop at a variety of buildings. All buildings have a parking area directly off the road. To earn all possible points for stoping at the building, cars are required to pull into the parking area and remain there for at least 5 seconds. Each parking area will be designated by blue tape on the side of the road with the parking lot. Parking spaces within the parking lot will be marked with ½ in white stripes. Each parking space will be at least 20cm wide. (Parking spaces may not be located at the edge of the parking lots as shown below.)

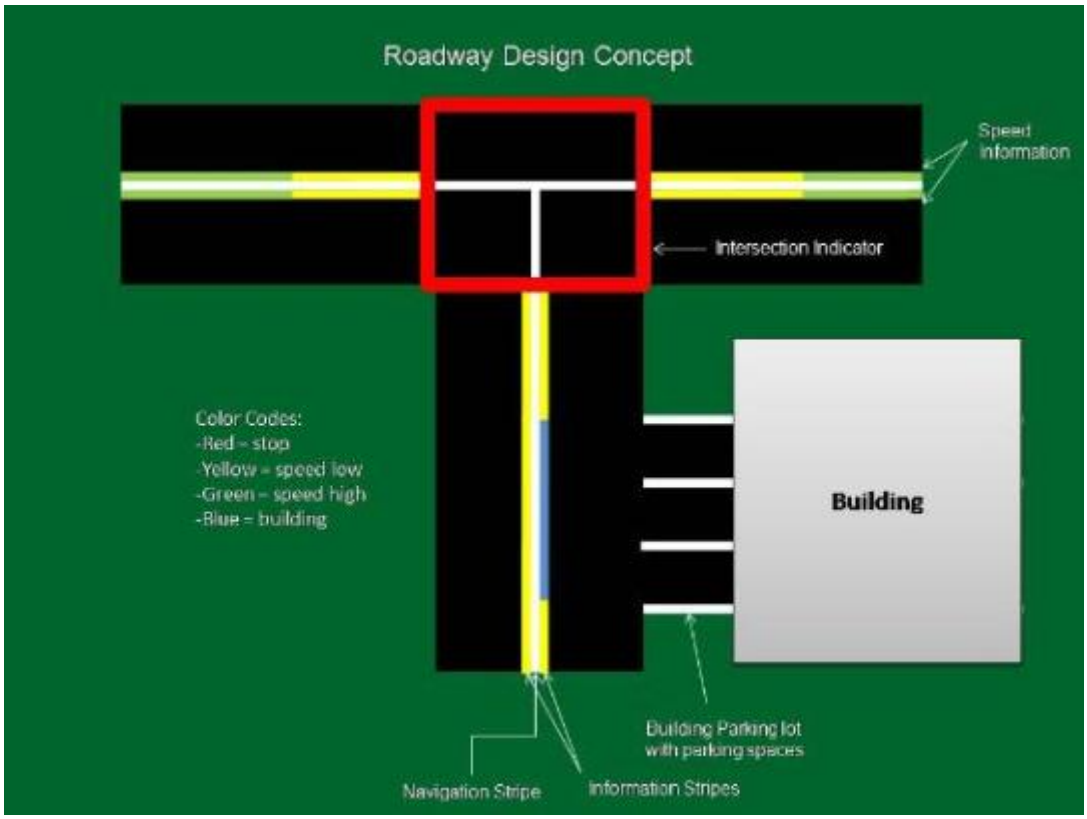

Figure 2-1: Roadway Design Concept

2.5 Scoring

Competitors are placed based on their total score in the competition. The total score is a composite of the points earned on the team's presentation, informal judges questioning, and the mini-urban competition. The individual components and the total scoring algorithms are outlined in this section.

2.5.1 Presentation Scoring

Each team shall give a technical presentation as part of the Regional Competition. If teams qualify for the National Competition they will give their presentation again at the National Competition. The presentation shall not exceed 30 minutes in length. All team members must be present during the presentation, though teams may designate one or two students to deliver the presentation.

A projector and computer with Microsoft PowerPoint 2003 shall be provided. Teams are not required to use the provided computer but if they do, it is recommended they email their presentation the competition POCs listed above for loading, and bring a backup copy on either a CD or on a memory stick.

The technical presentation scoring is out of 150 points and shall be as follows:

1.	Clarity of presentation (intro, body, summary)	60
2.	Level of technical relevance	60
3.	Ability to capture the audience's interest	30
	TOTAL	150

2.5.2 Judge's Questioning

Throughout the competition the judges will be interacting with the team members. During this time they will ask informal questions regarding the team's design and solution approach. Ability of all team members to answer questions will be evaluated. Each team will be asked up to 10 questions and team answers will be evaluated out of 50 points.

2.5.3 Mini-Urban Challenge Scoring

The scoring of the driving portion of the competition is out of 200 points and shall be as follows:

1.	Enter and exit city at designated points	20
2.	Obey posted speed limits	20

3.	Obey stop signs	25
4.	Correctly identity and stop at first location	35
	Parked in parking spot	10
5.	Correctly identity and stop at second location	35
	Parked in parking spot	10
6.	Correctly identity and stop at third location	35
	Parked in parking spot	10
	TOTAL	200
7.	Bonus points for each additional stop	20

Teams will also lose points for the following infractions:

1.	Leaving the road surface	(-5/infraction)
2.	Exceeding speed limit	(-5/infraction)
3.	Not stopping at a stop sign	(-5/infraction)
4.	Contacting a building, pedestrian, etc	(-10/infraction)

2.5.4 Total Scoring

All ruling and scoring by the judges shall be final.

Total score is a composite of the mini-urban challenge (80%) and the technical presentation and questioning (20%).

In the event of a tie, the team that navigated the Mini-Urban Challenge in the least amount of time (single scored run) will be declared the winner.

2.6 Prizes

The top two winners of the local competitions will be awarded prizes and will be invited to compete at the National Competition. The top two winners of the National Competition will receive monetary prizes. Prize amounts are based on the number of sponsors and values will be posted on the competition web page (www.MiniUrbanChallenge.com).