Design Competition: Official Rules

This document details the official rules for the Binghamton University *Junior Design Competition,* and provides a basic overview of the competition's gameplay. This document is subject to change over the semester; changes will be announced via Moodle and in our weekly lecture sections.

The Teams

Design teams of three-to-four individuals will be assigned during the first week of EECE 387; and will consist of at least one electrical engineer and one computer engineer. As a course requirement, each team must enter and attend the competition, and must enter a design constructed via collaboration between all of the team members.

The team's designs must reflect only the original work of the team members; though pre-existing engineering designs and code may be used as a reference work with permission of the instructor. Integrating *cited selections* of code from an external engineer's open source project is likely acceptable, as is asking for design opinions from external engineers; asking an external engineer to contribute code or designs is not. If you are not sure if a use is acceptable, ask the instructor.

The Robot

Each team should create and enter a single self-contained *autonomous* robotic system, which will serve as primary competing participant. While each team may only enter a single design, teams may find it beneficial to create multiple "copies" of a design to aid in testing; and to provide a backup in case of electrical or mechanical failure.

While the choice of a robotic platform is left to the teams, teams will be selected to ensure that at least one member of each team owns a Digilent RDK platform in order to reduce costs to the student. To ensure that the competition is fair to all entrants, the robot platform used in this year's sophomore-level classes (the *Dagu Rover 5*) cannot be used without prior instructor approval.

In addition to the requirements above, each robot must meet the following requirements:

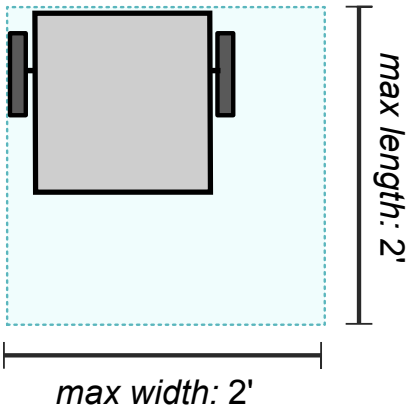

Figure 1: Size limits

- To ensure that the robot fits into each possible playing field, the robot must be less than t*wo feet wide*; and less than *two feet long*; measured from the furthest produding points.
- To ensure that robots cannot interact with other competition areas, robots must be less than *one foot tall*, measured from the highest point.
- All robots must be completely autonomous: that is, no human interaction is allowed. Once the robot has entered the field area, it cannot receive any communications from outside of the field area.
- Robots may not be designed to intentionally interfere with the gameplay elements or opposing team. Unintentional interference may be acceptable—for example, ultrasonic sensors may be employed; but note the possibility of unintentional interference from the other team. If you suspect your robot may produce (or receive) interference, ask the instructor if your design is acceptable.
- All robots must be designed for safety; even under failure conditions. As a safety precaution, your robot *may not use lithium-based battery technologies* (e.g. Li-ion/Li-Pol); while these batteries offer high energy densities, they can pose a fire hazard if incorrectly designed or used. If you are unsure as to the safety of any design or technology, ask the instructor.

The Field

All competition gameplay will take place within a 6' x 6' square area, which is enclosed on all sides by foot-tall immovable walls. The field's walls are designed to provide a boundary for the field; they both constrain the competing robots and block light from entering the playing field at low angles—preventing any light from entering from the side of the field.

Walls are opaque and matte to reduce reflection, but do not completely absorb incoming light: some minor reflections are to be expected in both the visible and IR ranges. Samples of the wall material will be available in the lab after the first few weeks of the semester for characterization, if desired.

The floor of the field will be composed of a "non-slip" high friction material, intended to afford robots a good amount of traction during gameplay; though a good design will not make any assumptions about the flooring material. More detailed information about the characteristics of the flooring material will be made available as a separate document.

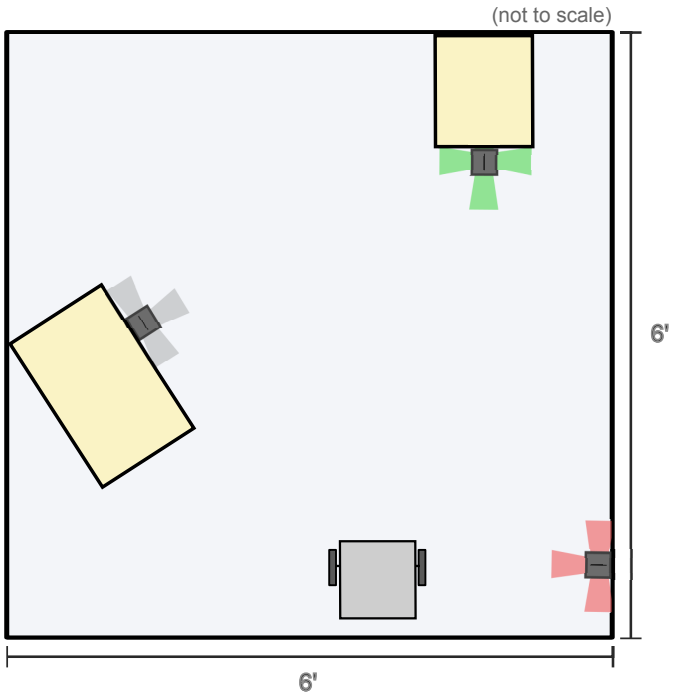

Figure 2: Overview of a possible field setup.

The Beacons

Each field will contain three *beacon towers* (or "beacons"); which will be situated at various strategic locations. The locations of these beacons will not be available to the participants prior to the competition; robots may not have any information regarding the beacon's location prior to entering the field.

Beacon towers are approximately 9" tall, and have a width and depth of 2.75". The shell of each tower is composed of a matte black acrylic, which is designed to absorb IR and visible light—the towers thus do not reflect a significant amount of visible or IR light.

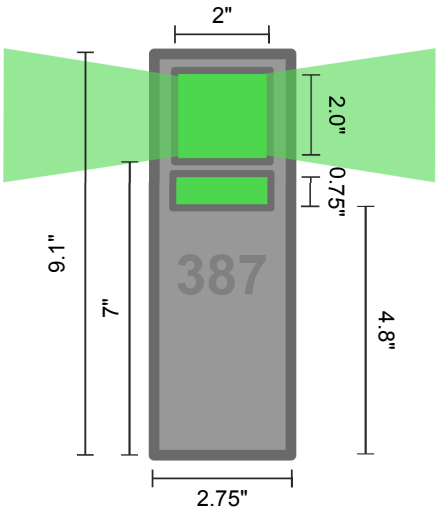

Figure 3: Beacon dimensions

Two windows exist on the side of each beacon tower:

- At the top of each beacon, a 2" tall by 2" wide window exists, exposing high-power LED lights in *red*, *white*, and *green*. These lights will only display a single color at a time, and are intended to broadcast the beacon's current status and location to competing robots in all directions. The behavior of these lighting elements is described in the gameplay section below.
- At approximately 4.8" from the ground, a 0.75" tall by 2" wide window exists, exposing a set of infrared (IR) transponders. As an element of the competition, robots will need to both send to and receive data from the three beacons in play. The transmission power of these IR responders has been limited such that a robot will need to be reasonably close to a given beacon in order to effectively communicate; the communication distances possible depend on the design of the competing robot's IR receiver.

Beacons are not firmly held in place, though their bases are weighted to reduce the chance of a beacon tipping over if struck. Competitors will likely wish to avoid beacon collisions, as a sufficiently forceful collision may "unplug" a beacon from the competition system or knock it over—preventing the competing robot from communicating with the beacon.

The Obstacles

Each field will also contain at least two *obstacles*, which prevent direct movement throughout the field, as they may occupy the space directly between a robot and any surrounding beacons. Obstacles will be approximately 6" tall, and thus will not block direct line-of-sight between a participating robot and the bright visible-spectrum lights atop the nearby beacons. The height of the obstacles *will* block the IR light used for communications.

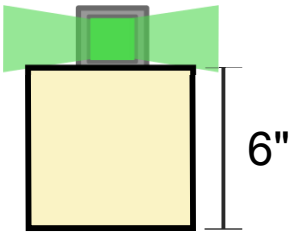

Figure 4: Obstacle height

The length and width of obstacles will vary, but obstacles will not exceed 3' in either horizontal dimension. Granted these dimensions, obstacles will be placed as to allow a maximum-dimension robot (2'x2'x1') to reach each of the beacons. No obstacles will be placed between the robot and the closest beacon; though object avoidance may be necessary to reach the remaining two beacons.

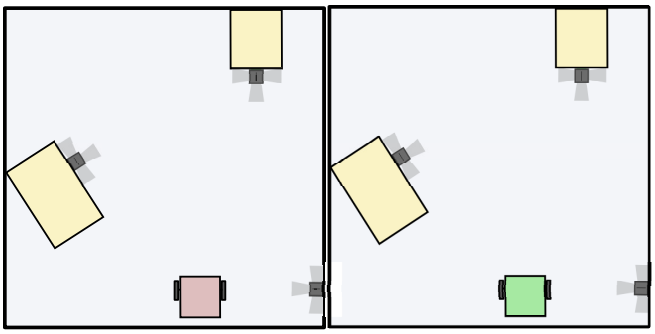

Figure 5: Competition setup

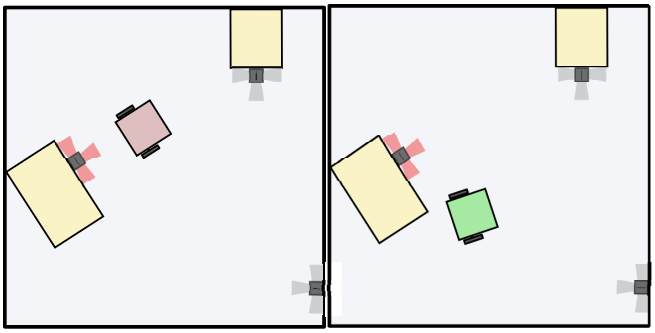

Figure 6: "Claiming" a Beacon

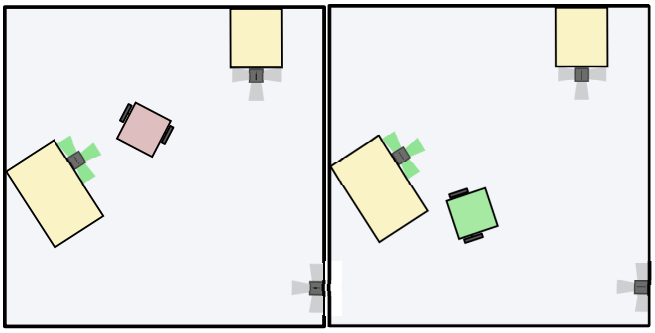

Figure 7: "Claiming" another team's beacon

Gameplay

Competition play will feature two identical playing fields, and will allow two participating teams to complete head-to-head. Each participating a team will be assigned a color: one team will be considered the *red* team, while the other team will be considered *green*.

Each round of gameplay will last exactly three minutes; during which two competing robots will vie for control over the three beacons present on their field. At the start of each round, each beacon will display white light (Figure 5), indicating that it has not yet been *claimed* by either team. To claim a beacon, a robot must navigate to a given beacon's location, and then communicate with the beacon via a simple IR protocol.

Once claimed, the corresponding beacons on both sides will "change color" to indicate the owning team—after which its new color will be displayed using the lights atop the beacon. As an example, if a beacon has been claimed by the "red" team, as in Figure 6, only the beacon's *red* LEDs will be enabled.

In addition to claiming *unclaimed* beacons, it's possible to claim a beacon owned by the opposing team, as in Figure 7. Claiming another team's beacon may be more advantageous, in some situations: in addition to scoring the claiming team a beacon, it also removes a beacon from the opposing team. In other situations, it may be more risky: as the other team's robot may still be nearby, and may rapidly re-claim the beacon! If more than one robot is attempting to claim a beacon, claims will be executed in the order received— so the most recent claim attempt will result in control of the beacon.

Competition Sequence

The general gameplay sequence for a single round of competition play will be as follows:

1. Prior to the start of each round, each robot will be placed within a 2.5' x 2.5' pen inside of the playing field, which will prohibit the robot's motion. To avoid damage to your robot's motors, it's recommended that you avoid running into the sides of the pen.
2. At the start of the round, the pen will be lifted, and the timer will start.
3. The robots will have three minutes to vie for ownership of the three beacons present on each field.
4. After three minutes, the timer will be halted, and the beacons will no longer accept IR communications. A camera will capture the location of each robot at the end the round.
5. Scores will be computed, and the winner will be declared. The winning team will move on to the subsequent round.

Scoring

At the end of the round, points will be awarded as follows:

Score	Criterion
30 points	for each beacon owned at the end of the round.
8 points	to the team who captured the first beacon, according to the gameplay software.
2 points	to the team whose robot is *furthest* from the starting point.

Table 1: Scoring Guide

This distribution of points yields the following ways to win:

- If one team owns more beacons than another at the end of the game, that team wins.
- If both teams have captured the same amount of beacons, the team who captured a beacon *first*—and is thus likely faster when capturing beacons— wins.
- If no beacons have been captured, the team who has moved the furthest from the starting point— and thus was more likely to find a beacon to capture— wins.

In the event of a true zero-to-zero tie, the winner will be decided by the course staff.