2023 IEEE Region 5 Annual
Conference

Rules for a Student Robotics Competition

This document contains the rules of the 2023 Region 5 Robotics Competition. The competition is open to teams of no more than 5 and no less than 2 undergraduate students who are enrolled in a College or University with a student chapter within the IEEE Region 5 boundaries. The competition encourages a multidisciplinary approach to robot development and recognizes the participation of students who may already be members of SAE, ASME, EEGS, etc. Therefore, only one team member will be required to be a current IEEE Student Member.

Competition Overview

The 2023 student robotics competition will encourage cooperative behaviors between ground robots and small drones. It expands on Denver's 2021 drone-based pandemic competition and Denver's 2017 ground-based tunnel mapping competition. Working together and leveraging the strengths of each platform, the two platforms will communicate to negotiate a series of simple obstacles. Both platforms may only communicate with each other.

A possible real-world applications might be autonomous delivery trucks moving through an urban area with one or more drones landing to gather packages for autonomous delivery. Another application might be an autonomous ship moving through a navigable river with one or more drones monitoring the status of stormwater outflows.

Based on lessons learned in 2017, Denver will strive to lower financial barriers by minimizing the complexity and cost of practice fields. Minimizing the complexity and cost of the competition field generally implies the ground platforms will operate on the carpeting and under the available lighting of the competition venue. It will never be too early in a team's concept design phase to consider uneven surfaces, imperfect carpet seams, wall, and ceiling color variations, and most importantly - the lighting irregularities commonly found in a conference hall.

The competition venue will be the Hyatt Regency Aurora-Denver Conference Center, 13200 E 14th Pl, Aurora, CO 80011

Introduction and General Round Description

The basic objective of the competition is for a ground robot to enter cardboard boxes in the correct order and finish near a designated box before time elapses. A drone will assist in guiding the ground robot to the next correct box. Variations on this theme are employed in each competition round.

The ground robot will have a landing pad for the drone. The rounds will begin with the drone on the ground robot's landing pad. At the finish, a successful Team will have landed their drone on a ground robot's landing pad.

Each cardboard box has an ID. The Box ID is represented by a QR Code and printed on the outer top surface. The drone will be required to read and interpret this QR Code.

The next box's ID is represented by a QR Code and printed inside each box on the inner top surface. The ground robot will be required to read and interpret this QR Code.

The round will begin with the drone on the ground robot's landing pad. The pair will be placed in a Start Area near the First Box. The round timing will begin when the drone lifts off. The ground robot will enter the First Box and read the Next Box ID. It will direct the drone to locate the Next Box by searching for the QR Code on top of each box. Once the drone locates the Next Box, it will help the ground robot find the Next Box. The Final Box will have the QR Code for Done. The task is complete when the ground robot exits the Final Box and the drone lands on the ground robot's landing pad. See Figure 1 for a simple layout.

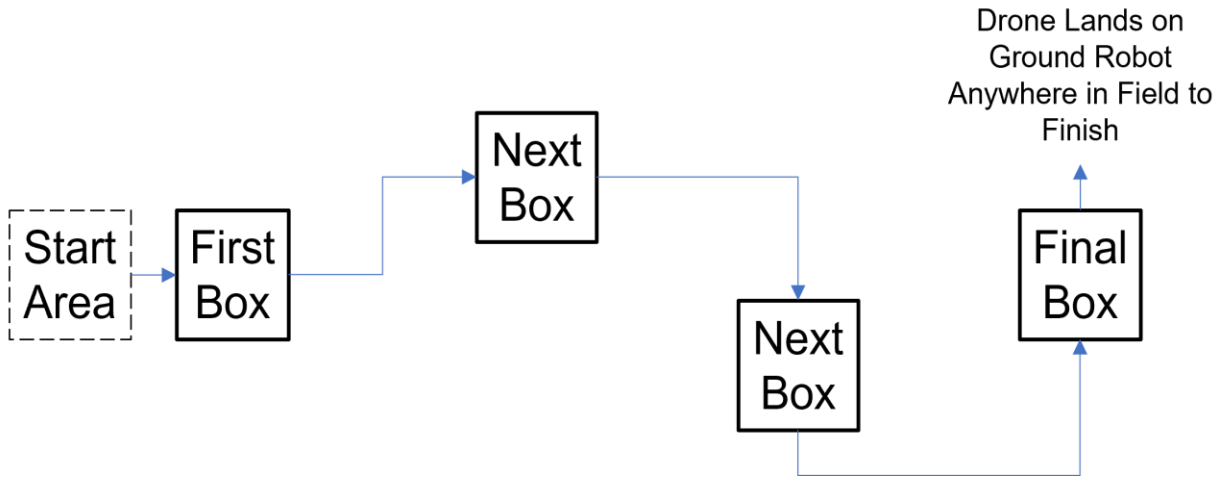

Figure 1 - Simple Field Layout with Possible Path of Drone and Ground Robot

Each Box will have an opening cut into the "front" and "back". Reflective tape will outline the openings. After being assisted into the vicinity of the Next Box by the drone, the ground robot will locate an opening, enter the box to read the QR Code and exit using either opening.

Round 1 – One Player Field

Teams will perform this round as the sole participant.

Points will be awarded for each Box the ground robot enters in the correct order. Points will be awarded for a single "touch & go" landing on the ground robot's landing pad between Boxes entered in the correct order.

Round 2 – Multiplayer Field

Two (2) Teams will perform this round. To shorten the round, Teams will have a minimal amount of Boxes to navigate and the Field layout will strive to minimize, but not guarantee robot interactions.

Points will be awarded for each Box the ground robot enters in the correct order. Points will be awarded for a single "touch & go" landing on the ground robot's landing pad between Boxes entered in the

correct order.

If a ground robot exits the Final Box and the drone lands on its landing pad, the drone may choose to become “Poison”. If it chooses to be Poison, it will take off and search for the opposing Team’s ground robot and land on its EMPTY landing pad. If the Poison drone successfully lands on the opposing team’s EMPTY landing pad, the round is over and the “Poisoned” Team loses all points collected in the round. If the total time allowed for the round expires before a Team is Poisoned, there is no change in points awarded to either Team.

Prior to the round, Team Pairings will be randomly selected by the Head Judge. In the event of an odd number of Teams, any Team wanting a chance to improve their score, will be given an opportunity to be randomly selected for a pairing with the odd Team. Filling the odd Team selection will be made after the Team pairings are completed. If no Team volunteers, a single die will be rolled. The points showing will be the Award place given the odd Team. Sixes will be rolled again.

Robot Requirements

Drone – Only one drone per Team is allowed to compete in each Round. Any commercially available (RYZE) DJI Tello model is acceptable. The factory propellers, propeller guards, motors, motor drive system and batteries cannot be modified. While on the Competition Field, the drone can only communicate with the ground robot.

Ground Robot – Only one ground robot per Team is allowed to compete in each Round. While on the Competition Field, the ground robot can only communicate with the drone.

The ground robot must have a fixed, non-movable horizontal landing pad mounted at the highest point on the robot. There cannot be any part of the robot extending above the landing pad. The landing pad must be flat with no indentations or protrusions greater than 1-millimeter. The horizontal length and width of the landing pad must greater than or equal to 20-centimeters x 20-centimeters. The landing pad must reasonably support the weight of a Tello drone and cannot be equipped with any device that restricts a “Poison” drone from landing.

The ground robot must have a Master ON/OFF Switch mounted in a location easily visible to the Field Judge and easily accessible by a Team member. After being directed by the Field Judge to begin the Round, a designated Team member will use the Master switch to enable the ground robot and drone to initiate activities.

The overall size and weight of the ground robot is undefined, however we do suggest noting the dimensions of the openings on the Boxes.

Competition Field

One to four competition fields will be setup in the venue. The overall length and width of each competition field is dependent on venue dimensions and available infrastructure. The rules will be updated as the field size is finalized. Each field will have netting on the perimeter to minimize injuries. Please note that the drones required for this competition have blade guards and have been used in school competitions around the world without nets.

Boxes

The boxes will be modified Extra Large Moving Boxes, Home Depot SKU #1006188676. The dimensions of a box are length 24-inches, width 20-inches, and depth 21-inches. The openings will be 15-inches wide by 15-inches tall and cut in the 24-inch sides. The side of the box resting on the venue floor will be cut away between the openings to expose the venue floor. The inner and outer edge of the openings intended for use by the ground robot will be outlined in Red High Visibility DOT-C2 Reflective Tape 2-inches wide manufactured by Qomovo and available on Amazon. Clear packing tape will be used to assemble and modify the box. A Team should not see more than seven (7) boxes including the Done box. See Figure 2 for a representative sketch.

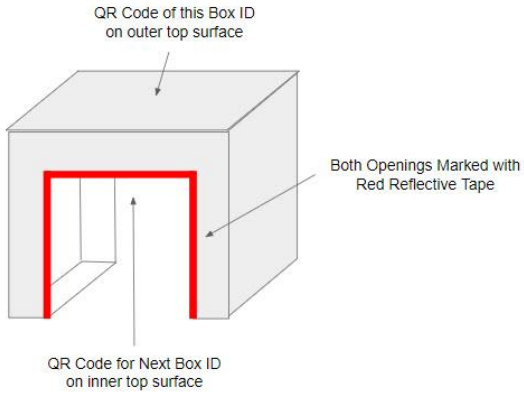

Figure 2 - Simple Box Sketch

The QR Codes will be laser printed on HP Copy&Print20 paper or similar. The HP paper has a brightness of 92 and a whiteness of 155. The Toner cartridge is a Brother TN-730 or TN-760. The dimensions of the printed QR Code will be square. The sides will 2 to 4-inches. The QR Code will attached to the box using any number of adhesive methods. The methods will not cover the QR Code.

The library of QR Codes for the competition is:

A
B
C
D
E
F
Done

Gameplay / Order of Operations

Rounds will proceed as follows:

1. T-20 minutes - Twenty (20) minutes prior to the start of a Round, teams will have 5 minutes to deliver their robot to the Quarantine Area.
2. T-15 minutes – Fifteen (15) minutes prior to the start of a Round, all robots are required to be in the Quarantine Area. The Quarantine Area will be closed. A Judge will have an opportunity to assess the robot field for rule infractions.
3. T-15 minutes – Configuration of the game fields by Judges and assistants will begin.

4. T-0 minutes – The fields are ready to begin the Round.
5. The A/V Screen at the Head Judge table will display the order of competition for each game field.
6. The public address system will call the first flight of robots to their respective game fields.
7. Upon entry to the Game Field Area (defined as inside the area surrounded by stanchions and/or netting), the Team Lead will place their robot fully within the START area.
8. Upon saying GO – the Timing Judge will start the Field Clock and the Team Lead is expected to start their robot. The Team Lead is the only person authorized to touch the robot to complete a Round. See End of Round Conditions.
9. Elapsed Time starts when the Timing Judge says "GO" and starts the Field Clock. Elapsed Time ends when any one of the End of Round Conditions occurs.
10. After any End of Round condition occurs, the Scoring Judge will ask the Team Lead to remove the robot from the Game Field and the remaining team members will leave the Game Field area.

Steps 1-6 will be repeated prior to each competition round.

Steps 7-10 will be repeated within each round until all robots in the Quarantine Area are given an opportunity to compete.

End of Gameplay Conditions

1. A team member touches the ground robot or drone after the Team has started their robot
2. Elapsed Time reaches ten (10) minutes
3. Any robot touches a Box
4. Any robot leaves or touches the perimeter of the field
5. In Round 2, any opposing team robots touch each other EXCEPT when a POISON Drone has landed

Round 1 Scoring

- One (1) point for every box entered in the correct order.
- One (1) point for each single "touch & go" landing between Boxes entered in the correct order

Round 2 Scoring

- One (1) point for every box entered in the correct order
- One (1) point for each single "touch & go" landing between Boxes entered in the correct order

Award Determination

- The highest robot point total in each round will be awarded First Place
- The second highest robot point total in each round will be awarded Second Place
- The third highest robot point total in each round will be awarded Third Place
- The fourth highest robot point total in each rounds will be awarded Fourth Place
- The fifth highest robot point total in each round will be awarded Fifth Place
- A tie will be decided by the Tie Breakers below
- If the head judge determines a team has communicated with their robots during the round, they risk forfeiting awards.

Tie Breakers

First Tie Breaker - Team with the highest number of single “touch and go” landings between boxes

Second Tie Breaker – Team with the shortest elapsed time to enter the First Box after the scoring Judge announces GO. If a tie remains, Teams will split the award

Game Restrictions

1. Flash photography is prohibited during the competition
2. No light sources external to the robots may be used by teams during the competition

Awards - Monetary awards will be given to the top five (5) finishers in each Round. The award amounts and disbursement process will be provided on the Region 5 Student Competition website

Team Registration – registration will be provided on the Region 5 Student Competition website

Glossary of Key Terms and Abbreviations

Head Judge – A Denver Section Robot Committee Member who makes all final rule decisions and award determinations
Scoring Judge – Records and reports all points and penalties
Timing Judge – Controls and reports elapsed time
Elapsed Time – The time interval between when the Scoring Judge announces “GO” and the moment when any End of Round Condition occurs.
Field Clock – The timing device controlled by the Timing Judge