

ASME Student Design Competition 2018 Contest

Robot Football⁴: Gooooaaalll !!!!!

Design Problem Setup

In the summer of 2018 the sporting world's attention will be drawn to the FIFA World Cup in Russia, where the best football (soccer in the US) teams will compete. The 2018 Student Design Competition challenges your imagination and technical design skills to create a "team" to compete against three other teams in a modified four-way football competition. You may choose to construct a team that is just one device or a team with multiple devices that are remotely controlled and must fit in a specified box provided by your team. The competition will have a multi-game group stage followed by a semi-final and final round for the top teams.

The constraints and competition procedures for all devices are as follows:

Pre-Game Warmup (General Rules)

1. Students participating in the competition must be undergraduate engineering students (any engineering discipline is allowed) and must be ASME members. There is no limit on the number of students on a team.
2. At the start of the competition, your *football squad* (all robot devices and controls, any extra batteries, and any tools your team would use to make minor repairs during the competition) must fit within a rigid sizing box that is no more than 50 cm x 50 cm x 50 cm (internal dimensions). This sizing box **must be provided** by your team.
3. Your *football squad* will be sequestered inside your sizing box throughout all of the rounds of the competition. Teams will have one minute to prepare your device(s) to compete in each round after removal from the box.
4. All energy for the device must be provided by rechargeable batteries. No other forms of stored energy (such as pre-compressed springs or gas) are allowed unless the stored energy of this component is returned to the initial state (for example an initially compressed spring must be re-compressed using the energy from the battery).
5. Teams may replace batteries between rounds, however replacement batteries must be identical to the original and mounted in the same way to the device.
6. Your device or devices must be controlled either via remote control through a transmitter/receiver radio link or through an umbilical cord.
7. Transmitter/receiver radio links may be any commercially available model controller. Radio transmitters may have their own batteries and these batteries **do not** have to be rechargeable. All radio controllers will be shut off and stored within the team's box during the competition unless the team is competing.
8. Communication between controller and device(s) must be able to be secured to allow for at least 3 other teams simultaneously using live controllers, as well as other games taking place in the same auditorium area.

9. If umbilical cord controller(s) are used, mechanical forces on the umbilical cord may not be used to help propel or control the device, and **a dedicated team member must manipulate any cords to avoid interference with other competitors**. The umbilical cord must be detachable from the vehicle using a commercial connector. The umbilical cord may not be a part of the supporting structure of the device. The umbilical cord may only be used to transmit the commands from the controller. Teams will receive a penalty for any event where the umbilical cord is used to apply mechanical force to the device.
10. Flying devices are not allowed. Devices must remain intact throughout the game (for example, a part of the device may not be fired at a ball).

Kick Off! (Individual Game Rules)

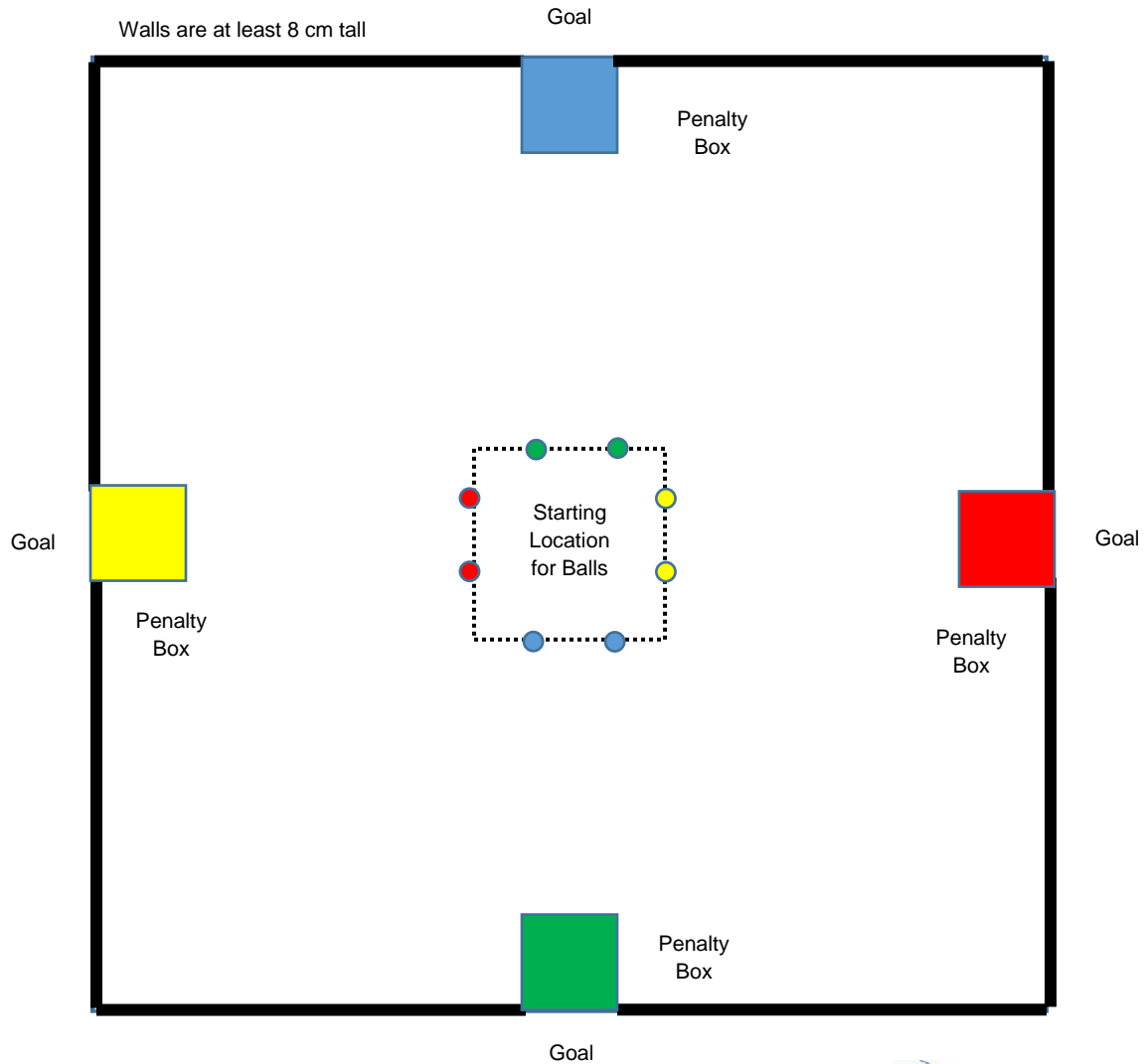
11. The playing surface dimensions are 5m x 5m, with boundary wall barriers that are at least 8 cm tall. Goals are 50 cm wide by 50 cm high, located in the center of each side of the playing surface. A 50 cm x 50 cm penalty box in front of each goal will be marked by tape on the ground. See Figures 1 and 2.
12. The playing surface will be level, and may be either hard surface or carpet typically found in public areas.
13. At the start of each game, the four teams will be randomly assigned a color (blue, red, green, or yellow) for that round. The color determines the goal the team is defending and the points that will be earned for each goal scored.
14. Games consist of **two 5 minute halves**. At the start of the 1st or the 2nd half of each game, eight tennis balls (two balls marked with each of the four colors) will be placed on a 1m x 1m square marked by tape on the ground as shown in Figure 1.
15. All teams' devices will begin both the 1st the 2nd half of each game within the penalty box that is their designated color for that game.
16. All devices must leave their penalty area at the start of play, and **all teams** must stay outside of **all penalty areas** during the game unless there is a ball inside a penalty box.
17. All the teams' devices will attempt to gain control of the balls and score goals in any of the other three goals that are not their team's designated color. A team scores a goal when a ball that they **control and propel** goes into another teams' goal.
18. Teams will earn points for goals scored against the other teams as follows:
 - five points for scoring with a ball into the same color goal
 - two points for scoring with a ball into a different color goal
 - shot that deflects off another team, into a goal counts as a goal for the original team controlling and shooting the ball
19. Teams lose one point for every goal scored in their own goal. This includes deflected or own-goals.
20. Once a ball has been scored it will remain off the playing surface, but will be repositioned at the start of the 2nd half. If a ball leaves the playing surface over the boundary wall, a judge will quickly replace the ball at its original starting position in the middle.
21. If all eight balls are scored in less than 5 minutes, the half will end at that time.
22. The following rules apply to team control of a ball:
 - A team may push, or secure a ball within their device in any way they chose
 - Teams may only attempt to control one ball at a time

- Teams may only attempt to steal a ball from another team when the ball is touching the ground (see next rule for further interactions between teams)
23. The following rules apply to team interactions:
- Some contact between devices will be allowed and should be expected. Devices must be robust to survive low speed collisions
 - Teams are allowed to play defense and block other teams (but must remain outside all penalty boxes)
 - Intentional *fouls* and overly aggressive behavior will be stopped by the judges
 - Excessive contact with other devices, or repeated attempts to control more than one ball may result in a **yellow card** – the team must then remain motionless for 60 seconds before the judge allows the team to resume competing. Teams may earn more than one yellow card in a game, but multiple yellow cards do not turn into red cards as they do in traditional football.
 - Behavior that is unprofessional and likely to damage another device may result in a **red card** – the team will be removed from that game. A second red card during another game will cause that team to be removed from the entire competition

And the Winner is! (Overall Competition Scoring Rules)

24. Each team will receive a score for each round (points for all balls in the other team goals, minus balls scored in their team goal)
25. All teams will compete in as many preliminary rounds as can be run during the competition (the group stage), and every team will get to compete the same number of times.
26. Preliminary rounds will have either four or three teams in each round. If a round only has three competitors the two colored balls for the missing team will not be put in play.
27. Teams will be sorted during the group stage so that different teams compete against each other as much as possible.
28. At the end of the preliminary rounds, total scores for each team will be added. The top eight scoring teams will continue to the semifinals. If necessary, the tiebreaker will be 1) total number of five point goals scored in preliminary round, 2) if still tied, highest number of points scored in one preliminary game, 3) if still tied, a coin toss.
29. In the semifinal rounds, seeded teams 1, 4, 5, and 8 will compete, and seeded teams 2, 3, 6, and 7 will compete.
30. Each of the two semifinals will consist of two rounds with the same teams (colors will be re-drawn for the 2nd round). The top two scoring teams from each of the two semifinals will advance to the finals. If necessary, the tiebreaker will be 1) total number of five point goals scored in two semifinal rounds, 2) if still tied, the higher seeded team.
31. There will be one final match between the top finishers from the semifinals. The team with the most points is the champion. If teams are tied, only the tied teams will compete in a final shootout: all eight balls will be put in play and the tied teams will compete in one five minute half. If tied, this will be repeated until there is a winner.

Figure 1: Top View of the Playing Surface



The 5m x 5m playing surface has boundary walls made from wood 2x4's or comparable height material. 50 cm wide gaps in the center of each edge are the goals. Goals are 50 cm high. A 50 cm x 50 cm "penalty box" will be taped on the ground in front.

At the start of each game and 2nd half, each team will start in their designated color penalty box, with eight marked tennis balls (two balls of each of four colors) placed on a 1m x 1m square in the center. Teams are trying to score goals with any of the balls in any of the other teams' goals, and trying to defend their own goal.

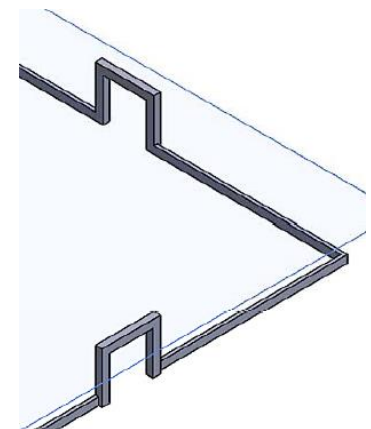


Figure 2: View of the Goals