

AtBC™ – Autonomous tennis Ball Collector, Robofest® 2018 Game

November 17, 2017 – V.1.0 - US Kickoff Version

**Figure 1. Jr. AtBC Field, an example****1. Game Synopsis**

Your mission is to develop an autonomous robot that will collect tennis balls on Tennis Court Table and put them into a Ball Box. Points are earned based on number of balls in the box, inside the Box Fence, on the robot, or outside the Tennis Court Table. Additional points will be earned if Trash Bottles are moved *completely* off the Tables. All the tasks should be done completely autonomously within 2 minutes without any external help. The procedure on how to end a Game is unveiled on the competition day.

At the World Championship at Lawrence Technological University in Michigan, there will be additional unknown task(s) that require program changes and/or additions. Any robot kits may be used.

Learning objectives: logic and proportional logic, object detection, picking up objects, sensor types, localization, and navigation

2. How to start a Game

Robot starting location and orientation within the Start Zone will be unveiled 30 minutes before the impounding for each round. Robot orientation can be West, North, East, or South directions.

3. How to end a Game

How to end a Game will also be unveiled 30 minutes before the impounding for each round. An example for Junior division is for the robot to completely stop on a black Box fence. An example for Senior division is to stop on the black Box Fence and display the length of the box in millimeters. Game competition time will be recorded only when this ending mission is completed correctly. (Otherwise the time must be BLANK, not zero).

4. Violations, Resets and Important Detailed Rules**A. Violations**

1. Violations are defined as the following:
 - a. If human player touches either the robot or any field material, intentionally to stop the game or unintentionally
 - b. If the robot drops off the tables and touches the floor
2. If any violation occurs, the judges will announce “violation”, and give the team the option to either reset the field and continue the run (see “B. Resets” below) OR decline a reset
3. If team declines the reset, Judges end the run and calculate the score for that round

- B. Resets
 1. The team may request a complete reset at any time during the run even when there is no violation.
 2. Only one complete reset of the playing field is allowed for a run
 - a. Done only by a Judge while the 2-minute countdown timer continues to run. - Judges must reset as quickly as possible
 - b. A reset penalty is assessed as defined on the scoring sheet
 - c. Partial reset is NOT allowed
 3. When the field is reset, all the points earned from the previous attempt are lost (cleared)
 4. A team can repair robot and/or change program during the reset
- C. The robot may attempt/complete the tasks in any order except the unknown Game ending task.
- D. Unknown factors will be unveiled according to Table 2 – Field Dimension and Unveil Times. A 30-minute work-time will be given to adjust the robot and/or change the code after the unveiling. During this time, all people except contestants and authorized staff/volunteers will be evacuated from the pit/room.

5. AtBC Game Playing Field

Two 6ft plastic folding tables are used to construct a playing field as depicted in Figure 2.

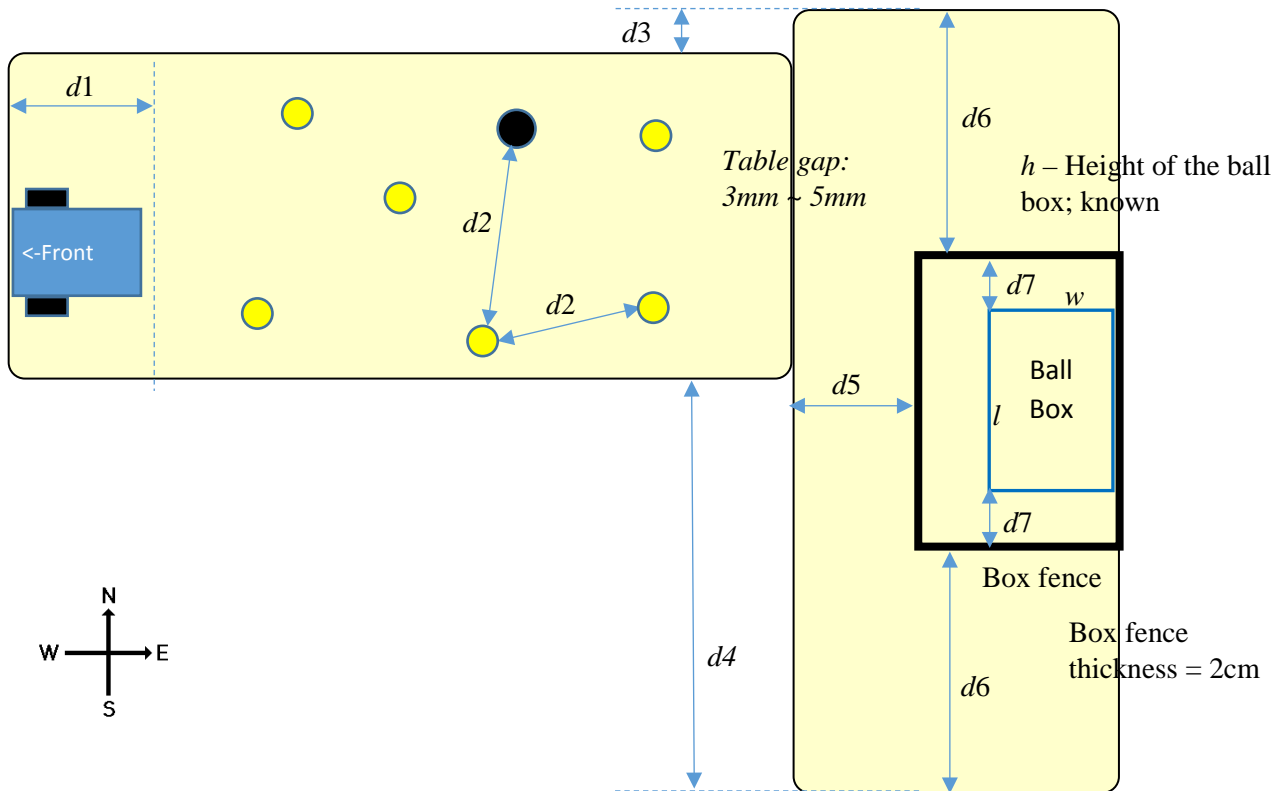


Figure 2. AtBC Playing Field

<p>6ft plastic folding table</p>	<p>The playing field is a 30"x72" (actual size is about 75 x 182cm) plastic folding table that can be purchased at discount stores like Lowes. The recommended brand is "LifeTime". The four corners of the table are rounded. The radius of the corner circle is 4cm ~ 7cm. The thickness of the table is about 4.5cm. The surface is light in color such as white, gray, or almond; however, the exact size, color, brightness, and edge shape of the tables are unknown until the competition day. Fold-In-Half plastic tables can be used if the center seam is covered with</p>
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	(masking) tape similar to the table color. The color of the tape would also be an unknown factor in that case. Pieces of plywood cut similarly to the folding tables can also be used if plastic folding tables are not available. The gap between tables is 3mm ~ 5mm . (see Figure 3) It is not taped. The tables are placed on floor. To mark the location of balls and Trash Bottles, tapes, labels, or markers may be used. Exact color and size are unknown factors.
Floor color under tables	Unveiled at the beginning of competition day. Possibly not homogeneous. However, all the colors should be noticeably darker than the table color.
Tennis ball	5 to 10 balls will be used. Standard competition size; color is unknown. Locations and the number of tennis balls are unveiled after impounding. The minimum distance between a ball and the edge of table is 2.5cm. (See Figure 4) The ball cannot be punctured, broken, or physically altered in any way.
Trash Bottle	Unopened 500ml (16.9 FL Oz) water bottle. The height is about 20cm. Bottle diameter is approximately 7cm. Aluminum foil tape (such as https://www.amazon.com/3M-Foil-Tape-3381-Silver/dp/B0759VQ37N) covers the bottom part of the bottle as seen in Figure 5. The bottles will be unveiled at the beginning of the competition day. Max 3 bottles will be used. Locations will be unveiled after impounding. Same number of bottles will be used for each round.
Box fence	Made by black foam boards such as Elmer's 20 x 30 inch. The thickness of the board is 3mm ~ 5mm. Width is 2cm as seen in Figure 6. After assembly, the outer dimension is 72 x 43cm. Non reflective Scotch tape is used to connect 4 pieces and tape to the table. (See Figures 6 and 7)
Ball box	Made of packaging box, plywood, or foam board. Color is unknown. The thickness of the material is less than 1cm. Placed (flushed) without taping at the back of Box Fence as shown in Figure 7. Box may be touched and moved by robot.

Table 1. Field Component Properties/Color and Unveil Times



Figure 3. Examples of table gap measurement

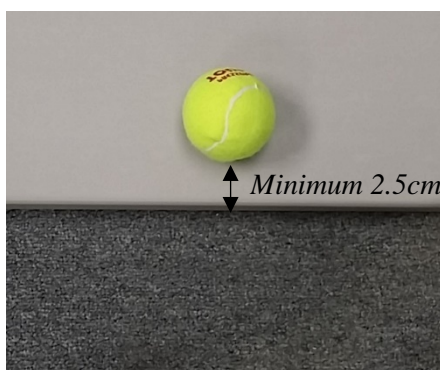


Figure 4. Ball and Bottle location



Figure 5. Water bottle with aluminum foil tape

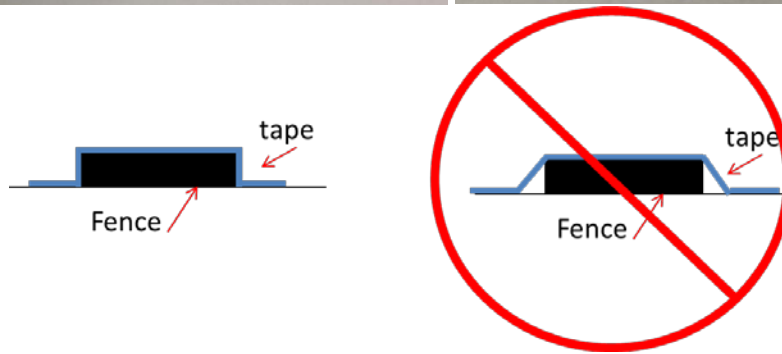
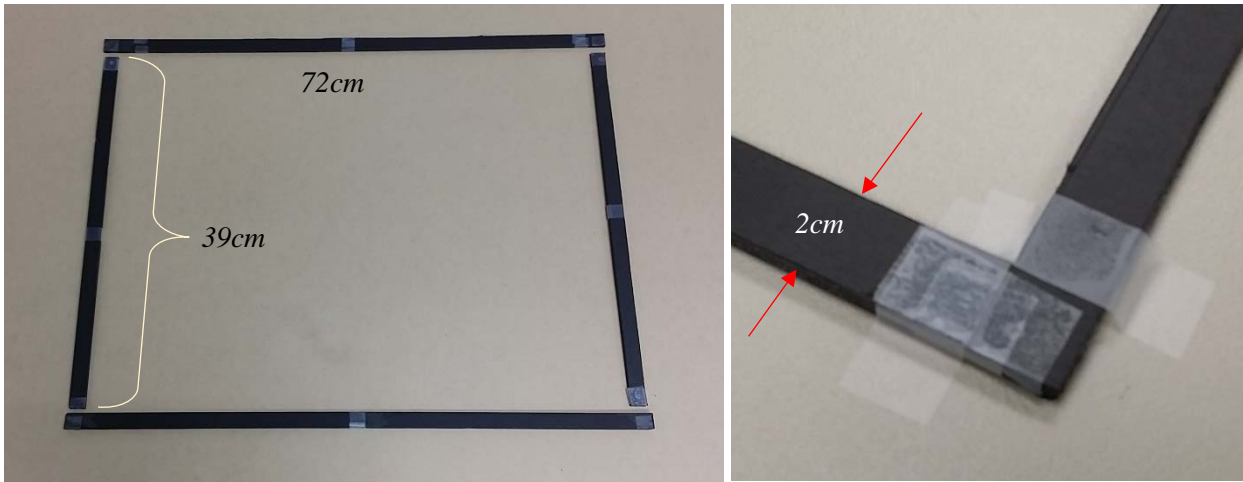


Figure 6. How to make the Box Fence



Figure 7. Where to place the Box Fence and the Ball Box

	Min. value	Max. value	Unveiled when?	Note
$d1$	35cm	35cm	Known factor	Dotted line is imaginary, but Robot may not extend past
$d2$	10cm	130cm	The range is known. Actual distances will be unveiled after impounding	Edge to edge distance. Balls and Bottles are included for this range.
$d3, d4$	0cm	$(182-75) = 107\text{cm}$	Jr: Unveiled before work-time for each round. Sr: Unveiled after impounding	See Section 6.
l	25cm	50cm	Jr: At the beginning of competition day Sr: After impounding	Outside dimension of the box.
W	22cm	32cm		
$d5$	$(75 - 43) = 32\text{cm}$	Known. But it depends on the actual table size.		Centered North/South on the table
$d6$	$(182 - 72) / 2 = 55\text{cm}$			
$d7$	$(72 - 4 - l) / 2$		Jr: At the beginning of competition day Sr: After impounding	Centered North/South in the Box fence

Table 2. Field Dimension and Unveil Times

6. Differences between Junior and Senior age divisions

	Junior (5 th ~ 8 th grades)	Senior (9 th ~ 12 th grades)
Game End task(s)	Easier	Harder
h value (height of the ball box)	7cm	20cm
Box size (w and l)	Unveiled at the beginning of competition day	Unveiled after impounding
$d3, d4$	Unveiled before work-time	Unveiled after impounding
Number of trash bottles	1	Up to 3
Number of on-board computer controllers	One	No limit

Table 3. Differences between Jr. and Sr. age divisions

7. Robot Specifications (For both Junior and Senior Divisions)

- (1) A Robofest team ID tag on top of the robot is required.
- (2) A label identifying the **front** side of the robot is required
- (3) At the start, the robot maximum width, length, and height dimensions are each 35cm. However, after the round starts, the robot may autonomously expand to a maximum width, length, and height of 50cm each. During impounding both sizes will be checked as shown in [Figure 8](#). (Note that the robot must not exceed the 35cm start zone when placed at any orientation) Robot wires are allowed to extend beyond the maximum dimensions.
- (4) Weight limitation: none
- (5) Any number of sensors/sensor types (unless it is harmful to humans). Note that ultrasonic sensors may not detect the tennis balls.
- (6) Any number/type of motors/servo motors (multiplexor is OK to use)
- (7) Any material/robot kit may be used to construct your robot including tape, glue, bolts and nuts, rubber bands, etc.

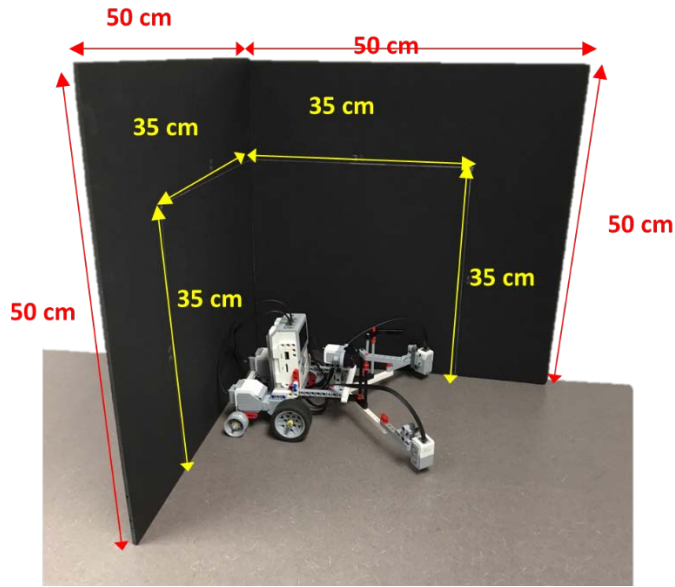


Figure 8. Robot Measure Procedure

8. Detailed Rules and Procedure to Play Two Rounds and Determine Winners

1. Only contestants are allowed to access the pit area, team tables, practice fields and official game fields throughout the competition day, including during the setup time before the opening ceremony, during work time and breaks (adult coaches, mentors, and other volunteers may assist with transporting team materials if necessary)
2. Playing field ball and bottle locations will be different for each round.
3. When unknown factors are unveiled, teams will be provided hard-copy of unveiled information or the information will be projected on the screen.
4. Teams will be given 30 minutes (work-time) after unknown factors, “how to start”, and “how to end” are unveiled to work on their robots. During this time, all people except contestants and authorized staff/volunteers will be **evacuated** from the pit/room.
5. All teams must submit their robot to the impound area when 30-minute work-time has expired.
6. During the impounding process, judges will inspect robots. (Size of the robot before & after expanding, Team ID, and label indicating the front side, number of computer controllers, etc.)
7. After impounding, the judges will setup official playing fields with balls and bottles.
8. Teams will compete in a pre-determined order decided by the site host.
9. A maximum of two contestants per team are allowed at the playing field during the run.
10. Contestants must move away at least 1m from the field edge after starting the robot.
11. Final scoring is done after the run is over.
12. A team member must sign the score sheet to confirm the team’s score.
13. Entered and normalized scores in percentage shall be displayed to teams to validate data entry.
14. Winners in each age division will be decided by the **average** total % Score of the 2 rounds. Tie breakers will be: (1) best % score of two rounds, (2) highest time left from best % score, (3) rerun, if needed. See an example in Table 4.

Team Name	Round 1 % score	R1 time left	Round 2 % score	R2 time left	Avg. % Score	(1) Best % score	(2) Time left best % score	Rank
Team A	80	20	100	15	90	100	15	1
Team B	100	10	80	0	90	100	10	2
Team C	90	20	90	20	90	90	20	3

Table 4. Example of breaking ties

9. Reminders of General Rules

- Proctors are watching for the following Violations:
 - Coaches or Parents in the pit area during practice or work-time (except for initial transport of materials).
 - Coaches or Parents accessing the practice or official game tables at any time.
 - Verbal/electronic communication between team and coach/parent during practice and work-time.
 - Team member leaves the pit unsupervised before their robot is impounded.
 - Team alters its own robot in the impound area after impound.
 - Team handles or interferes with another team's computer or robot, either in the pit or impound area.
 - Destruction of property.
 - Use of inappropriate words and/or behavior toward team members, other teams, audience, judges or staff.
- Any violations can result in deduction of points or disqualification at the judge's discretion.
- If anyone sees any suspicious activities, please notify the nearest volunteer immediately.
- Spectators are welcome to take pictures or video, but please make sure your flash is off.

10. Special Notes

1. Though every effort is made to be consistent and precise in all of the dimensions of the playing field and parts, Robofest assumes a tolerance of $\pm 3\text{mm}$, unless stated otherwise.
2. If there are multiple playing fields at the competition sites, the Chief Game Judge will check consistency between the playing fields. However, there is no way to make them all identical.
3. Judges & contestants should maintain at least 1 meter distance from the field.
4. Final decisions are at the discretion of the Chief Game Judge.

11. Related important documents

- Robofest 2017-2018 General Rules document at robofest.net
- FAQs, Rule Clarification, and/or Rule Change documents may be posted on the web at Robofest.net

Robofest® 2018 Game AtBC Scoring Sheet

Division: Junior / Senior Team Name: _____

Team School / Organization Name: _____ Team Number: _____

Round: First Second Field No.: _____

Judging Items (to be checked when the Game is ended)		Count	Point Value (per count)	Score Earned / Lost
#1	Tennis balls (Total # of tennis balls, $n = \underline{\quad}$) (*) ball must touch the table inside the fence. (**) The ball must not touch the table and the robot must be on a Table.	In the ball box	15	Max. $n*15$
		In the box fence completely*	10	
		On the robot**	8	
		On the Ball Box table	5	
		In the gap between Ball Box table and tennis court table	4	
		On the floor	3	
#2	Trash bottles (Total # of trash bottles, $t = \underline{\quad}$)	Removed completely from the tables. The bottle must not touch the top surface of the table at all.	12	Max. $t*12$
		Bottle is on the Ball Box Table, OR Bottle is in the Ball Fence, OR Bottle is in the Ball Box	-2	
#3	Game ending mission is achieved	0 (no) 1 (yes)	10	Max. 10
#4	The robot remained intact throughout the run	0 (no) 1 (yes)	5	Max. 5
#5	A Reset was done (Reset penalty)	0 (no) 1 (yes)	-3	Max. 0
		Total Score		
		Time left in seconds <i>Time stops when the robot complete the Game ending mission. If #3 is no, then Time Left is BLANK</i>		
		Total Possible max. score for this competition = $n*15 + t*12 + 15$		
		Total Score in percent (This will be calculated in Excel or tool)		X

Judge initials: _____ Team player initials: _____