Autonomous Programming Challenge Rules

1 October 2021

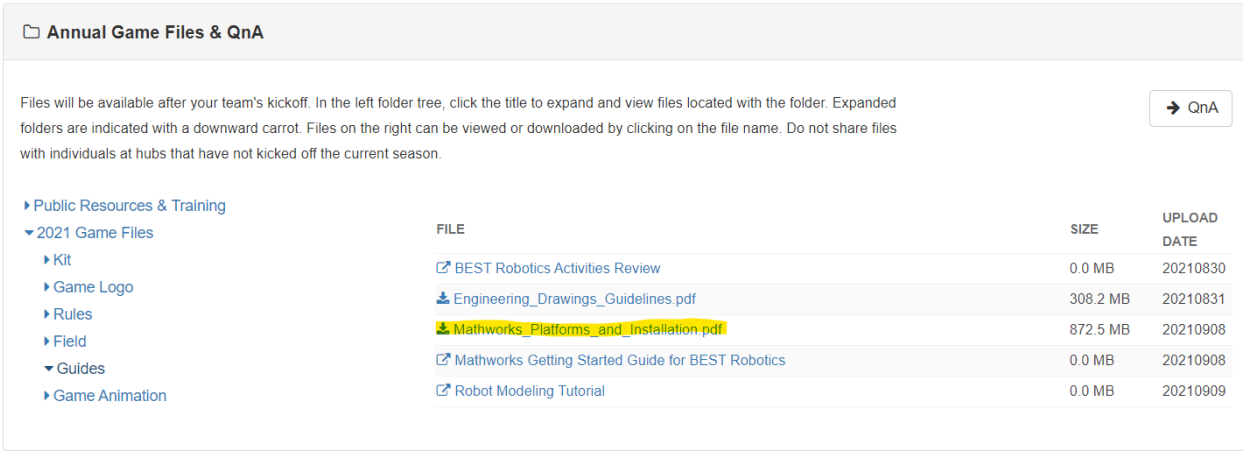
(updated Section 2.8.2 & 2.8.5 11/22/2021)

Contents

Section 1 Robotics Playground

The Autonomous Programming Challenge utilizes Mathworks Robotics Playground 3D virtual environment to simulate the BEST DemoDaze game play. To participate in the challenge, students will need to access the Mathworks MATLAB and Simulink software, and install the Robotics Playground add-on. They may install MATLAB/Simulink on a Windows based machine or utilize the MATLAB Online version which requires only a computer with an internet browser. Complete installation instructions can be found in your Team Workflow, Annual Game Files panel, under the Guides folder. You MUST complete ALL these steps before you will be able to execute this challenge. Please follow the directions carefully. You must install the latest version of the Robotics Playground add-on **after the challenge start date**.

Locate and follow the installation directions in the Mathworks_Platforms_and_Installation.pdf.



Section 2 Autonomous Programming Challenge

2.1 Purpose

The Autonomous Programming Challenge is intended to challenge students to explore and improve their programming skills by writing autonomous programs for a virtual robot within a virtual Demo Daze game field. The challenge is designed to be very similar in concept and objectives as a physical Demo Daze competition. All students can participate in the Autonomous Programming Challenge regardless of the BEST competition format they are competing in (Classic, Classroom, Online). The challenge is open to all teams nationally. Awards will be provided for hub-level and national-level rankings.

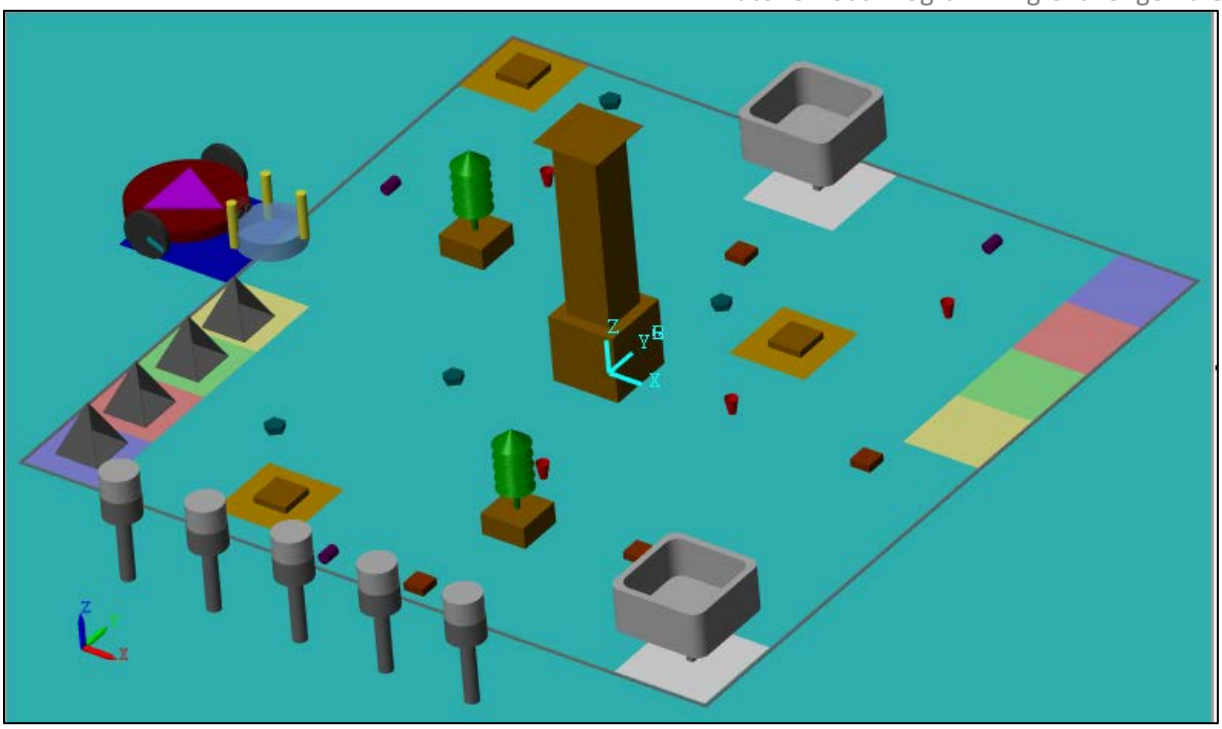


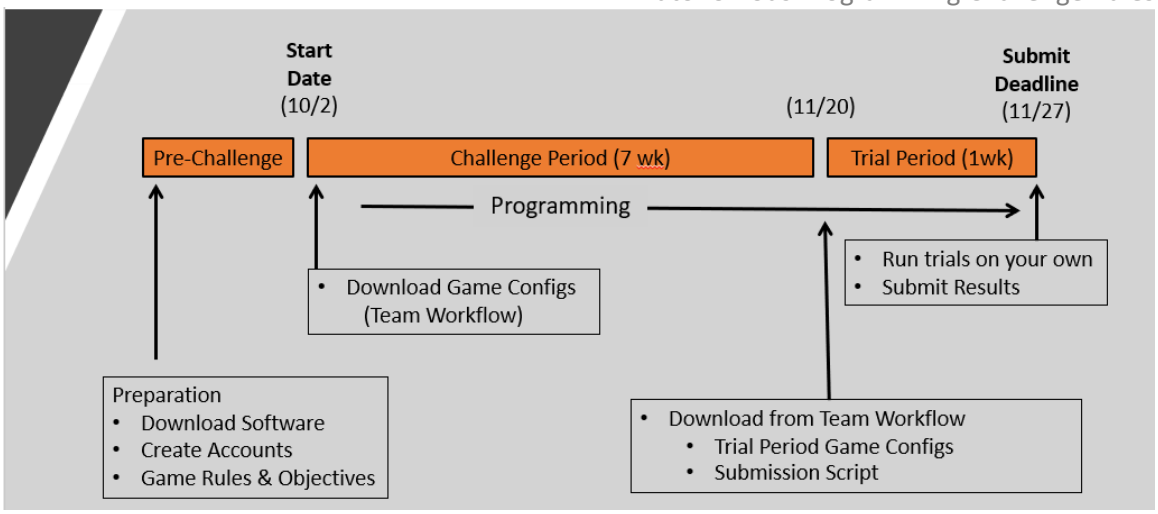
Figure 2.1 2021 DemoDaze Virtual Field

2.2 Challenge Rules

1. There are multiple Phases to the Autonomous Programming Challenge
2. Each phase presents unique objectives and constraints for the participant
3. Each phase introduces increasing difficulty and new programming techniques/opportunities. See Table 1.
4. The challenge is for students to create autonomous program(s) that can best achieve the objectives given the constraints and score the highest number of points through all 6 phases.
5. The Final Challenge score will be the points accumulated in each of the Phases, with the Phase 6 simulation time being a tiebreaker.

2.3 Schedule

1. The Autonomous Programming Challenge begins on October 2nd. The Game Configuration files required for each Phase will become available on this date, through the Team Workflow, Annual Game Files panel. This is the earliest that teams may begin their programming development.
2. Final Game Configuration files for the Trial Period will become available to teams on November 20th, 11:59pm Central Time.
3. The Challenge will end on November 27th. Final results for participating teams must be uploaded on this date by 11:59pm Central Time.



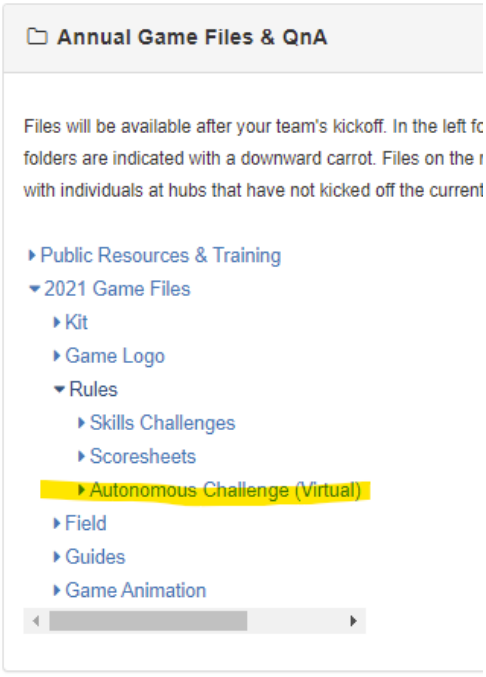


Table 2.1 Autonomous Programming Challenge Phases

Phase	Objectives	Contraints	Task Programming
1	***Implement Site Security Measures*** Install security light poles on their designated platforms. Move fence objects to their final destinations.	1 fixed obstacle (Building) Simulation Time <= 75 seconds	Drop items in fixed locations. Pick up items from fixed locations.
2	***Site Clean Up*** Remove "Refuse" objects to the Trash Pile.	1 fixed obstacle (Building) Simulation Time <= 60 seconds	Pick up items from fixed locations. Drop items in fixed locations. Identify object type (decision).
3	***Site Cleanup & Site Salvage*** Collect "Refuse", "Recycle" & "Reuse" objects from fixed locations.	1 fixed obstacle (Building) Simulation Time <= 60 seconds	Pick up items from fixed locations (minor random). Drop items in fixed locations (high & low). Identify object type (decision). Locate destination. Robot position, field navigation.
4	***Site Cleanup & Site Salvage - Random*** Collect "Refuse", "Recycle" & "Reuse" objects from randomized locations.	1 fixed obstacle (Building) Object start locations randomized. Simulation Time <= 180 seconds	Search for items in randomized locations. Pick up items from random locations. Drop items in fixed locations (high & low). Identify object type (decision). Locate destination. Robot position, field navigation.
5	***Environmentally Conscious Site Cleanup & Salvage*** Collect "Refuse", "Recycle" & "Reuse" objects from randomized locations, while avoiding obstacles.	1 fixed obstacle (Building) 2 random obstacles (Trees) Object start locations randomized. Simulation Time <= 200 seconds	Search for items in randomized locations. Pick up items from random locations. Drop items in fixed locations (high & low). Identify object type (decision). Locate destination. Robot position, field navigation. Obstacle avoidance.
6	***Implement Site Security Measures AND*** ***Environmentally Conscious Site Cleanup & Salvage*** All game objectives combined. Install security light poles on their designated platforms. Move fence objects to their final destinations. Collect "Refuse", "Recycle" & "Reuse" objects from randomized locations, while avoiding obstacles.	All objects are in play. 1 fixed obstacle (Building) 2 random obstacles (Trees) Object start locations randomized. No maximum Simulation Time. Simulation Time is Tiebreaker.	Pick up items from fixed locations. Search for items in randomized locations. Pick up items from random locations. Drop items in fixed locations (high & low). Identify object type (decision). Locate destination. Robot position, field navigation. Obstacle avoidance.

2.4 The Virtual Environment

2.4.1 Demo Daze Virtual Field

The Demo Daze virtual field and its major components is shown in Figure 2.2.

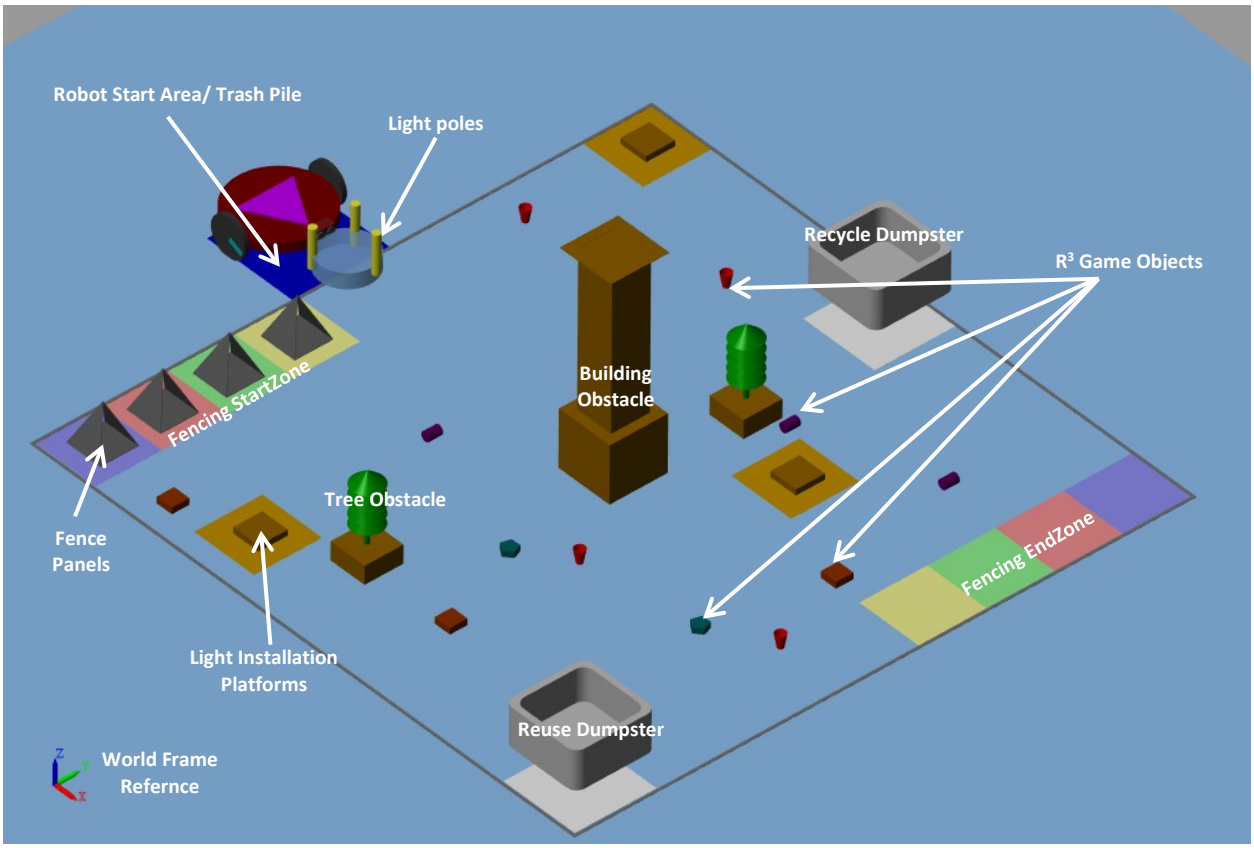


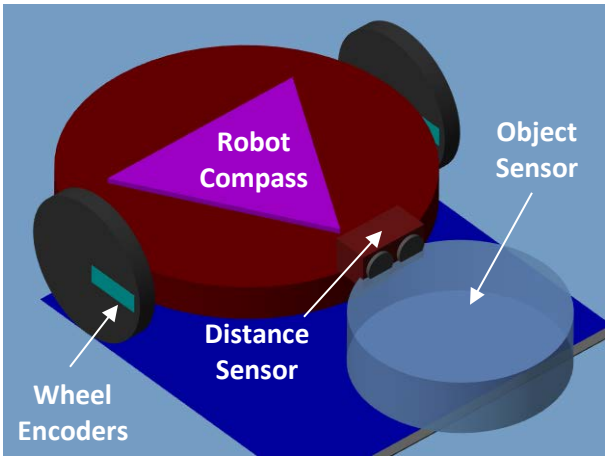
Figure 2.2 Demo Daze Virtual Field Components

1. Robot Start Area/Trash Pile – a fixed location outside of the field boundary where the robot starts each phase. This area also doubles as the Trash Pile scoring area for certain objects.
2. Security Light Installation Platforms – 3 fixed locations within the field boundary where security light poles are to be installed.
3. Fencing Start Zone – a fixed area of color-coded starting zones for fence panels.
4. Fencing End Zone – a fixed area of color-coded ending zones along the edge of the field where fence panels are to be placed.
5. Recycle Dumpster – a raised dumpster, set in a fixed location on the field, where recyclable objects are to be stored.
6. Reuse Dumpster – a raised dumpster, set in a fixed location on the field, where reusable objects are to be stored.
7. 2-story Building – a fixed location obstacle in the center of the field. A collision with the obstacle will impede the robot's forward motion.

8. Trees – 2 tree obstacles will exist on the field, in random locations, during Phases 5-6. A collision with the obstacle will impede the robot's forward motion.
9. Objects on the field that can be manipulated by the robot include:
    a. Light poles (each phase begins with 3 light poles loaded onto the robot)
    b. Fence panels (4 fence panels begin the phase in fixed colored start locations)
    c. Refuse, Reuse, Recycle (R^3) game objects – multiple game objects are randomly distributed around the field and represent refuse (trash), recyclable items and reusable items.
10. The position of all field components and objects is relative to the World frame coordinates as indicated in Figure 2.2. The center of the 2-story building sits at coordinate (0,0,0).

2.4.2 Virtual Robot

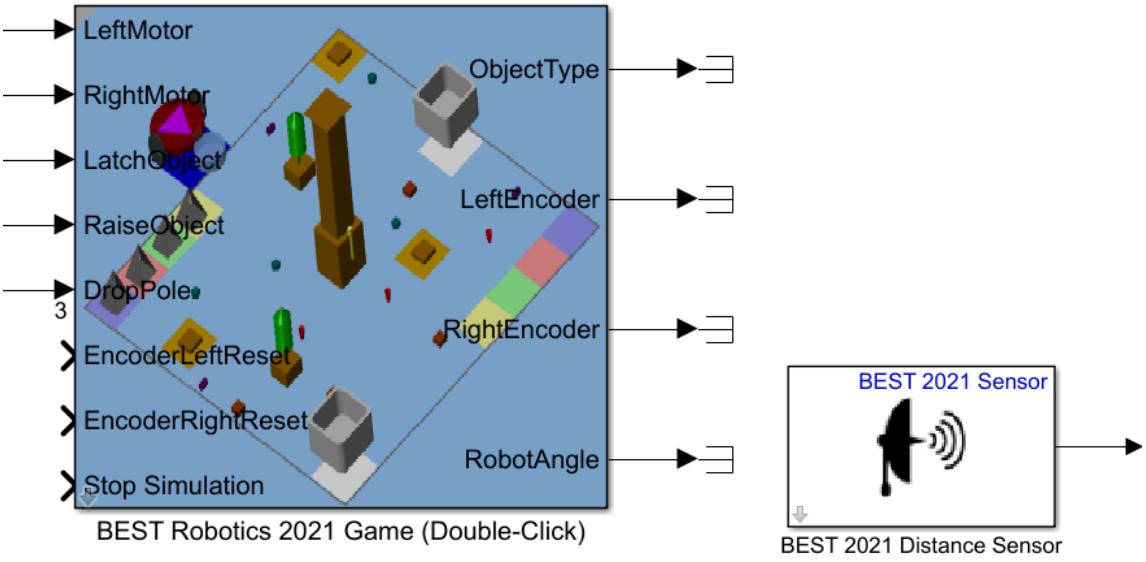
1. The virtual robot model is provided for this challenge. The user only needs to provide an algorithm to control the robot.

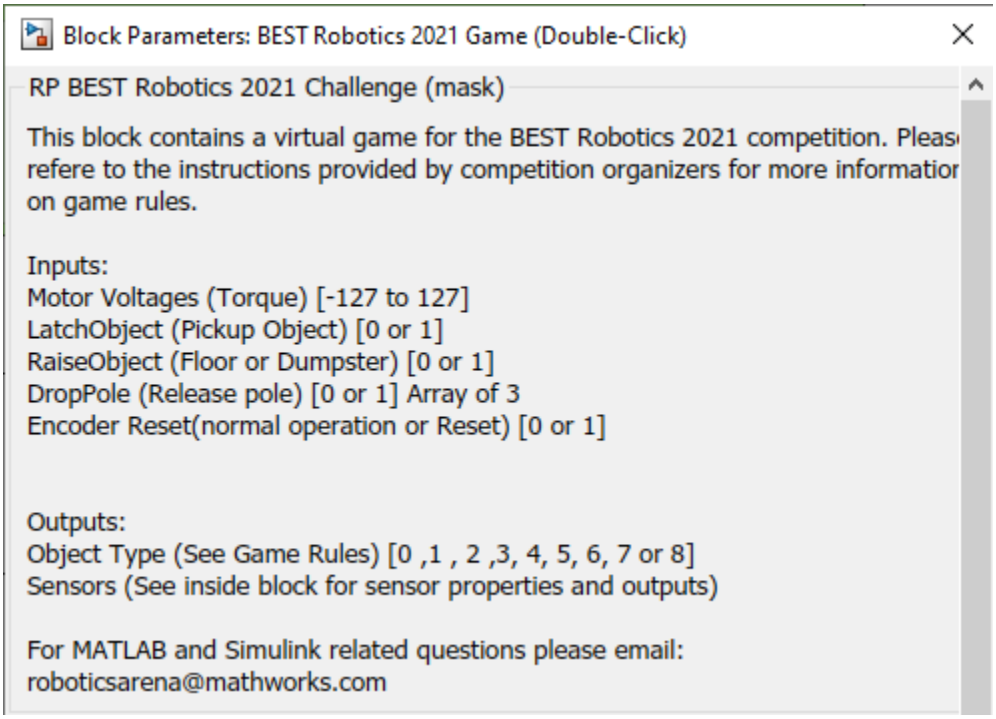


2. Some minimal configurations of the robot can be made prior to the phase, at the discretion of the programmer. Refer to section 2.4.3 for details.
3. The virtual robot actions are controlled through the following 6 inputs with these ranges:
    a. Right Motor voltage (-127 to 127)
    b. Left Motor voltage (-127 to 127)
    c. Latch Game Object (0 or 1); 0=drop, 1=grab
    d. Level Select (0 or 1); 0=lower arm, 1=raise arm
    e. Reset LeftEncoder; 0=normal operation, 1=reset to 0
    f. Reset RightEncoder; 0=normal operation, 1=reset to 0
4. The virtual robot provides the following sensor outputs with these ranges:
    a. Object Sensor: ObjectType (0-8)
    b. Wheel Encoders
        i. LeftEncoder (ticks per rotation, configurable)
        ii. RightENcoder (ticks per rotation, configurable)
    c. Compass: RobotAngle (0-359 degrees), angle with respect to World coordinates X-axis

d. Distance Sensor: meters (sensitivity configurable by user)

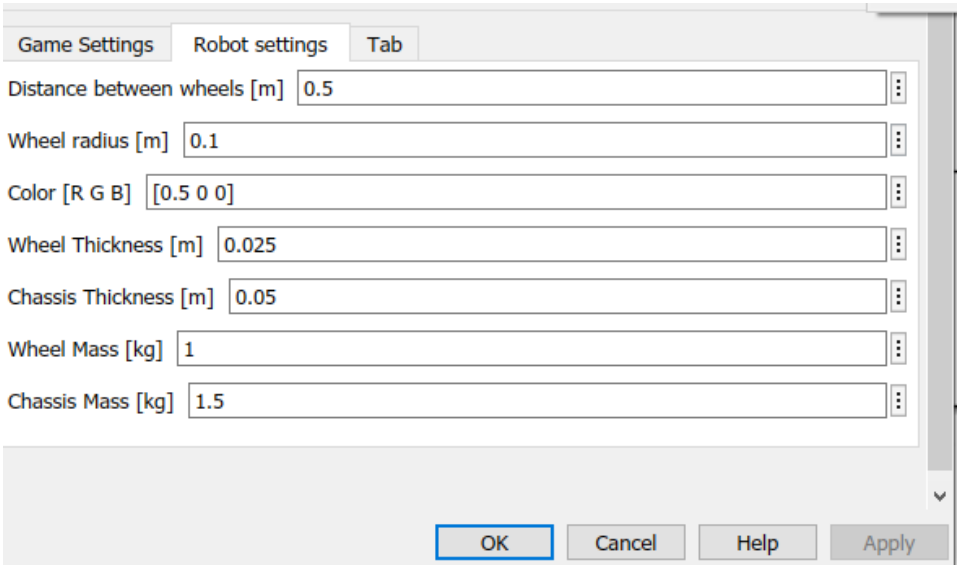
5. Once Distance Sensor is provided on the virtual robot. Additional Distance Sensors can be added to the robot by simply copying and pasting the sensor and configuring its location/orientation on the robot and sensitivity.
6. Double-clicking on the BEST Robotics 2021 Game block will open a dialogue box with information about the valid values for each of the Virtual Robot inputs and outputs.





2.4.3 Virtual Robot Configuration

The virtual robot has some limited configurability that can be done by the user. Double-click on the BEST Robotics 2021 Game block will open a dialogue box. On this dialogue, click the "Robot Setting" tab. Here, the user can set a few of the parameters that affect the dimensions and mass(weight) of the robot. Changing these settings will affect the movement and operation of the virtual robot within the simulation. The default settings are sufficient and do not need to be changed but the user is free to experiment with other settings.

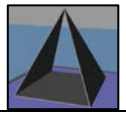
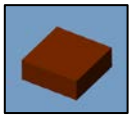
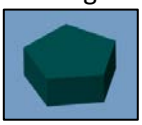
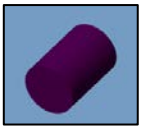


2.5 Game Play Rules

1. The robot may exit and re-enter the field boundary at any time.
2. All scoring must be accomplished within the time specified for the phase. The maximum simulation time allowed must be set during field configuration, prior to beginning the phase.
3. The algorithm can stop the phase simulation when desired by controlling the *Stop Simulation* input to the 2021 Game Field block. This allows teams to end their phase simulation before the maximum time allowed is reached or in the case of Phase 6 to end the simulation when all tasks have been completed.
4. Game objects that can be manipulated and scored are identified in Table 2.2. See section 2.7.1 for the starting position of each game object.
5. The location of the game objects at the end of the phase will determine the score for that phase.
6. The security fence panel game object is represented by the Triangle geometric shape.
7. The security light pole game object is represented by the vertical cylinder.
8. Three security light poles are pre-loaded onto the virtual robot at the beginning of each phase simulation.
9. The Refuse, Recyle and Reuse (R3) game objects are represented by 4 unique geometric shapes (Brick, Horizontal Cylinder, Pentagon, and Cup).

10. Each of the 4 geometric shapes represents 2 object types (see Table 2.2). The object type may vary each time the Phase simulation begins.
11. Except for the light poles, the game object "object type" is determined using the Virtual Robot's "Object Sensor".
12. The Object Sensor will return a unique number corresponding to each object type as shown in Table 2.2.

Table 2.2. Game Objects

Type	Object Type[1]	Object	Geometric Shape	Qty Avail	Points Each	Max Points	Scoring Location
Security	N/A	Light Pole	Vertical Cylinder 	3	15	45	Any Light Installation Platform (1 per platform max)
Security	0	Fence	Triangle 	4	20	80	Fence Endzone (corresponding colored zone)
Refuse	1	Insulation	Cup 	2	10	20	Trash Pile
Reuse	2	Metal		2	20	40	Reuse Dumpster
Refuse	3	Cement Block	Brick 	2	10	20	Trash Pile
Recycle	4	Glass		2	25	50	Recycle Dumpster
Reuse	5	Tile	Pentagon 	2	20	40	Reuse Dumpster
Recycle	6	Plastic		2	25	50	Recycle Dumpster
Reuse	7	Water Pipe	Cylinder 	2	20	40	Reuse Dumpster
Recycle	8	Wire		2	25	50	Recycle Dumpster
						435	**TOTAL POSSIBLE POINTS**

2.6 Scoring

1. All final game object positions are determined at the end of the simulation:

   a. The center of the game object in relation to the scoring area boundaries. Scoring areas include:
      i. Each of the colored squares in the fencing endzone (0.35 m square)
      ii. Light Installation Platforms (0.15 m square)
      iii. Trash Pile (0.5 m square)
      iv. Recyclable Dumpster (0.42 m square)
      v. Reusable Dumpster (0.42 m square)
   b. The center of the game piece must be inside the scoring area boundary to score
   c. Game pieces in the robot's grasp will not score.
2. The Center position of each scoring area with respect to the world frame coordinates is shown in Figure 2.3. The dimensions of each scoring area are shown in Table 2.3.
3. Security fencing items – will only score if in the corresponding colored square in the fencing endzone
   a. FYI, fence panels are not colored but their starting location is known by the system and scoring is based on this information. For example, a fence panel starting in the purple square and ending in the red endzone will not score.
4. Security light poles – will score only if in the light installation platforms (inside the smaller square) – see Figure 2.3; no more than one light pole will score per installation platform.
5. Refuse items – will score only if inside the Robot Start Area
6. Recycle items – will score only if inside the Recycle Dumpster
7. Reuse items – will score only if inside the Reuse Dumpster
8. A summary of the scoring opportunities for each Phase is provide in section 2.7 .

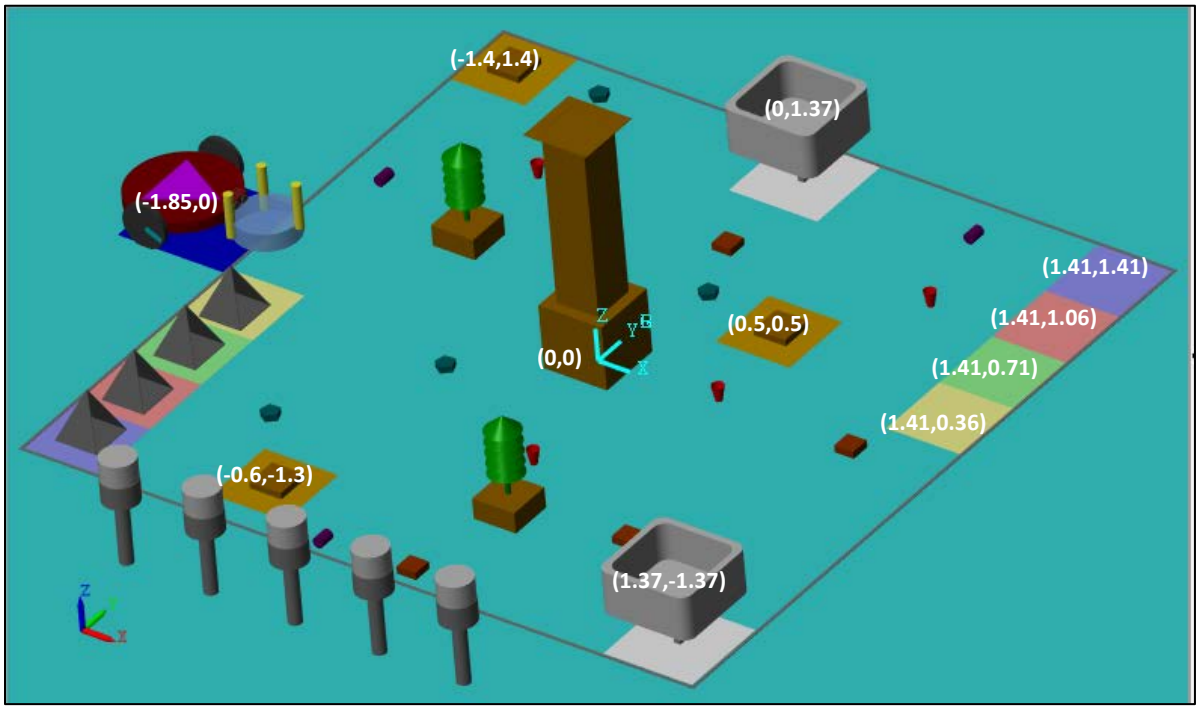


Figure 2.3. Center Coordinates of each Scoring Area on the Field

Table 2.3. X-Y Dimensions of Each Scoring Area on the Field

Scoring Area	Dimensions (X) x (Y)
Robot Start Area/TrashPile	0.5m x 0.5m
Fence endzone squares	0.35m x 0.35m
Recycle Dumpster	0.42m x 0.42m
Reuse Dumpster	0.42m x 0.42m
Light Installation Platform	0.15m x 0.15m

2.7 Phase Details

2.7.1 Starting Locations of Game Objects

The starting location of game objects is determined by each phase.

Table 2.4. Game Objects Starting Locations

Type	Object	Starting Location	
		Phases 1-3	Phase 4-6
Security	Light Pole	On The Robot	On The Robot
Security	Fence	Fence StartZone	Fence StartZone
R^3	Bricks	Fixed Location (defined by ConfgFile)	Random Location (defined by ConfgFile)
R^3	Cups	Fixed Location (defined by ConfgFile)	Random Location (defined by ConfgFile)
R^3	Cylinders	Fixed Location (defined by ConfgFile)	Random Location (defined by ConfgFile)
R^3	Pentagons	Fixed Location (defined by ConfgFile)	Random Location (defined by ConfgFile)

2.7.2 Phase 1: Implement Site Security Measures

The objectives of Phase 1 are

- Install security light poles on their designated platforms.
- Move fence objects to their final destinations.

Constraints

- Figure 2.4 represents the field layout expected during Phase 1.
- The building in the center of the field is an obstacle to avoid. Any collision between the robot and the building will stop the robot forward motion.

- Three (3) security light poles are preloaded onto the robot at the beginning of the phase. Once dropped, the light pole(s) cannot be retrieved.
- All other game objects and obstacles are removed from the field.
- Phase 1 is allocated a maximum of **75 seconds** to complete the objectives.

Rules:

- Light poles must be dropped onto the installation platform (the inner square show highlighted in the diagram) to score.
- Each fence panel begins in a colored area of the Start Zone. That same fence panel must be placed in the SAME colored End Zone area to score.

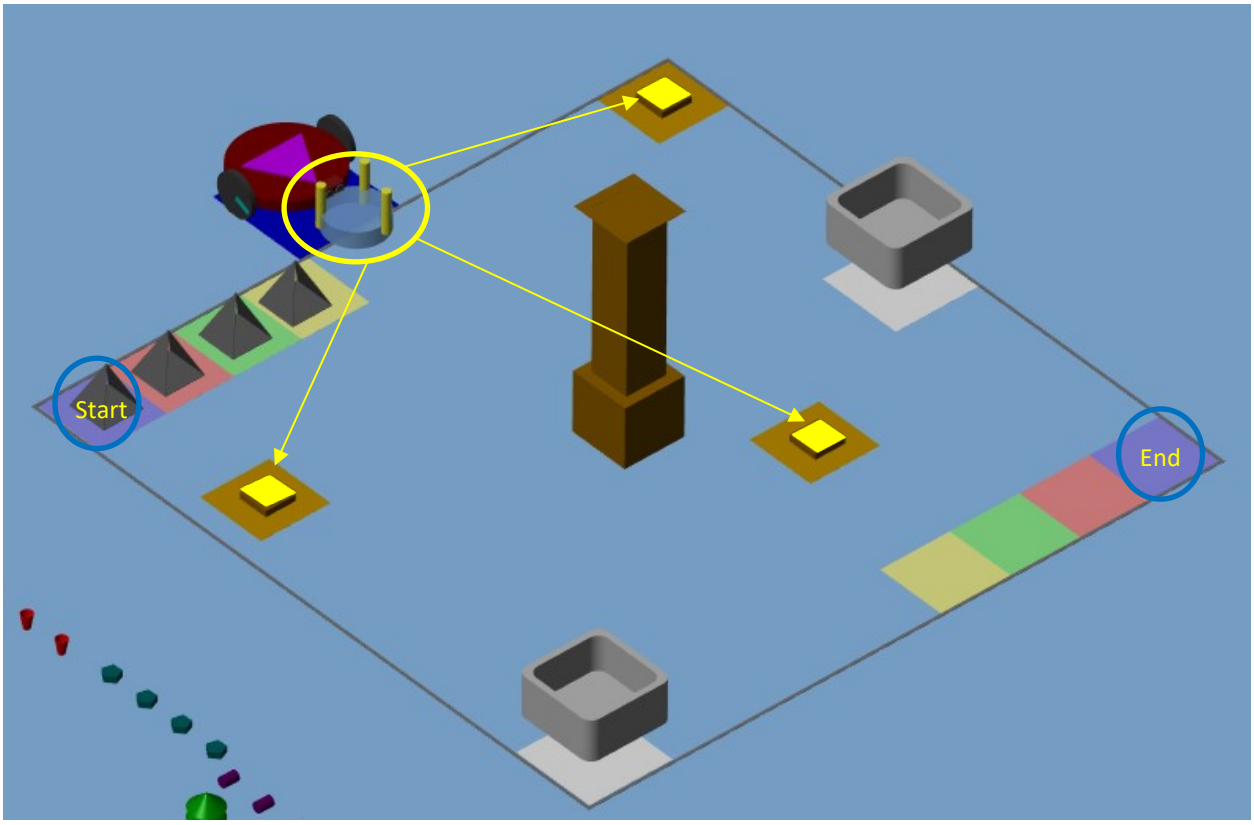


Figure 2.4 Phase 1 Field Layout & Objectives

2.7.3 Phase 2: Site Cleanup

The objectives of Phase 2 are

- Locate and move all Refuse (trash) objects to the Trash Pile.

Constraints

- Figure 2.5 represents the field layout expected during Phase 2.
- The building in the center of the field is an obstacle to avoid. Any collision between the robot and the building will stop the robot forward motion.

- Three (3) light poles are preloaded onto the virtual robot at the beginning of the phase. These light poles play no role in this Phase.
- All game objects except for 4 bricks and 4 cups are removed from the field (out of play).
- All game objects will be in fixed locations at the beginning of the phase, as defined by the configuration file provided. The fixed locations will never change in Phase 2.
- All other obstacles (trees) are removed from the field (out of play).
- Phase 2 is allocated a maximum of **60 seconds** to complete the objectives.

Rules:

- Dropping light poles have no impact on final score.
- The Robot Start Area will be used as a Trash Pile in this Phase.
- Valid Refuse (trash) objects located within the Trash Pile area at the end of the phase will score.
- The bricks and cups can each represent 2 object types (see Table 2.2). Only object types 1 & 3 are considered trash and valid refuse to be collected and moved to the Trash Pile.

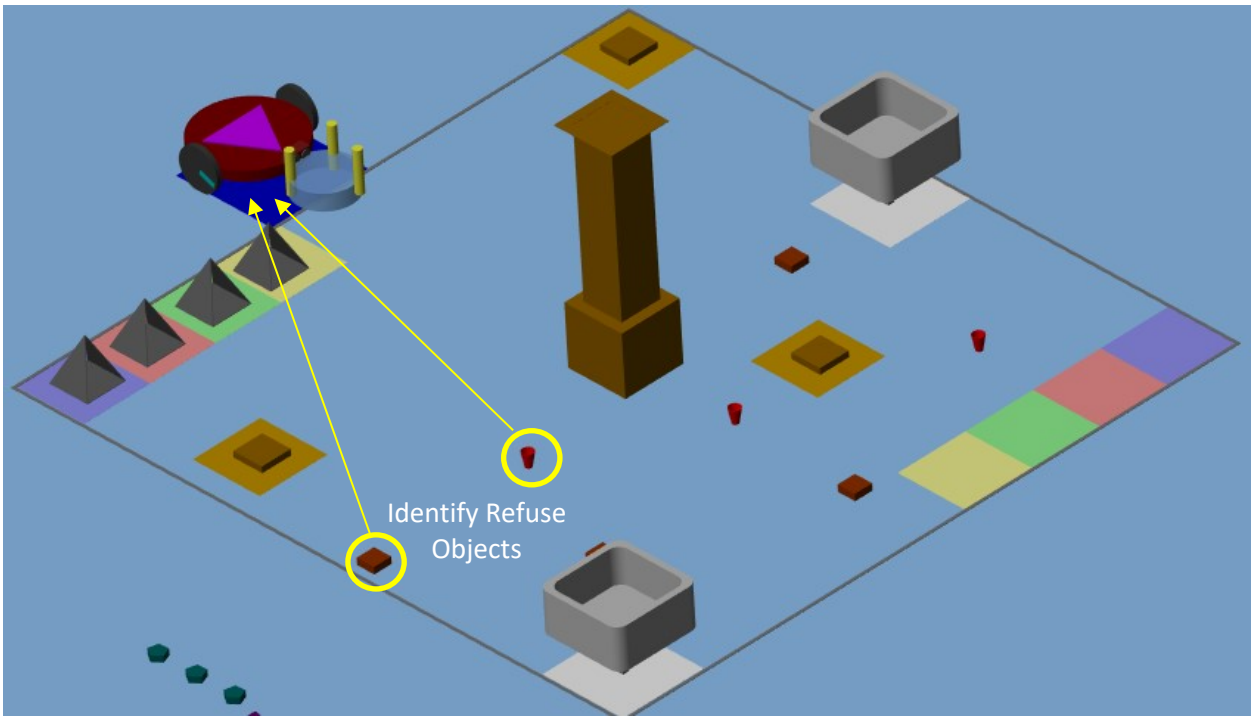


Figure 2.5. Phase 2 Field Layout and Objectives

2.7.4 Phase 3: Site Clean-Up and Site Salvage

The objectives of Phase 3 are

- Locate and move all R^3 objects [Refuse (trash), Recyclable and Reusable] from **FIXED** field locations to the appropriate collection points (Trash Pile, Recycle dumpster, Reuse dumpster, respectively).

Constraints

- Figure 2.6 represents the field layout expected during Phase 3.
- The building in the center of the field is an obstacle to avoid. Any collision between the robot and the building will stop the robot forward motion.
- Three (3) light poles are preloaded onto the virtual robot at the beginning of the phase. These light poles play no role in this Phase.
- All 16 R^3 game objects will be in fixed locations at the beginning of the phase, as defined by the configuration file provided. The fixed locations will never change in Phase 3.
- All other obstacles (trees) are removed from the field (out of play).
- Phase 3 is allocated a maximum of **60 seconds** to complete the objectives.

Rules

- Dropping light poles have no impact on the final score.
- Moving fence panels have no impact on the final score.
- The Robot Start Area will be used as a Trash Pile in this Phase.
- Refuse (trash) objects located "inside" the Trash Pile area at the end of the phase will score.
- Recyclable objects located "inside" the raised Recycle dumpster at the end of the phase will score.
- Reusable objects located "inside" the raised Reuse dumpster at the end of the phase will score.
- Reusable or Recyclable objects placed inside the Trash Pile will not score.
- Reusable or Refuse (trash) objects placed inside the Recycle dumpster will not score.
- Recyclable or Refuse (trash) objects placed inside the Reuse dumpster will not score.
- Each geometric object will represent 1 of 2 object types (see Table 2.2). The allocation of object types for this phase will be as indicated in Table 2.5.

Table 2.5. R^3 Object Allocations for Phases 3-6

Geometric Shape	Qty	Object Type (Material)	Point Value Each	Total Possible Points
Cup	2	Insulation	10	20
	2	Metal	20	40
Pentagon	2	Tile	20	40
	2	Plastic	25	50
Cylinder	2	Water Pipe	20	40
	2	Wire	25	50
Block	2	Cement Block	10	20
	2	Glass	25	50
			Max Points	310

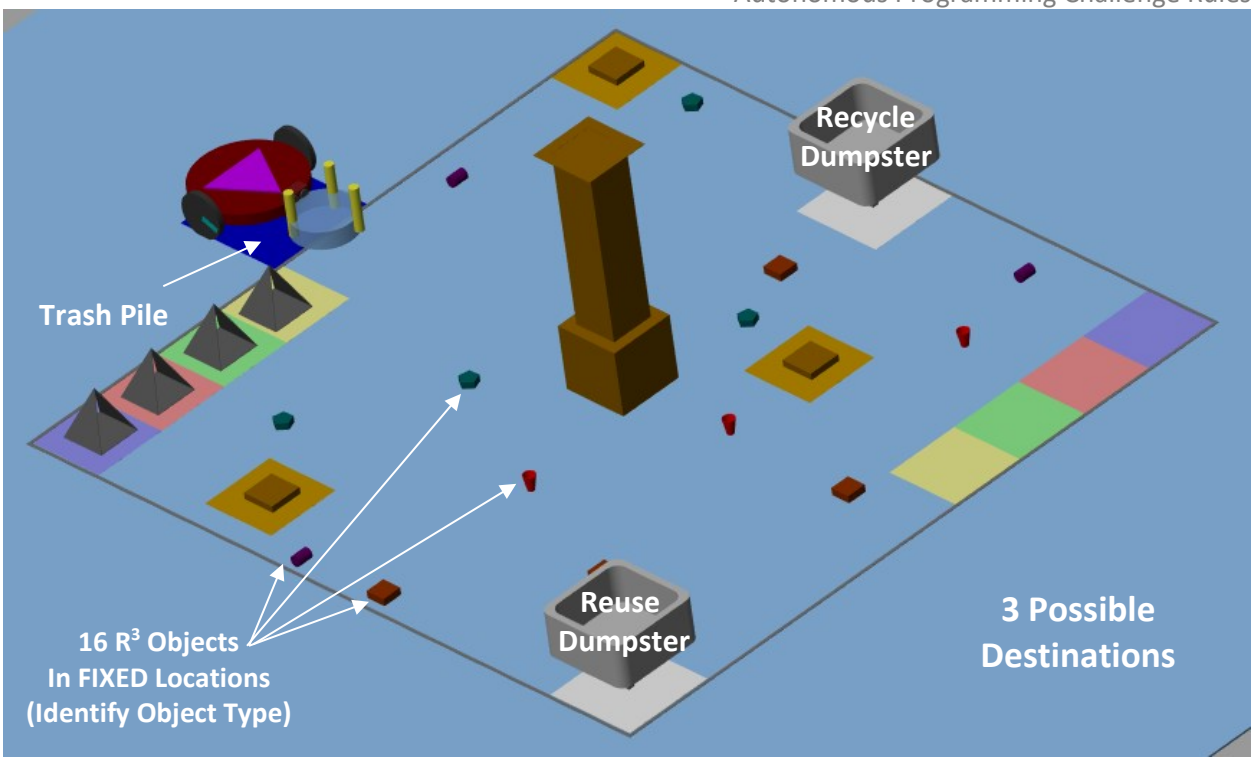


Figure 2.6. Phase 3 Field Layout and Objectives

2.7.5 Phase 4: Site Clean-Up and Site Salvage – Random

The objectives of Phase 4 are

- Locate and move all R^3 objects [Refuse (trash), Recyclable and Reusable] from **RANDOM** field locations to the appropriate collection points (Trash Pile, Recycle dumpster, Reuse dumpster, respectively).

Constraints

- Figure 2.7 represents the field layout expected during Phase 4.
- The building in the center of the field is an obstacle to avoid. Any collision between the robot and the building will stop the robot forward motion.
- Three (3) light poles are preloaded onto the virtual robot at the beginning of the phase. These light poles play no role in this Phase.
- All 16 R^3 game objects will be in random locations at the beginning of the phase. For each phase 4 run, the objects will start in unique random locations.
- All other obstacles (trees) are removed from the field (out of play).
- Phase 4 is allocated a maximum of **180 seconds** to complete the objectives.

Rules

- Dropping light poles have no impact on the final score.
- Moving fence panels have no impact on the final score.
- The Robot Start Area will be used as a Trash Pile in this Phase.

- Refuse (trash) objects located “inside” the Trash Pile area at the end of the phase will score.
- Recyclable objects located “inside” the raised Recycle dumpster at the end of the phase will score.
- Reusable objects located “inside” the raised Reuse dumpster at the end of the phase will score.
- Reusable or Recyclable objects placed inside the Trash Pile will not score.
- Reusable or Refuse (trash) objects placed inside the Recycle dumpster will not score.
- Recyclable or Refuse (trash) objects placed inside the Reuse dumpster will not score.
- Each geometric object will represent 1 of 2 object types (see Table 2.2). The allocation of object types for this phase will be as indicated in Table 2.5.

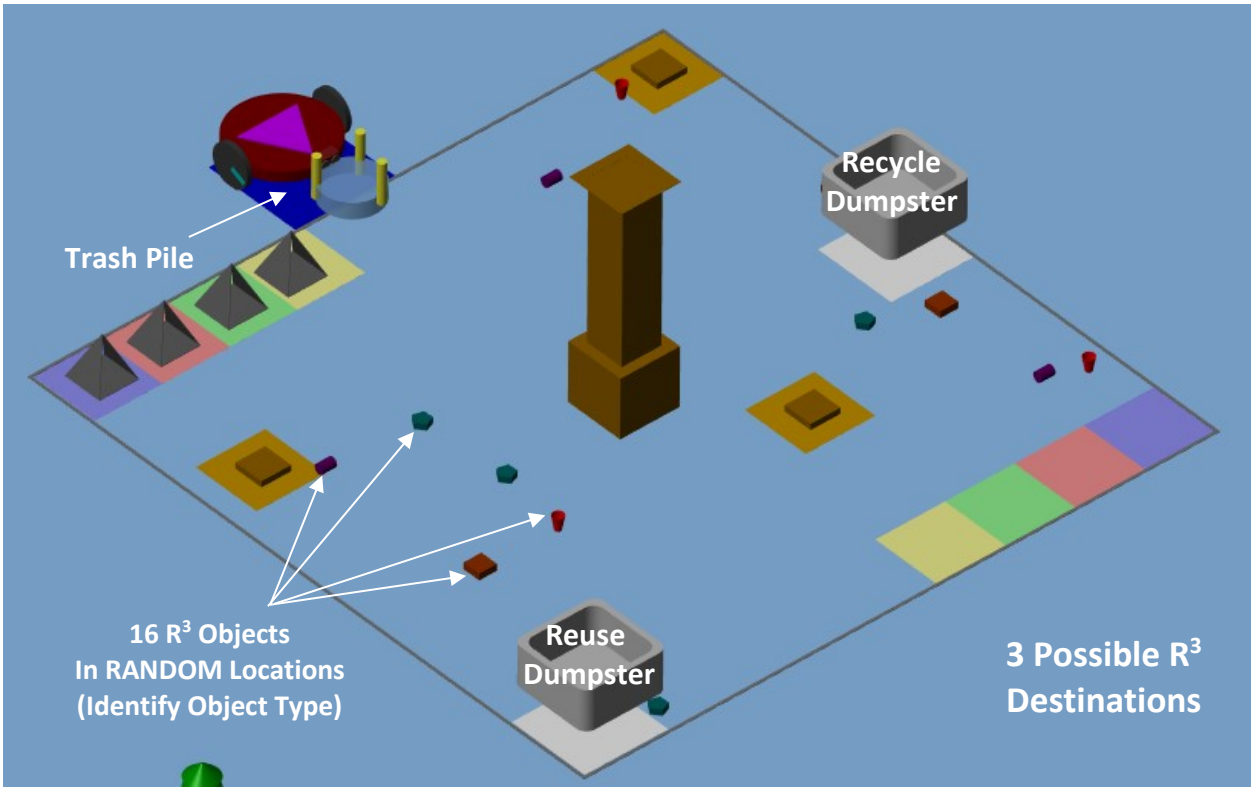


Figure 2.7. Phase 4 Field Layout & Objectives

2.7.6 Phase 5: Environmentally Conscious Site Clean-Up and Salvage

The objectives of Phase 5 are

- Locate and move all R^3 objects [Refuse (trash), Recyclable and Reusable] from **RANDOM** field locations to the appropriate collection points (Trash Pile, Recycle dumpster, Reuse dumpster, respectively).
- Avoid additional “Tree” Obstacles placed in RANDOM locations.

Constraints

- Figure 2.8 represents the field layout expected during Phase 5.

- The building in the center of the field and two additional trees are obstacles to avoid. Any collision between the robot and an obstacle will stop the robot forward motion.
- Three (3) light poles are preloaded onto the virtual robot at the beginning of the phase. These light poles play no role in this Phase.
- All 16 R^3 game objects will be in random locations at the beginning of the phase. For each phase 5 run, the objects will start in unique random locations.
- Two additional "tree" obstacles will be in random locations at the beginning of the phase. For each phase 5 run, the trees will start in unique random locations.
- Phase 5 is allocated a maximum of **200 seconds** to complete the objectives.

Rules

- Dropping light poles have no impact on the final score.
- Moving fence panels have no impact on the final score.
- The Robot Start Area will be used as a Trash Pile in this Phase.
- Refuse (trash) objects located "inside" the Trash Pile area at the end of the phase will score.
- Recyclable objects located "inside" the raised Recycle dumpster at the end of the phase will score.
- Reusable objects located "inside" the raised Reuse dumpster at the end of the phase will score.
- Reusable or Recyclable objects placed inside the Trash Pile will not score.
- Reusable or Refuse (trash) objects placed inside the Recycle dumpster will not score.
- Recyclable or Refuse (trash) objects placed inside the Reuse dumpster will not score.
- Each geometric object will represent 1 of 2 object types (see Table 2.2). The allocation of object types for this phase will be as indicated in Table 2.5.

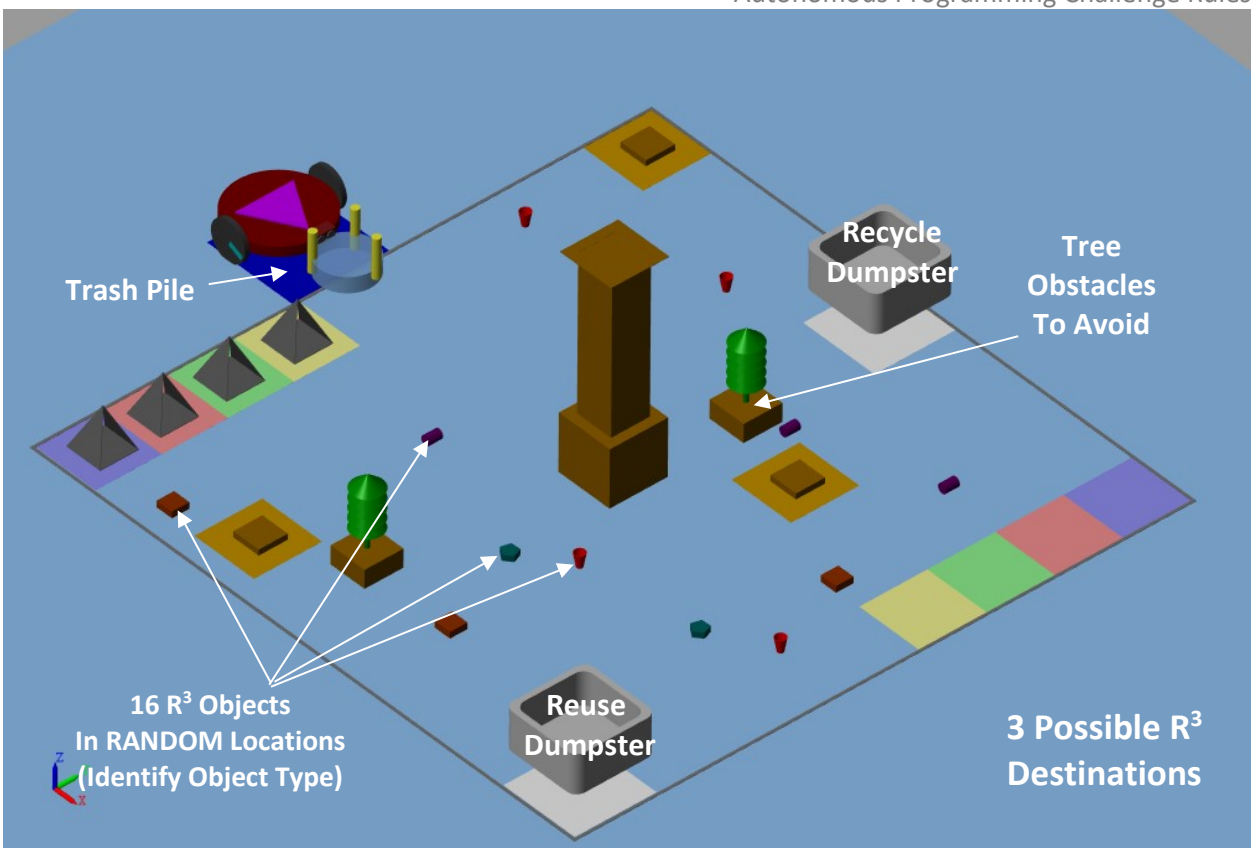


Figure 2.8. Phase 5 Field Layout and Objectives

2.7.7 Phase 6: Implement Site Security Measures AND Environmentally Conscious Site Cleanup & Salvage

The objectives of Phase 6 are

- Install security light poles on their designated platforms.
- Move fence objects to their final destinations.
- Locate and move all R^3 objects [Refuse (trash), Recyclable and Reusable] from **RANDOM** field locations to the appropriate collection points (Trash Pile, Recycle dumpster, Reuse dumpster, respectively).
- Avoid additional "Tree" Obstacles placed in RANDOM locations.

Constraints

- Figure 2.9 represents the field layout expected during Phase 5.
- The building in the center of the field and two trees are obstacles to avoid. Any collision between the robot and an obstacle will stop the robot forward motion.
- Three (3) light poles are preloaded onto the virtual robot at the beginning of the phase. Once dropped, the light pole(s) cannot be retrieved.
- All 16 R^3 game objects will be in random locations at the beginning of the phase. For each phase 6 run, the objects will start in unique random locations.
- Two "tree" obstacles will be in random locations at the beginning of the phase. For each phase 6 run, the trees will start in unique random locations.

- Phase 6 has no time limit imposed to complete the objectives. The amount of time required will be used as a tiebreaker when scores between teams are equivalent.

Rules

- Light poles must be dropped onto the installation platform (the inner square show highlighted in the diagram) to score.
- Each fence panel begins in a colored area of the Start Zone. That same fence panel must be placed in the SAME colored End Zone area to score.
- The Robot Start Area will be used as a Trash Pile in this Phase.
- Refuse (trash) objects located "inside" the Trash Pile area at the end of the phase will score.
- Recyclable objects located "inside" the raised Recycle dumpster at the end of the phase will score.
- Reusable objects located "inside" the raised Reuse dumpster at the end of the phase will score.
- Reusable or Recyclable objects placed inside the Trash Pile will not score.
- Reusable or Refuse (trash) objects placed inside the Recycle dumpster will not score.
- Recyclable or Refuse (trash) objects placed inside the Reuse dumpster will not score.
- Each geometric object will represent 1 of 2 object types (see Table 2.2). The allocation of object types for this phase will be as indicated in Table 2.5.

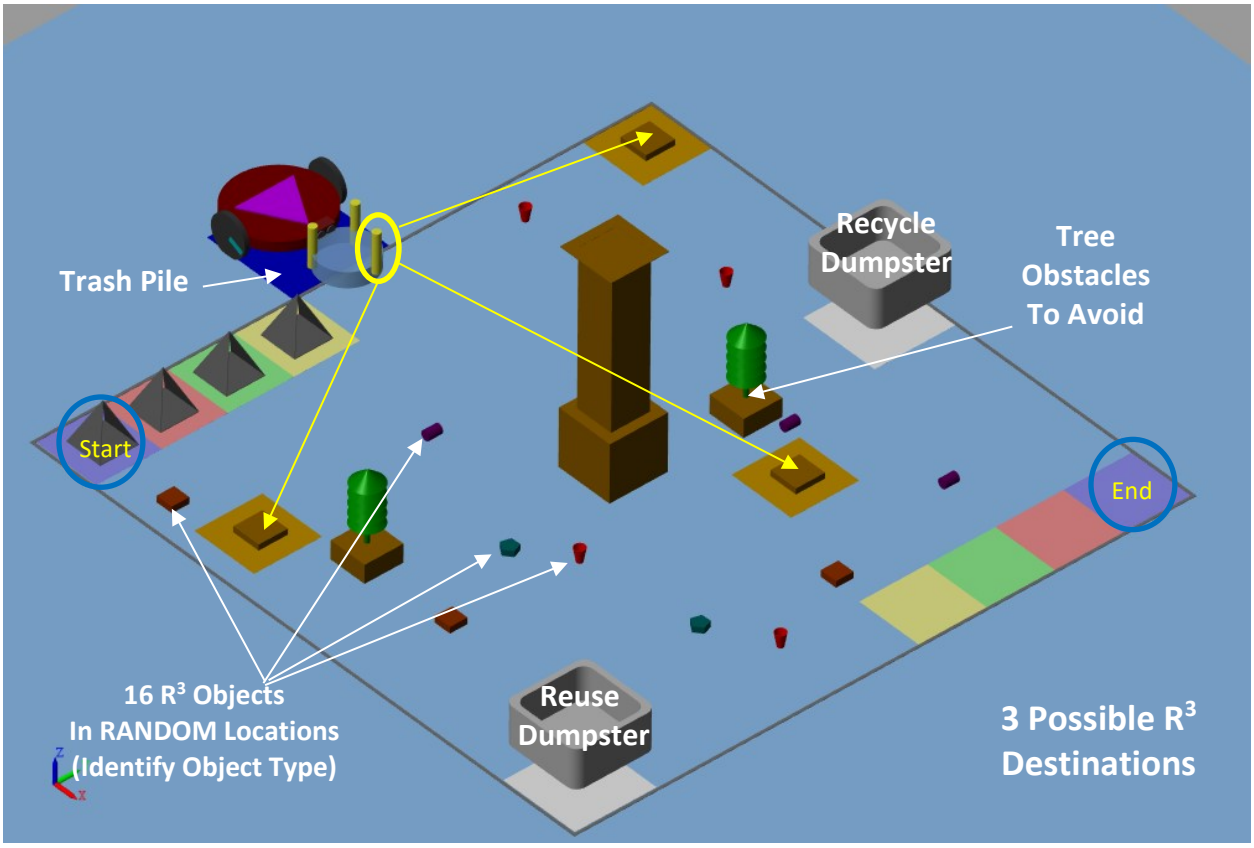


Figure 2.9. Phase 6 Field Layout and Objectives

2.8 Running Simulations

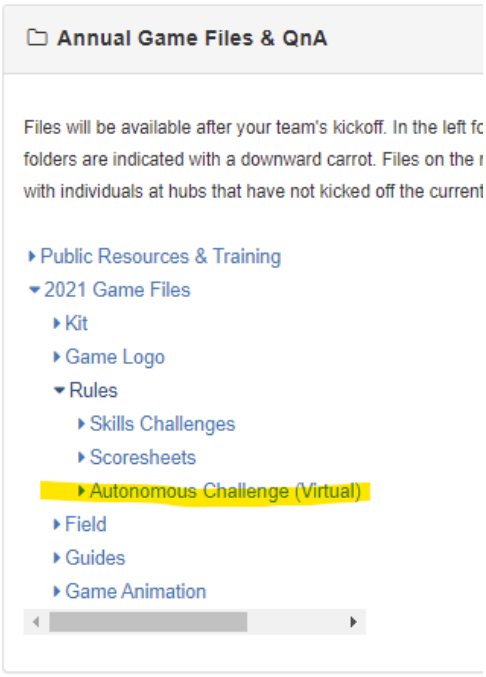
Each Phase requires a Game Configuration file that determines the field setup and objectives for the phase. These configuration file(s) must be loaded into the same folder as your Simulink model before beginning the simulation.

2.8.1 Simulation Setup

1. Initial Game Configuration Files for each phase will be provided at the beginning of the Challenge. Final Game Configuration Files will be provided at the beginning of week 8 of the challenge.
    a. The starting coordinates of any Fixed Location objects will not change between the Initial and Final configuration files, although the R^3 Object Types may change.
    b. The starting coordinates for R^3 objects may be fixed or random, depending on the Phase. When the R^3 locations are randomized, the random start locations are determined on each phase simulation run.
    c. For Phases 5 & 6, the tree obstacle locations are randomized on each phase simulation run.
    d. The Game Configuration Files (Initial & Final) will be available through your Team Workflow, Annual Game Files Panel. The filenames will be as shown in Table 2.6. ***These configuration files MUST be stored in the same folder as your Simulink Model. The filenames must be as shown in the table; DO NOT alter the filenames.***

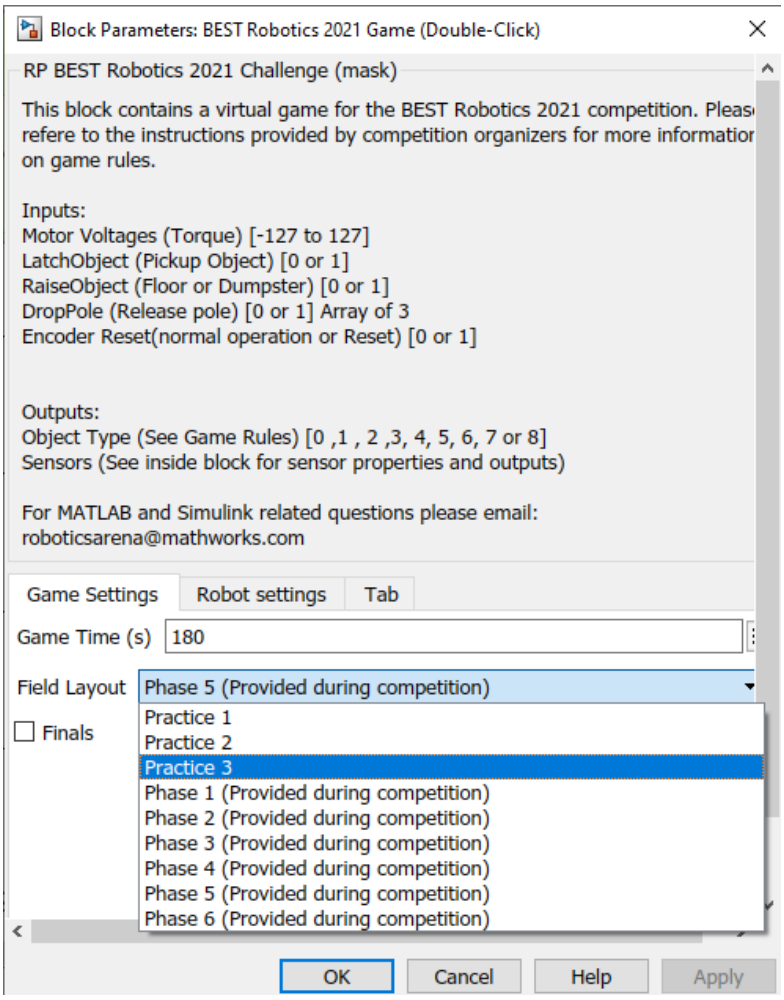
Table 2.6. Game Configuration Filenames

Initial Game Config Files	Final Game Config Files (available in Week 8)
BEST2021GameConfig1.m	BEST2021GameConfigFinal1.m
BEST2021GameConfig2.m	BEST2021GameConfigFinal2.m
BEST2021GameConfig3.m	BEST2021GameConfigFinal3.m
BEST2021GameConfig4.m	BEST2021GameConfigFinal4.m
BEST2021GameConfig5.m	BEST2021GameConfigFinal5.m
BEST2021GameConfig6.m	BEST2021GameConfigFinal6.m



2. For your Final runs in the Trial Period, be certain that the Final Competition Phase configuration file has been downloaded and stored in the same directory as your Simulink model. There are 6 configuration files, one for each of the 6 Phases. ***These configuration files MUST be stored in the same folder as your Simulink Model.***
    a. BEST2021GameConfigFinal1
    b. BEST2021GameConfigFinal2
    c. BEST2021GameConfigFinal3
    d. BEST2021GameConfigFinal4
    e. BEST2021GameConfigFinal5
    f. BEST2021GameConfigFinal6

3. Double-click on the 2021 BEST Game block and on the Game Settings tab
    a. Set the Game Time to the maximum time allow for the Phase being simulated.
    b. Select the Competition Phase (1-6) from the pulldown menu.
    c. For FINAL phase runs (Week 8), be certain to select the “Finals” checkbox.



4. Three (3) Practice field configurations are provided when you initially install the Robotics Playground software. These 3 configurations are not identical to ANY of the Phase1 – Phase6 initial or final field configurations. They are STRICTLY for your own practice use.
5. If you download or use the incorrect Field configuration for a Phase, and you submit this as Final results, you will receive a score of 0 for that Phase.
6. Click OK to accept the configuration selected.
7. You may press Ctrl-D to update the diagram, compile the model and open Simscape Explorer (3D view). Game Pieces will not populate on the field until the simulation is started.

2.8.2 Simscape Mechanics Explorer View

The Simscape Mechanics Explorer view defaults to a 3-camera view of your robot and the environment. You can resize and re-orient these camera views however you would like for your simulation run. However, we request that the Top View OR Isometric View be included in your final video capture that you submit.

You can see may of the controls available to you in the Mechanics Explorer. A menu of environment objects will appear in a window to the left when you initially open the viewer. Simply click on the arrow icons to close this menu and make your 3D views full screen (see Figure 2.10).

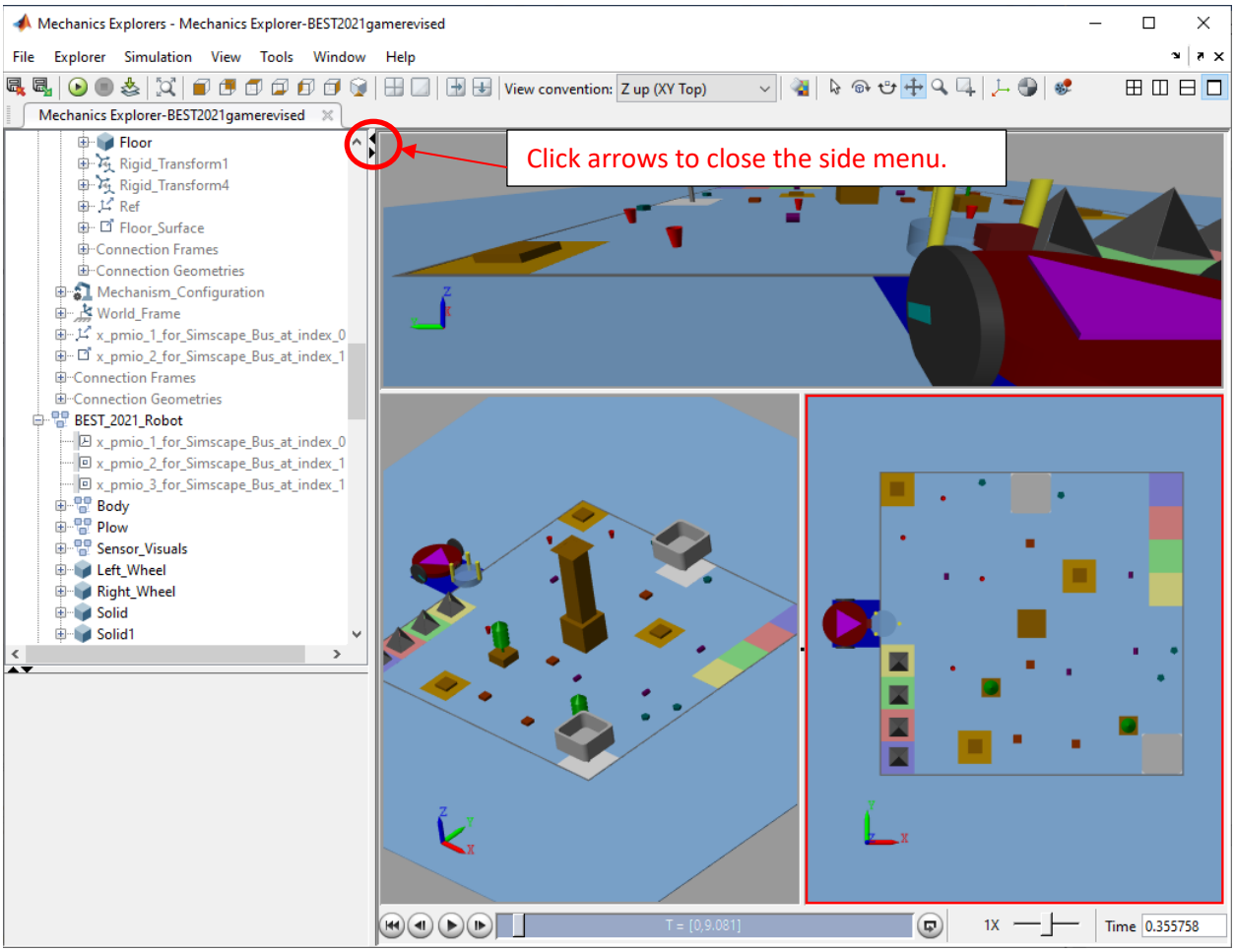


Figure 2.10. Simscape Mechanics Explorer Default

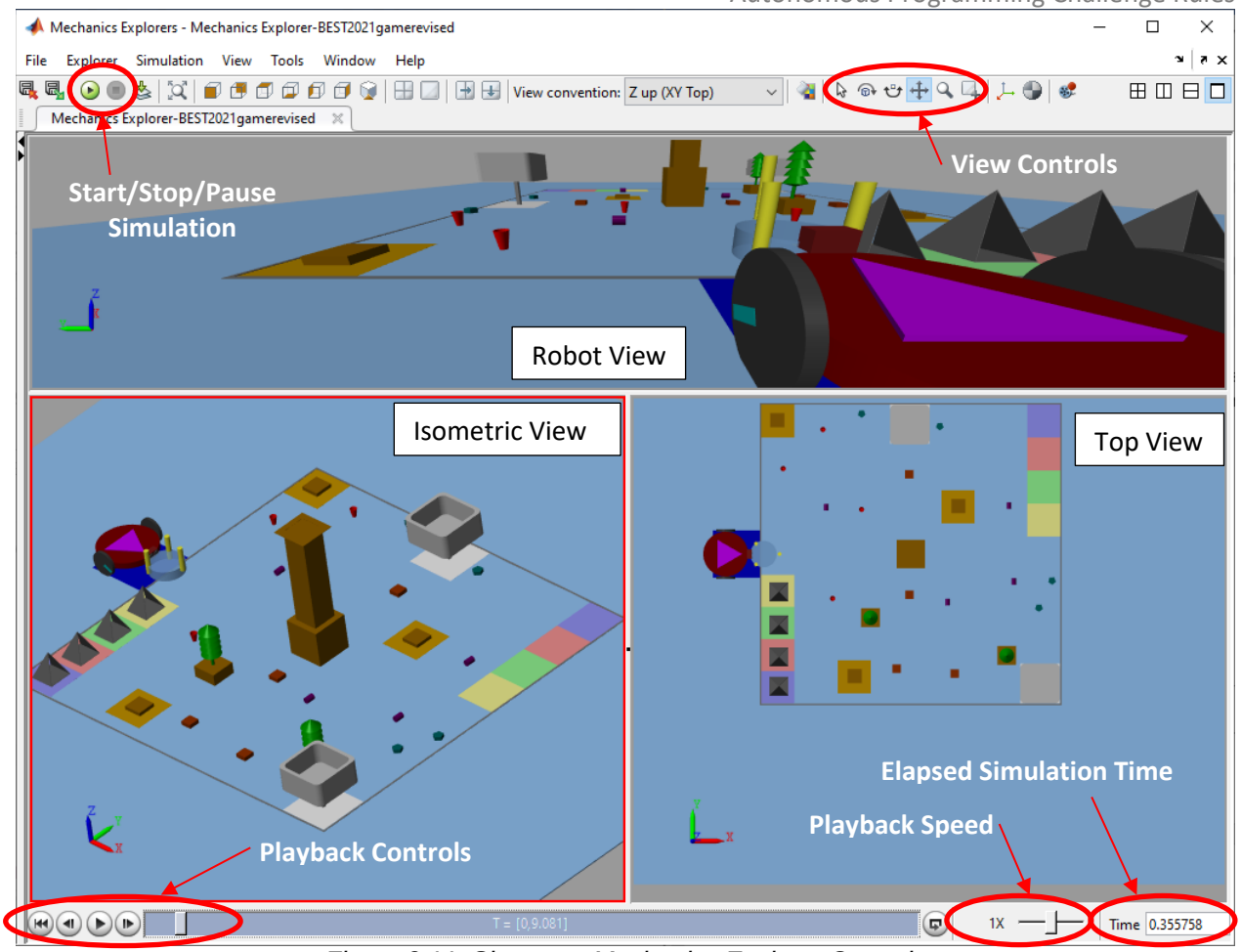
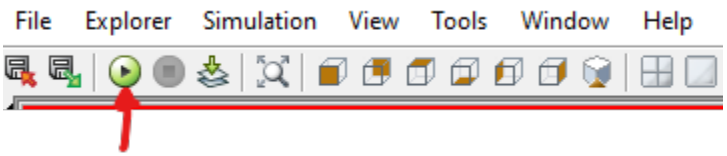


Figure 2.11. Simscape Mechanics Explorer Controls

2.8.3 Running the Phase Simulation

1. You can start the simulation run through either the Simulink Model (RUN button) or the Simscape Mechanics Explorer window (Run icon at top of screen).

2. Start the simulation by pressing the Start Simulation button ▷ along the top menu of the Mechanics Explorer window.



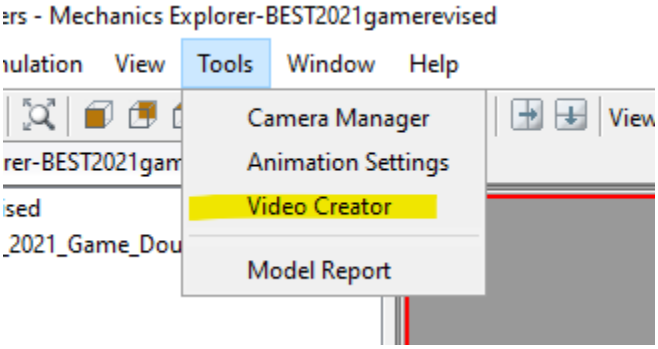
When the simulation is activated, the Mechanics Explorer view should be visible.

The timer in the lower right corner of the window will show the time elapsed during the phase simulation. This counter will increment to the maximum number of seconds defined on simulation setup dialogue and will stop the simulation at that time. All inputs to the simulation will be ignored after that point.

2.8.4 Generating a Video of the Simulation

2.8.4.1 Running on a PC

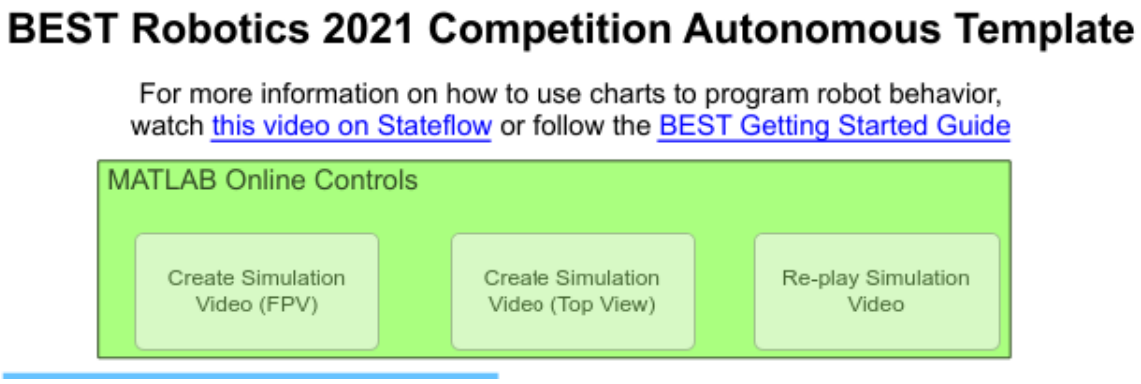
After the simulation completes, to generate a video of the resulting simulation, simply use the Video Creator menu from the Mechanics Explorer window.



REMEMBER, the video is required as part of your FINAL results submission. Be certain that the video matches your simulation run when you upload final results. If the judges determine a mismatch between the video, results and your Simulink model, you may lose all points for that phase.

2.8.4.2 Using MATLAB/Simulink Online

When using MATLAB Online, you must create the video using the green buttons provided on the Simulink Model. Do NOT delete these buttons! After you complete a simulation for a phase and are happy with it. Click on the "Create Simulation (Top View)" button. The simulation will repeat and the video will be captured.



2.8.5 Uploading Final Results

Be certain that you have downloaded the *uploadPhaseResults.p* script and *MyMultipartFormProvider.m* file from your Annual Game Files, prior to running your final Phase simulation. This script is necessary to

complete upload of your final Phase simulation results. Store these scripts in the same directory as your Simulink model.

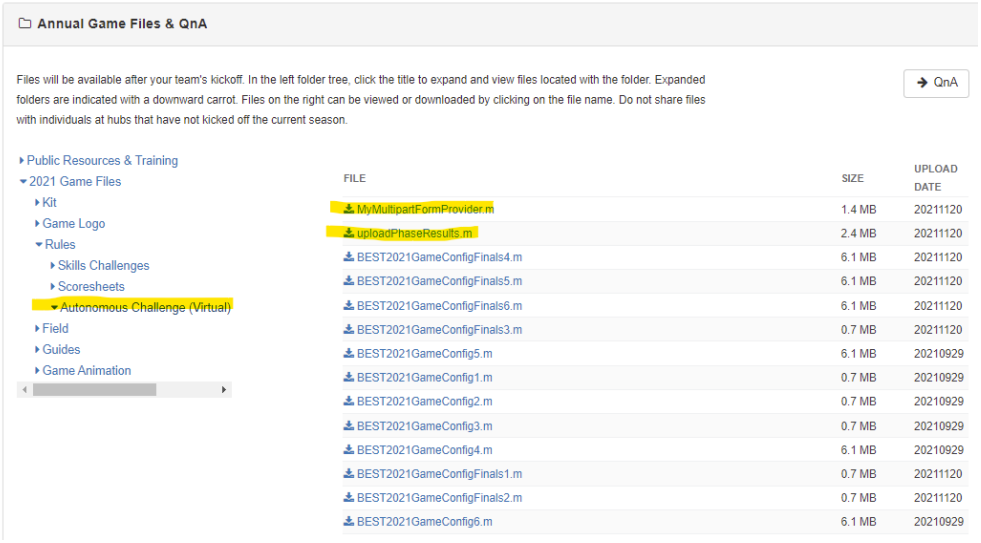
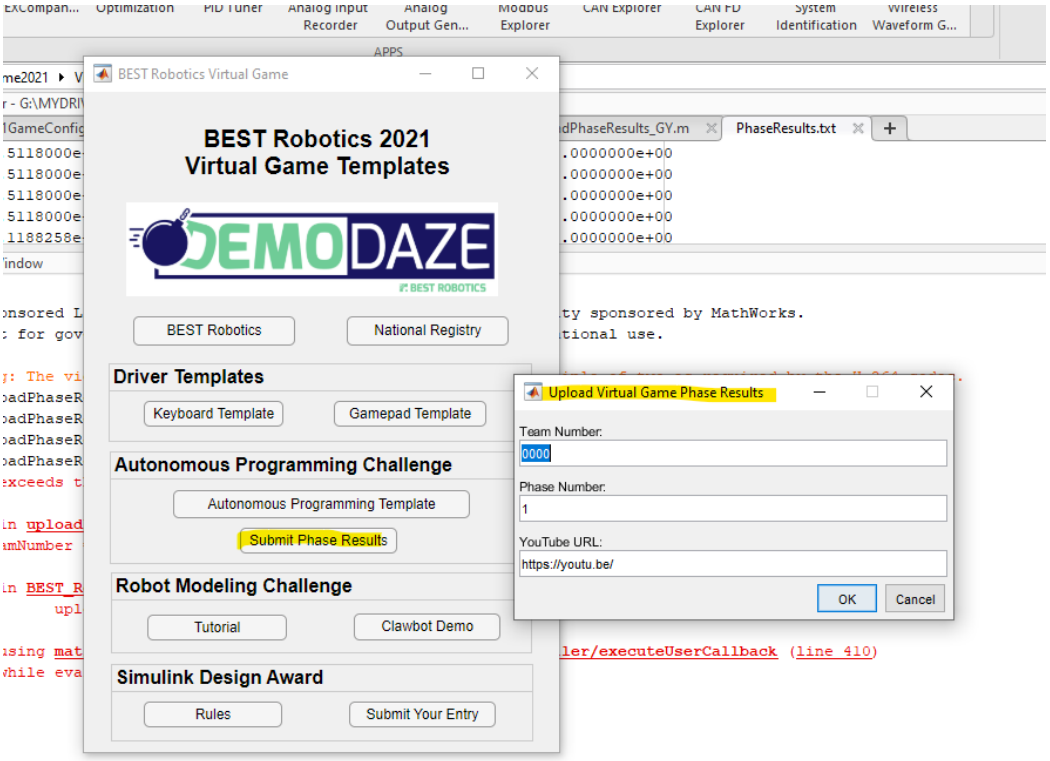
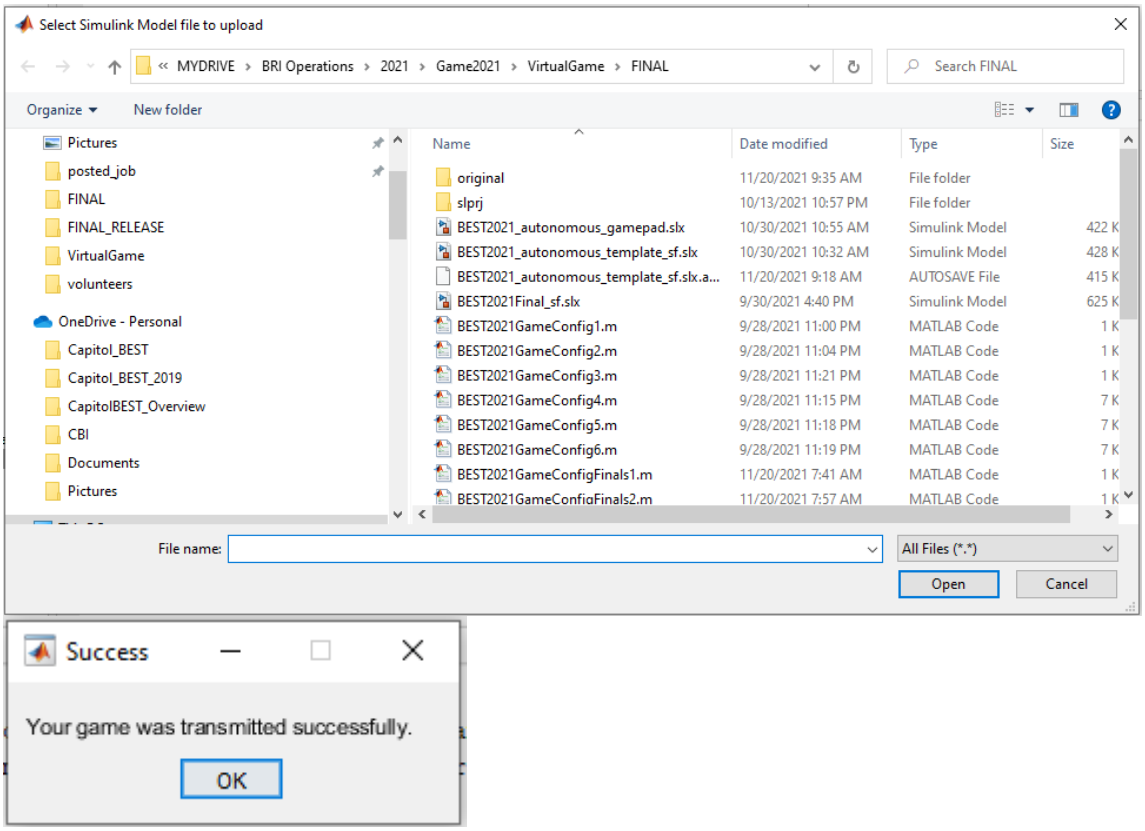


Figure 2.12. BEST Robotics App

After completing your final simulation and video capture/upload for each Phase, invoke the uploadPhaseResults script by clicking on the ***Submit Phase Results*** button in the BEST Robotics App (or type *uploadPhaseResults.p* in the MATLAB command window after simulation completes).



1. When the form pops up, fill in the correct information for the Phase results being submitted.
    a. Team Number
    b. Phase Number
    c. YouTube Video URL
2. Click OK
3. You will be prompted to select and load the Simulink Model (.slx)
4. Be Patient, a popup dialogue will appear indicating the upload was successful.



2.9 Evaluation

2.9.1 Hub Level Ranking and Awards

1. Each participating team's total cumulative score from all phases they completed and submitted will be ranked against all participating teams from their Hub.
2. The team scoring the most cumulative points will receive the 1st place award for this skill challenge.
3. Ties will be broken using the Phase 6 simulation time required.

2.9.2 National Level Ranking and Awards

1. Each participating team's total cumulative score from all phases they completed and submitted will be ranked against all participating teams nationally (i.e., from every Hub).
2. The team scoring the most cumulative points will receive the 1st place award for this skill challenge.
3. Ties will be broken using the Phase 6 simulation time required.