

MathWorks Minidrone Competition

Rules and Guidelines

Table of Contents

A. Competition Overview	2
B. Simulation Round	3
B.1 Pre-work	3
B.2 Rules.....	3
B.3 Judging.....	3
B.4 Submission.....	4
C. Simulation and Deployment Round.....	5
C.1 General Guidelines	5
C.2 Competition Set-Up.....	5
C.3 Scoring and Judging	6
D. Safety Rules	8
E. Participation Requirements	8
F. Arena Information	9
G. Reference Material	10

This document was last updated on 22 January 2020.

A. Competition Overview

The MathWorks Minidrone Competition will introduce participants to Model-Based Design using [Simulink](#).

The competition consists of two rounds:

- **Round 1 Simulation Round** Teams will work virtually on designing a Minidrone line follower algorithm. Teams will need to use their modeling skills to refine a Simulink model.
- **Round 2 Simulation and Hardware Deployment Round** The teams that qualify from the virtual Round 1 will be invited to the Round 2 live event. Teams will deploy their Simulink model at the live event on the [Parrot Mambo Minidrone](#) hardware using the [Simulink Support Package for Parrot Minidrones](#).

MathWorks will provide each participating team with complimentary software to work on the problem statement. The teams will also be provided with the Parrot Mambo Fly drone, batteries and, dongle on the day of the competition.

B. Simulation Round

This is the virtual round of the competition which will aim at performing the line follower task in simulation using Simulink.

B.1 Pre-work

- Participating teams are expected to complete *MATLAB Onramp*, *Simulink Onramp*, and *Stateflow Onramp* courses before starting to work on their algorithm.
- It is recommended that participating teams view the video series *MathWorks Minidrone Competition* to better understand the competition details.

B.2 Rules

- Teams can use only the latest release of Simulink and related MathWorks products to complete the task.
- The complete logic for the task completion must be contained in the *parrotMinidroneCompetition* folder that the teams submit for Round 1 evaluations.
- The models that the teams submit should be code generation capable. More details about this can be found in [this](#) video.

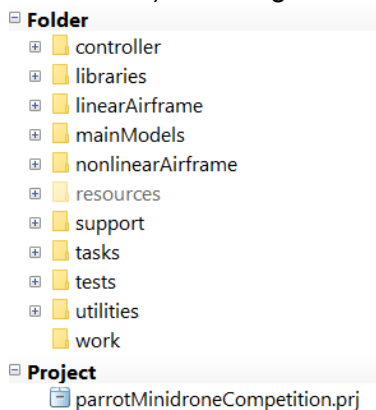
B.3 Judging

- This round will be judged by MathWorks engineers.
- The model will be evaluated based on the capability of completing the line follower track followed by landing on the circular marker.
- The model must be code generation capable.
- The model will be tested on multiple tracks with multiple number of track sections oriented at different angles. The color of the track for the simulation round will be Red (#FF0000).
- The model performance will be verified using an internal judging interface prioritizing the algorithm in the following order:
 - Code generation capability of the model
 - Number of tracks completed by the Minidrone including soft landing on the circular marker
 - Accuracy of the path traced by the drone with respect to the track laid in the Simulink 3D environment
 - Time taken by the drone to complete a track
 - Complexity of the model
- The most efficient and accurate algorithms that complete maximum number of tracks in the shortest simulation time will be shortlisted for Round 2.
- The decision made by the judges will be final.

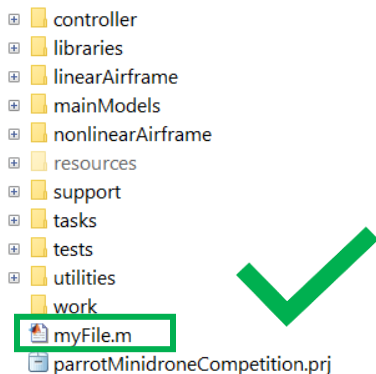
B.4 Submission

To submit an entry, the team captain needs to send the Simulink Project files to MathWorks. To do so, please use the following guidelines.

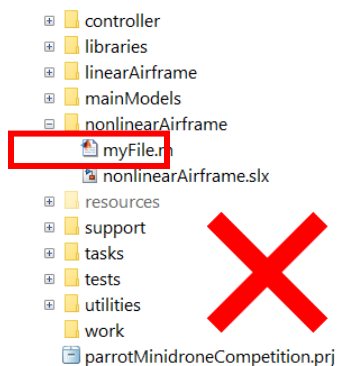
1. Ensure that you retain the original file and folder structure from the *parrotMinidroneCompetition* project (from the Simulink Support Package for Parrot Minidrones). The original folder structure looks like the following:



2. Ensure that all the Simulink models and MATLAB files have the same names as in the original *parrotMinidroneCompetition* project.
3. Do not add any Simulink models or MATLAB files to the subfolders. If you have written any additional MATLAB files or Simulink models, you can add them to the main *parrotMinidroneCompetition* model folder. For example, if you have created a new file supporting your model called *myFile.m*, add the file to the folder as shown by the screenshot with the check mark. Do **not** add the files inside a subfolder like in the second screenshot with the X:



myFile.m outside the subfolders



myFile.m present inside a subfolder

4. Compress the main *parrotMinidroneCompetition* folder. The acceptable compression formats are *.zip*, *.rar*, and *.tar.gz*.

5. Rename the compressed folder to `<TeamName>` where `<TeamName>` is the name of your team. Send the model to roboticsarena@mathworks.com with the subject as '`<TeamName> at <EventName> <EventYear>`' where `<EventName>` is the name of the event as found on the web page for the competition (often a location, conference, or university) and `<EventYear>` is the year when the deployment round of the competition is to be held. For example, if your team name is 'Drone Squad' and you are participating in the event at IROS 2019, your email would be titled 'Drone Squad at IROS 2019'.
6. The Team Captain should submit the model using their registered email address.

C. Simulation Round

C.1 General Guidelines

- Round 2 of the competition will be judged by a designated set of engineers organizing the event.
- The Minidrone should follow the line follower track laid on the arena and land on the *End Circular Marker* in the shortest time to win.
- Teams will be ranked in the ascending order of time taken to complete the track and land on the circular marker.
- The track will be divided into multiple sections. The track will have only straight lines and no smooth curves.
- The track will be disclosed to the teams only on the day of the deployment round.
- The track layout can differ between Practice Round and the Live Round. However, the color of the track will remain the same.

C.2 Competition Set-Up

The deployment round will be one- or two-day event. The competition will be divided into two parts:

a. Practice Round:

- In this round, each team gets **two slots of 15 minutes each** in the Arena to calibrate their model gains and thresholds.

Performance of the Minidrone during this round will not be considered to declare the winners.

b. Live Round:

- Each team will get one **15-minute** assigned slot in the arena. This includes the setup time and the Minidrone flight.
- Each team gets **maximum 7 chances** during the 15 minutes to fly the Minidrone.

Note: The time allocated for each round may vary depending on the judge and will be communicated to the teams by the judge before the round begins.

C.3 Scoring and Judging

- The judge will be responsible for assessing the Minidrone's *Stage* in a given Minidrone run.
- The decision of the judges will be final.
- The scoring will be based on the conditions if the team has landed their drone correctly on the circular marker or not:
 - If the drone is in Stage Complete:
 - **The time factor will come into account only when the drone is in *Stage Complete*.**
 - The team that reaches Stage Complete in the shortest time, wins the competition.
 - A team is in *Stage Complete* when the Minidrone bottom touches the landing marker and stays there.
 - The judge will note the time from the Minidrone's takeoff to landing.
 - If a team does not reach Stage Complete:
 - The consistency of the algorithm will be considered.
 - They will be ranked based on the farthest stage they have reached and the number of times they reached it (so the team that reached the farthest stage the highest number of times would be given a higher ranking).
 - To understand the evaluations, let us take an example. Let's assume that the competition had 4 sections and seven teams in the final. We would name Stage Land as Stage 5 and Stage Complete as Stage 6, for convenience (See Note).

			stages	time
1	IJK	👑	• 6 5 3 3 2 2 1	00:48.65
2	ABC	👑	• 6 5 2 5 6 3 6	00:50.32
3	DEF	👑	• 2 5 5 3 4 2 -	NaT
4	PQR	-	• 3 3 3 1 5 2 1	NaT
5	XYZ	-	• 5 2 2 3 3 2 1	NaT
6	UVW	-	• 1 2 2 2 2 1 2	NaT
7	LMN	-	• 1 1 1 1 1 1 1	NaT

- Team *IJK* has been ranked higher than team *ABC* because team *IJK* completed the task in the shortest time even though team *ABC* has completed Stage 6 (Stage Complete) a greater number of times in the seven attempts.
- The farthest stage team *DEF* and team *PQR* have reached is Stage 5. However, team *DEF* has reached Stage 5 two times whereas team *PQR* has reached the stage just once. Hence, team *DEF* has been ranked higher.

Note: The scoring criteria used for evaluation will be based on the maximum number of section stages the Minidrone has completed. The following are the guidelines for the division of the task into stages (N is the number of track sections):

- **Stage 0:** Take off complete
- **Stage 1:** Track Section 1 complete
- **Stage 2:** Track Section 2 complete
- **Stage 3:** Track Section 3 complete
- **Stage 4:** Track Section 4 complete
- .
- .
- .
- **Stage N:** Track Section N complete
- **Stage Land:** Landing Complete
- **Stage Complete:** Validating landing on the circular marker

A few examples of correct and incorrect landings are illustrated below:

Successful landings:

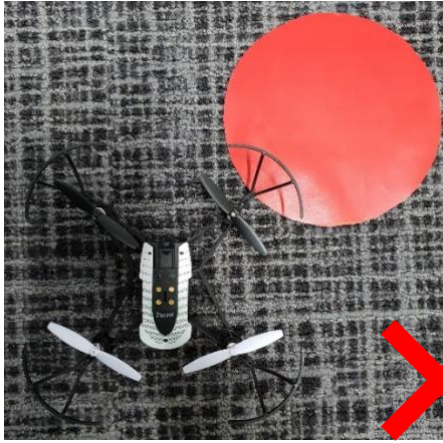


Complete minidrone landing on the circle



A part of minidrone landing on the circle

Unsuccessful Landings:



Minidrone's bumper hovering over the circle



Minidrone landing upside down on the circle

D. Safety Rules

- Teams will not be allowed to fly the Minidrone outside the arena.
- No team member can enter the Arena while the Minidrone is flying.
- No team member is allowed in the Arena during the Live Round. The Judge will oversee placing the Minidrone at the necessary location on the track.
- Team members entering the arena during the Practice Round must wear safety goggles which will be available on the day of the competition.
- If the Minidrone crashes into the net during a live round run, the entry for that run will be disqualified.

E. Participation Requirements

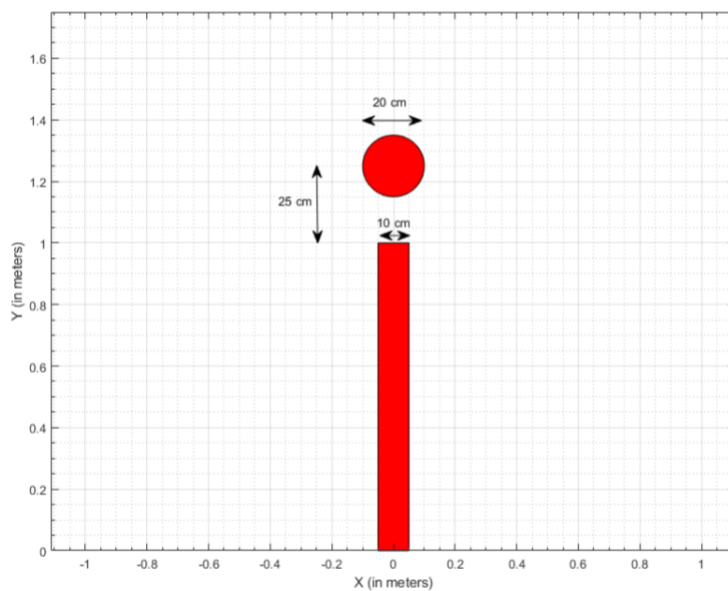
It is mandatory for teams to be present on the day of the deployment round with the following:

- **MATLAB installation:**
A system with the latest release of MATLAB used during the simulation round installed.
For example, if the simulation round of the competition was launched when R2019b was the latest release, the teams are expected to be present for the Round 2 of the competition with R2019b even if R2020a may be released by that time.
- **Hardware Support Package installation:**
Teams should install 'Simulink Support Package for Parrot Minidrones'. The procedure for installation of the support package can be found below:
<https://www.mathworks.com/help/supportpkg/parrot/ug/install-support-for-parrot-minidrone.html>
- **Competition Model:**
The submitted simulation model with changes, if necessary.

F. Arena Information

The following are the details about the arena track:

- The arena would be a rectangular space enclosed by nets on all sides.
- The arena track will be 10 cm in width.
- The landing circular marker will have a diameter of 20 cm.
- The line follower track will consist of connected line segments only and will not have any smooth curves at the connections.
- The distance from the end of the track to the center of the circle will be 25 cm.
- The color and the track will be disclosed on the day of the competition.
- The background will not be a single color and will have texture.
- The track for the Practice Round and the Live Round may be different.



G. Reference Material

- Recommended Tutorials:
 - MATLAB Onramp:
<https://matlabacademy.mathworks.com/>
 - Simulink Onramp:
<https://www.mathworks.com/learn/tutorials/simulink-onramp.html>
 - Stateflow Onramp:
<https://www.mathworks.com/learn/tutorials/simulink-onramp.html>
 - MathWorks Minidrone Competition Video Series
<https://www.mathworks.com/videos/series/mathworks-minidrone-competition.html>
- Additional Video Tutorials:
 - Programming Drones using Simulink:
<https://www.mathworks.com/videos/programming-drones-with-simulink-1513024653640.html>
 - Tech Talk on Drone Simulation and Control:
<https://www.mathworks.com/videos/series/drone-simulation-and-control.html>
 - Tutorials on Computer Vision and Code Generation:
<https://www.mathworks.com/academia/student-competitions/tutorials-videos.html>
 - Tech Talk on State Machines:
<https://www.mathworks.com/videos/tech-talks/state-machines.html>
 - Tutorials on Stateflow:
<https://www.mathworks.com/videos/series/stateflow-tutorials-94460.html>
- Documentation Links:
 - Simulink Support Package for Parrot Minidrones:
<https://www.mathworks.com/hardware-support/parrot-minidrones.html>
<https://www.mathworks.com/help/supportpkg/parrot/index.html>
 - Aerospace Blockset:
<https://www.mathworks.com/products/aeroblks.html>
 - Simulink 3D Animation:
<https://www.mathworks.com/products/3d-animation.html>
 - Stateflow:
<https://www.mathworks.com/products/stateflow.html>
 - Color Thresholder App:
<https://www.mathworks.com/help/images/ref/colorthresholder-app.html>