MathWorks Minidrone Competition

Rules and Guidelines Document

Contents

This Document was last Updated in August 2025

1 Competition Overview

- The MathWorks Minidrone Competition introduces participants to Model-Based Design using Simulink. It offers an opportunity to gain expertise in developing an autonomous line-following algorithm for a quadcopter, utilizing the relevant MATLAB & Simulink toolboxes.
- The competition is conducted in two formats: In-Person and Virtual. Both formats consist of two rounds. Round 1 is common for both the formats, while Round 2 differs based on the competition format.
    - **Round 1 Simulation Round:** Teams will work virtually on designing a Minidrone line follower algorithm. Participants will need to use their modeling skills to refine the given Simulink model.
    - **Round 2 – Format-Specific**

      In-Person Format – Hardware Deployment Round: Teams that qualify from Round 1 will be invited to a live, in-person event. During this round, teams will deploy their Simulink model onto a Parrot Mambo Minidrone using the Simulink Support Package for Parrot Minidrones

      (Or)
    - **Virtual Format – Video Presentation Round:** Participants qualifying from Round 1 will be invited to the virtual Round 2 event. Shortlisted teams must submit a 5-7 minute video explaining their approach to solving the problem. The video will be showcased during the event, followed by a Q&A session with the team.

- MathWorks will provide each participating team with a complimentary software license to work on the problem statement. In the case of an in-person event, teams will be provided with the necessary hardware, including the drone and required accessories, on the day of the finals

1.1 Pre-work

- It is recommended that participants view the video series MathWorks Minidrone Competition to better understand the competition details.
- Participants are expected to complete MATLAB Onramp, Simulink Onramp, Stateflow Onramp, and Image processing and Computer vision Onramp courses before starting to work on their algorithm.

2 Round 1 - Simulation Round

- In this round, teams will be provided with a starting point model and are expected to work inside the flight control system block to develop a robust line follower algorithm for the quadcopter using relevant toolboxes available in the MATLAB & Simulink.
    - To access the competition starting point model, participants must install the 'Simulink support package for parrot minidrones' and run the command

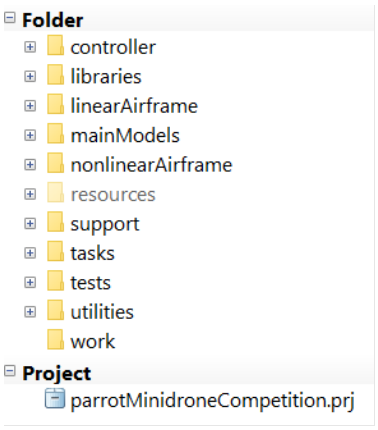
parrotMinidroneCompetitionStart. This opens a new project, where participants should develop their algorithm inside the 'flightControlSystem' model. For more details on accessing the model, please watch the Minidrone video series.

- **Note:** To run this project, the MATLAB must have the following toolboxes installed.
  - MATLAB
  - Simulink
  - Aerospace Toolbox
  - Aerospace Blockset
  - Computer Vision Toolbox
  - Control System Toolbox
  - DSP System toolbox
  - Embedded Coder
  - Image Processing Toolbox
  - MATLAB Coder
  - Motor control blockset
  - Optimization Toolbox
  - Signal Processing Toolbox
  - Simulink 3D Animation
  - Simulink Coder
  - Simulink Design Optimization
  - Stateflow
  - System Identification Toolbox
  - UAV toolbox

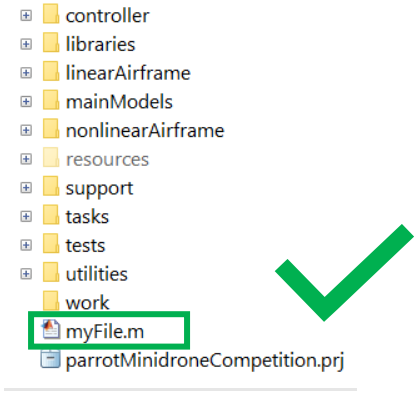
- The developed algorithm must be submitted as a project by filling out the submission form (Submit your entry) on the webpage.
- Detailed guidelines for submission and the evaluation process are provided in the following sections.

2.1 Submission – Guidelines

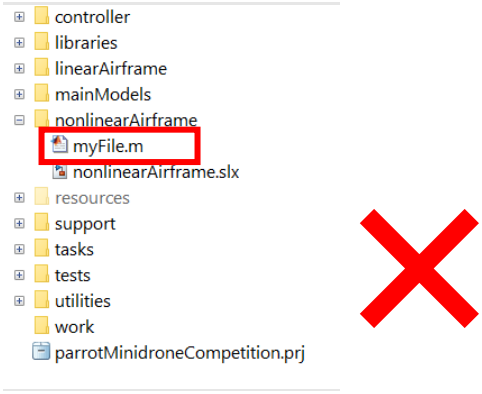
- The complete logic for the task completion must be contained in the *parrotMinidroneCompetition* folder that the teams submit for Round 1 evaluations.
- To submit an entry, the team captain needs to share the Project files with MathWorks. To do so, please use the following guidelines.
  1. **Ensure correct folder structure:**
     - 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:



- Ensure that all the Simulink models and MATLAB files have the same names as in the original *parrotMinidroneCompetition* project.
- Do not add any Simulink models or MATLAB files to the subfolders. If you have used 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:



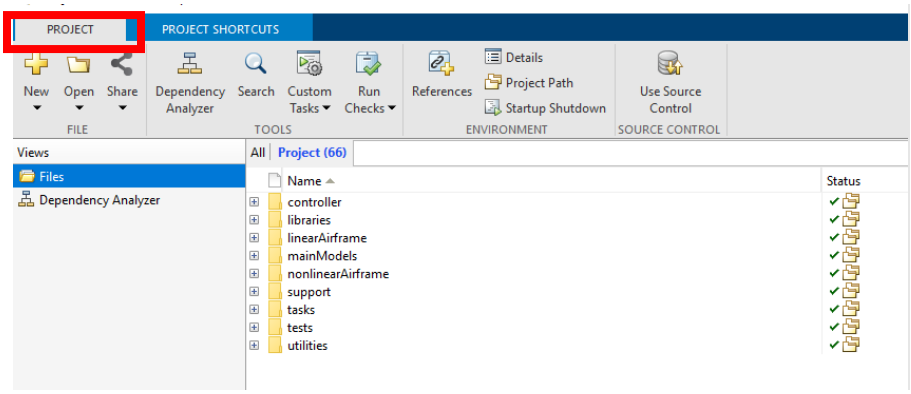
myFile.m outside the subfolders



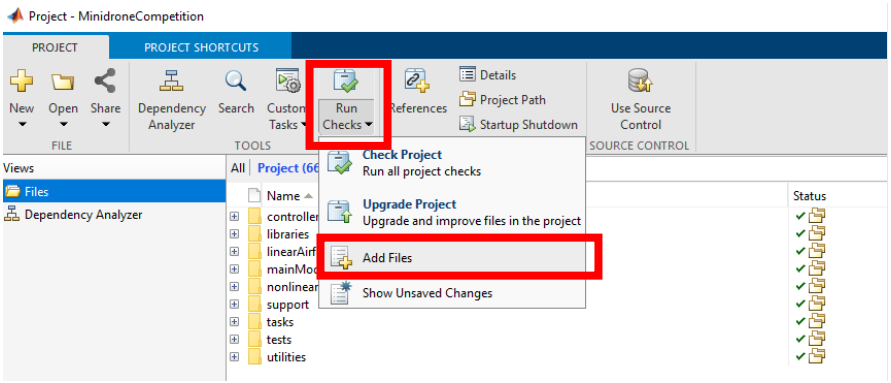
myFile.m present inside a subfolder

2. Add additional files to the project

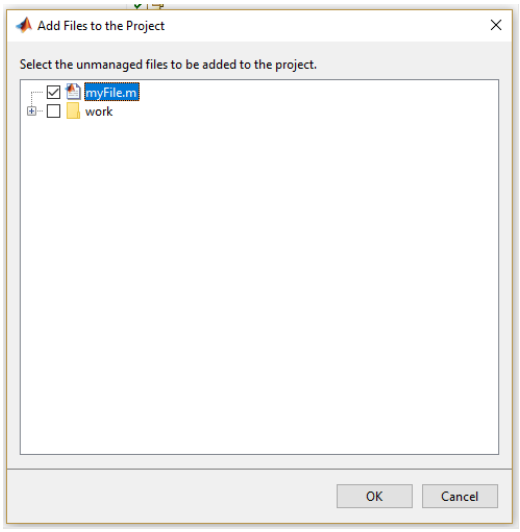
- *Note:* Move to *(3) Submit Project Archive* if there aren't any additional files to be added.
- Add the necessary files to the Project by navigating to Project tab



- Select Run Checks -> Add Files.

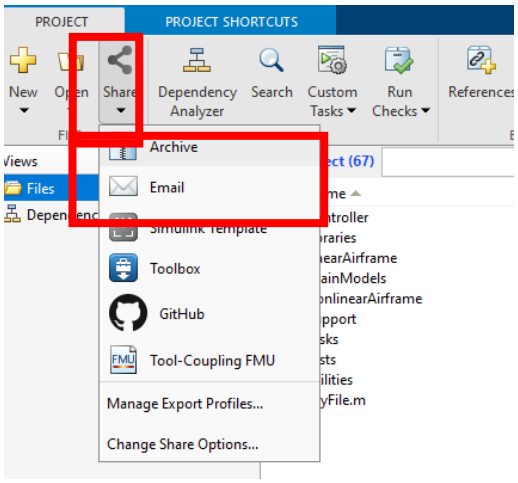


- Check the boxes for the necessary files and click OK.



3. Submit the Project Archive

- In the Projects folder, click on Share and then select *Archive* or *E-mail*.



- Select *Export Profile* as 'Whole Project' and name the Project Archive as per below instructions:

  When saving your **Project Archive (.mlproj)**, please follow the naming format below:

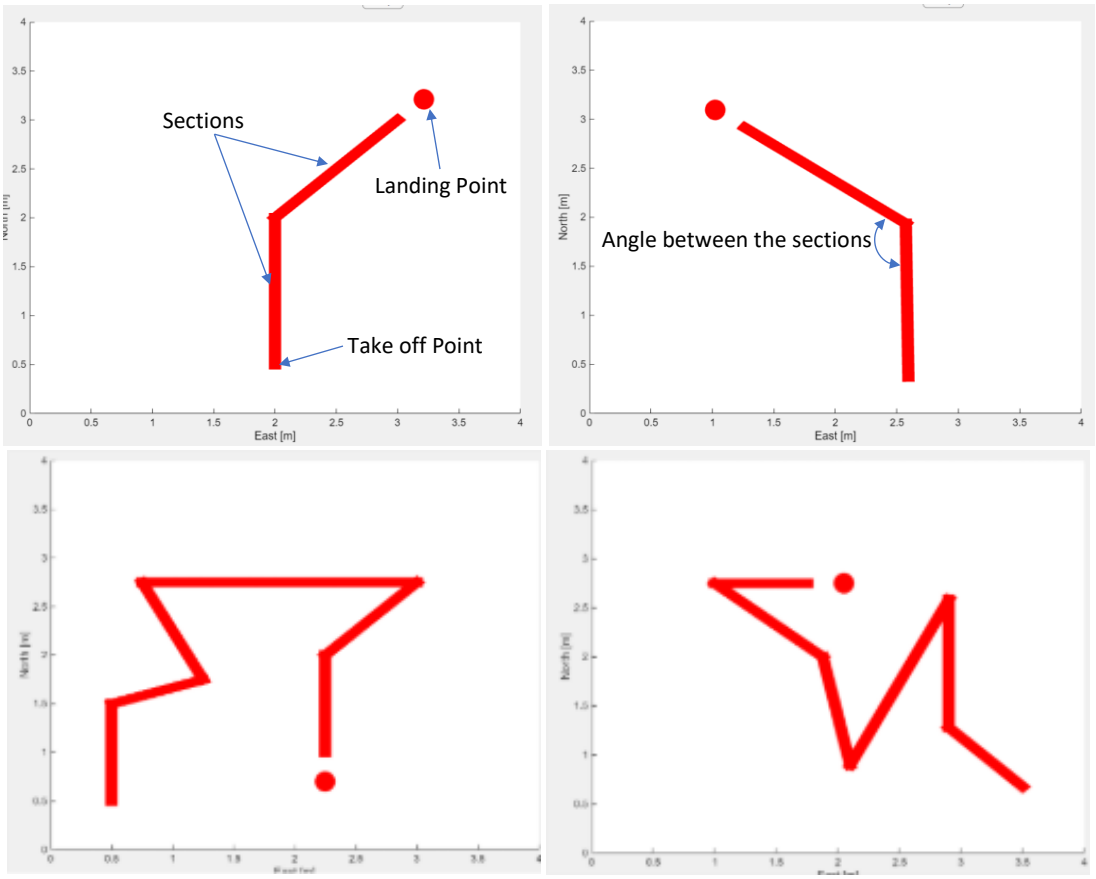
  - **`<TeamName>_<EventName>_<EventYear>.mlproj`**
  - **<TeamName>**: Your registered team name
  - **<EventName>**: Use `MDC<Location>` (e.g., `MDCIndia`)
  - **<EventYear>**: The year of the competition (e.g., `2025`)

  Example:
  If your team name is **DroneSquad** and you are participating in the **Minidrone Competition – India 2025**, your file should be named: **`DroneSquad_MDCIndia_2025.mlproj`**
- The team captain should submit the project using their registered email address. The submission should be made by filling out the submission form on the competition webpage (Submit your entry).

2.2 Evaluation and Judging

- The submitted model will be evaluated by MathWorks engineers.
- The model will be evaluated based on its ability to complete the line-following track and accurately land on the designated circular marker
- The model must be code generation capable.
- The model will be tested across multiple track structures
  - **Track Structure:**
    - Each track will consist of a minimum of 2 sections and a maximum of 7 sections.

- The angle between any two connected sections will range between 30 < Angle < 330 degrees.
- **Examples:** The following are a few sample tracks for your reference.



- Cross sections or very near side-by-side sections will not be included in any tracks.
- 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 of importance:
    - Code generation capability of the model
    - Number of sections successfully navigated within each track
    - Accuracy of the path traced by the drone with respect to the track including accurate and soft landing on the circular marker.
    - Time taken by the drone to complete a track (You can use Simulink Profiler to find the execution time)
- Among the received entries, the most efficient and accurate algorithms that complete all test tracks in the shortest simulation time will be shortlisted for Round 2
- The decision made by the judges will be final.

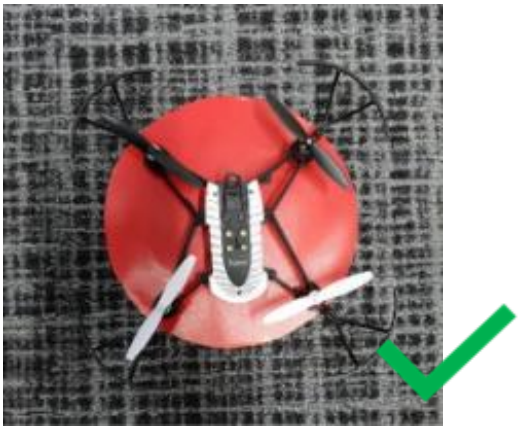
3 Round 2 – Format Specific

3.1 In-Person Format – Hardware Deployment Round

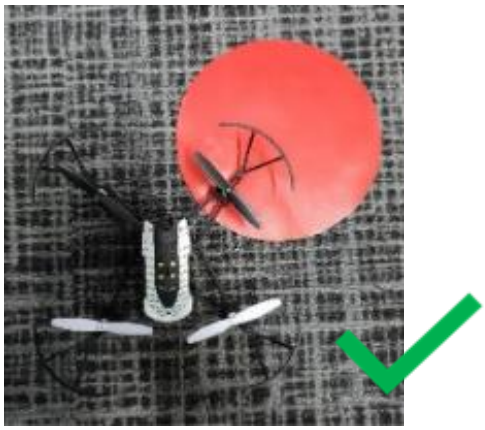
- The deployment round will be a one or two-day event. Round 2 of the competition will be divided into two parts:
- Practice Session:
    - The practice session is to help students get familiar with the hardware — including how to pair the drone with a PC, generate code, deploy it to the drone, and fine-tune model parameters like gains of the color thresholds etc.
    - Once students are comfortable with the setup, each team will get one or two practice rounds to test their algorithm on track.
        - During the practice round, each team will have a 15-minute slot to test their algorithm on the practice track.
    - Performance in the practice round will not affect the final result. Also, please note that the practice track could be different from the one used in the final live round.
- Final Live Round:
    - This is the final round where winners will be decided based on their performance.
    - Each team will be assigned one 15-minute time slot in the arena. This time includes both setup and Minidrone flight attempts.
    - Teams will have a maximum of 7 flight attempts within the 15-minute slot to showcase their algorithm performance.
    - A score will be awarded for each flight, and the highest score among all attempts and the corresponding time of flight will be considered for winners' evaluation.

3.1.1 Evaluation and Judging

- The final live round performance of the team will be evaluated based on how accurately the drone follows the track and lands on the circular marker.
- Scoring is based on completing different stages during each flight. Each completed stage earns 1 point, and landing earns up to 2 points.
    - Soft landing: Altitude of the drone must reduce gradually.
    - Accurate landing: The drone must land on the circle, with at least 20% of its body within the circle to be considered an accurate landing. Refer to the images below for examples.
    - Accurate/successful landings:

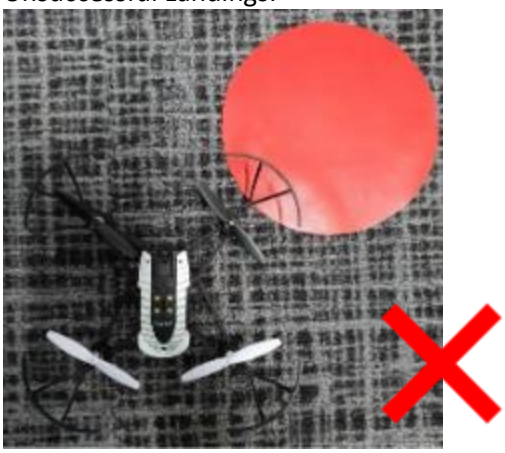


Complete minidrone landing on the circle.

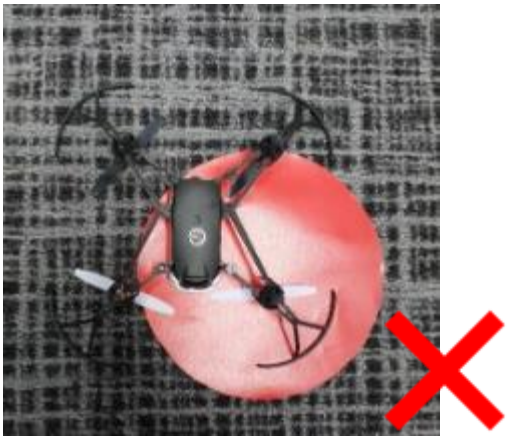


A part of minidrone landing on the circle

- Unsuccessful Landings:

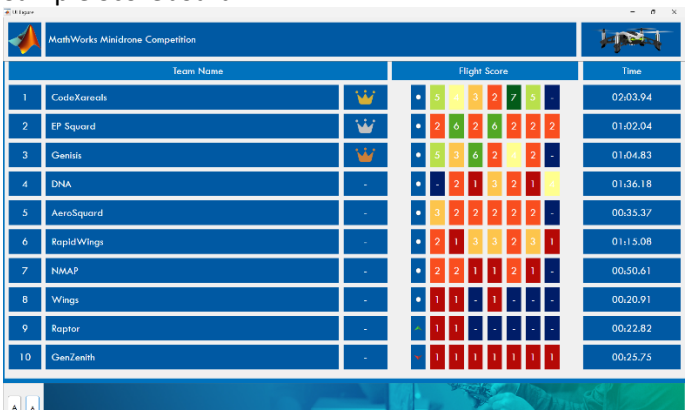


Part of the propeller guard is on the circle



Landing upside down on the circle

- Scoring Stages:
    - **Stage 0:** Take off complete – 1 point
    - **Stage 1:** Track Section 1 complete – 1 point
    - **Stage 2:** Track Section 2 complete – 1 point
    - .
    - .
    - **Stage N:** Track Section *N* complete – 1 point
    - **Stage Land:** Soft Landing Complete – 1 point
    - **Stage Land:** Accurate landing on the circular marker – 1 point
    - **Example:**
        - For a track with 4 sections:
        - Takeoff = 1 point
        - 4 sections = 4 points
        - Landing (soft + accurate) = 2 points
        - Maximum Score = 7 points
- The best score among all 7 flights during the 15 min slot will be considered for winners' evaluation.
- The top 3 teams with the highest scores will be declared winners and runners-up.
- In case of a tie in score, the flight time (from takeoff to landing) will be used as a tiebreaker.
- Refer below image for sample score board:
    - Sample Scoreboard:



The time shown on the scoreboard is the fastest time achieved for the team's highest-scoring flight.

3.2 Virtual Format – Video Presentation Round:

- The top scoring 5-7 teams from Round 1 will be shortlisted for Round 2 which would be a virtual round.
- For virtual round, the shortlisted teams are asked to submit a short video of 5 to 7 min about their approach used to solve the problem statement. The teams can consider the following structure for the presentation video, but not restricted to the same:

- Team introduction
- Approach used to solve the problem
  - Image processing subsystem
  - Path Planning subsystem
- Challenges you faced and how did you tackle them
- Key learnings and takeaways

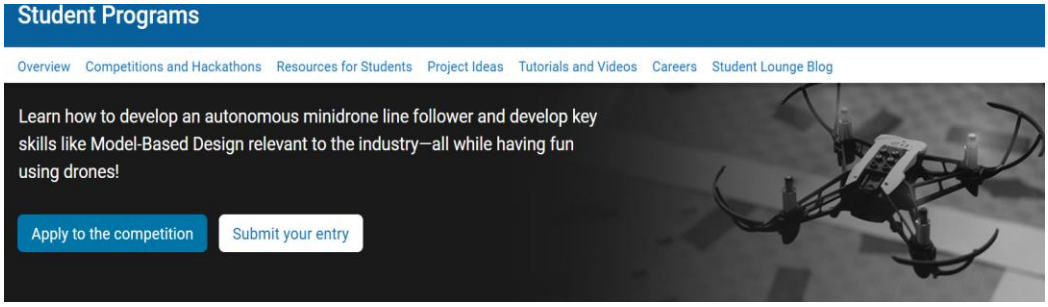
- The videos submitted by the team will be streamed on the virtual platform for the virtual round.
- This will be followed by a Q&A session where MathWorks engineers will interact with the team about their developed algorithm. The audience will also have the opportunity to ask questions.
- While it is recommended that the entire team attend the virtual finals, at a minimum, the team captain must be present for the team to remain eligible
- The virtual round will be a 90 to 150-minute event.
- The details about the virtual session will be shared with the team captain. The team captain must join the session 30 minutes in advance.
- **Video Submission Guidelines:**
  The team captain must email the video to **minidronecompetition@mathworks.com** by the specified deadline. The email subject and video filename should follow this format:
  <TeamName>_<EventName>_<EventYear>_Video.mp4
  <TeamName>: Your official team name
  <EventName>: Name of the event, including the location (e.g., MDC_Australia)
  <EventYear>: The year in which the deployment round is being held
  Example:
  If your team name is **DroneSquad**, and you're participating in the Minidrone Competition in **Australia** in **2025**, the subject and filename should be:
  DroneSquad_MDC_Australia_2025_Video.mp4

3.2.1 Evaluation and Judging

- In the virtual round, the video submitted by the teams will be showcased, followed by a Q&A session with MathWorks engineers and audience.
- The scores awarded for virtual round will be based on the quality of the video, the logic used for the algorithm development, and performance in the Q&A session.
- The top 3 winners will be selected based on their scores from Round 1 and Round 2. Round 1 scores will carry 90% of the weight, and Round 2 scores will carry 10% weight.
- The top 3 winners will be announced towards the end of the virtual event.

4 Rules

- Participants must compete as a part of a team of two to four members. If at all there are any changes in the team structure post the registration, an e-mail about the same should be dropped to minidronecompetition@mathworks.com.
- Teams must use only MATLAB release R2024b or R2024a to complete the tasks for both the rounds.
- Round 1 submissions must be made using the 'Submit Your Entry' link on the competition webpage, and should include the registered team name and the email ID of the team captain



- To be eligible to win, at least the team captain must attend the in-person or virtual final round of the competition
- Evaluation and judging for Round 1 will be conducted by MathWorks engineers. Round 2 may additionally involve academic and industry experts as part of the judging panel.
- All decisions made by the judges will be final.

5 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/stateflow-onramp.html
    - Image Processing Onramp:
        - https://www.mathworks.com/learn/tutorials/image-processing-onramp.html
    - MathWorks Minidrone Competition Video Series
        - https://www.mathworks.com/videos/series/mathworks-minidrone-competition.html
- Additional Video Tutorials:
    - Tech Talk on Drone Simulation and Control:

        - https://www.mathworks.com/videos/series/drone-simulation-and-control.html
    - Programming Drones using Simulink:
        - https://www.mathworks.com/videos/programming-drones-with-simulink-1513024653640.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