STEM-ED Drone Coding Competition

Rule Book 2023

Final Mission Stage Tasks

1. Drone Coding Competition Overview

The Drone Coding Competition is designed to provide high school students with a hands-on opportunity to program and fly drones. Teams are asked to program a DJI Tello drone to accomplish tasks autonomously over several months. Teams will submit their code which will then be judged based on how well the program allows the drone to complete the tasks.

The competition is split in two stages: the Qualification stage and the Mission stage. In the Qualification stage, all teams will attempt to complete as many virtual tasks as they can using the DJI Tello drone. If teams complete enough tasks, they will become eligible to compete in the Mission stage. The Mission stage begins once the Qualification stage ends. Teams who have completed enough points to qualify for the Beginner/Intermediate/Advanced Mission stage will have approximately one month to complete the Mission task and submit a presentation. The final team score will be based on their mission stage scores.

Prize money will be awarded to the best teams in each category; additionally, 2nd place and 3rd place prizes will be awarded for teams that compete in the Advanced category. In addition, the first team who completes **all** qualification tasks will win a monetary prize.

2. Team Requirements

a. Each team must be composed of at least 1 student and maximum of 3 students. Teams larger than 3 students must split into multiple teams and will be asked to register as separate teams.
b. This is a high school level competition; however, all students from K-12 are invited to compete (home-schooled students are encouraged to compete as well).
c. There is no limit to the number of teams that can come from each school as long as each team is no larger than 3 students.
d. Schedule:
    i. Competition registration will open on August 15th.
    ii. Mission Description Released: October 15th
    iii. Qualification Task Deadline: November 1st
    iv. Registration Fee deadline: November 1st
    v. Mission Stage Deadline: November 27th 11:59 PM PST
    vi. Presentations: Week of November 27th
    vii. Results announced: December
e. Teams must register here: https://www.stemed.org/dcc
f. Teams must pay a $175 fee to officially be eligible to earn prize money. The fee is to cover all competition costs as well as prize money.

3. 2023 Competition Overview

a. Summary

i. The competition is split in two stages: the Qualification stage and the Mission stage. In the Qualification stage, all teams will attempt to complete as many virtual tasks as they can using the DJI Tello drone. If teams complete enough tasks, they will become eligible to compete in the Mission stage. The Mission stage begins once the Qualification stage ends. Teams who have completed

enough points to qualify for the Beginner/Intermediate/Advanced Mission stage will have approximately one month to complete the Mission task and submit a presentation. The final team score will be based on their mission stage scores.

b. Drone Requirement

i. Teams will use either the Tello drone or the Tello EDU drone. The Robomaster add-ons will not be allowed.

ii. The Tello drone can have one or two “balloon poppers” attached to the bottom of the drone. The balloon poppers will be lined up with the camera (see below figure for example with two)

Notional balloon poppers are shown in blue. The poppers are sharp sticks (skewers, picks, etc.) where contact with the balloon will cause the balloon to pop. The poppers will be oriented as shown and attached onto the drone such that it is on the bottom of the drone. Teams may use Rubber Bands, Tape, and other adhesives to attach to the bottom of the drone.

iii. The poppers must extend at least 5 inches and no longer than 1 ft.

iv. Teams are allowed to sharpen the poppers as needed to ensure the balloon is popped without difficulty

v. No other modifications besides the poppers will be added to the Tello drone

c. Code Requirements:

i. Teams must use Python

ii. Teams may use any open source Python library available online. Paid/limited access Python libraries are not allowed

iii. During submission of code, teams must list every single Python library used for two reasons: 1. Compliance to 3.c.ii and 2. Ensure submission code runs correctly

iv. Teams may not use code without express permission of the primary author.

v. Teams must give very clear instructions on how to run the code. If judges cannot figure out how to run code, the score will automatically be set to 0.

vi. The ArUCo marker that will be used is the Original ArUCo marker set. Teams can generate what will be used for competition here: https://chev.me/arucogen/

d. Flight Requirements

i. Definitions: the following definitions apply to all tasks/missions

1. Flight timing: time between takeoff and landing
2. Computation time: time spent on the ground after the program executes
3. The drone may land anywhere to indicate the end of a flight
4. Attempt time: time that includes flight time and computation time

5. For all missions, the attempt time limit is 5 min
6. The attempt time counting will end when the drone lands.
7. The flight time will be used for all scoring calculations
8. Each balloon shall be between 8 inch to 10 inch tall

e. Qualification Stage Tasks:

i. Tasks are shown in the table below:

Task Number	Description	Points Awarded	Extra Material Required
1	Take-off autonomously, hover for 15 sec, and land	5	
2	Take-off autonomously, fly square pattern with 100 cm sides, and land	5	
3	Take-off autonomously, fly diamond pattern with 100 cm sides, and land	10	
4	Take-off autonomously, fly circle pattern, and land	10	
5	Take-off autonomously, take a team selfie, and land	20	
6	Take-off autonomously, read an ArUCo tag, and land (show on console) Teams must demonstrate with at least 4 different ArUCo tags of the team's choice. Please note which ArUCo tags the team chose.	20	ArUCo tag. Produce then here: https://chev.me/arucogen/
7	Take-off autonomously, pop a balloon in front, and land. The balloon can be either mounted onto a wall or mounted on a stick.	30	Balloon, Balloon popper attached to drone
8	Take-off autonomously, recognize balloon color, and land. For judging purposes, please demonstrate with blue, red, and green balloons.	50	Balloon, Balloon popper attached to drone

9	Take-off autonomously, read ArUCo tags, and fly towards the ArUco tag specified before flight, and land. Teams must demonstrate with at least 4 different chosen ArUCo tags of the team's choice with at least 3 tags for the Tello to choose from. Please note which ArUCo tags the team chose.	50	ArUCo tag. Produce then here: https://chev.me/arucogen/
10	Take-off autonomously, read ArUCo tag, draw the number using the Tello, and land. The drawn number must be similar to hand-drawn numbers and not like stadium/digital "stick" numbers. Drawing can be done in a variety of ways. We will accept the drone simplying flying the pattern of the number through its flight path. Teams can also attach a marker and have the Tello "draw" the marker on a surface (either floor or wall). We leave it up to the team to decide/demonstrate. Teams must demonstrate with at least 4 numbers of the team's choice.	50	ArUCo tag. Produce then here: https://chev.me/arucogen/
11	Build a neural network system that is trained on MNIST data. Demonstrate that it works by drawing 5 different digits and having it recognized. Hint: See https://machinelearningmastery.com/how-to-develop-a-convolutional-neural-network-from-scratch-for-mnist-handwritten-digit-classification/ for an example implementation	50	
12	Take-off autonomously and fly through a sequence of waypoints in the shortest path possible. Waypoints should be in cm, cm space centered around the starting point of the drone. Judges will test the code of the route optimizer, so ensure that it is robust.	50	

13	Take-off autonomously, scan the room for tennis balls and count how many there are, and land. Tennis balls should be on the floor. For judging purposes, please submit a video of the drone counting 3 tennis balls.	50	Tennis Ball
14	Take-off autonomously, search a room for a specific ArUCo tag with a pre-selected number. Once it finds it, it takes a photo of the ArUCo tag, and does the corresponding number of flips before landing autonomously. The ArUCo tag should be mounted on a small stand or placed on the wall. Teams must demonstrate with at least 4 different chosen ArUCo tags of the team's choice with at least 3 tags for the Tello to choose from. Please note which ArUCo tags the team chose.	50	ArUCo tag. Produce then here: https://chev.me/arucogen/
15	Take-off autonomously, search the room for a balloon with a pre-selected color. Once it finds it, it takes a photo of the balloon, and proceeds to pop the balloon. Once the balloon is popped the drone makes a controlled landing. Balloons may all be mounted on the wall or on top of individual mounts. For judging purposes, please select the color red. There should be at least 3 balloons colored blue, green, and red.	100	Balloon, Balloon popper attached to drone
16	Take-off autonomously, search the room for hand-drawn numbers. Using the machine learning algorithm you built in Task 11, the drone must recognize and record every number it sees. Once all numbers are collected, the drone will land. Drawing can be done in a variety of ways. We will accept the drone simplying flying the pattern of the number through its flight path. Teams can also attach a marker and have the Tello "draw" the marker on a surface	100	

	(either floor or wall). We leave it up to the team to decide/demonstrate. For demonstration purposes, please use the numbers 3,6,8,2. These numbers may be mounted on a single wall.		
17	Take-off autonomously, and search for 4 ArUCo tags that are mounted circularly around the drone. The drone must determine at what angle the ArUCo tag is located from the drone's starting orientation visually. Once it is done, the drone will land autonomously. For grading purposes, please set-up the 4 ArUCo tags 3 ft away from the drone at 45 deg, 100 deg, -165 deg, and -20 deg.	100	ArUCo tag on stands

ii. The following point levels must be achieved to qualify for the mission stage of the competition:

Level	**Point required**
Beginner	100
Intermediate	200
Advanced	400

f. Mission Stage Tasks:

i. Overview:

1. The mission stage requires teams to solve difficult challenges of various levels and attempt to score the highest score possible. Teams will submit video proof of their implementation as well as their code for judging.
2. Teams must only choose **1** level of difficulty for the mission stage
3. A presentation will be required by all teams. The rubric for the presentation will be released at the same time as when the mission stage details are released. Teams must present in front of a panel of industry judges and will be graded on presentation as well as technical content.
4. The same code must be used within each difficulty level for every course (i.e. for each difficulty, the same code must be run for each course described in the Appendix)

ii. Mission Stage Tasks

1. Beginner

a. Overview: The Beginner level mission involves flying through a set course and identifying as many balloons' color within a set amount of time. Additional points will be given to teams that detect tennis balls at the base of the balloons. Recognition and efficiency of travel/processing will be important for teams to consider.

b. Balloons used for mission can be purchased from here: https://www.amazon.com/Balloons-Assorted-Birthday-Decoration-Accessory/dp/B07MKWX51X/ref=sr_1_6?crid=2UQC4IZG2UARN&keywords=balloons&qid=1660515420&sprefix=balloons%2Caps%2C164&sr=8-6

c. The corresponding example colors can be found in the Amazon link above and placed here for convenience:

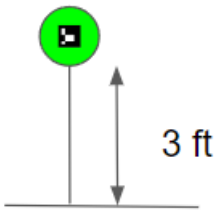
d. The arena is 25 ft by 25 ft square area. Balloons will be placed in different parts of the arena with various parts of the area. The Tello drone will start in the middle of the area. See section h for specifics on how the balloons will be set up.

e. There may be a maximum number of 6 balloons in the mission area; teams should not expect to know the number of balloons beforehand

f. A tennis ball may be placed at the base of the indicated balloon. Please ensure that the tennis ball is as close to the balloon stand as possible.

g. No penalty will be assessed for flying out of the drone area; however, any contact with obstacles (ex. walls, tables, etc.) outside the area will result in the end of the attempt and be deemed as a "landing"

h. Each balloon will be mounted as shown below (disregard the ArUCo tag shown in the figure for the beginner mission):



a. The balloon should be exactly 3 ft above the ground (+/- 2 inches). The balloons can be placed at the 3 ft height either by a dowel rod or some support with an air-filled balloon at the top or a 3 ft string tied to a helium-filled balloon.

i. Scoring of the task is as follows:

i. $S_B = 200\left(\frac{N}{N_t}\right)\left(\frac{T_{max}}{T}\right) + \max(0, B) \cdot 10$

ii. S_B = Beginner Mission Score

iii. N = Number of balloon colors identified correctly

iv. N_t = Total number of balloons within the field

v. T_{max} = Time limit (in seconds)

vi. T = run time (in seconds). NOTE: $T = T_{max}$ if $N_t > N$

vii. B = # of tennis balls identified (max of B = 3). Simply detecting that there are tennis balls and the number of tennis balls detected is sufficient. However, if the # of tennis balls detected is larger than the actual number of tennis balls in the course, $B = 0$.

2. Intermediate

a. The Intermediate Mission involves finding and identifying all the balloons in a field by the ArUCo Tag and the color of the balloon. Teams must pop the balloon with a specificed number or color. Teams that finish the fastest will score more points with a 5 min time limit. Teams must also geolocate the balloons as best, and will be graded on the accuracy of the resultant map.

b. Balloons used for mission can be purchased from here: https://www.amazon.com/Balloons-Assorted-Birthday-Decoration-Accessory/dp/B07MKWX51X/ref=sr_1_6?crid=2UQC4IZG2UARN&keywords=balloons&qid=1660515420&sprefix=balloons%2Caps%2C164&sr=8-6

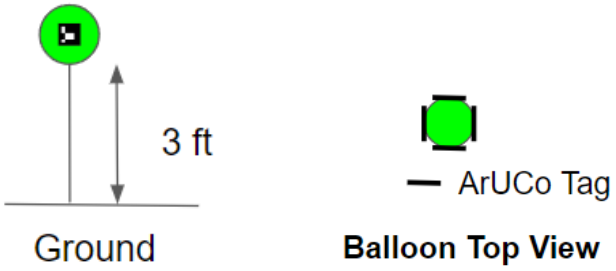
c. The corresponding example colors can be found in the Amazon link above and placed here for convenience:

d. The arena is 25 ft by 25 ft square area. Balloons will be placed in different parts of the arena with various parts of the area. The Tello drone will start in the middle of the area. See section h for specifics on how the balloons will be set up.

e. There may be a maximum number of 6 balloons in the mission area; teams should not expect to know the number of balloons beforehand

f. No penalty will be assessed for flying out of the drone area; however, any contact with obstacles (ex. walls, tables, etc.) outside the area will result in the end of the attempt and be deemed as a “landing”

g. Each balloon will be mounted as shown below.



h.

i. The balloon should be exactly 3 ft above the ground (+/- 2 inches). The ArUCo tag sized 3 inch x 3 inch (or 76 mm x 76 mm) will be placed in the center on 4 sides of the balloon as shown below. The balloons can be placed at the 3 ft height either by a dowel rod or some support with an air-filled balloon at the top or a 3 ft string tied to a helium-filled balloon.

j. Scoring of the task is as follows:

   i. $S_I = 300 \cdot \frac{N}{N_t} \cdot \frac{G_t}{G_1+G_2} \cdot \frac{T_{max}}{T} + 100 \cdot P$

   ii. S_I = Intermediate Mission Score

   iii. N = Number of balloon colors and tags identified correctly

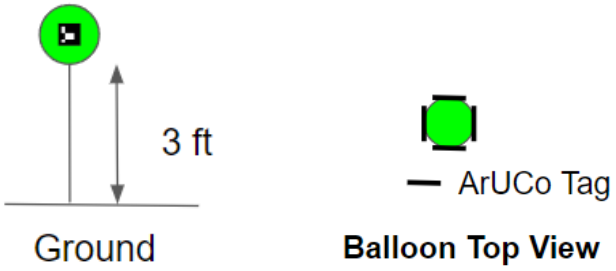
   iv. N_t = Total number of balloons within the field

v. T_{max}= Time limit (in seconds)
vi. T = run time (in seconds). NOTE: if $N_t > N$, $T = T_{max}$
vii. G = # of total balloons to be geolocated
viii. G_1 = # of balloons successfully geolocated to accuracy meeting Level 1
ix. G_2 = # of balloons successfully geolocated to accuracy meeting Level 2
x. P = Whether the balloon that was indicated was popped successfully or not
    1. $P = 1$ If indicated balloon was popped
    2. $P = 0$ If indicated balloon was not popped

k. Geolocation accuracy is as described:
    i. Level 1 = $\sqrt{(\Delta x)^2 + (\Delta y)^2} < 2$ where Δx, Δy is the difference between the actual location and the estimated location in feet.
    ii. Level 2 = $\sqrt{(\Delta x)^2 + (\Delta y)^2} < 5$ where Δx, Δy is the difference between the actual location and the estimated location in feet.

3. Advanced
    a. The Advanced Mission involves finding and identifying all the balloons in a field by the number hand-drawn on the balloon and the color of the balloon. Teams must pop the balloon with a specificed number or color. Teams that finish the fastest will score more points. Teams must also geolocate the balloons as best, and will be graded on the accuracy of the resultant map.
    b. Balloons used for mission can be purchased from here: https://www.amazon.com/Balloons-Assorted-Birthday-Decoration-Accessory/dp/B07MKWX51X/ref=sr_1_6?crid=2UQC4IZG2UARN&keywords=balloons&qid=1660515420&sprefix=balloons%2Caps%2C164&sr=8-6
    c. The corresponding example colors can be found in the Amazon link above and placed here for convenience:

d. The arena is 25 ft by 25 ft square area. Balloons will be placed in different parts of the arena with various parts of the area. The Tello drone will start in the middle of the area. See section h for specifics on how the balloons will be set up.
e. There may be a maximum number of 6 balloons in the mission area; teams should not expect to know the number of balloons beforehand
f. No penalty will be assessed for flying out of the drone area; however, any contact with obstacles (ex. walls, tables, etc.) outside the area will result in the end of the attempt and be deemed as a "landing"
g. Each balloon will be mounted as shown below. Please replace the location of the ArUCo tag with hand drawn numbers:



h. The balloon should be exactly 3 ft above the ground (+/- 2 inches). The number should be drawn on the balloon with a black sharpie. There is no size limit or how the number should be drawn on the baloon. The balloons can be placed at the 3 ft height either by a dowel rod or some support with an air-filled balloon at the top or a 3 ft string tied to a helium-filled balloon.
i. Scoring of the task is as follows:
    i. $S_A = 300 \cdot \frac{N}{N_t} \cdot \frac{G_t}{G_1+G_2} \cdot \frac{T_{max}}{T} + 100 \cdot P$
    ii. S_A= Intermediate Mission Score
    iii. N = Number of balloon colors and tags identified correctly
    iv. N_t = Total number of balloons within the field
    v. T_{max} = Time limit (in seconds)
    vi. T = run time (in seconds). NOTE: if $N_t > N$, $T = T_{max}$
    vii. G = # of total balloons to be geolocated
    viii. G_1= # of balloons successfully geolocated to accuracy meeting Level 1
    ix. G_2= # of balloons successfully geolocated to accuracy meeting Level 2
    x. P = Whether the balloon that was indicated was popped successfully or not
        1. $P = 1$ If indicated balloon was popped
        2. $P = 0$ If indicated balloon was not popped

j. Geolocation accuracy is as described:
   i. Level 1 = $\sqrt{(\Delta x)^2 + (\Delta y)^2} < 2$ where $\Delta x, \Delta y$ is the difference between the actual location and the estimated location in feet.
   ii. Level 2 = $\sqrt{(\Delta x)^2 + (\Delta y)^2} < 5$ where $\Delta x, \Delta y$ is the difference between the actual location and the estimated location in feet.

4. Presentation (required for all submissions)
   a. Teams must present their solution/design live in front of a panel of judges
   b. The presentation will be no longer than 10 min
   c. The grading criteria is as follows (100 points total):
      i. Presentation
         1. Slides are legible (5 pts)
         2. Presenter speaks clearly and audibly (5 pts)
         3. Presenter speaks professionally and is well-prepared. Minimal mannerisms such as “um” or “you know” (5 pts)
         4. Photos/models/videos are present (5 pts)
         5. Presenter speaks to the room (5 pts)
      ii. Content
         1. Team Organization (5 pts)
         2. Challenge Description/Understanding (10 pts)
         3. Programming Methodology and Process (10 pts)
         4. Algorithm Design/Strategy (20 pts)
         5. Flight Testing including data, videos, methodology, etc. (20 pts)
         6. Lessons Learned (10 pts)
   d. Teams will submit their presentation at the date that the mission stage
5. Mission Stage Overall Scoring
   a. Mission Stage Tasks:
      i. The average score between the 3 mission files will be used to determine the final rankings. Scores will be verified by inspection of flight video, console video, and code inspection. If a judge determines there is a discrepancy between the score of reported by the team and the judge’s calculation of score, the judge’s calculation of score will used.
      ii. Code must be the **same** used for each course described in Appendix A, B, and C.
      iii. Any hardcoding or disingenous implementations inside the code will automatically result in the team’s submission score = 0.
   b. Presentation:
      i. The scores amongst a panel of judges will be averaged to determine the presentation score for the team

c. Final score = Mission stage task score + presentation score
d. The final score will be calculated to determine the winners of each difficulty level.

4. Judging and Submission

a. Judging:
   i. The Drone Coding Competition is a virtual competition. Teams will submit videos of their attempts to STEM-ED which will validate and record the score
b. Submission:
   i. Teams are only eligible for one prize level award; however, teams may submit for multiple difficulty levels and indicate to us which level they would formally like to compete.
   ii. Teams will record a demo of their runs using the demo layouts outlined in Appendix A through C. Teams will submit the following:
      1. Video of drone performing the task of the full attempt (i.e. > 5 min long)
      2. Calculated score
      3. Console output
      4. Presentation
   iii. Teams must submit their code through a GitHub/GitLab link with the corresponding commit number
   iv. The submission form for the Qualification stage is here: **Submission Link**
   v. Mission Stage Submissions:
      1. Teams must send in an email declaring which difficulty level they intend to compete. Teams must have sufficient points gained in the qualification stage to qualify. Teams may decide to change difficulty levels in until 11/21/23 provided that they have enough points to compete in that difficulty level.
      2. The submission form for the Mission stage is here:
         a. Mission stage flight grading: Submission link
         b. Mission stage presentation submisison: Submission Link
      3. Please follow ALL instructions outlined in the form. Non-conforming submissions will be rejected and not graded.
         a. Teams must submit 3 things:
            i. Code
            ii. Video of drone flight
            iii. Video of code running (screen capture of console log as drone is flying)
            iv. Ideally, the video of the drone flying + code running should be on same screen and time synchronized. Highly encouraged, but not required.
      4. Teams may submit as many times as needed if they can improve on the scores of their previous submission. For presentations, teams can simply resubmit the same one if no change is needed. The highest score submission will be used to compare against other teams
      5. Teams must submit for all 3 courses out in the Appendix for the corresponding level being completed.

6. Teams are encourage to submit early before the Mission stage deadline to allow for confirmation of the team's claimed score by judges.
7. Judges will aim to respond within 2 days; if a team submits within 2 days of the deadline, there should be no expectation of receiving feedback before the submission deadline.

5. Prize:

a. To be eligible for a prize, the following conditions must be met:
   i. Registration fee must be paid in full
   ii. The attempt score must be non-zero to be eligible
   iii. The presentation must be submitted and presented

b. The first team to complete all qualification tasks will receive a small prize money amount. They will still be eligible for the mission level prizes. For the Beginner and Intermediate missions, only the first place teams will receive prize money. First, second, and third place teams will earn prize money for the Advanced mission. The below table outlines the prize money amounts:

Rank	Stage	Notes	Prize Money
1st	Qualification	1st Finisher	$500
1st	Mission	Beginner	$250
1st	Mission	Intermediate	$750
1st	Mission	Advanced	$2000
2nd	Mission	Advanced	$1000
3rd	Mission	Advanced	$500

c. If less than three fully-registered teams participate in the Advanced mission level, no prizes will be awarded. If 3~10 fully-registered teams participate in the Advanced mission level, the prize money will be halved for each prize-winning rank.

d. No team number restriction exists for the Beginner and Intermediate mission teams

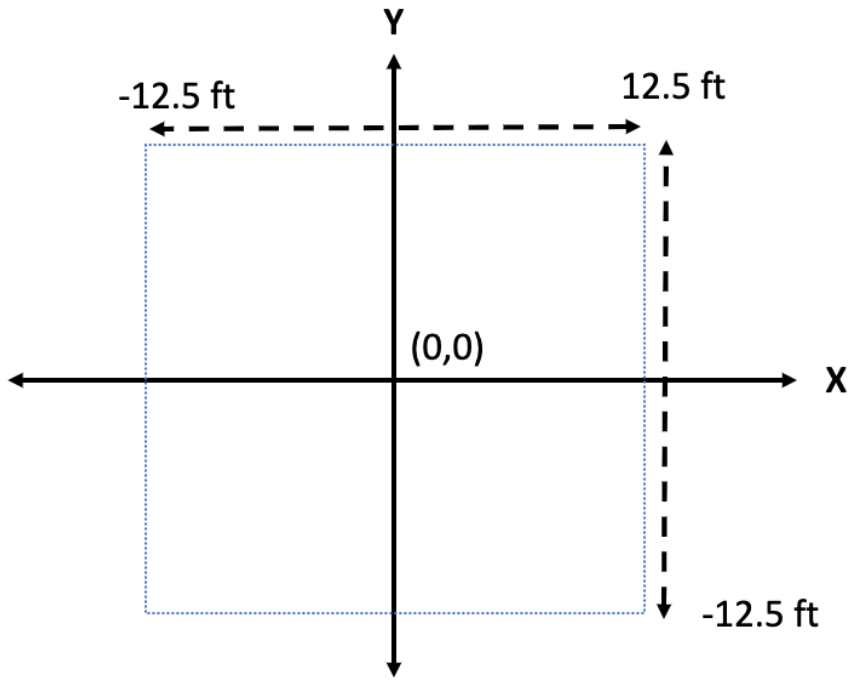
6. Helpful Resources

a. Teams are encouraged to procure DroneBlocks curriculum accounts to gain access to step-by-step walkthroughs on flying drones to programming drones to identifying ArUCo detectors

b. Please see the website for additional helpful resources.

Appendix A: Beginner Mission Details

The field reference is shown below:



The blue line indicates the course boundary. The center of course is (0,0) and is where the drone will start. The balloon, tennis ball locations will be given with the above coordinate system.

Course A

X	Y	Balloon Color	Tennis Ball at base?
-5	5	Red	No
5	5	Darker Blue	No
5	-5	Darker Green	No
-5	-5	Red	Yes
10	-10	Darker Blue	Yes
-10	10	Darker Green	No

Course B

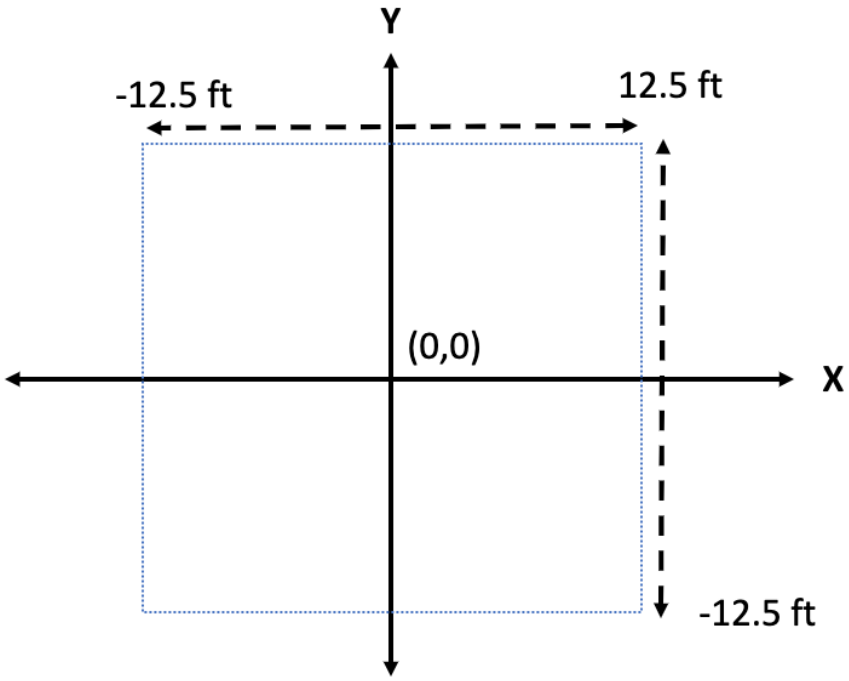
X	Y	Balloon Color	Tennis Ball?
-5	5	Pink	Yes
5	5	Purple	Yes
5	-5	Lighter Green	No
-5	-5	Pink	No
10	-10	Purple	No

-10	10	Lighter Green	Yes

Course C

X	Y	Balloon Color	Tennis Ball?
-7.5	5	Red	Yes
5	2	Purple	Yes
10	-5	Yellow	No
-6	-6	Pink	No
10	-10	Orange	Yes
-10	10	Lighter Blue	No

Appendix B: Intermediate Mission Details



The blue line indicates the course boundary. The center of course is (0,0) and is where the drone will start. The balloon, tennis ball locations will be given with the above coordinate system. ArUCo tag must be generated from here with the original ArUCo tag set: https://chev.me/arucogen/

Course A

X	Y	Balloon Color	ArUCo Tag	Popped?
-5	5	Red	1	Yes
5	5	Darker Blue	2	No
5	-5	Darker Green	3	No
-5	-5	Red	4	No
10	-10	Darker Blue	5	No
-10	10	Darker Green	6	No

Course B

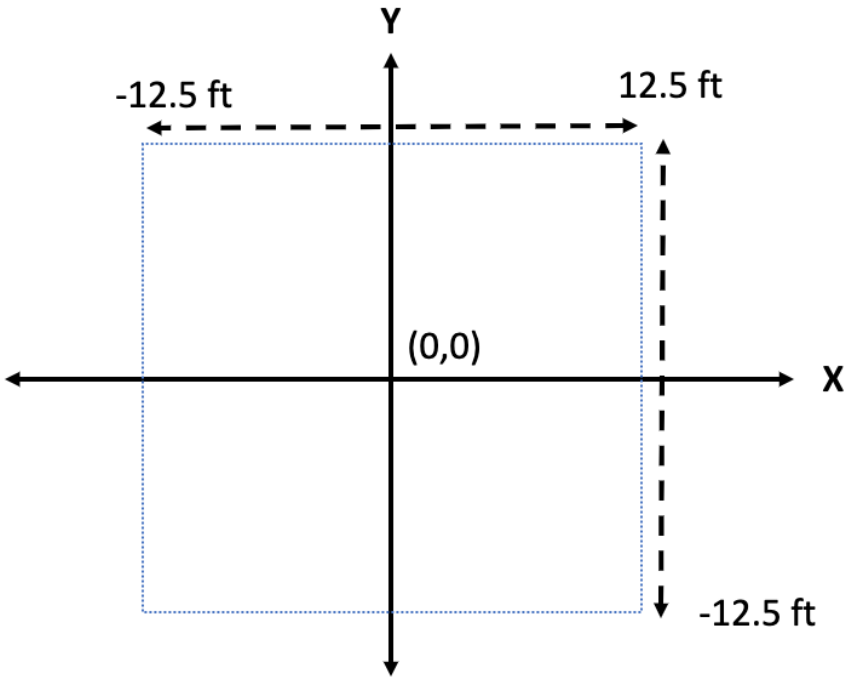
X	Y	Balloon Color	ArUCo Tag	Popped?
-5	5	Pink	1	No
5	5	Purple	7	No
5	-5	Lighter Green	9	No
-5	-5	Pink	20	No

10	-10	Purple	13	Yes
-10	10	Lighter Green	17	No

Course C

X	Y	Balloon Color	ArUCo Tag	Popped
-7.5	5	Red	17	No
5	2	Purple	22	No
10	-5	Yellow	9	No
-6	-6	Pink	4	No
10	-10	Orange	13	No
-10	10	Lighter Blue	3	Yes

Appendix C: Advanced Mission Details



The blue line indicates the course boundary. The center of course is (0,0) and is where the drone will start. The balloon, tennis ball locations will be given with the above coordinate system. ArUCo tag must be generated from here with the original ArUCo tag set: https://chev.me/arucogen/

Course A

X	Y	Balloon Color	ArUCo Tag	Popped?
-5	5	Red	1	Yes
5	5	Darker Blue	2	No
5	-5	Darker Green	3	No
-5	-5	Red	4	No
10	-10	Darker Blue	5	No
-10	10	Darker Green	6	No

Course B

X	Y	Balloon Color	ArUCo Tag	Popped?
-5	5	Pink	1	No
5	5	Purple	7	No
5	-5	Lighter Green	9	No
-5	-5	Pink	20	No

10	-10	Purple	13	Yes
-10	10	Lighter Green	17	No

Course C

X	Y	Balloon Color	ArUCo Tag	Popped
-7.5	5	Red	17	No
5	2	Purple	22	No
10	-5	Yellow	9	No
-6	-6	Pink	4	No
10	-10	Orange	13	No
-10	10	Lighter Blue	3	Yes

Date	Version	POC	Notes
9/1/22	0.1	Beldon Lin	Draft Rulebook Released with details about qualification stage
9/9	1.0	Beldon Lin	Qualification tasks finalized
9/29	1.1	Beldon Lin	Added clarifications for qualification tasks
10/22	2.0	Beldon Lin	Released bare descriptions for Mission stage tasks
11/4	2.1	Beldon Lin	Mission stage tasks finalized with demo course layout released