Lesson 10: Drone Mastery

Key Concepts:

- Drone Programming
- Navigation
- Spatial Perception and Orientation
- Problem Solving

Objectives:

- Students reinforce the standards learned in the previous lessons through activities

Instructor Background: Grades 5 – 12+

Time: 1 – 2 hours

Supplies:

1. Circuit Scribe Drone Builder Kit
2. PCB Arms
3. Cardboard Arms
4. iOS or Android-enabled Device
5. CS Pilot App

Roles:

- Engineer – responsible for turning off the drone, which must be done before conducting any maintenance, fixing the drone and putting the drone back together, in case the pilot crashes their drone.
- Project Manager – responsible for safety. They advise the pilot if they are getting too close to anyone or if the group breaks any safety rules. They are also responsible for carrying the drone and necessary materials to the designated flying zone.
- Pilot - responsible for flying the drone and recording flight info into the flight log. They also complete a secondary safety check after being approved by the project manager and the pre-flight checklist.

Safety and FAA Guidelines:

Review these safety procedures to the students again.

- Always keep a flying drone in sight. Don't lose track of the drone.
- Keep the drones off the ground when not in use (to prevent them from being stepped on).
- Always keep a clear flying zone.
    - Try to keep a 10 ft radius clear of people and objects while flying the drone
- Do not fly in adverse weather conditions, such as in high winds or reduced visibility.
    - Your Circuit Scribe Drone weighs 3.3 oz., making it light enough for wind to blow them away. A strong enough gust of wind can even blow your drone right at you or your cadets.

- Do not touch the motors after the drone has been in flight, as they may be hot to the touch.
- Never leave the battery plugged in for extended periods of time or overnight.
- The cadet in the “engineer” role must always turn off the drone before fixing or putting anything back together.

The Federal Aviation Administration requires the following:

- Fly your drone at or below 400 feet when in uncontrolled or "Class G" airspace. (Your Circuit Scribe Drone flies up to 150 ft. in the air, so no need to worry about this one!)
- Do NOT fly in controlled airspace (around and above many airports).
- Never fly near other aircraft, especially near airports.
- Never fly over groups of people, public events, or stadiums full of people.
- Never fly near emergencies, such as any type of accident response, law enforcement activities, firefighting or hurricane recovery efforts.
- Never fly under the influence of drugs or alcohol.
- Do not fly near or over sensitive infrastructure or property, such as power stations, water treatment facilities, correctional facilities, heavily traveled roadways, government facilities, etc.
- Do not intentionally fly over unprotected persons or moving vehicles.
- Check and follow all local laws and ordinances before flying over private property.

Designating a Fly Zone:

For the most optimal flying conditions, find a flat, open field away from any cars, streets or obstacles. Using cones or indicating markers, place a cone at each corner of a 10x10 foot square. Make as many fly zones as there are groups and be sure to number them for each group. Be sure to keep the fly zones at a safe distance from any hazardous obstacles.

Avoid flying near any cars or a populated playground. The fly zones should be spaced out enough to prevent any rogue drone from crashing into other cadets.

Activity 1: Drone Safety Review

Time:
10 min.

Description:
Cadets review the drone safety procedures with a few questions in class.

Step-By-Step:
1. Pass out a worksheet with three to five questions on it/ask students three to five questions orally (true or false + explanation):
    a. Possible worksheet questions can be:
        i. You can fly your drone in adverse weather conditions or conditions with reduced visibility. (Answer: False, drones should only be flown in clear weather conditions.)
        ii. You should not touch the drone's motors immediately after it has been in flight. (Answer: True, the drone's motors will be hot and shouldn't be touched.)
        iii. The pilot disassembles the drone. (Answer: False, the engineer disassembles the drone.)
        iv. You should fly over private property at any time. (Answer: False, you should check the local laws before attempting to fly over private property.)
        v. You should keep your drone at or below 400 feet in the air at all times. (Answer: True, you should always keep your drone under 400 feet.)
        vi. You should remove the batteries from the drone if you are leaving it overnight. (Answer: True, never leave the batteries in the drone overnight.)
        vii. You should not fly under the influence of drugs or alcohol. (Answer: True, always fly with full awareness.)
        viii. You should fly over moving vehicles. (Answer: False, it is dangerous for both your drone and a driver to fly near a moving vehicle.)
2. According to how the students do, review the above safety rules.

Activity 2: Drone Programming Obstacle Course

Materials:

- **Drone**
  - **PCB Arms**
  - **Cardboard Arms**
- **Timer/Stopwatch**
- **Drone Permit**

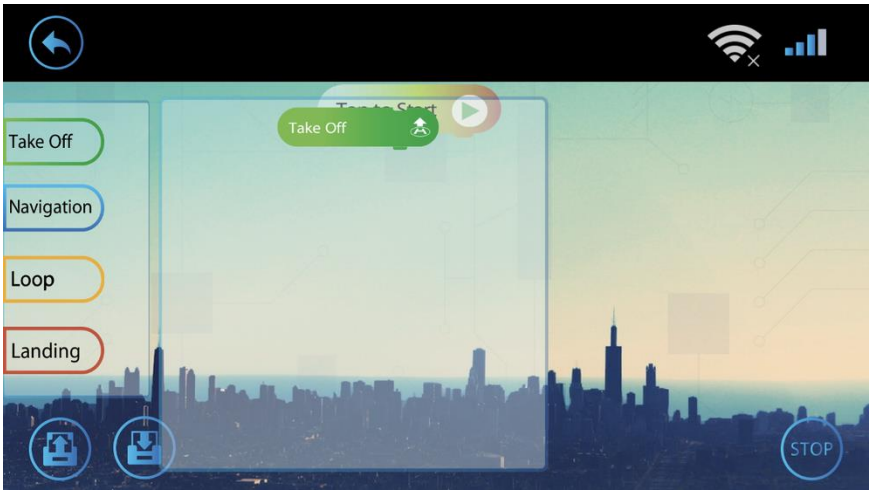
Time:
1 hour

Description:
Cadets will program their drone in order to navigate certain obstacles.

Guide:

Takeoff

Drag the Takeoff instruction block to the “Tap to Start” Button. The Takeoff block will snap onto the start button. The Takeoff block must always be the first block after the “Tap to Start” Button. If you hit “Tap to Start”, you'll notice that the program won't work. It needs one more block that we will add next.



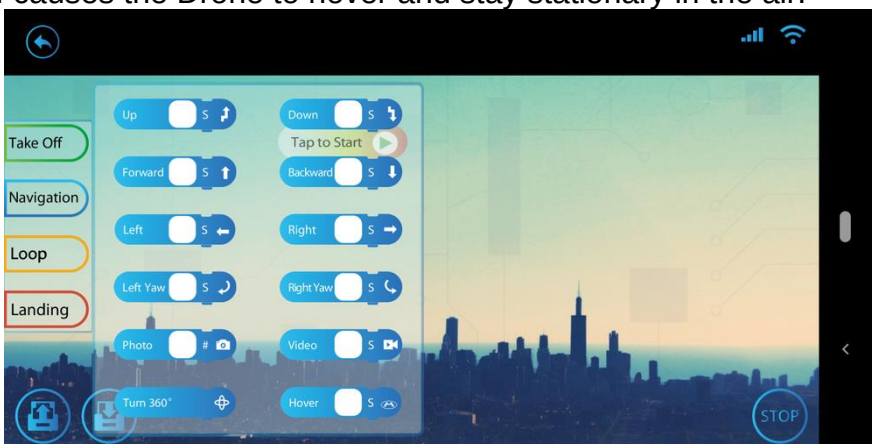
All programs must begin with the takeoff block.

Navigation

By using the building blocks in the navigation menu, you can program the Drone to autonomously navigate! Programs are limited to 30 seconds of flight time. Navigation blocks are very simple to use.

- Up/Down/Forward/Backward/Left/Right: moves the Drone in the corresponding direction for however many seconds are input. 1 second/ ~60cm.

- Left Yaw/Right Yaw: turns the Drone for however many seconds are input. 1 second/ ~90°.
- Photo: takes a specified number of photos using the Drone's forward facing camera and save them to the app's photo roll.
- Video: takes a video for a specified number of seconds using the Drone's forward-facing camera and save them to the apps photo roll.
- Turn: turns the Drone a complete 360°. 1 second/ ~360°.
- Hover: causes the Drone to hover and stay stationary in the air.



Loops

The loop menu has two coding blocks in it: the Loop block and the Loop Close block.

- The Loop block has an input field where you can write a number from 1 to 99, which specifies how many times the code inside the loop will run. The Close loop block specifies the end of the code that is run in the loop.

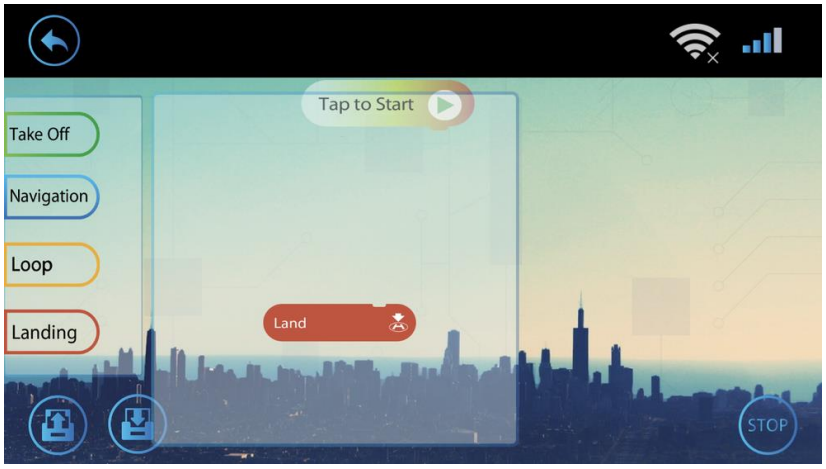
Using the blocks is easy: drop the Loop block into your program anywhere below the Take Off block and before the Land block and add the code blocks you would like to run multiple times afterwards. Finally, use the Close Loop block to specify that the code you want to loop over is done.

When the Drone runs your code, it will run the code inside the loop as many times as you specify in the Loop block input field!

Landing Block

The Landing window lets you add the "Land" block. Drag the Land block to just under the Takeoff block and it will snap in place. The Land block must always be the last block, or the program won't start.

Congratulations! You've created your first program.



All programs end with the land block.

Step-by-Step:

1. Go over practice maneuvers with the class to get them re-acquainted with the programs (take off/navigation/loops/land).
2. Afterwards, create groups, assigning roles for each group member. Allow the cadet with the Pilot role, in each group, to study the obstacle course and report to their team with ideas for programs.
    a. Students can decide whether to use the PCB arms or the cardboard arms – each come with strengths and weaknesses. Have the Engineer disassemble and reassemble the drone.
3. Give the teams time (15-20 minutes) to design a program that will get them through or around the obstacles in the drone's path.
4. Use the attention signal and bring the students to the obstacle course outside.
5. Have the Pilots use the program and attempt to clear the obstacle course. If they can't clear the course, give them the opportunity to bring their drone back to their team to make edits.
6. If a battery dies or a Pilot clears the obstacle course, have the cadets switch roles.
7. Before the next cadet that takes the Pilot role begins, give the cadets an opportunity to edit their code to make it better.
8. After each student has piloted the drone, instruct each group's engineer to disassemble the drones and the project manager to gather the drone's batteries to charge them.

Scoring Rubric:

- Cadets that clear the obstacle course gain 10 points for each member of a group that clears.
- The group that clear the obstacle course the fastest gains 10 points.

Class Discussion:

Have the most successful teams explain their strategies. Offer the cadets a chance to ask questions. Once the cadets' questions are answered, begin to review the discussions as a whole class.

Activity 3: Drone Race!

Materials:

- **Drone**
  - **PCB Arms**
  - **Cardboard Arms**
- **Timer/Stopwatch**
- **Drone Permit**

Time:

30 – 60 mins.

Description:

Groups of cadets will compete to navigate around obstacles in a race.

Step-By-Step:

1. Create groups, assigning roles for each group member. Allow the cadet with the Pilot role, in each group, to study the obstacle course and report to their team.
   a. Students can decide whether to use the PCB arms or the cardboard arms – each come with strengths and weaknesses. Have the Engineer disassemble and reassemble the drone.
2. Have the Pilots attempt to clear the obstacle course. If they can't clear the course, give them the opportunity to bring their drone back to their team to create a new strategy or let the project manager ask the instructor questions.
3. If a battery dies or a Pilot clears the obstacle course, have the cadets switch roles.
4. After each student has piloted the drone, instruct each group's engineer to disassemble the drones and the project manager to gather the drone's batteries to charge them.

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