UAV/DRONE FLIGHT AND PROGRAMMING

Grades 3-8

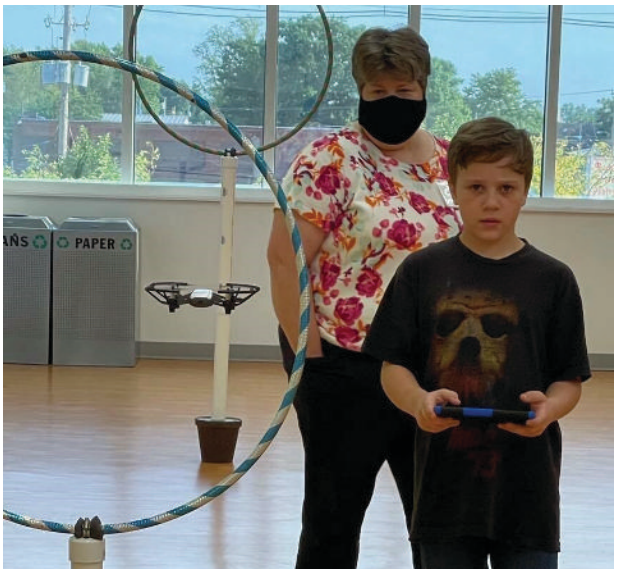
Day #1 Flying

Supplies Needed:

- 3 quality indoor UAVs/drones (Tello, Codrone, etc.)
- 9 charged replacement UAV/drone batteries
- 3 UAV/drone controllers (handheld, smart phone, Chromebook, IPAD, etc.)
- Various obstacle course components (even tables and chair make good obstacles)

Ask the students, what is an UAV? Most will not know, so tell them it is an "Unmanned Aerial Vehicle." We commonly call them "drones," but that is really not correct. A drone is a vehicle without a human operator onboard. We have satellites, robots, submarines, and even cars that are "drones." A UAV is a flying drone.

Next, ask, how does a UAV fly? We are not talking about the radio control, we are talking about actual flight? If the students need it broken down, ask them, what needs to happen, after the radio control signal, to actually get the UAV off the ground? With luck, someone will mention that the blades need to move very quickly. This is a good time to mention Newton's third law, for every action there is an equal and opposite reaction. Thus, as the blades push air down, the opposite reaction pushes the UAV up. Ask the



Controlled flight of a Tello UAV though an obstacle course.

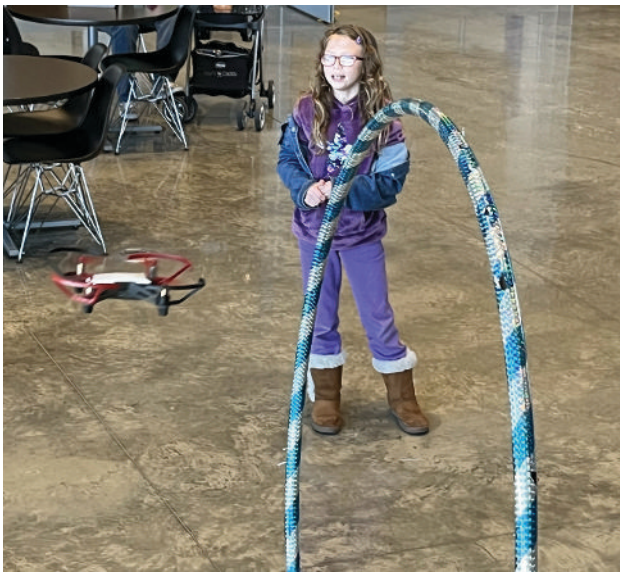
students, what happens to the motors to make the UAV come down? Hopefully, they will understand that the motors need to be slowed, in order to allow for a controlled landing. Turning off the motors will result in a crash. Now, ask them a hard question, what makes a UAV go forward? If they can't get the answer immediately, ask them to think about which two propellers you could slow down in order to make the UAV move forward. Of course, it is the front two; however, they may tell you it is the back propellers, in which case,

UAV/DRONE FUN

Continued

hold the UAV in front of you, and show how slowing down the back propellers would make it move backward into your face. The action of slowing two motors will help explain the directions the UAV can fly; however, you may want to review pages 3-5 of this NASA workbook: NASA Quadcopter Science . It does a good job of explaining how reducing torque on two motors will allow the drone to pivot/rotate.

Discuss careers currently available in UAV flight: real estate photography, agricultural photography and spraying, movie production, military, wildlife conservation, energy inspector, search and rescue, law enforcement, journalism, property management, delivery, and construction management. Within a few years, we will be able to add human transportation to this list. Everyone flying UAVs outside should take and pass the FAA TRUST examination (all ages). If you want to make money flying an UAV, you need, at the very least, to have an FAA Part 107 license, which you can take at the age of 16. So, what does being a full-time UAV pilot pay? According to "Glassdoor" (2024) a first-year pilot will average about $42,000 with pay quickly advancing to $88,000 by the fifth year of a piloting. Of course, you can always fly drones as a side-job. How much college is required to fly UAV's for profit? None, however, various colleges have drone-based degrees, which will likely be required once drones are flying human passengers and moving heavier cargo.



Testing a program in the "flying robot."

Spend some time helping students become familiar with basic UAV controls on a Tello, Codrone, or similar quality indoor flying drone/UAV. Do not use discount-store drones. Students need to have a positive experience with their early flights; and, big-box drones have a very bad reputation. Set-up no more than three obstacle courses in a classroom. Up to six courses can be constructed in a gym; however, if four or more UAVs are flown at the same time in a smaller room, expect some radio interference. Line up students at each course, provide them with a connected drone, and allow them to fly. Give helpful hints, repair crashed UAVs, replace batteries as needed (usually after about 10 minutes of flight). It is always a good idea to have an extra UAV ready to fly immediately. This will buy you time to repair or change batteries.

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Extension

UAV/DRONE FUN

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Day #2 Programming

Supplies:

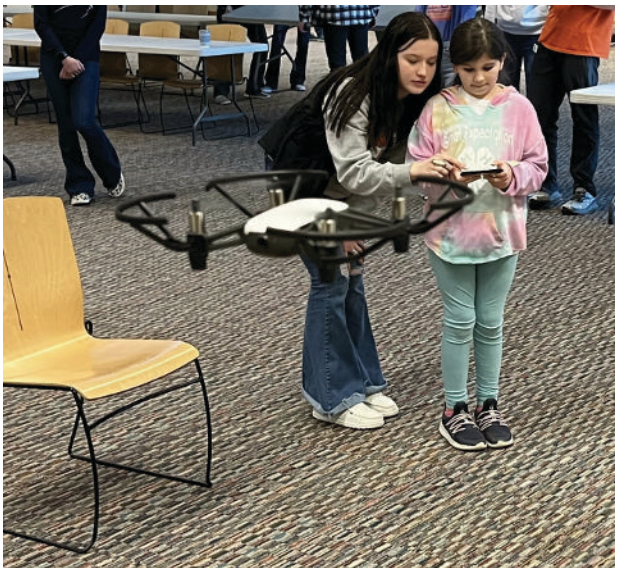
- Student computers/Chromebooks/IPADS (Make sure that school "nanny" software will allow them to open the Droneblocks and/or Robolink sites.)
- Google accounts to sign-in
- A way to project your screen…or, just have students follow along on their devices.

Go to the Droneblocks simulator at: https://dev.droneblocks.io/simulator.html.

Sign-in to the "Crazyflie" drone simulator. Coding options are to the left, you simply drag them to the right and connect blocks to build your code. ALWAYS start with a "takeoff" and a "land", then build the rest of the code in between "takeoff" and "land." Remember, all blocks must be connected. Use primarily "Navigation" blocks. To change distances from the preset value, simply click in the box of the value and change it to what you want. Show students a basic takeoff, fly forward, fly left/right, yaw, and circle. Get rid of old code by dragging it to the left.

If you are going to stay on the simulator, break the class into groups of 2. Tell the class that, if they have not guessed, the simulated classroom is 5 chairs wide by 6 chairs deep with an instructor's desk centered in front of the third row. 1. Assign the groups to program the UAV/drone to fly and land on the desk in front of them (in the simulator). Show them how to view the room from the drone's camera and how to "Reset" the screen. 2. Tell them that their next task is to fly to, and land on, the teacher's desk (3 in front of them) without crashing. They can take any route they want. 3. Last, have them fly to and land on the far desk to the right front (two rows in front of them, two desks to the right). Then, add to the program to fly a diagonal line back to the starting desk, and land.

If extra time allows, have them fly to any corner. Using loop programming, make the shortest possible program that will fly the outside of the seating rectangle, stopping over each desk for 5 seconds. For example, if a student's UAV is on the desk in the upper right corner, and they have adjusted their UAV to face the front desk in the left corner, they can simply add a loop (set to repeat 4 times) containing enough forward code to fly to the next desk, and a 5 second wait. Once in the next corner, yaw will be needed in order to turn the drone to face the back left



First flight.

corner and then another loop (set to repeat 5 times) with enough forward code and a wait code to reach the first desk. At that point they should be able to add the last two loops without much help.

If you are utilizing real UAVs/drones, break the class into the largest number of groups for which you have UAV's/drones. Set up your own obstacle course, with an easy fly forward and land challenge and then more difficult tasks. If using Tellos, use the free verson of Droneblocks to download code to your UAV/drone. If using Codrones, use their free version of blockly at: https://codrone.robolink.com/edu/blockly/. It works basically the same as the Droneblocks app. If using another UAV/drone, look up an appropriate block programming site. Remember, real drones have real problems (low batteries, unbalance propellers, HVAC systems that will disturb their flights, etc.). Thus, they will not be as accurate as drone simulators. However, they are more fun than simulators; thus, it is up to the instructor to decide the best mix of real and simulated flight.

Indiana Standards: Attached

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