IWLAR Training Manual— Learning How to Fly a Drone


November 7, 2021

A. Introduction

Drones are not difficult to fly but require development of muscle memory so that the need for adjustments to flight direction and altitude becomes instinctive. Further, the pilot has to learn how to control the drone when it is facing the pilot and control inputs are reversed. These skills are taught inside our chapter house by our drone instructors, using a very small drone designed for indoor use. Any of our members and their immediate family may participate. This training manual was prepared with a set of lesson plans that can teach a beginner to fly a drone.

B. The Ryze Tello Drone

The Ryze Tello is a compact drone developed by maker DJI and fellow Chinese start-up Ryze. This is a lightweight quadcopter safe for indoor flight with very stable flight characteristics. It comes with an onboard nose-mounted camera that is capable of capturing 5MP photos and streaming 720p HD video. It offers 13 minutes of flight time per fully charged battery and stability sensors that help keep it from drifting off into walls, shrubberies, and gardens.
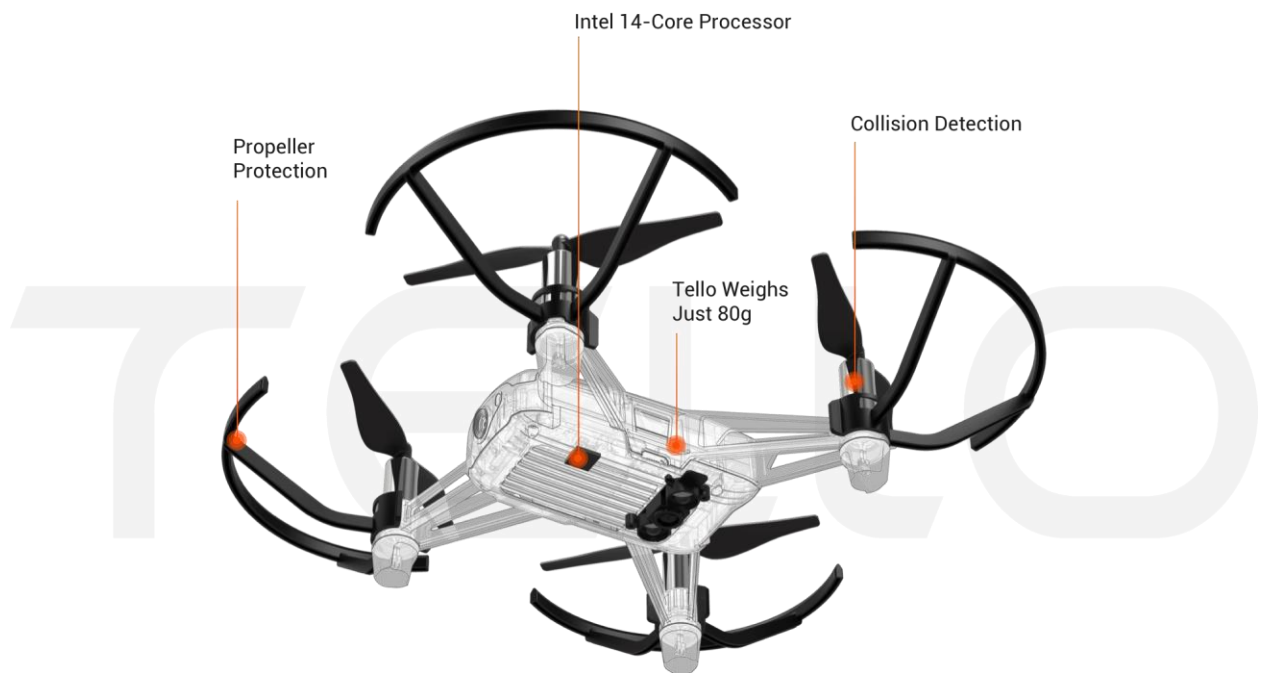
Flyable via a Wi-Fi-equipped smartphone running the Tello app, the drone has a theoretical control range of 325 ft. and a maximum altitude of 100 ft. The Tello has two flight speeds that you can select when flying the aircraft manually:

- Slow (default): The maximum flight attitude angle is 9° and the maximum flight speed is 6.7 mph.
- Fast: The maximum flight attitude angle is 25° and the maximum flight speed is 17.8 mph.

You can download the Tello User manual [here](#).
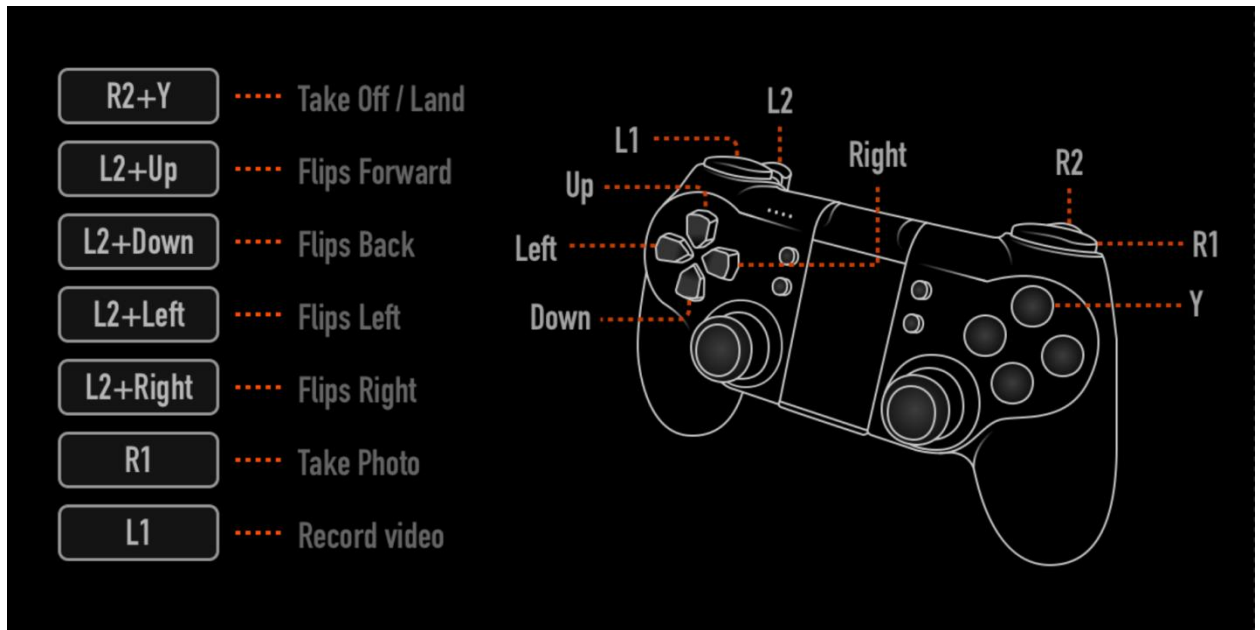
C. The Tello App

The Tello app runs on both Apple IOS and Android and is a free download. It offers a simple, with clearly labelled controls and a limited (but not restrictive) set of options. There's an on-screen battery indicator while flying, plus a built-in warning system that kicks in when power is low, to help ensure you don't lose the Tello due to it abruptly running out of juice. The app comes with automatic take-off and landing controls, plus an on-screen responsive twin-stick setup.

D. Bluetooth Controller

The GameSir T1D Bluetooth, when paired with the phone or tablet paired with the Tello application serves as controller to the drone. To activate the controller, the tablet or phone Bluetooth has to be turned on and the user has to activate the controller within the settings of the Tello application.

Download the GameSir T1d manual from [here](#). Below are the button assignments on the controller.

R2+Y	····· Take Off / Land
L2+Up	····· Flips Forward
L2+Down	····· Flips Back
L2+Left	····· Flips Left
L2+Right	····· Flips Right
R1	····· Take Photo
L1	····· Record video

E. Use of the Control Sticks

Definitions:

Roll – Done by pushing the right stick to the left or right. Literally rolls the quadcopter, which maneuvers the quadcopter left or right.

Pitch – Done by pushing the right stick forwards or backwards. Tilts the quadcopter, which maneuvers the quadcopter forwards or backwards.
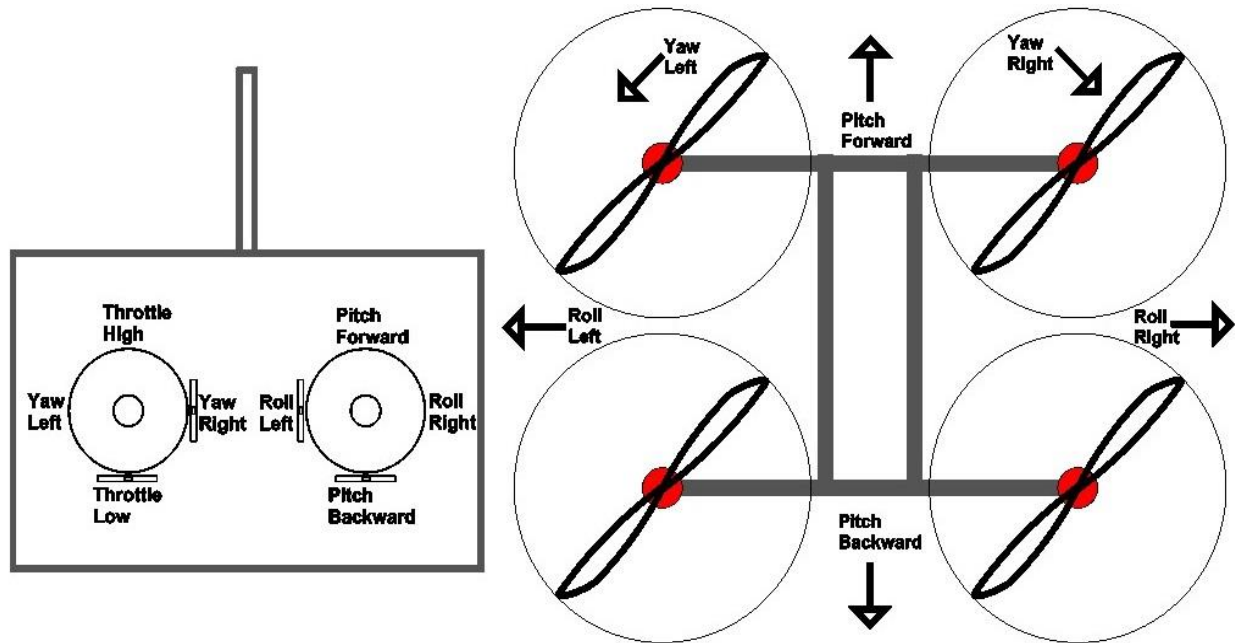
Yaw – Done by pushing the left stick to the left or to the right. Rotates the quadcopter left or right. Points the front of the copter different directions and helps with changing directions while flying.

Throttle – To increase, push the left stick forwards. To decrease, pull the left stick backwards. This adjusts the altitude, or height, of the quadcopter.

Bank turn – A consistent circular turn in either the clockwise or the counterclockwise direction.

Hovering – Staying in the same position while airborne. Done by controlling the throttle.

Controls—Roll, Pitch, Yaw, Throttle

Roll

- Roll moves your quadcopter left or right. It is done by pushing the right stick on your transmitter to the left or to the right.
- Here, the bottom of the propellers will be facing to the left. This pushes air to the left, forcing the quadcopter to fly to the right.
- The same thing happens when you push the stick to the left, except now the propellers will be pushing air to the right, forcing the copter to fly to the left.
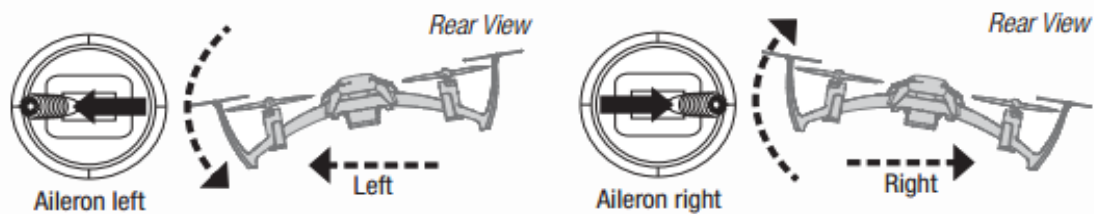
Pitch

- Pitch is done by pushing the right stick on your transmitter forwards or backwards. This will tilt the quadcopter, resulting in forwards or backwards movement.
- Example of a quadcopter pitching forwards and backwards. Note that this view is from the left side.
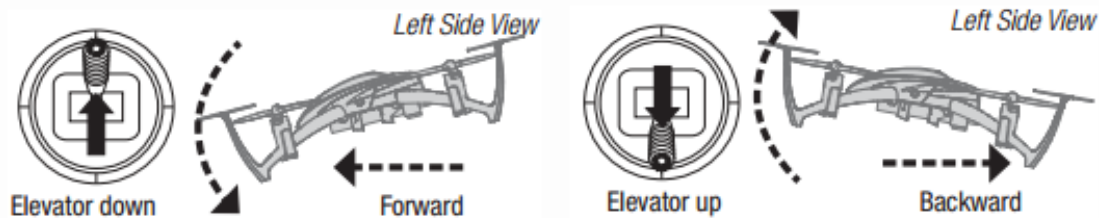
Yaw

- Essentially rotates the quadcopter clockwise or counterclockwise. This is done by pushing the left stick to the left or to the right.
- Yaw is typically used at the same time as throttle during continuous flight. This allows the pilot to make circles and patterns. It also allows photographers to follow objects that might be changing directions.

Throttle

- Throttle gives the propellers on your quadcopter enough power to get airborne and to climb. To engage the throttle, push the left stick forwards. To disengage, pull it backwards and the drone will descend.
- Make sure not to disengage completely until you are a couple inches away from the ground. Otherwise, you might damage the quadcopter, and your training will be cut short.

Important Note

When the quadcopter is facing you (instead of facing away from you), the controls are all switched.

This makes intuitive sense…
- Pushing the right stick to the right moves the *quadcopter* to the right (roll)
- Pushing the right stick forward moves the *quadcopter* forward (pitch)
- Pushing the right stick backward moves the *quadcopter* backward (pitch)

And so on.

So pay attention to that as you start changing directions. Always be thinking in terms of how the quadcopter will move, rather than how the copter is oriented towards you.

Each pilot has to successfully complete the following flight maneuvers in sequence. Maneuvers should be done with the Tello in the slow setting.

Lesson One

Connect the Drone to the phone or tablet using a WiFi connection and connect the controller to the phone or tablet using Bluetooth.

- **Step 1—Insert battery into drone.**
- **Step 2—Turn drone power on and place on launch pad. The front LED should flash.**
- **Step 3—Go to "Settings" on phone or tablet, make sure that WiFi is on, and set WiFi connection to Tello**
- **Step 4—Start the Tello application on the phone or tablet. The Tello or TelloFPV application should show video from the Tello camera.**
- **Step 5—Press the power button on the Bluetooth controller until the front LED lights turn on.**
- **Step 6—Go to Bluetooth "Settings" in the Tello or TelloFPV app and connect to the Bluetooth controller.**

Lesson Completion: This lesson is complete when video from the camera is displayed on the Tello app and the blue light on the controller is solid and no longer blinking.

Lesson Two

Takeoff from the landing pad with the drone facing away from the pilot, use the yaw control and rotate the drone in a clockwise mode and counter clockwise direction. Do three rotations in each direction. You will often use this technique to video your surrounding terrain. Best practice is to rotate the drone very slowly to prevent those viewing your drone video from getting dizzy.

Lesson Completion: This lesson is complete when the pilot has completed three complete rotations in clockwise direction and counterclockwise direction, without a crash.

Lesson Three

Takeoff from the landing pad with the drone facing away from the pilot, fly the drone to the other end of the room, use the yaw to change direction of

flight and return to the landing pad, then do a landing on center of the landing pad. Do this exercise three times. Note that the controls will be reversed as the drone approaches the landing pad.

> **Lesson Completion: This lesson is complete when the pilot has completed three takes-takeoffs and landings, without a crash and the drone is fully on the landing pad, near the center of the pad, each time.**

Lesson Four

Fly the drone in a square pattern to the right and then to the left using only the pitch and roll controls on the controller (right stick).

> **Lesson Completion: This lesson is complete when the pilot has completed three sets of square patterns, without a crash, while remaining outside of the cones.**

Lesson Five

This is the same lesson as lesson four except drone should be facing the pilot rather than away. This will result in the need for the pilot to reverse the controls. This can be challenging at first and pilot may need to practice this lesson several times before completing it.

> **Lesson Completion: This lesson is complete when the pilot has completed three sets of square patterns, without a crash, while remaining outside of the cones.**

Lesson Six

This is the same lesson as lesson four except that instructor will ask pilot to adjust altitude several times during the flight. This is the first lesson requiring the pilot to use both control sticks simultaneously. Altitude adjustments do not need to be perfect but should be close. Direction of flight and altitude adjustments should be seamless without disrupting speed of the drone or forward momentum. This exercise teaches multitasking.

> **Lesson Completion: This lesson is complete when the pilot has completed three sets of square patterns, without a crash, while remaining outside of the cones. All altitude adjustments are seamless without affecting forward momentum of the drone.**

Lesson Seven

This lesson will entail using the pitch and yaw controls to control the drone direction of flight. The pilot should use the pitch control to control forward speed and fly the full length of the room, using yaw to change flight direction as the drone approaches the walls.

Lesson Completion: This lesson is complete when the pilot has completed six laps in the room without a crash.

Lesson Eight

Fly the drone in a square pattern to the right and then to the left using the pitch and yaw controls.

Lesson Completion: This lesson is complete when the pilot has completed three sets of square patterns, without a crash, while remaining outside of the cones.

Lesson Nine

Fly the drone in a circle to the right and then to the left using the pitch and yaw controls.

Lesson Completion: This lesson is complete when the pilot has completed three sets of circles, without a crash.

Lesson Ten

Fly the drone in a figure-eight pattern to the right and then to the left using the pitch and yaw controls.

Lesson Completion: This lesson is complete when the pilot has completed three sets of figure-eight patterns, without a crash.

Lesson Eleven

This is a scavenger hunt (drone style). Turn the camera feature on and take photographs of the following items:

- **The fireplace,**
- **The rear deck through the chapterhouse window,**
- **All animals with horns or antlers.**

> **Lesson Completion: This lesson is complete when the pilot has completed the mission without crashing the drone.**

Lesson Twelve

Do a dronie. A dronie is the drone version of a selfie. Turn the video recording on and focus the camera on yourself. Now fly backwards from yourself while increasing altitude without colliding with the overhead fans or ceiling. Now reverse by flying toward yourself and lowering altitude. Repeat the lesson until your recording is smooth without jerkiness.

> **Lesson Completion: This lesson is complete when the pilot has completed the mission without crashing the drone.**

Lesson Thirteen

Orbit around a point. In this lesson, you will focus the camera on a certain point (called the focal point) and then circle the drone around that focal point while keeping the camera focused on the focal point during the circle. You can use yourself as the focal point.

> **Lesson Completion: This lesson is complete when your video shows the focal point in the center of each frame during the circle and without crashing the drone.**

Lesson Fourteen

This is the Fox and Hound exercise. One of the drones will be designated as the fox and the other drone designated as the hound. The object of the exercise is for the hound to give chase to the fox while remaining within 15 feet of the fox. The fox should be flown at a slow pace but may increase speed as the hound has demonstrated an ability to keep up with the fox. The fox and hound will exchange roles during the exercise.

> **Lesson Completion: This lesson is complete when both pilots have demonstrated an ability to keep up with the fox (within 15 feet of the fox) and neither pilot has crashed.**

Lesson Fifteen

Formation Flight exercise. In this exercise, two drones will take off simultaneously and fly in a formation from one end of the room to the

other. Drones will fly in parallel, 6 feet apart. At the end of the room, both drones will turn outbound and then merge for parallel flight, going the other direction, six feet apart. The goal of this exercise is precision flight with each drone 90-degrees from the other and uniform turns as the drones approach the walls.

Lesson Completion: This lesson is complete when the pilot has satisfied a majority of the spectators that performance met the standards without crashing the drones.

Lesson Sixteen

Competitive Timed Obstacle Course. This will be a competition between other pilots that have successfully completed Lesson Fifteen. An obstacle course will be set up consisting of fiberglass poles and suspended hula-hoops that must be flown through. Here are the rules:

The drone should be below the top of the poles and should not touch the poles or the hula-hoop when going through them. The pilot's total time will start at takeoff and end when the drone has landed. The following penalties will be applied: missed obstacles will add 10 seconds each to your total time. Contact with any of the obstacles will add 5 seconds each to your total time. If the pilot crashes before completing the course, then time before the crash will be added to your total time and you have to start again. The pilot with the best score will be declared "Top Gun" and entitled to use the name "Maverick" at any IWLAR chapter events.

Lesson Completion: This lesson is complete when the competition is over.

Progress Report for _____

| Date Performed	Lesson	Instructor Signoff
	1--Turn on Drone and Connect to Ipad application and controller	
	2—Rotating the Drone 360-Degrees Using Yaw	
	3—Takeoffs and Landings	
	4—Flying a Square Pattern using the Pitch and Roll Controls	
	5—Flying a Square Pattern using the Pitch and Roll Controls with Reversed Controls	
	6--Flying a Square Pattern using the Pitch and Roll Controls with Altitude Adjustments	
	7—Learning to use the Pitch and Yaw Controls to Control the Drone	
	8—Flying the Square Pattern using the Pitch and Yaw Controls	
	9—Flying a Circle Pattern using the Pitch and Yaw Controls	
	10—Flying a Figure-Eight Pattern using the Pitch and Yaw Controls	
	11—Scavenger Hunt	
	12—Do a Dronie	
	13—Orbit Around a Point	
	14—Performing the Fox and Hound Exercise with a Second Drone	
	15—Flying a Flight Formation with a Second Drone	
	16—Competitive Timed Obstacle Course	

Relevant Videos

a. [Drones 101: How Drones Fly](#)
b. [Tello + GameSir T1D Set-up](#)
c. [15 Drone Training Exercises to Learn How to Fly a Drone](#)
d. [Tello Drone App User Guide](#)
e. [Tello App Tutorial Review](#)

Drone Simulator

F. Zephyr Simulator Overview
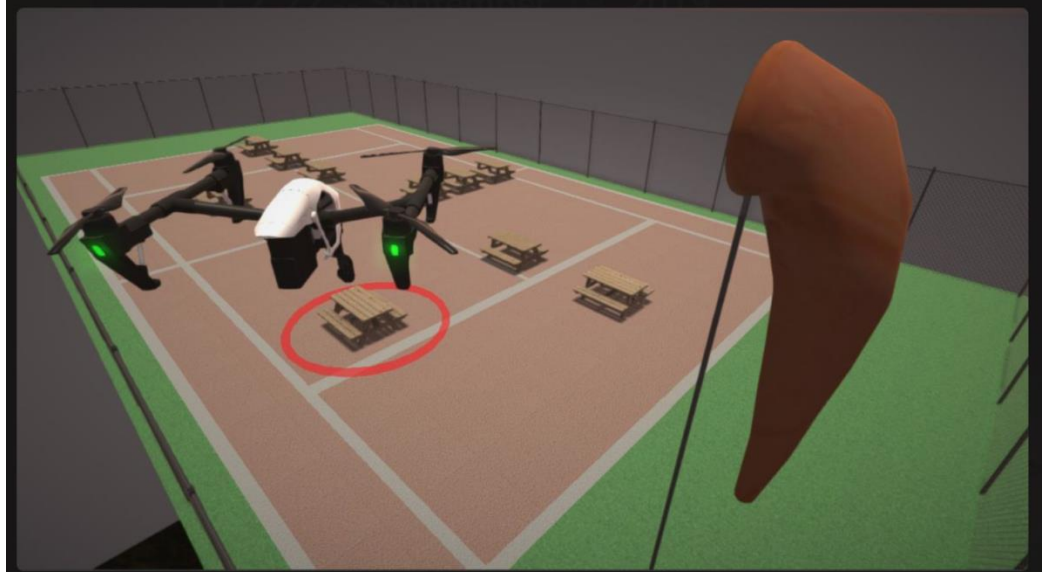
The Zephyr drone simulator was designed for drone pilot education and training. It is used by Universities, workforce development teams, law enforcement officers and professional trainers. The Zephyr drone flight simulator comes with a library of both training modules and drone platforms, each carefully created with accurate flight characteristics. Simulated drones include:

- DJI Phantom 3,
- DJI Inspire 1,
- 3DR Solo,
- Syma X5C,
- Autel X-star,
- Parrot Bebob, and
- DJI Mavic.

Training for Zephyr is divided into a number of scenarios and there are one or more training modules for each scenario. Some modules are for familiarization with a particular location. Other modules test your skill levels achieved and actually assign a letter grade. Your goal should be to obtain grades that would have made your parents proud when you were in high school.

Scenarios and Modules for Zephyr

Scenario	Modules
Tutorials	Tutorial
Basic Training	Throttle Control (3 modules)
	Landing (6 modules)
	Hover (6 modules)
	Forward Flight (4 modules)
	Horizontal Flight (6 modules)
The Hill	Free Flight
	Mushroom Landing
Yard	Free Flight
	Basic Exploration
Obstacle Course	Free Flight
	Timed Event
Community Park	Beginner
	Basic Exploration
	Advanced Playground Challenge
Parking Lot	Free Flight
	Zig Zag
Drone Racing	Free Flight
Flight Path Practice	Out and Back
	Figure 8
	Rectangle
	Circuit

G. The Controller—Flysky FS-16S

Our simulator uses the Flysky FS-16S controller which is very similar to the controllers used with the DJI drones. The controller is connected to the computer running the simulator by a USB cable. To turn on the controller, all top switches have to be in their upmost position and both power buttons have to be pressed simultaneously. Similarly, to turn the controller off, both power buttons have to be pressed.

You can download the Flysky FS-16S User manual here.

Relevant Videos

    a. [Zephyr Flight Simulator](#)
    b. [Zephyr Drone Flight Simulator Review](#)
    c. [Zephyr Introduction](#)
    d. [Zephyr Demo & Review](#)
    e. [Zephyr Drone Simulator Review](#)