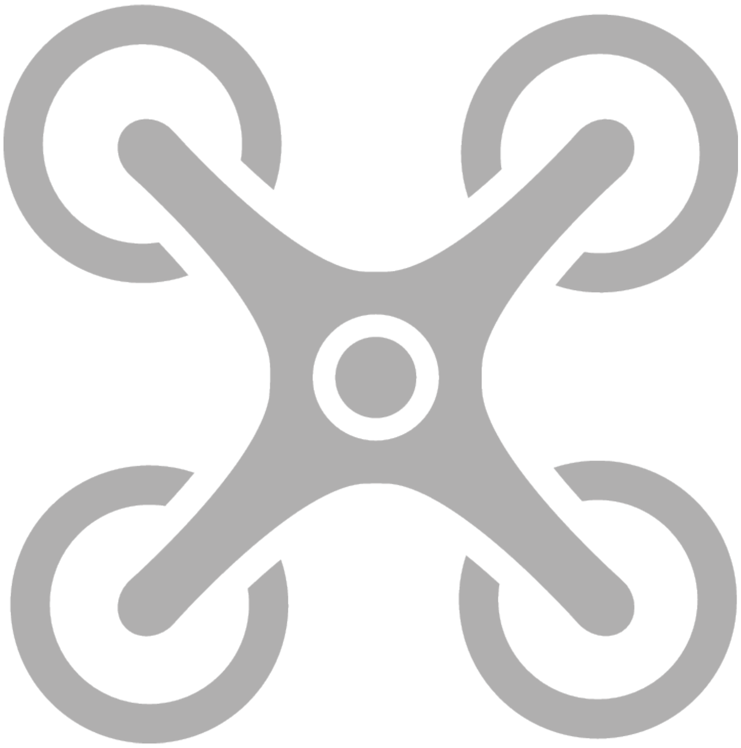
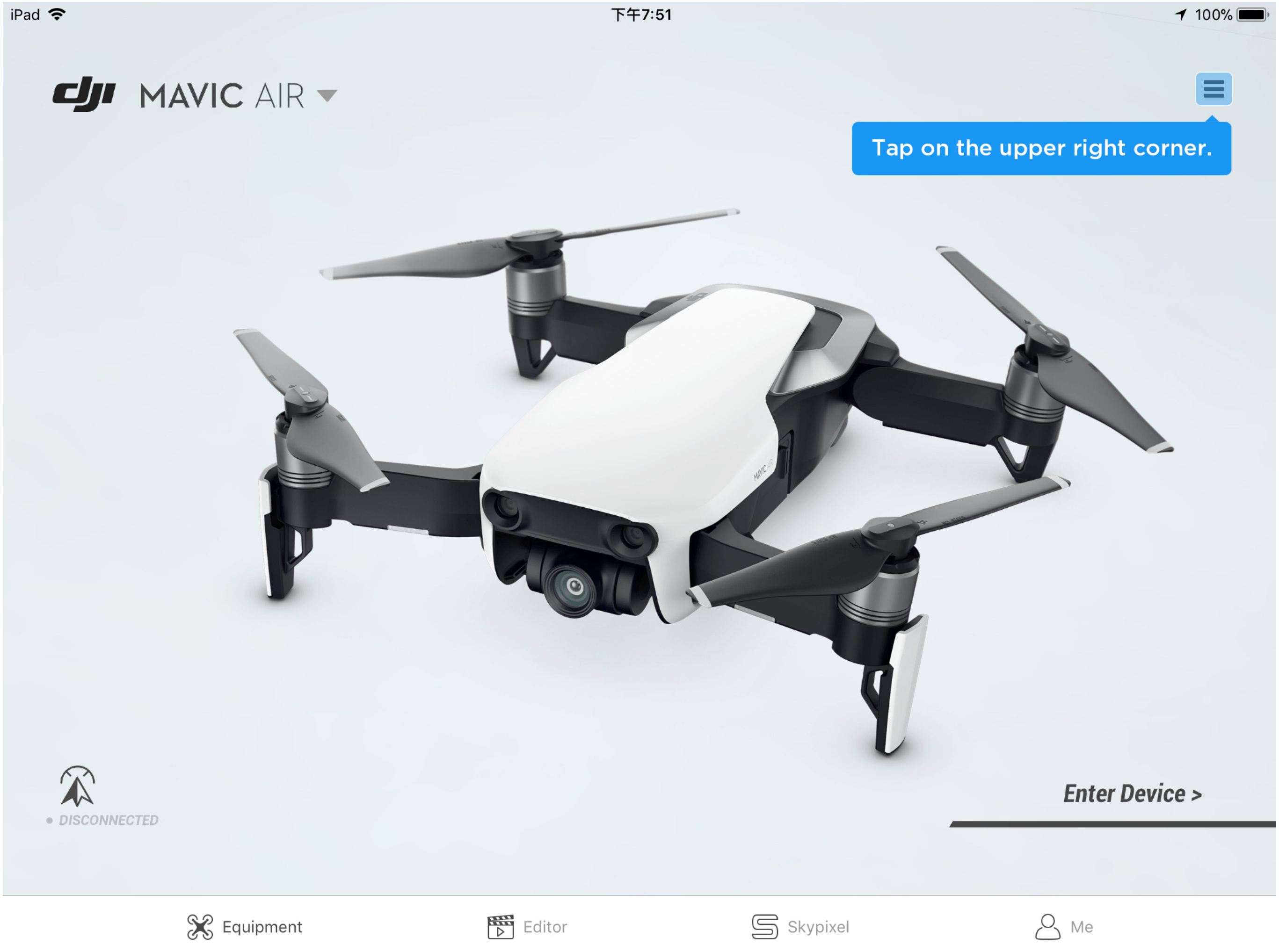
FLIGHT RECORDS ANALYSIS TUTORIA

V1.0 2018.04

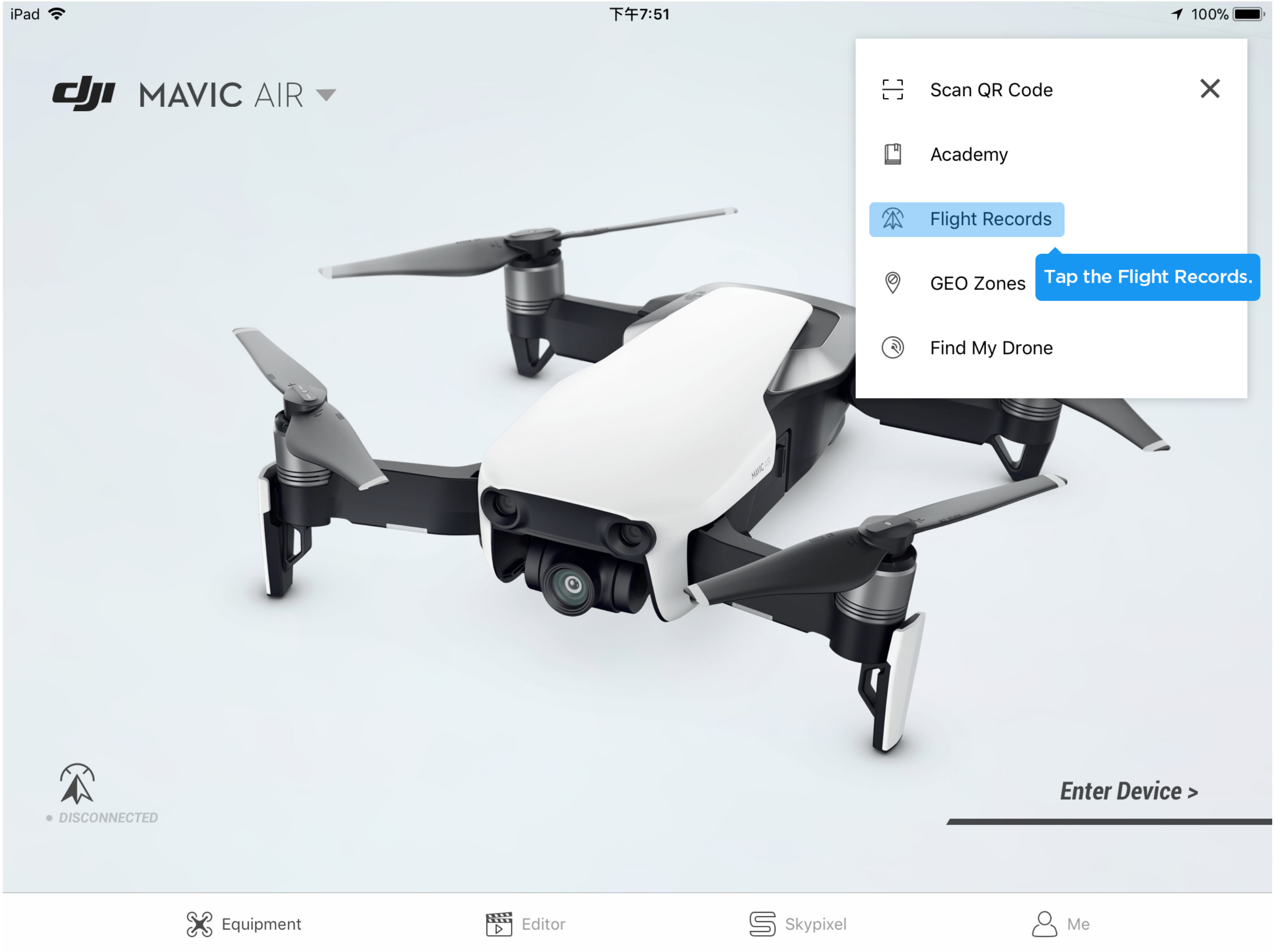


I. Analyzing the Cause of Accidents with the Flight Records in the App

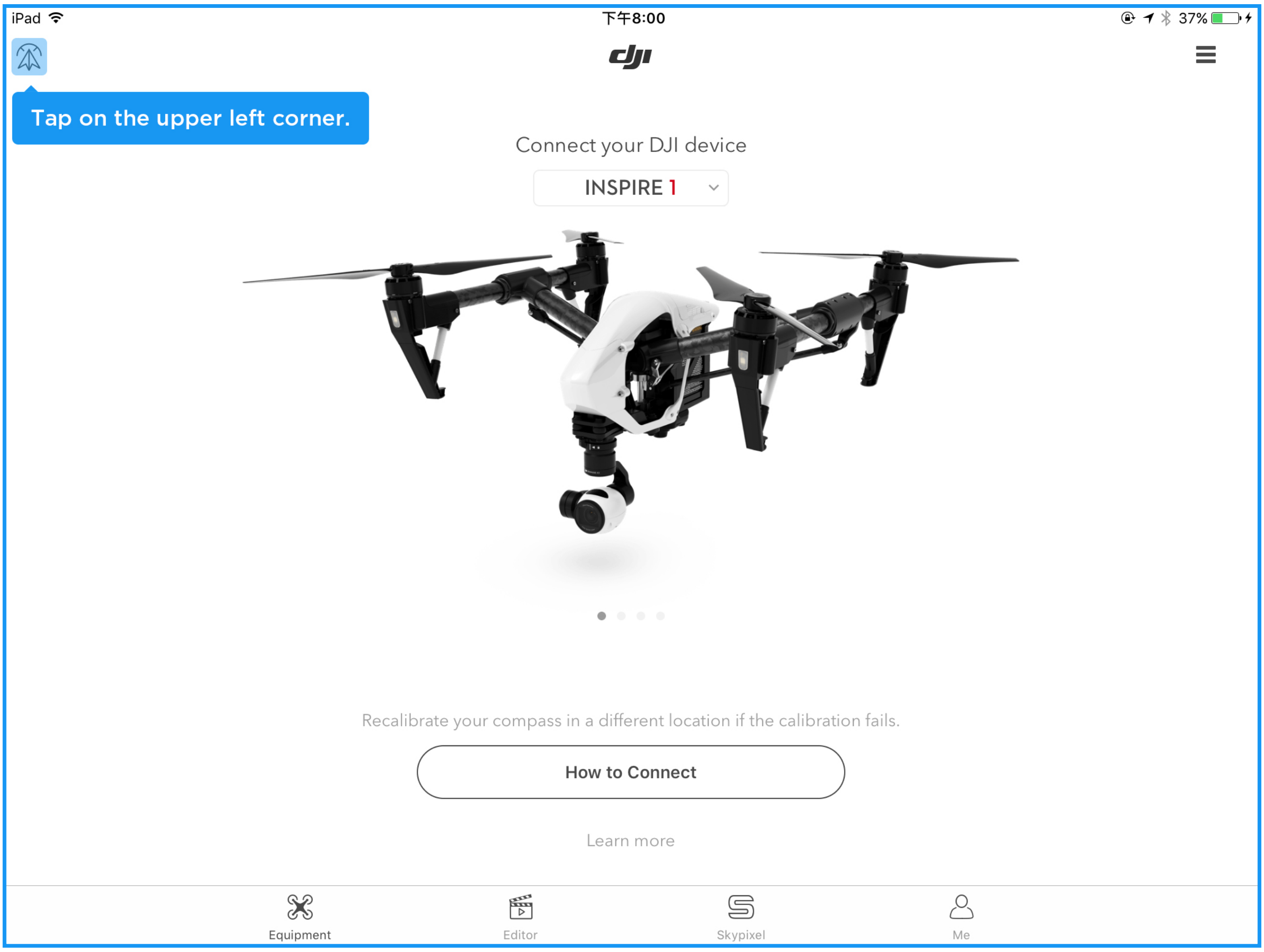
Flight records are similar to an air traffic control tower's data. They are generated in DJI GO or DJI GO 4 after the drone takes off if a mobile device is connected to the drone during flight. Log in to DJI GO or DJI GO 4 to find the flight records.



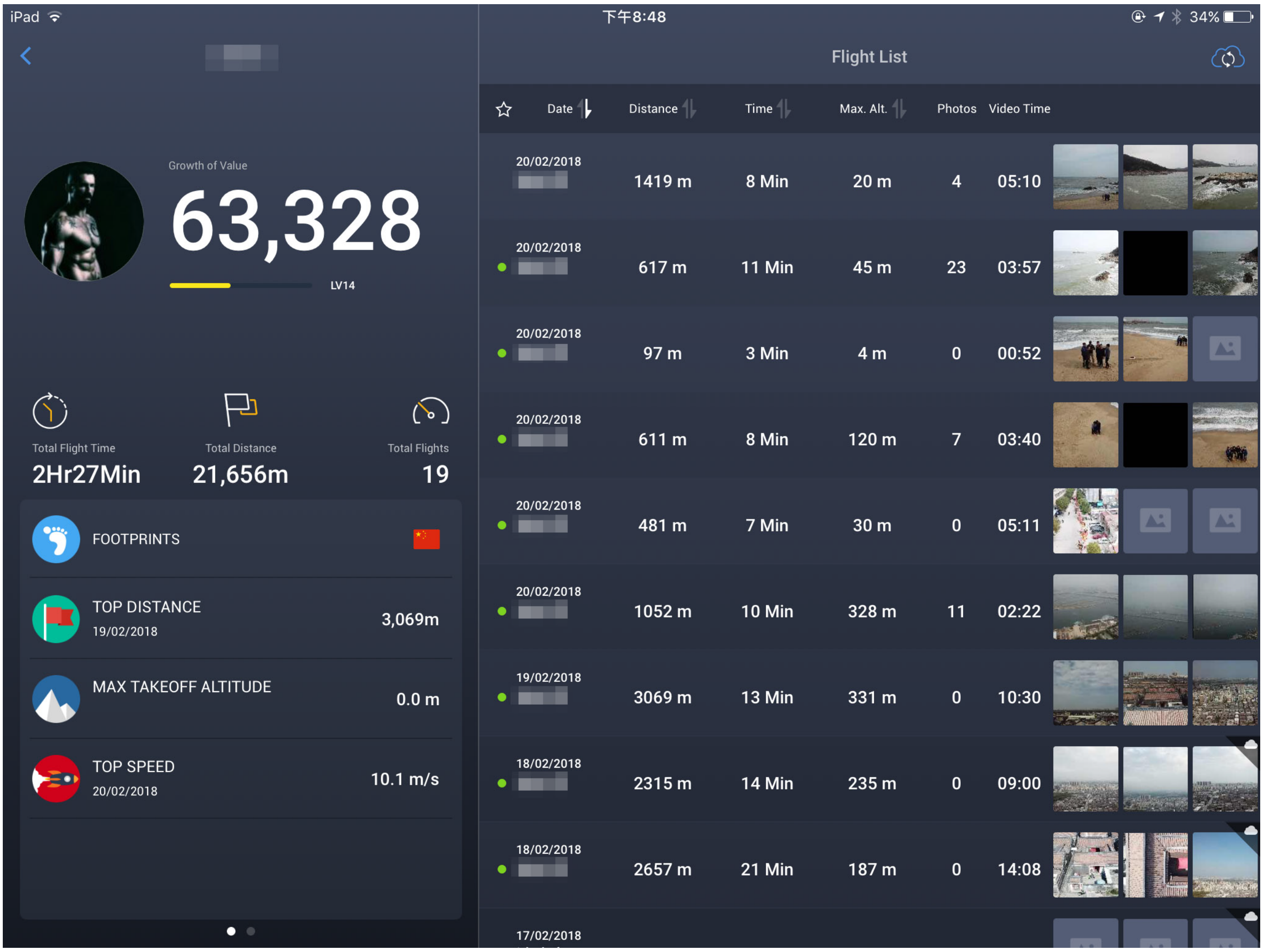
Log in to DJI GO or DJI GO 4 to find the flight records.



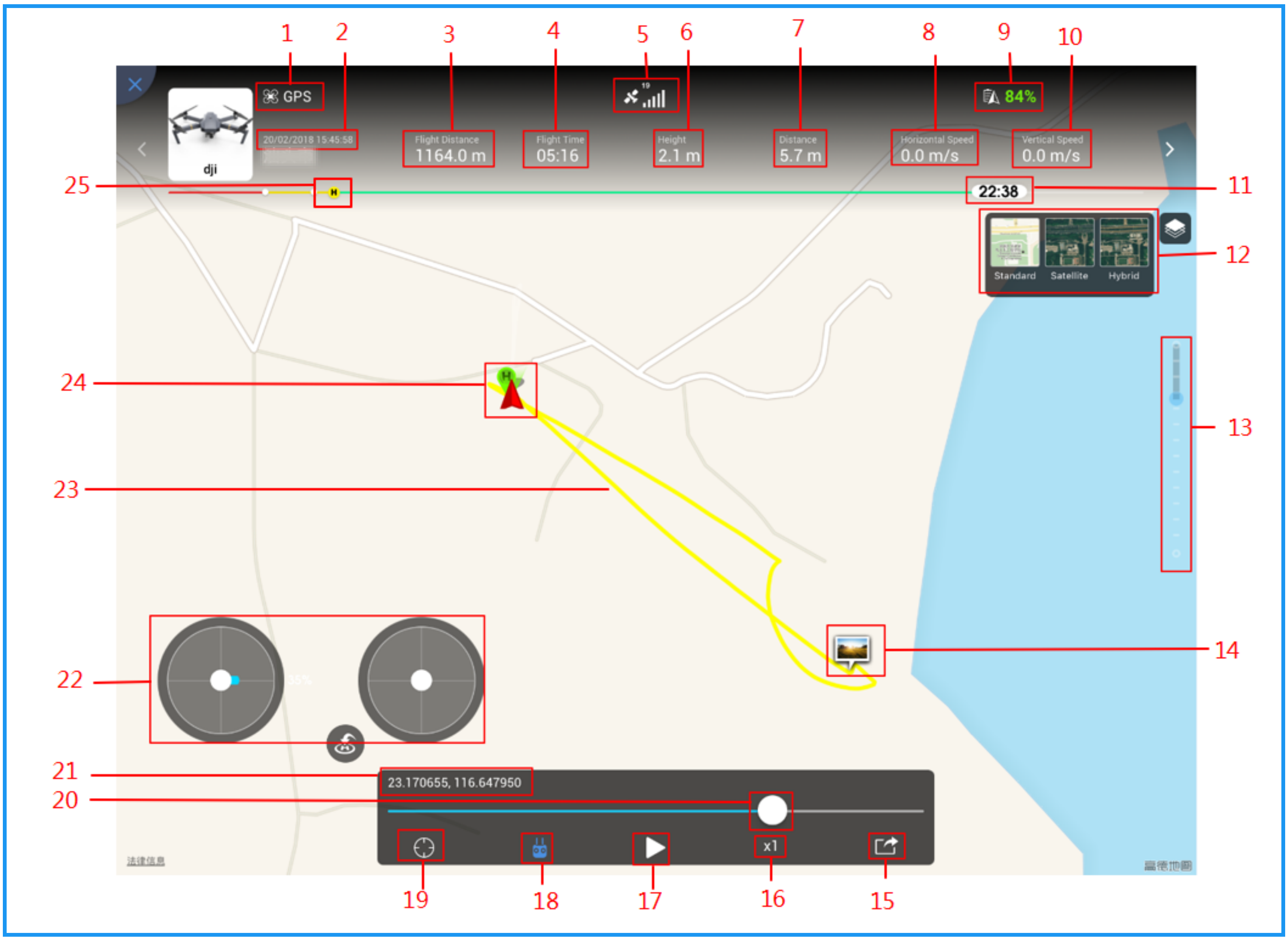
In DJI GO 4, tap the icon in the upper right corner to enter the flight record screen.



In DJI GO, tap the icon in the upper left corner to enter the flight record screen.



You can check the flight records of different drones and preview images.



Introduction to the Flight Record Screen in the App

No.	Description	Remarks
1	Drone's Current Flight Mode	GPS, ATTI, Landing, Go home, etc.
2	Drone's Takeoff Time	Based on the time zone where the mobile device is.
3	Flight Distance	Total distance of the flight path
4	Flight Time	
5	Number of the Connected GPS Satellites and Signal Strength Bars	When less than three signal strength bars are displayed in the app, the accuracy of the hovering will be decreased greatly.
6	Relative Height	Distance between the drone's current height and the takeoff point.
7	Distance	Distance between the drone and the Home Point. When no Home Point is recorded, it will be "N/A".

8	Horizontal Speed	
9	Battery Level	
10	Vertical Speed	
11	Remaining Flight Time	
12	Map	Standard map, satellite map, and composite map are available.
13	Gimbal Pitch Angle	The blue dot indicates the pitch.
14	Photo Taken	The blue dot indicates the pitch.
15	Share	Share the flight records to the social media.
16	Playback Speed	Normal, 4x, and 8x.
17	Play/Pause	
18	Show/Hide RC Screen	After hiding the RC screen, the RC operation playback screen will not be seen.
19	Optimal View	
20	Progress Bar	Normal, 4x, and 8x.
21	GPS Coordinates	"Calibrate Map Coordinates (For China Mainland)" needs to be enabled when using the drone in Mainland China.
22	RC Operation Playback Screen	
23	Flight Path	The flight path will not be displayed when no GPS satellite signal is available.
24	Drone's Icon and Home Point	The arrow indicates the drone's heading, and the green fan shows the gimbal's direction.
25	Battery Capacity Required for Returning to the Home Point	When the remaining flight time is 11 minutes, and the battery power bar stays at the H point,the remaining battery power is only sufficient for the drone to return to the Home Point.

Tap any one of the flight records to enter the flight record playback screen. You can check the control stick's input, drone's height, speed, location, battery power, etc. on the playback screen. Whether the drone was under control can be determined based on the control stick's input and drone's response.

At the end of a flight, the pilot normally lands their drone at the Home Point (or the place where the mobile device is) and then stops the motors by pulling the control sticks, at which point the flight record stops. But if the drone crashed, its heading will change quickly while its height will greatly decrease. Also, the flight record may stop while the drone is still in the air and far away from the Home Point or the mobile device. With this information, we can estimate when the drone's accident occurred. Next, we will analyze several cases with the flight records in the app.

Stopping Motors in Air

The drone's motors will stop if both control sticks are pushed to the bottom inner or outer corners, or the left stick is pushed down and held. For more details about stopping the motors midflight for different drones, please read their user manual. Pilots need to be aware of how to stop the drone's motors in emergencies, and also to avoid accidentally stopping the motors during flight.

We will use the Phantom 3 as an example. According to the above figure, after the drone had flown for 8 minutes and 45 seconds at a height of 38.7 meters and a distance of 18.9 meters, the user pushed the control sticks in the bottom inner corners, and the Phantom 3's motors stopped, and it fell to the ground.

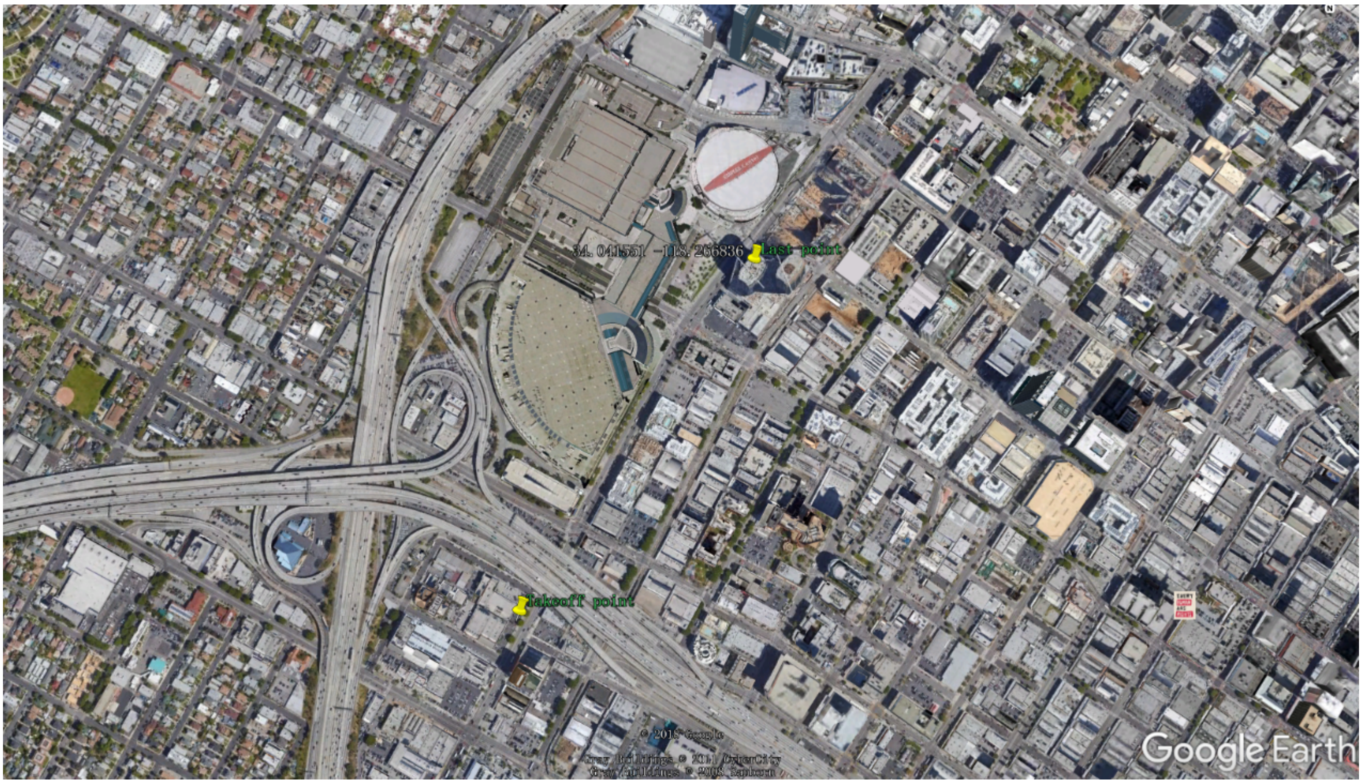
Incorrectly Pushing Sticks

As we only see what is happening in front of the drone from the video feed, please fly with caution and pay close attention to the distance between the drone and obstacles when flying it backward, leftward or rightward. In Sport mode or flying at a fast speed, make sure to retain a proper distance from other objects to allow the drone enough time to slow down to avoid collisions.

The drone took off.

The drone responded to the sticks' commands.

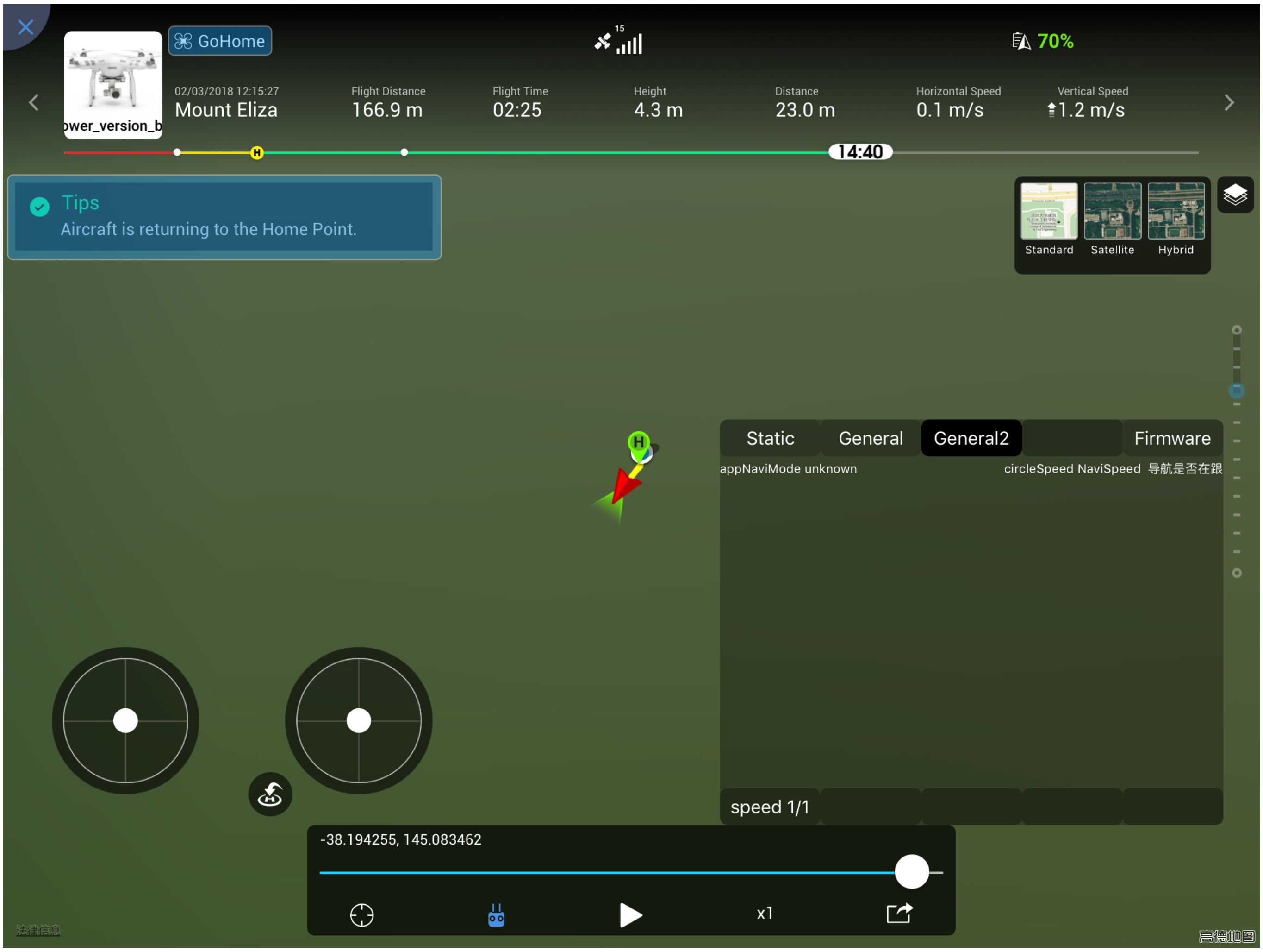
In this particular case, the operator was using Control Stick Mode 2. According to the record above, the control sticks were working normally, but the drone did not return to the takeoff point and was still flying when the flight record stopped. Let’s find the drone’s final location on the map.



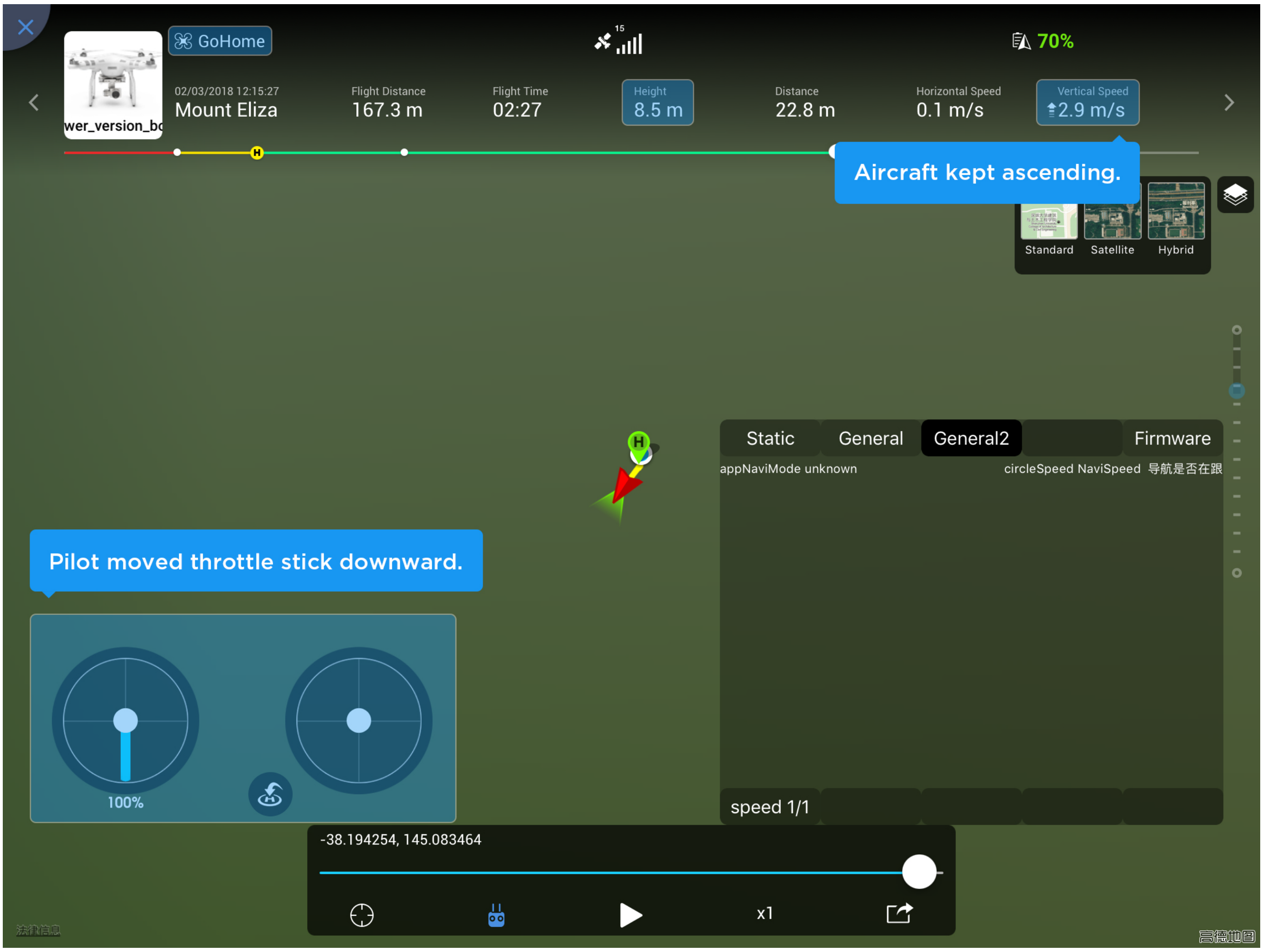
It can be deduced that the aircraft will probably have crashed on the building if it keeps flying backward at 6.4 m/s.

Crashing While Ascending During Return to Home

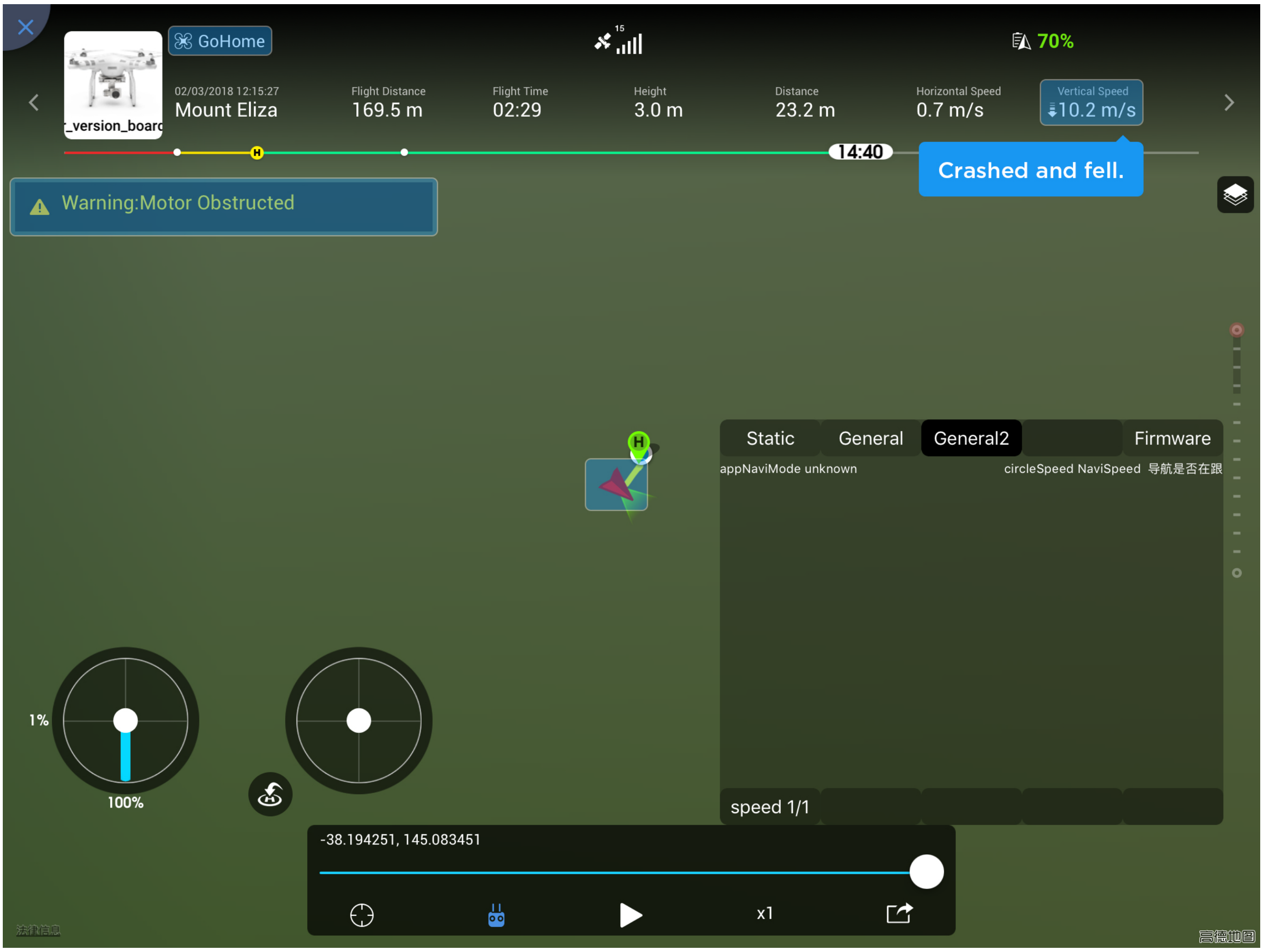
When RTH is used, the drone will ascend to the set RTH height and proceed to return to its home point. If the aircraft has obstacle avoidance sensors and it meets an obstacle on its return, it will ascend again to avoid it. However, as most drones don't have an upward facing obstacle avoidance sensor they are at risk of hitting anything that may be above them. Accordingly, it is recommended to avoid triggering Return to Home when the drone is flying under any objects, such as trees and bridges. If you activate RTH by mistake, you can stop the drone ascending by canceling the Return to Home process.



The drone started flying to the Home Point.



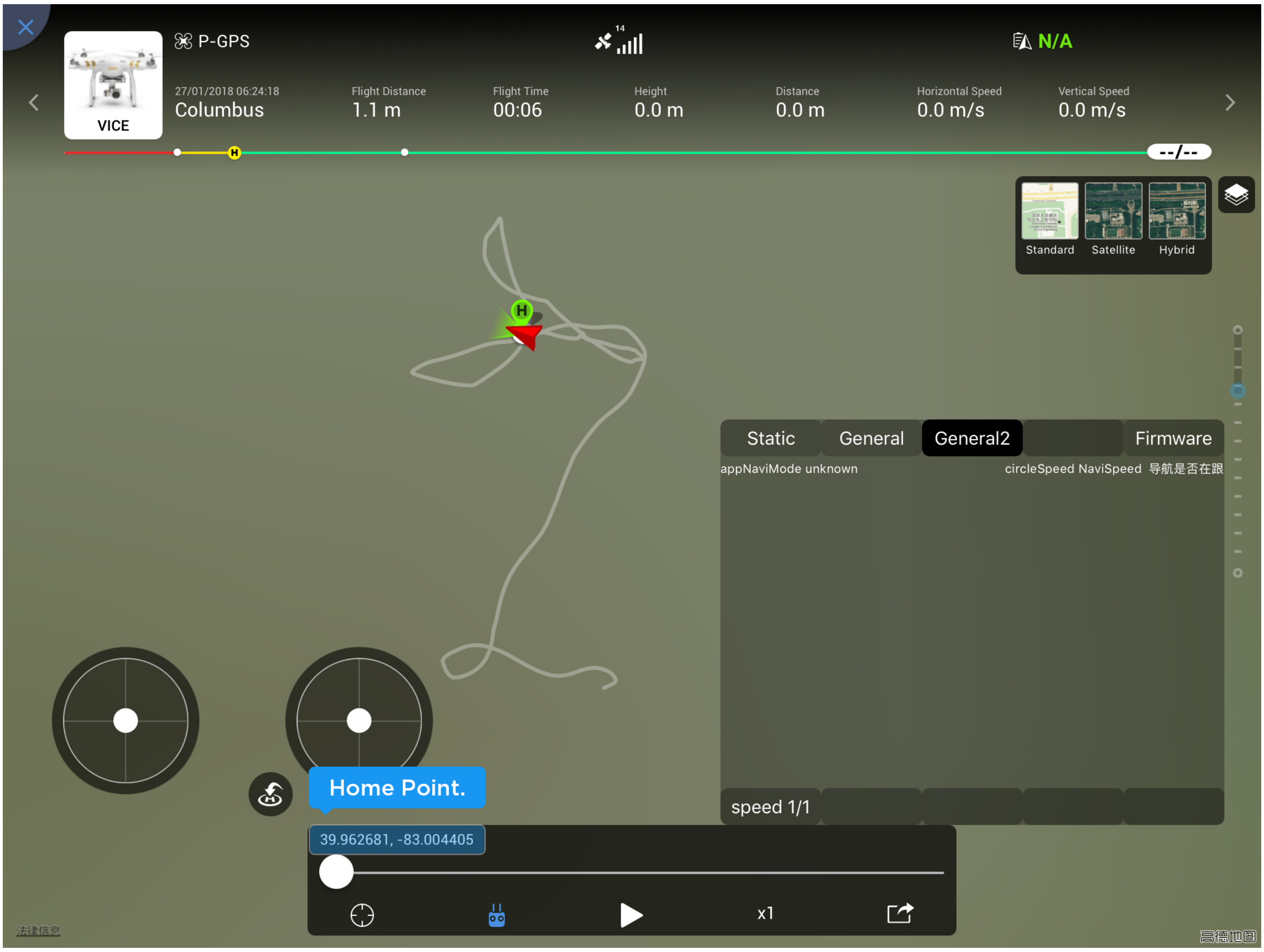
As it was preset that the drone must ascend by 20 meters before returning home, the aircraft kept rising upward even though the throttle stick was pushed down.



The drone crashed and fell during the ascent.

Crashing While Flying Back During Return to Home

During the Return to Home process, the drone will fly horizontally to the Home Point after ascending to the preset height. If the aircraft isn't using obstacle avoidance, it will collide with any object directly in its flight path. Even with obstacle avoidance enabled it may still crash as the forward vision system cannot effectively recognize obstacles in low light conditions. So make sure that the RTH height is set high enough to avoid any potential obstacles during its return flight.



The GPS signal was strong, and the drone recorded the Home Point successfully when taking off.

The aircraft responded to the stick's command made by the pilot during flight.

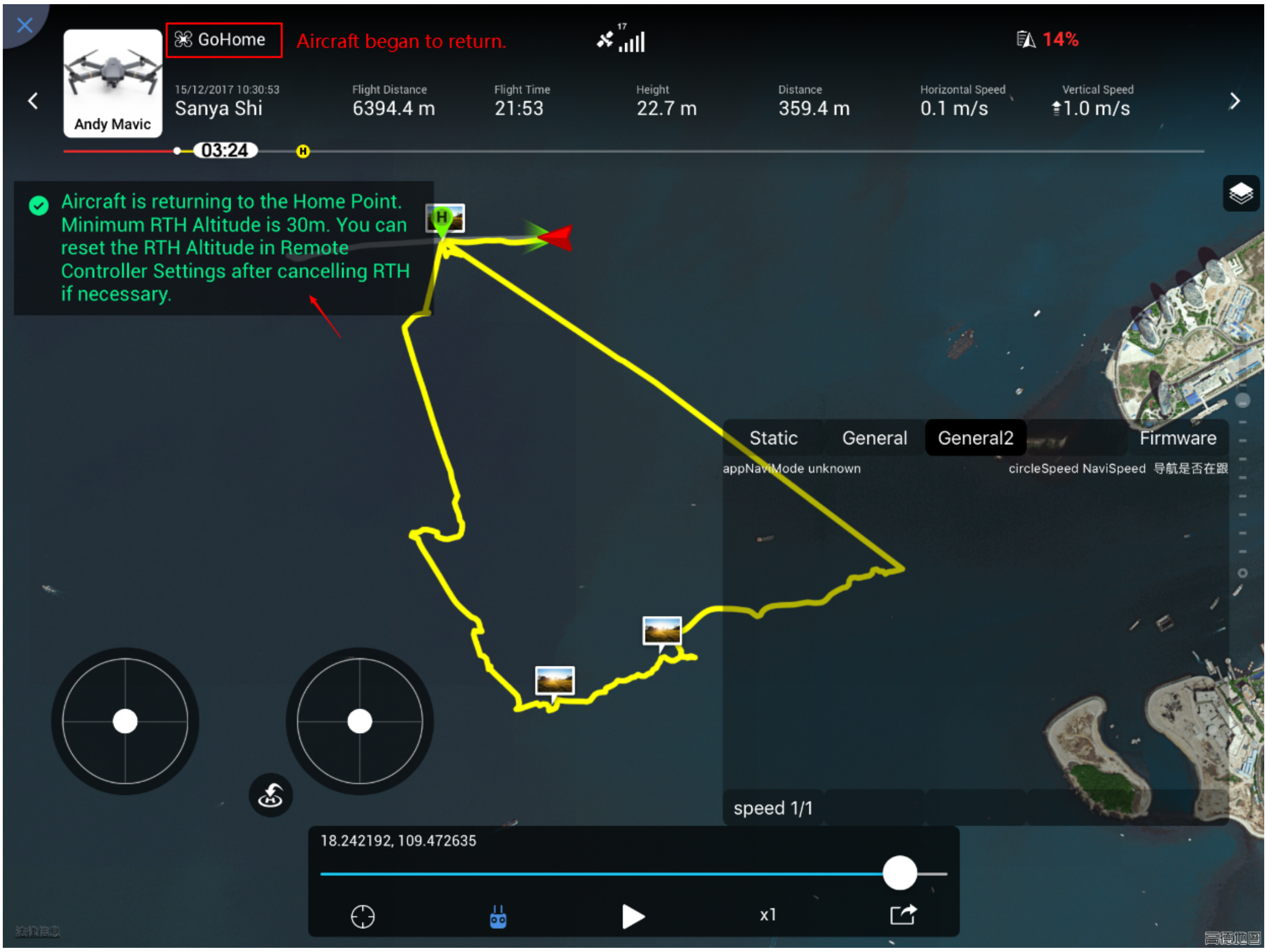
The flight record stopped at 11:30, and the drone was not at the home point.

After positioning the Phantom 3 on the map, it was found that there was a building between the drone and Home Point, and the flight record finished after the remote controller's signal was blocked. So the aircraft probably crashed into the building during the Return to Home.

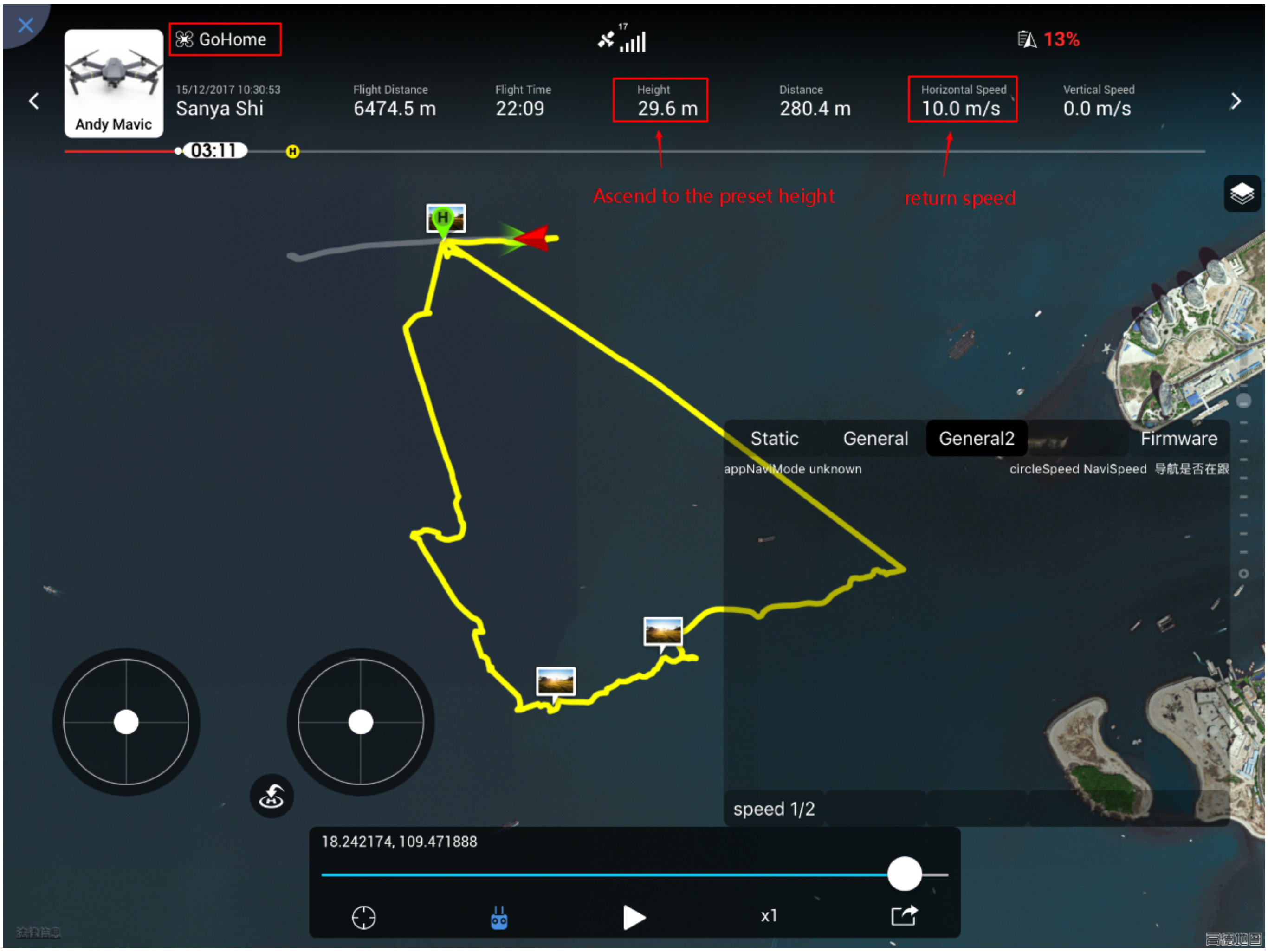
Crashing While Descending During Return to Home

When flying above the Home Point, the drone will start descending slowly. In this situation, if you push the control sticks, it will fly away from the Home Point while descending. So the drone may land in an unsuitable place resulting in damage to the aircraft.

You should pay close attention to the distance between the drone and Home Point as well as the flight mode. Do not make the aircraft fly away from the Home Point purely based on visual assessment as it's easy to misjudge the distance. Furthermore, the GPS system on consumer drones is not infallible so the drone might not land exactly at the recorded Home Point. If necessary, cancel the landing or use the control sticks to change the drone's location and land it in a safe place.



Return to Home was triggered at 21:53 minutes into the flight, when the distance was 359.4 meters and height was 22.7 meters.



The aircraft ascended to the preset height and started flying horizontally to the Home Point.

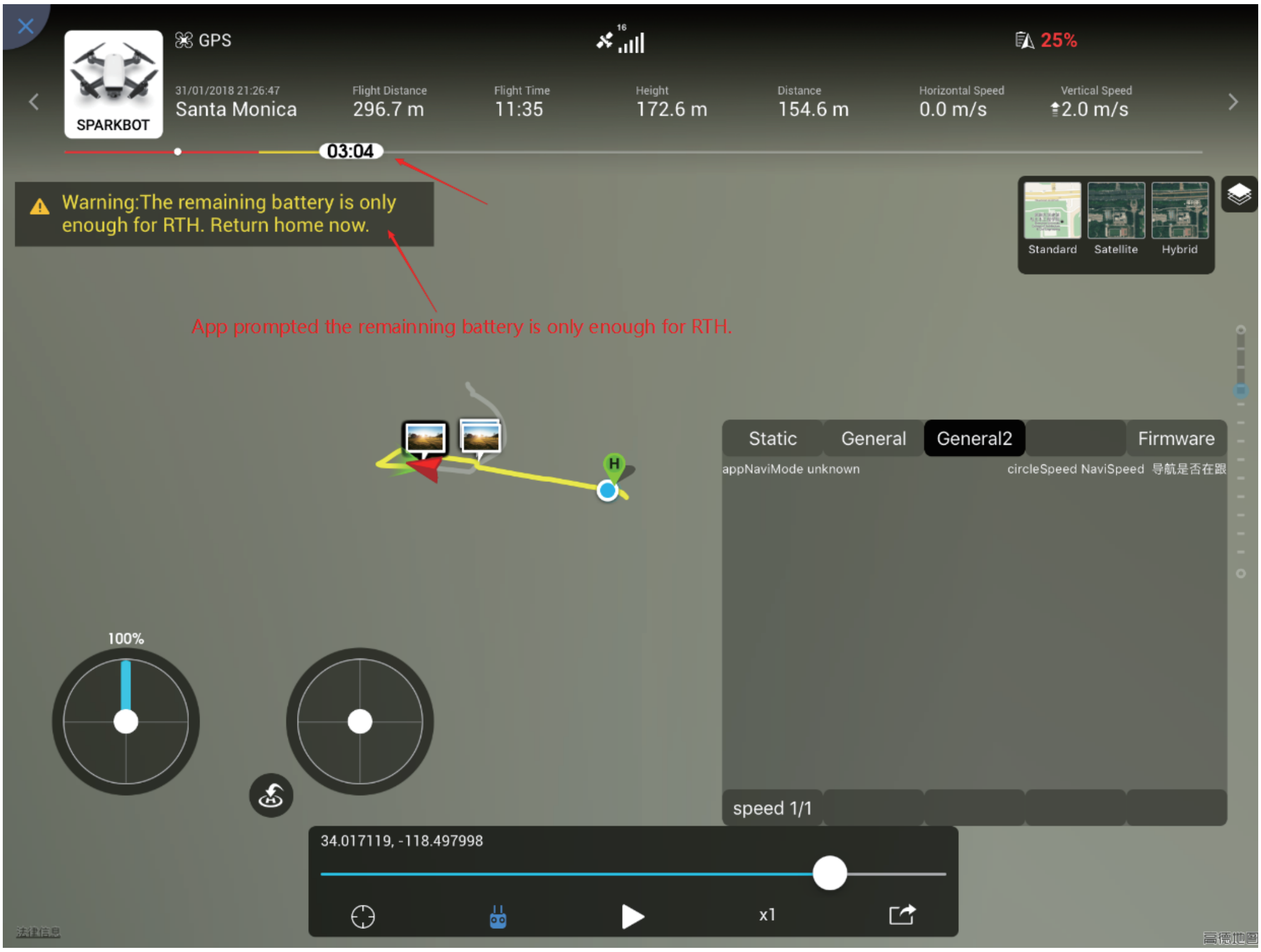
It arrived at the Home Point at 22.43 minutes into the flight and started descending.

Then the user made the drone fly away from the Home Point by pushing the stick.

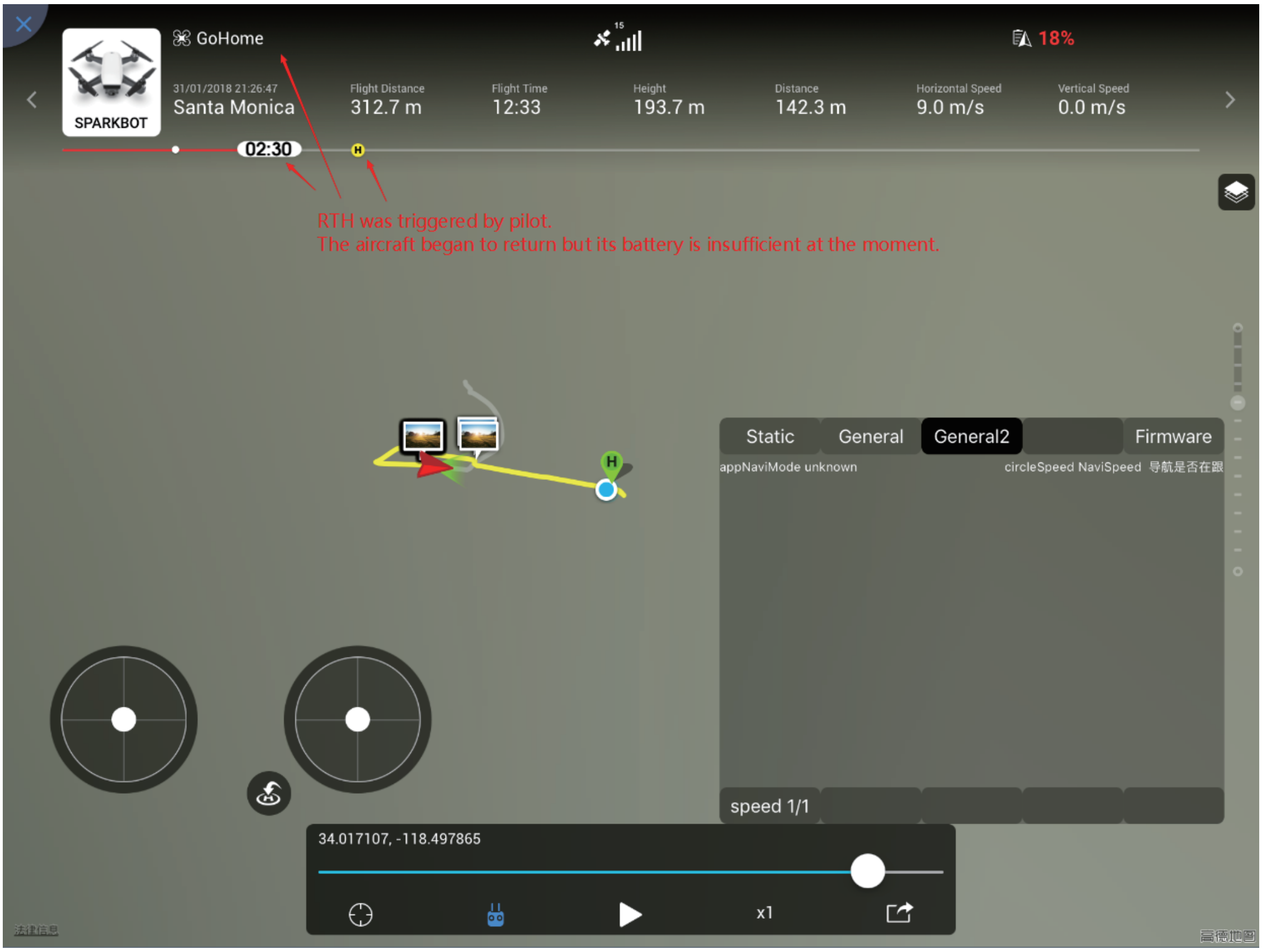
The flight record ended at 24:12 minutes into the flight, and the drone would have kept descending.

Drone Missing After Landing Due to Insufficient Battery Power

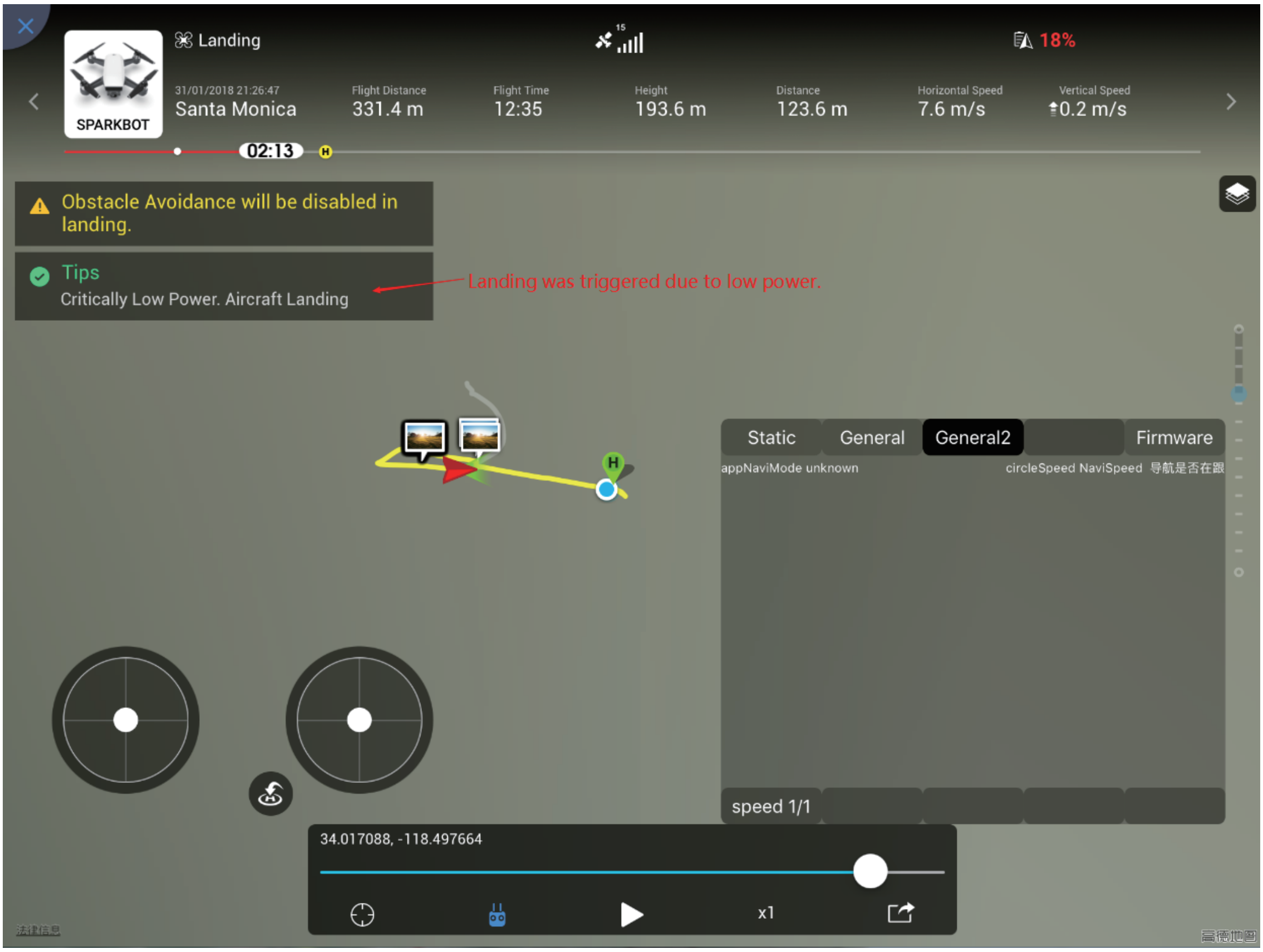
During a flight, the flight controller will calculate the battery power (according to the drone's height, distance, and preset flying speed) for the drone to return to the Home Point. The app will prompt the pilot to return their aircraft to the home point before the battery power is too low to do so. If the user ignores the warning and flies their drone even further away from the Home Point, it is very likely that the battery will run out of power when the drone is returning.



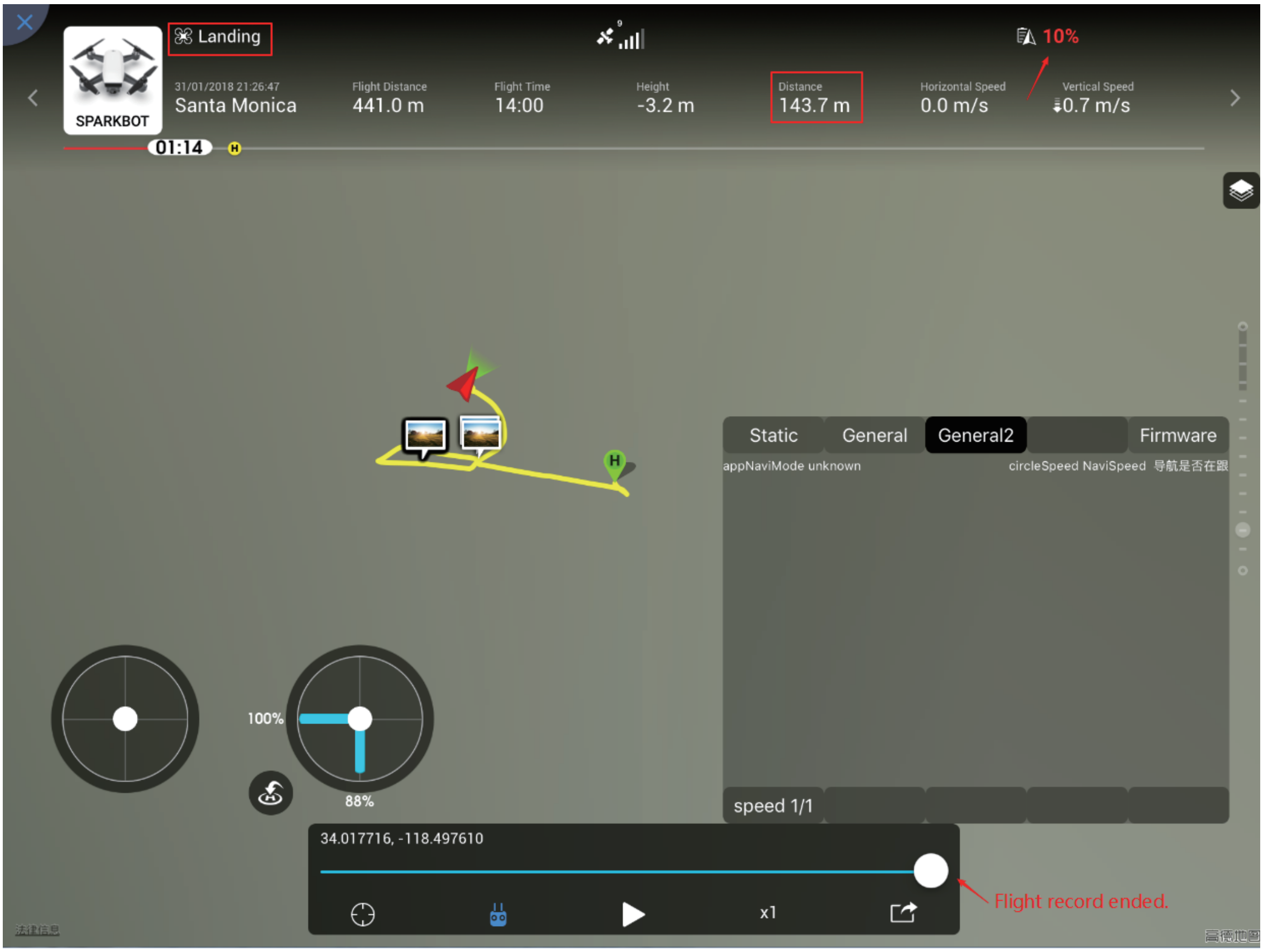
At 11:35 minutes into the flight, when the drone was flying at a height of 172.6 meters and a distance of 154.6 meters with 25% battery power remaining, the app prompted the user that the battery level was only sufficient for the drone to return to the Home Point.



The pilot ignored the warning. At 12:33 minutes into the flight, when the drone was flying 142.3 meters away at an 18% battery level, the user made it fly back to the Home Point.

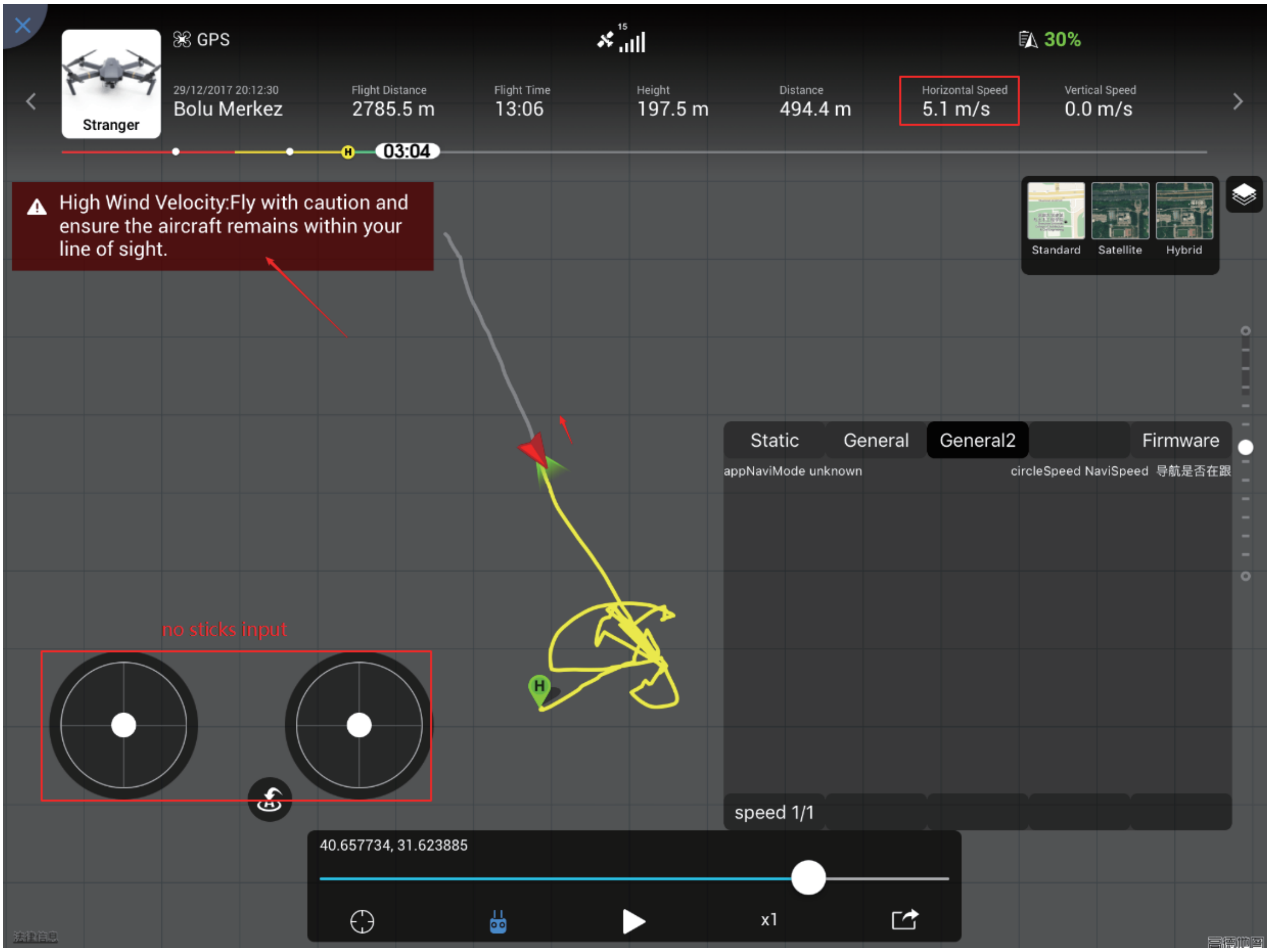


On its way back the aircraft descended because the battery power was insufficient.

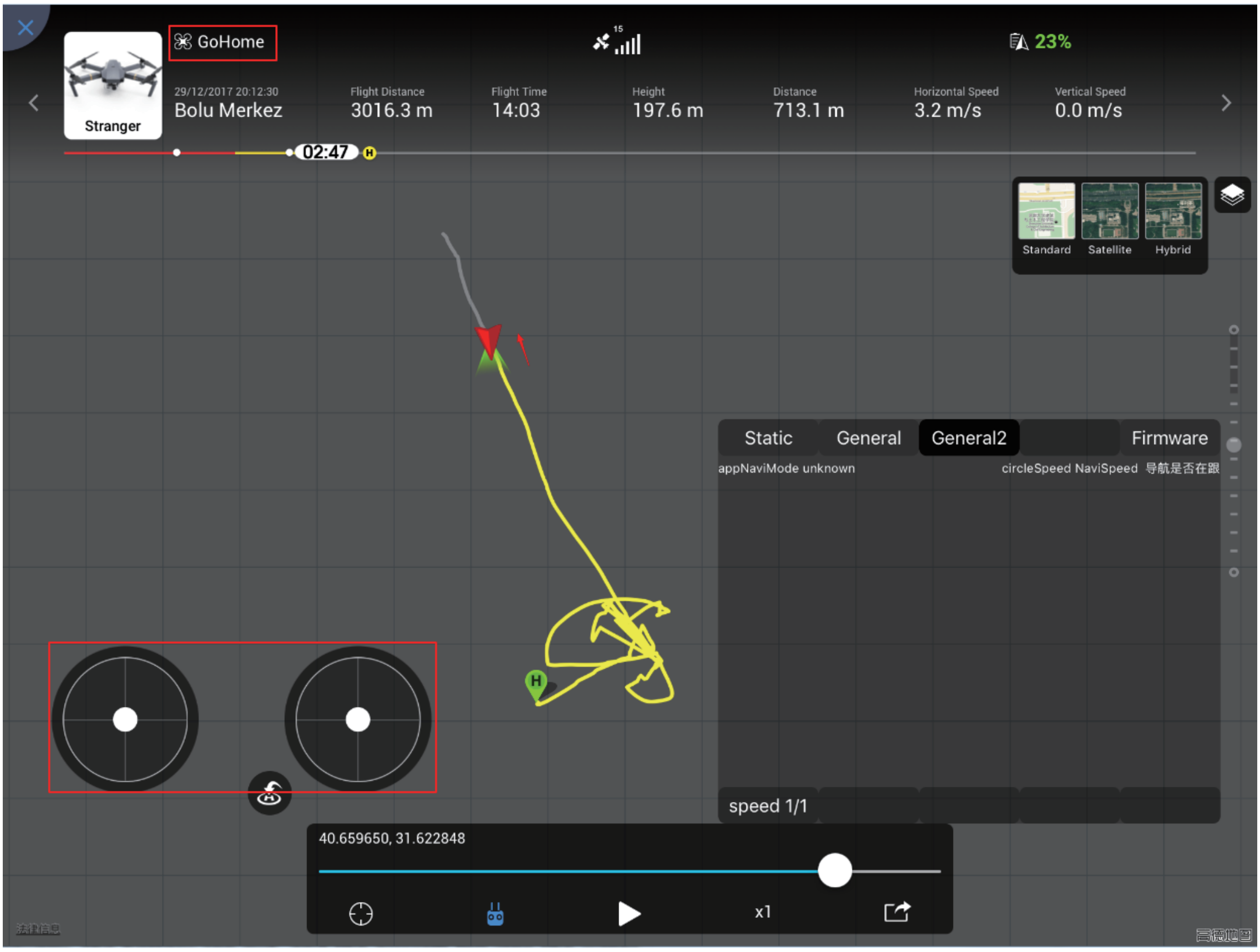


As a result, it would crashed and was lost as the battery ran out.

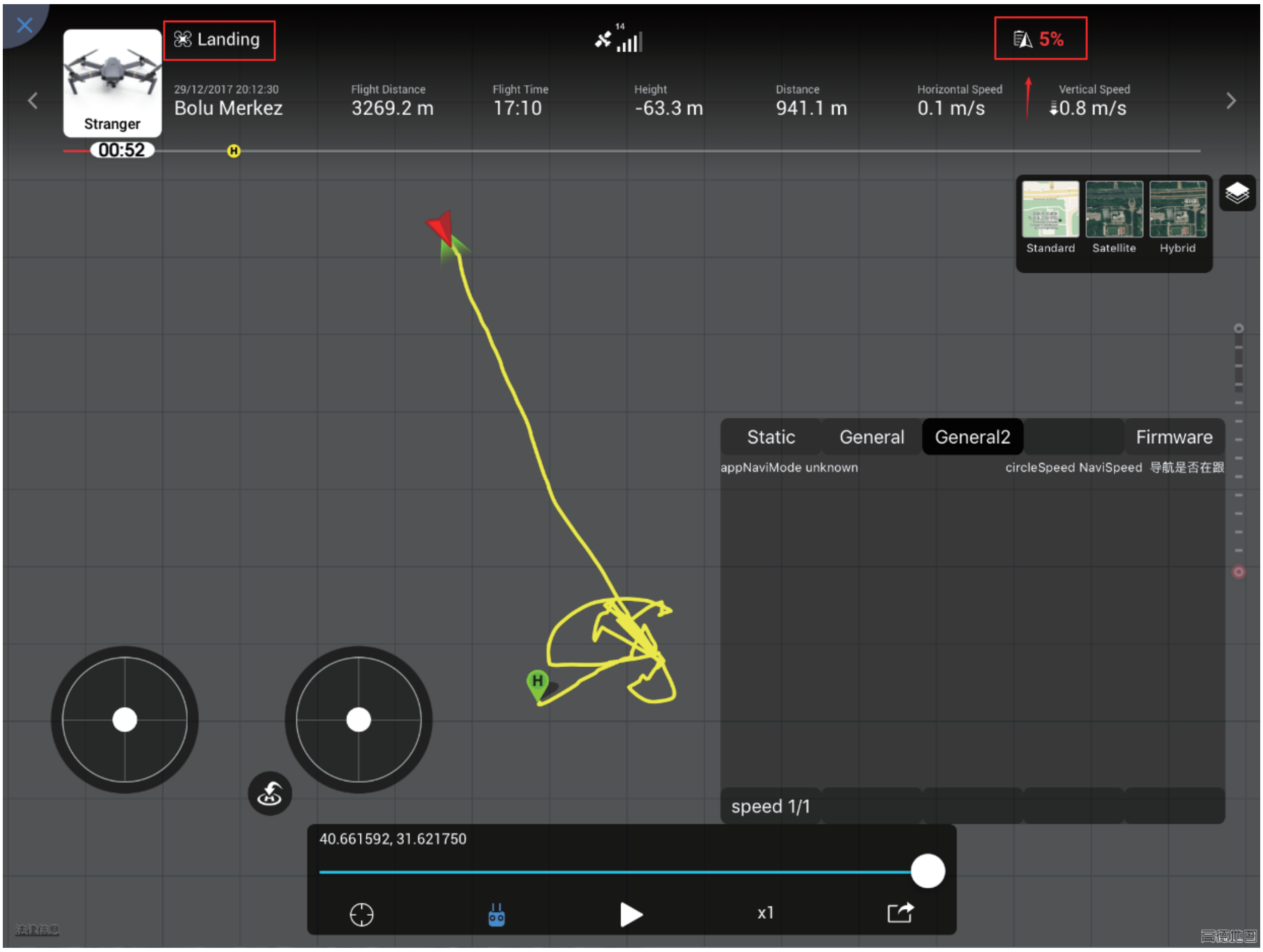
Drone Missing Due to Strong Winds



Without any control stick input, the drone was still moving horizontally, and a high wind speed warning popped up in the app, meaning that the drone could not hover steadily against the strong wind.



Even though Return to Home was enabled, the strong winds were pushing the aircraft away from the Home Point.



Even though Return to Home was enabled, the strong winds were pushing the aircraft away from the Home Point.

II. Flight Controller Data Analysis Series Tutorials - Exporting the Flight ControllerData and Introducing DataViewer

DataViewer is included in DJI Assistant 2, which can be used to analyze the flight controller data from the DJI Phantom series and Inspire series drones, A3, and N3.

1.1 How to Export the Data

The flight controller data refers to the data, including the working statuses of different modules, control and navigation information, etc., generated by the flight controller after the DJI drone is powered on and stored in the internal memory until the drone is powered off. One data file will be generated after the drone is powered on and off. The data files will be named in a sequential numbering order. The log file will be split when its file size exceeds 450 MB. Around 10 MB data will be generated after the drone has flown for one minute, so the log file size will reach 450 MB after the drone has flown for 45 minutes.

DataViewer is mainly used for checking and analyzing the drones' flight controller data, examining the performance, and troubleshooting the malfunctions of drones. It is an effective tool for finding out the causes of the drones' malfunctions.

Operate the following steps to export the flight controller data with DataViewer:

1.Launch DJI Assistant 2.
2.Connect to a drone via the USB port on the drone.
3.Click "Flight Data" on the left panel and enter the Flight Record List screen. For the Phantom 3 series and Inspire 1 series drones, you need to enter "Read flight data mode" with DJI GO.
4.Click the button for the SD card mode and you will see a "DJI FLY LOG" removable drive on the PC, as shown in figure 1.1.

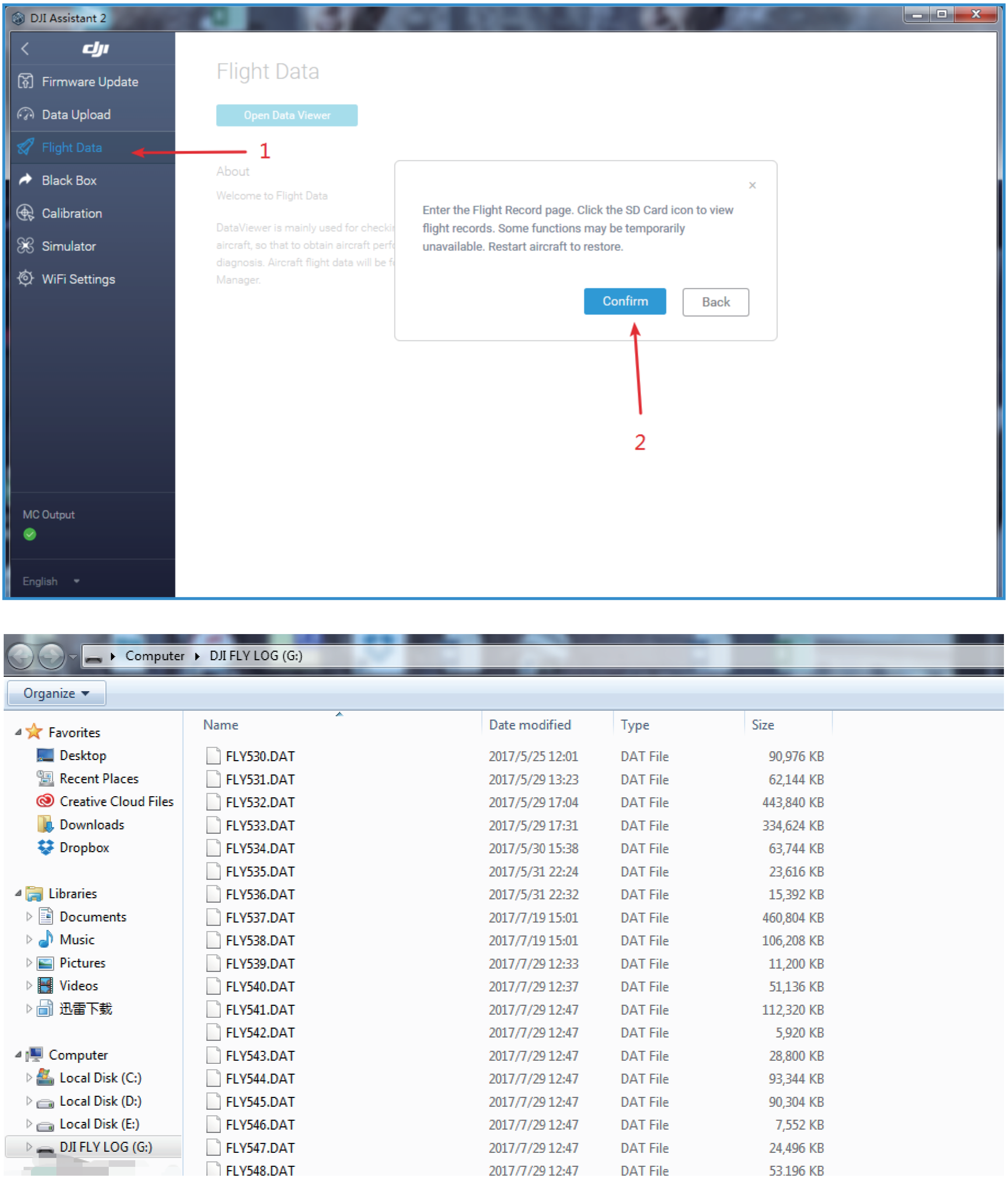
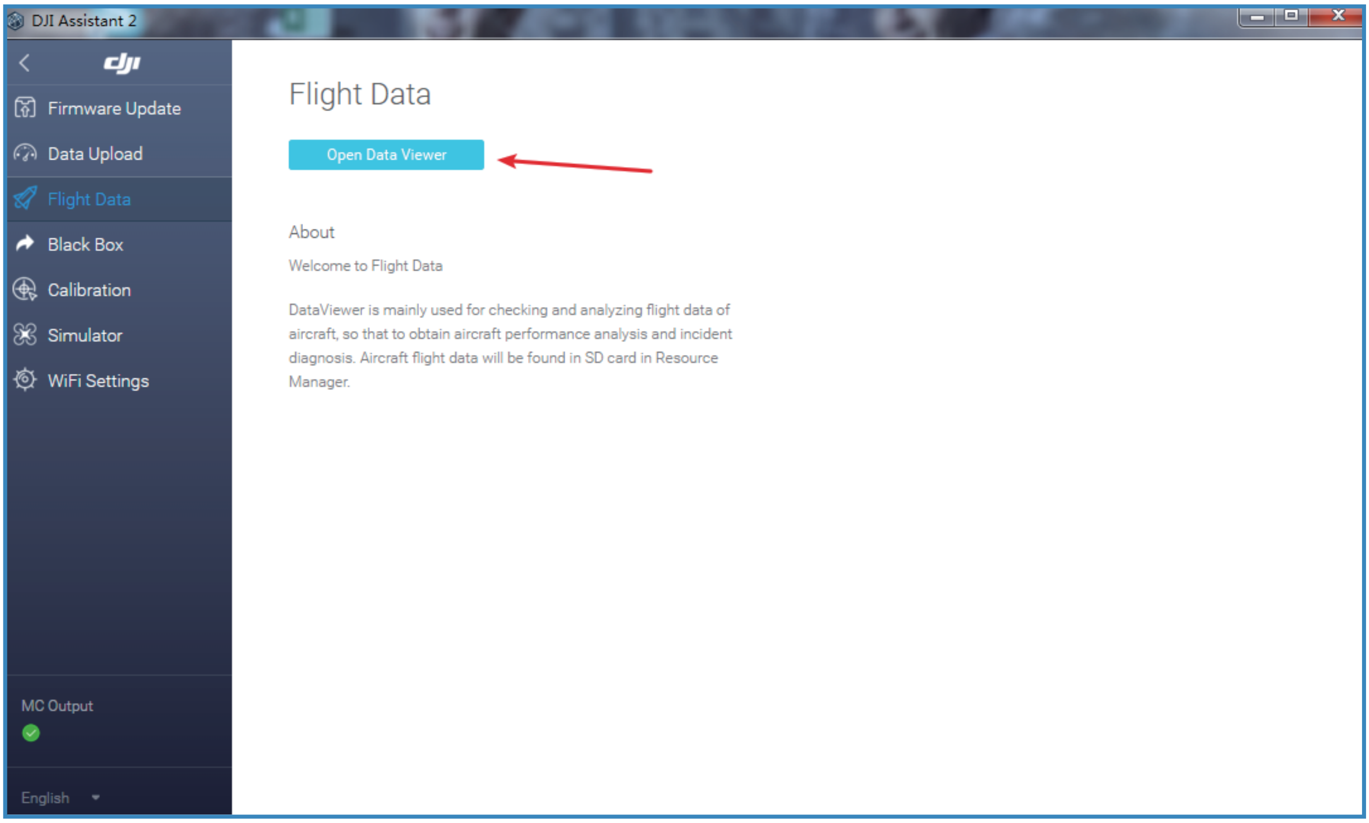


Figure 1.1

5.Then copy the flight controller data to your local disk.

1.2 Introduction to DataViewer

Click “Flight Record” on the left panel, enter the “Flight Record List” screen, and click “Open Data Viewer”.



Click the button marked in figure 1.2 to open a flight record file.

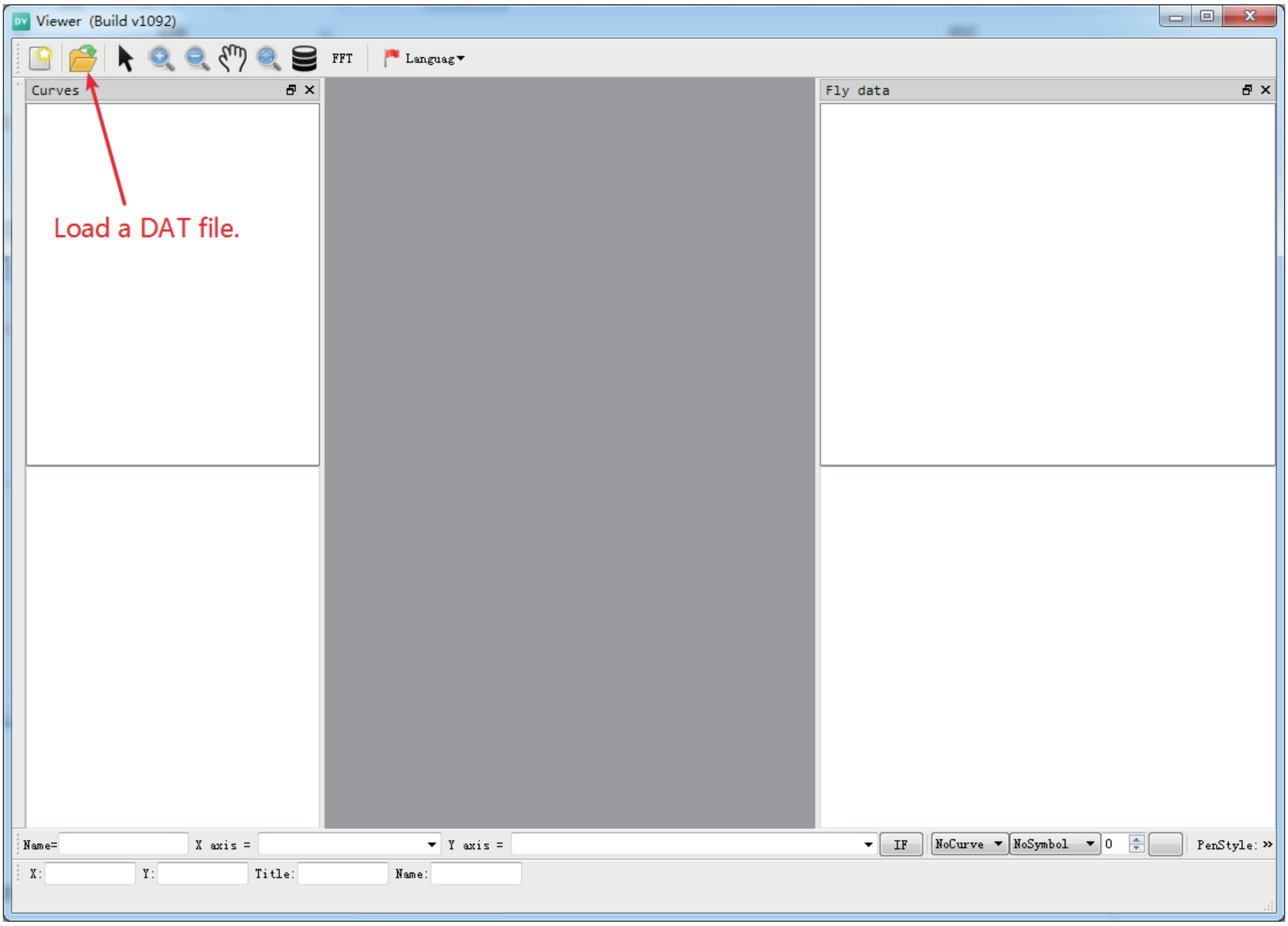

Viewer (Build v1092)
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Figure 1.2

Figure 1.3 shows the main screen of the DataViewer software and table 1.1 lists DataViewer's features.

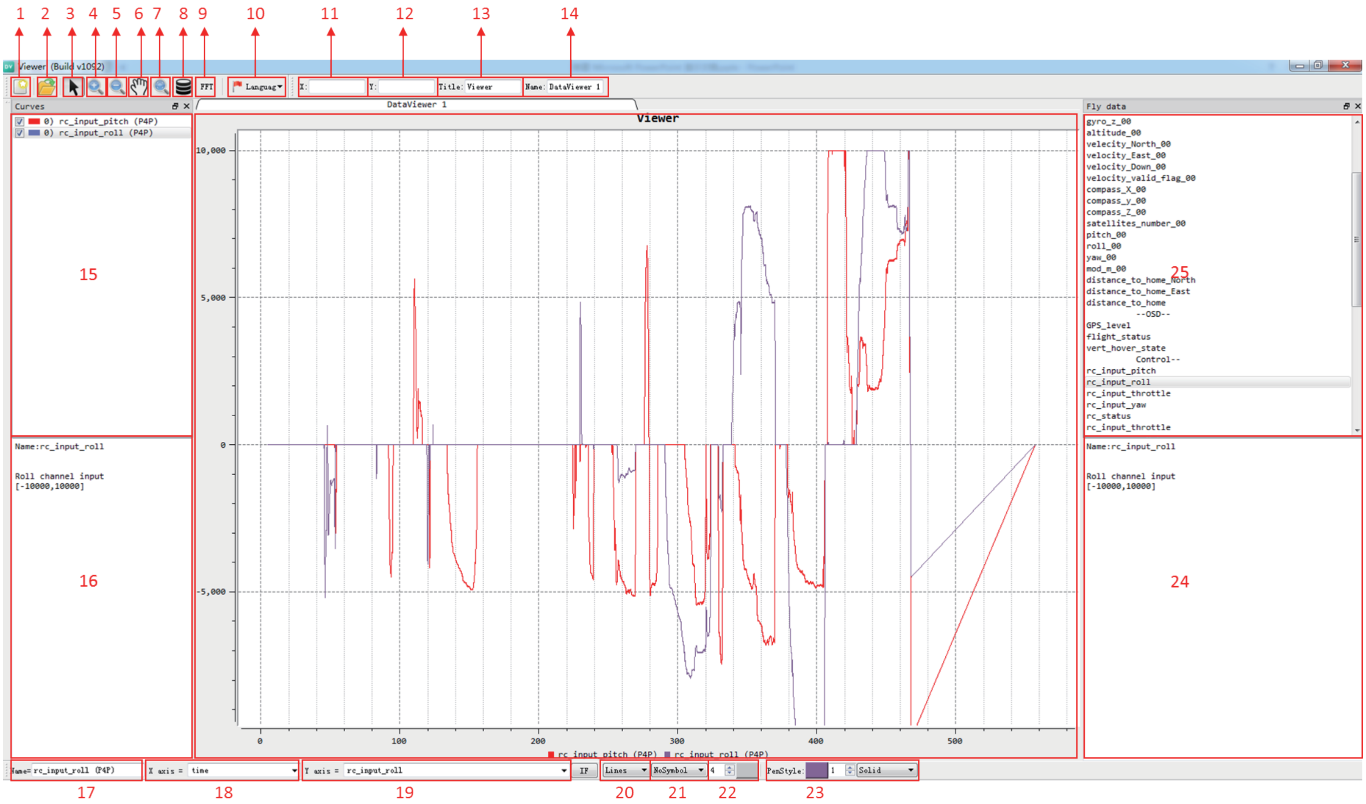


Figure 1.3

Table 1.1

No.	Icon	Name	Feature
1		Create New View	Create a new tabbed view.
2		Load Data	Load a new data file.
3		Arrow	Select a data point.
4		Zoom In	Zoom into a certain part of the curve.
5		Zoom Out	Click any part of the screen to zoom out the screen.
6		Hand Tool	Drag the screen.
7		Resize Window	Resize the current aspect ratio of the window to fit the curve.
8		GPS Export GPS	This feature will be available in the future.
9	FFT	Fast Fourier Transform (FFT)	Conduct FFT calculation on the selected region.
10	语言	Language	Set a language.
11	–	X Axis	Describe the X axis.
12	–	Y Axis	Describe the Y axis.
13	–	Title	Title of the diagram.
14	–	Name	Name of the tab.
15	–	Curve List	Show the displayed curves.
16	–	Description	Describe the selected curve on the Curve List.
17	–	Name of the Curve	Name of the selected curve.
18	–	Name of the X Axis Variable	Add "+" or "-", or a number after the name to move, stretch out , draw back, zoom in, or zoom out the time axis of the curve.

19	–	Name of the Y Axis Variable	Add “+” or “-”, or a number after the name to move, stretch out, draw back, zoom in, or zoom out the Y axis of the curve.
20	–	Curve Type	Display the curves in a certain form. Set this option to “NoCurve”, “Lines”, or “Sticks”.
21	–	Data Point Type	Display the data points in a certain shape. Set this option to “XCross”, “Cross”, “UTriangle” etc.
22	–	Size and Color of the Data Point	Set the size and color of the data point.
23	–	Type, Color, and Thickness of Line	Set the type, color, and thickness of the line. Thickness can be set by scrolling down or up.
24	–	Description	Describe the selected curve in the flight data region.
25	–	Flight Data	Shows all flight data.
26	–	Diagram Region	Displays all curves.

Curves can be zoomed in, zoomed out, and moved by using the Arrow, Zoom In, and Zoom Out tools.

Zoom Out: Move the arrow of the mouse to the diagram region and scroll up the mouse to zoom out by using the Arrow, Zoom In, Zoom Out, or the Hand Tool. Or, with the Zoom Out tool, left-click the diagram region to zoom out.

Zoom In: Move the arrow of the mouse to the diagram region and scroll down the mouse to zoom in by using the Arrow, Zoom In, Zoom Out, or the Hand Tool. Or, with the Zoom In tool, press and hold the left key of the mouse, and drag the rectangular region to zoom in.

Move: Press the button of the mouse to move a curve by using the Arrow, Zoom In, or Zoom Out tool. Or, with Hand Tool, press and hold the left key of the mouse to move a curve.

In the diagram region, X axis always represents time in the unit of second. Y axis represents different parameters according to the curves. For height curves, the unit is meter. For speed curves, the unit is m/s.

1.3 Introduction to Major Data

In the Flight Data region, you can check all data packages and values of the variables of the flight controller data. Next, we will introduce the major types of data packages and the meaning of the specified variables. DataViewer will visualize the data in the data packages in curves for data analysis.

The data in the current flight data records mainly includes the attitude data, OSD data, controller data, remote controller data, motor data, ESC data, battery data, and Obstacle Avoidance data. Flight data may vary according to the drone models, firmware version, etc.

Table 1.2 lists the data packages in the flight controller data and their contents.

Table 1.2 Major Data Packages (might differ with model of the aircraft)

Name	Content
Attitude Data	Mainly includes the navigation information including location, speed, attitude, angular speed, etc. and sensors information including accelerometer, gyroscope, magnetometer, barometer, etc.
OSD Data	Mainly includes the flight status information of the drone, such as GPS signal strength, flight status, and Return to Home status, etc.
Controller Data	Mainly includes the control information output by the drone.
Remote Controller Data	Mainly includes the remote controller's information, such as flight mode, and control sticks' movements, etc.
Motor Data	Mainly includes the PWM output data from the drone to the motors.
ESC Data	Mainly includes the operating status information of the ESCs.
Battery Data	Mainly includes the battery's information, including voltage, current, temperature, capacity, etc.
Obstacle Avoidance Data	Mainly includes the Obstacle Avoidance information of the vision sensors, ultrasonic sensors, and infrared sensors.

Next, we will introduce the commonly used data packages and their meanings.

Table 1.3 lists the common data items in the attitude data package and their meanings.

Table 1.3 Major Data in the Attitude Data Package

Item	Description	Unit
Altitude	0 at sea level, pay attention to relative height.	m
Satellites_number	Number of detected satellites	
Pitch	Pitch angle (A positive value indicates that the drone's nose is up while a negative indicates that the drone's nose is down.)	deg
Roll	Roll angle (A positive value indicates that the drone tilts to the right while a negative value indicates that the drone tilts to the left.)	deg
Yaw	Yaw Angle (A positive value indicates the angle between the north and the direction to which the drone points when the drone is rotating clockwise. When the drone points to the north, this value will be 0.)	deg
mode_m	e_mode_m (compass)	1
Distance From the Home Point	Distance from the Home Point	m

Table 1.4 lists the common data items in the OSD data package and their meanings.

Table 1.4 Major Data in the OSD Data Package

Item	Description	Unit
GPS Level	0 = No GPS Signal 1 = Poor GPS Signal 2 = GPS Signal Only Sufficient for Hovering 3 = GPS Signal Sufficient for Return-to-Home 4 = GPS Signal Sufficient for Recording a Home Point 5 = Strong GPS Signa	*To guarantee the flight safety, ensure that the drone's GPS signal level is higher than level 3, or the aircraft's hovering may be affected.
Flight Status	0 = Motors stop. 1 = Motors are rotating, but the drone does not take off. 2 = The drone is flying in the air.	

Table 1.5 lists the common data items in the remote controller data package and their meanings.

Table 1.5 Major Data in the Remote Controller Data Package

Item	Description	Unit and Remarks
rc_input_pitch	Remote controller pitch channel input	[-10000,10000]A positive value indicates that the stick is pushed forwards while a negative value indicates that the stick is pushed backwards.
Satellites_number	Remote controller roll channel input	[-10000,10000]A positive value indicates that the stick is pushed to the right while a negative value indicates that the stick is pushed to the left.
rc_input_throttle	Remote controller throttle channel input	[-10000,10000]A positive value indicates that the stick is pushed upwards while a negative value indicates that the stick is pushed downwards.
rc_input_yaw	Remote controller yaw channel input	[-10000,10000]nA positive value indicates that the drone's nose is rotating to the right while a negative value indicates that the drone's nose is rotating to the left.
	0 = Attitude mode 1 = Sport mode 2 = Positioning mode 3 = Abnormal 4 = Receiver disconnected from the transmitter 5 = Receiver disconnected from the flight controller	

Table 1.6 lists the common data items in the motor data package and their meanings.

Table 1.6 Major Data in the Motor Data Package

Item	Description	Unit
Motor Status	0 = Motors stop. 1 = Motors are rotating.	
motor_pwmn	Motor n's PWM output	0.01% (n = 1-8, varying according to the drone model)

Table 1.7 lists the common data items in the ESC data package and their meanings.

Table 1.7 Major Data in the ESC Data Package

Item	Description	Unit
ESC n's Status	0 = Normally functioning Non 0 = ESC error	(n = 1-8, varying according to the drone model)
ESC n's Rotation Speed	Motor's rotation speed measured by the ESC n	(n = 1-8, varying according to the drone model)

Table 1.8 lists the common data items in the battery data package and their meanings.

Table 1.8 Major Data in the Battery Data Package

Item	Description	Unit
Bat_Voltage	Battery's voltage	mV
Bat_Current	Battery's current	mA
Bat_Temperature	Battery's temperature	0.1 °C

Table 1.9 lists the common data items in the Obstacle Avoidance data package and their meanings.

Table 1.9 Major Data in the Obstacle Avoidance Data Package (Varying According to Drone Models)

Item	Description	Unit
Ultrasonic_height	Height measured by ultrasonic sensors	mm
Usonic_valid_ Flag	Ultrasound wave reliability flag 0 = Unreliable 1 = Reliable	
Forward Sensor Detection Distance	Distance from an obstacle detected by the forward camera	cm
Forward Sensor Validity Flag	Forward camera validity flag 0 = Invalid 1 = Valid	
Emergent Braking Flag	Emergent braking flag 0 = Not braking in emergencies 1 = Braking in emergencies	

If you want to know the meaning of an item, click it in the Flight Data region, and its description including the meaning and unit will be shown in Description region on the lower right corner, as shown in figure 1.4.

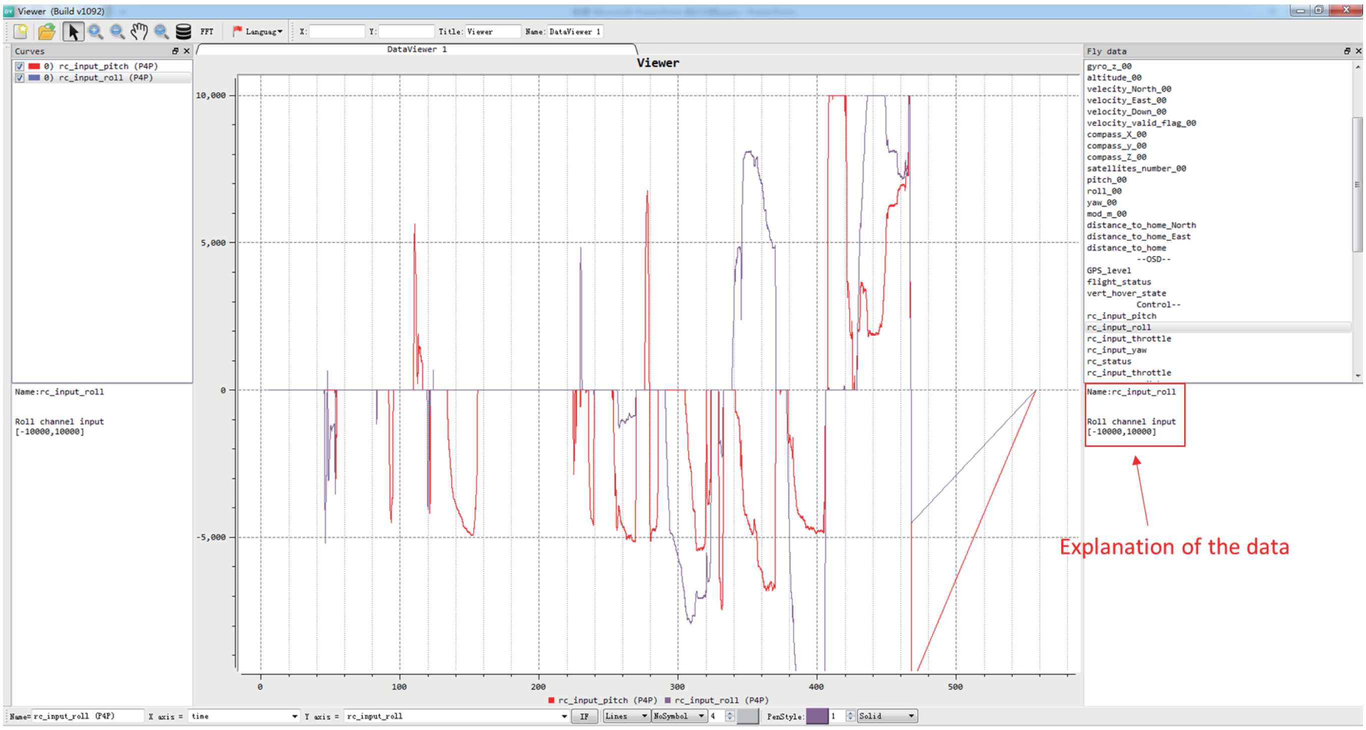


Figure 1.4

III.Flight Controller Data Analysis Series Tutorials – Locating the Crash Data

Crash data for drones is like the black box data for planes. It records everything that occurred during flight, which helps us to know more about the situations when accidents happen.

One flight controller data record will be generated when the drone is powered on. So, there will be many data records for a drone. The first step for analyzing the drone's data is to sort out the crash data from multiple flight data records.

Generally, you can locate the crash data by using four indicators: data size, accelerometer value, motor data, and drone's height.

- Data Size: Estimate the flight time according to the size of the flight controller data files and delete those data files generated when the drone did not fly.
- Accelerometer's Value: The sum of the external forces that the drone undertakes. When the sum of the external forces is 0, the drone in motion continues to move at constant velocity, or the drone remains at rest. If the drone crashes with an obstacle, the sum of external forces will increase significantly in a short period of time and the accelerometer's value will suddenly change.
- Motor Data: Motors must be working before the crash and may be obstructed after the crash.
- Drone's Height: The drone's relative height must change after the drone takes off. Mostly, the drone will drop down from air after a crash. The original values along the height curve are close to the altitude of the location where the drone is flying. So, to get the relative height of the drone, the height of the take-off point must be deducted.

Next, we will show you how to analyze the data. Figure 2.1 shows the crash data of a drone.

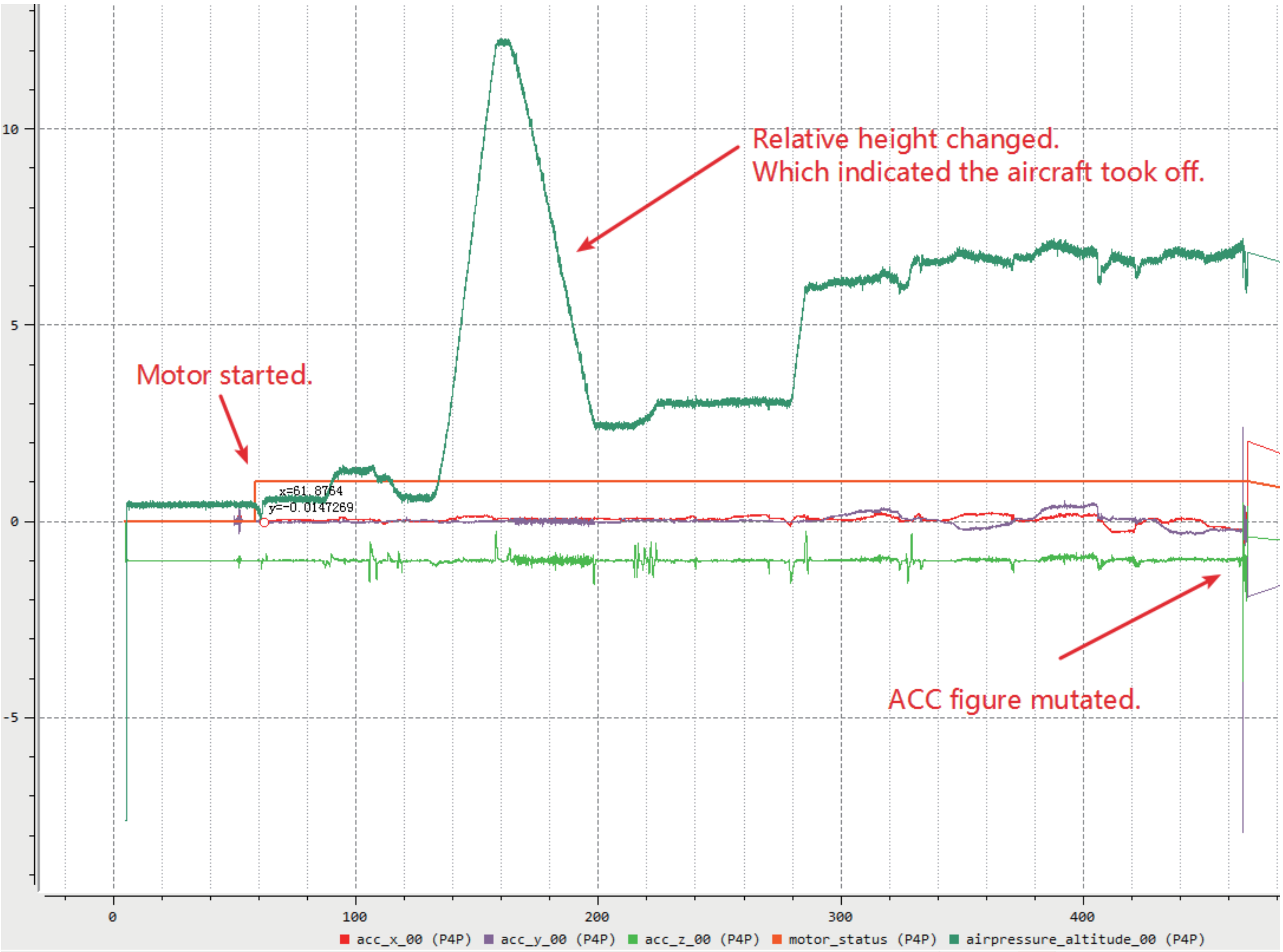


Figure 2.1 Crash Data of a Drone

In figure 2.1, the accelerometer curve drops down significantly, indicating that the drone may have crashed. After the crash, the motors stop rotating and the height decreases considerably. With the preceding data, we can locate the crash data and the time when the crash occurred. But we can also see that the accelerometer's values along the X axis (red line) decrease to negative values and change much more severely than those along the Y axis and Z axis. In the next passage, we will introduce the meanings of the positive and negative values of each curve.

We will also discuss the causes of drone cashes.

IV. Flight Controller Data Analysis Series Tutorials – Introduction to Coordinate Systems

It is necessary to get a full understanding of the coordination systems, including their definitions, indicators, and icons, before analyzing the crash data. Next, we will introduce the two coordination systems used by DJI drones.

1. North-East-Down (NED) Coordinate System

NED coordinate system is the geodetic coordinate system applied by DJI drones, in which the Z-axis points downwards along the ellipsoid normal, the Y-axis points towards the ellipsoid east, and the X-axis points towards the ellipsoid north.

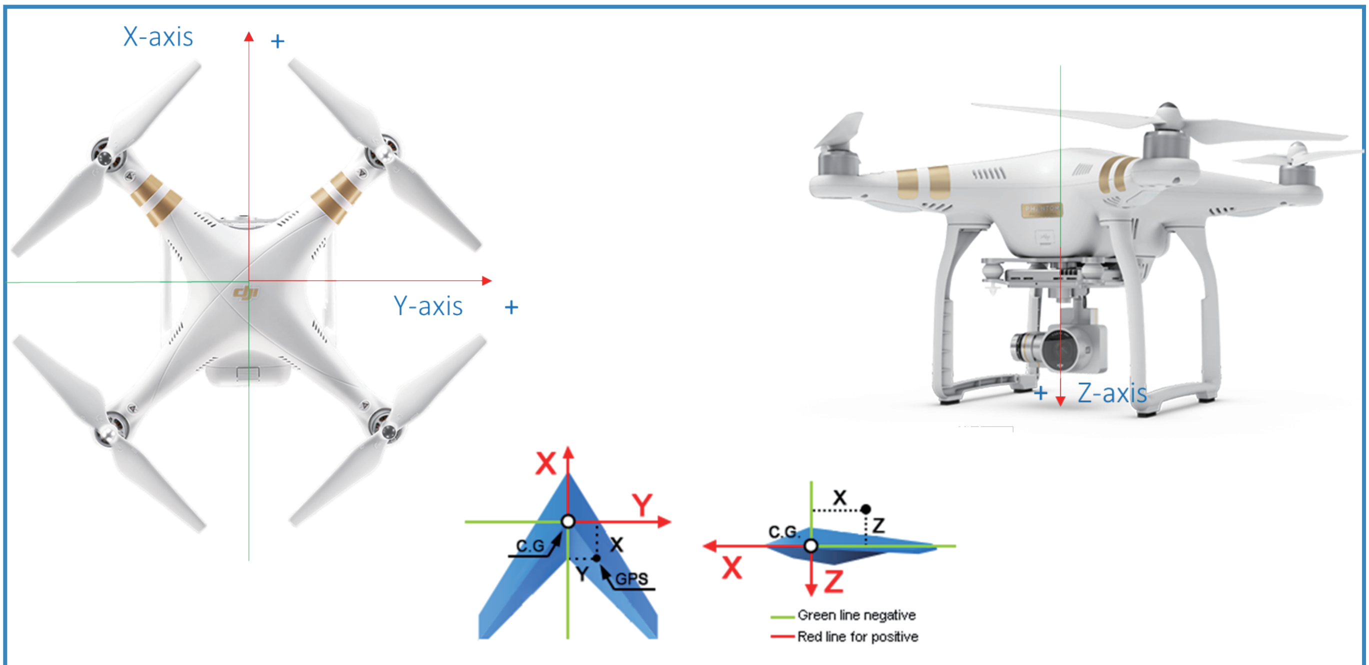
In the attitude data package, you can find the curves for the north, east, and ground. If the values along the curves are positive, the drone is flying towards north, east, or ground.

Figure 3.1 Crash Data of a Drone

In figure 3.1, when the time is 419.771s, the drone's speed towards north is 13.1 m/s, indicating that the drone is flying towards north. If the values along the curve are negative, the drone is flying towards south (assuming that the values along the speed curves for other directions are 0).

2. Body Coordinate System

The point of origin of the body coordinate system is at the center of the drone. The X-axis points through the nose of the drone, the Y-axis points to the tail of the drone, and the Z-axis points down through the bottom of the drone, as shown in figure 3.2. When the control sticks are pushed upwards or to the right, the values in DataViewer will be positive. When the control sticks are pushed downwards or to the left, the values in DataViewer shown will be negative, as shown in figure 3.2.



Define the coordinate and direction.

Figure 3.2

For the attitude data, when the pitch angle is a positive value, the drone's nose is pointing backwards. When the pitch angle is a negative value, the drone's nose is pointing forwards. When the roll angle is a positive value, the drone tilts to the right. When the roll angle is a negative value, the drone tilts to the left.

Figure 3.3 shows the indications of the control sticks on the remote controller.

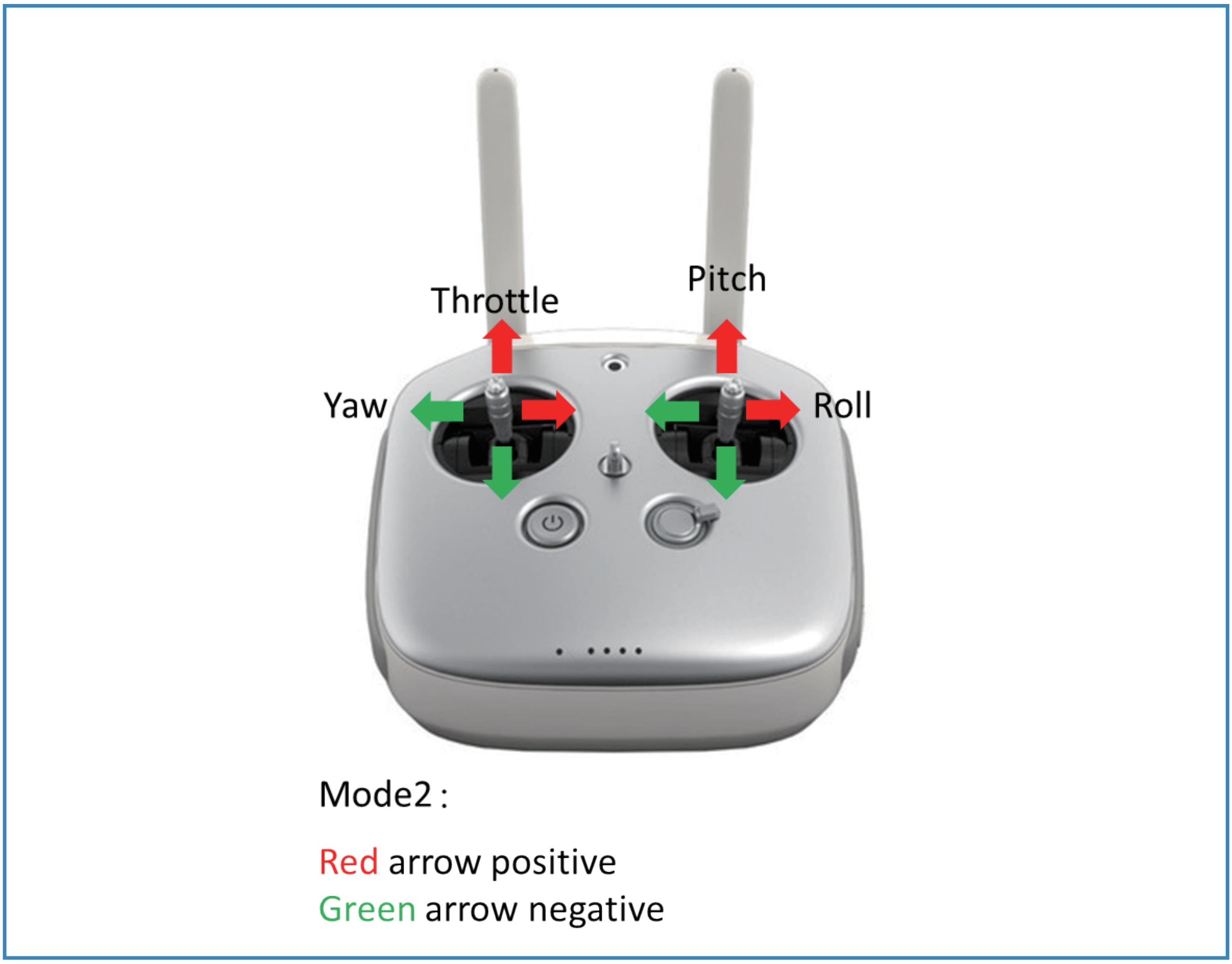


Figure 3.3

Figure 3.4 shows the curves reflecting how much the control sticks are pushed.

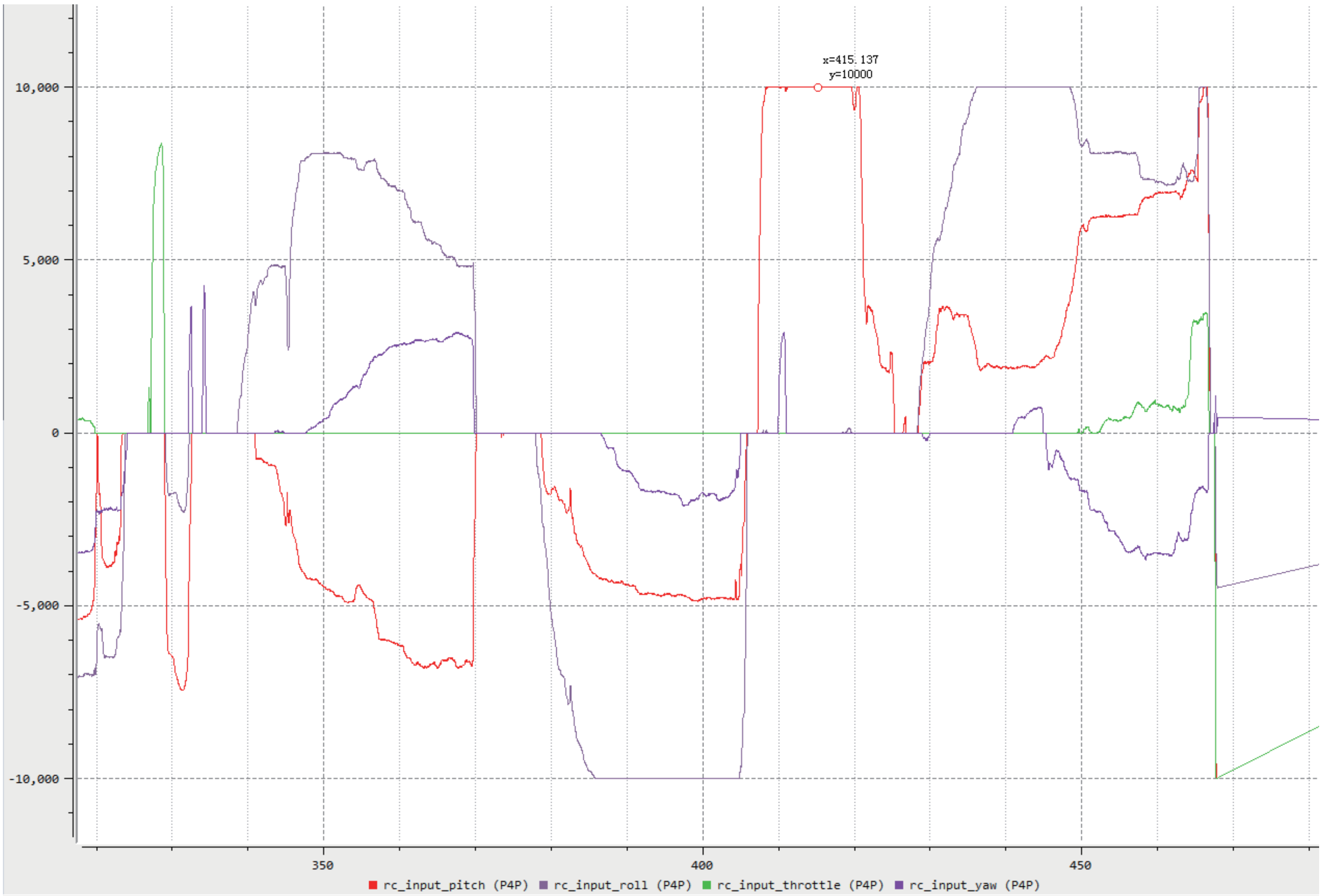


Figure 3.4

In figure 3.4, when the time is 415.137s, the pitch stick is pushed forward by 100% of its total travel. And this operation lasts for around 15 seconds.

Figure 3.5

In figure 3.5, when the time is 397.776s, the drone tilts to the left by 22.9 degrees and then tilts to the right. The actual operation may be that the roll stick is pushed to the left and then released quickly. So, we can imagine that the drone tilts to the right, then quickly tilts to the left, starts braking, and slows down its speed during flight.

We also need to pay special attention to the yaw angle's value. The yaw angle represents the current direction to which the drone's nose points to. When the aircraft's nose points to the north, the yaw angle's value will be 0. When it is a positive value, the drone is rotating clockwise, or the drone is rotating counter-clockwise (looking down from the top of the drone), as shown in figure 3.6.

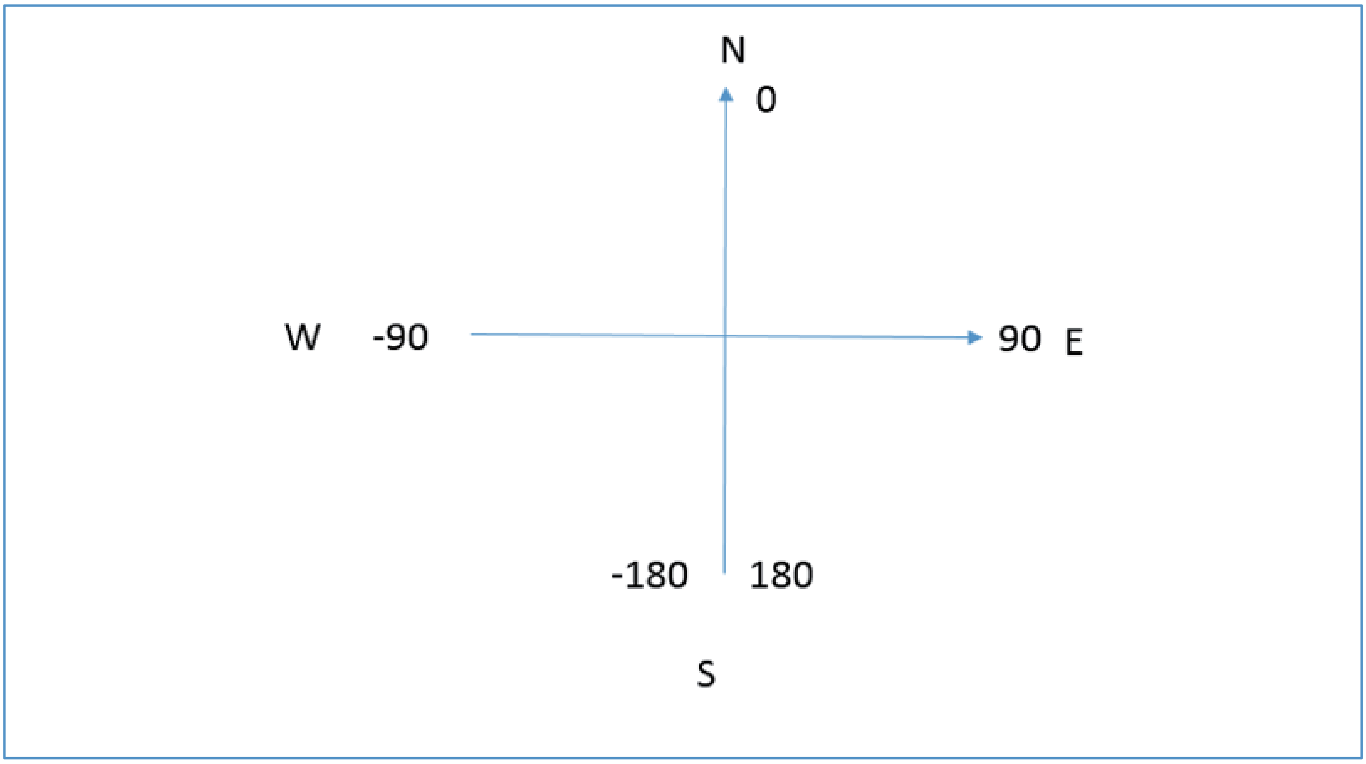


Figure 3.6

Figure 3.7 shows the curve for the yaw angle.

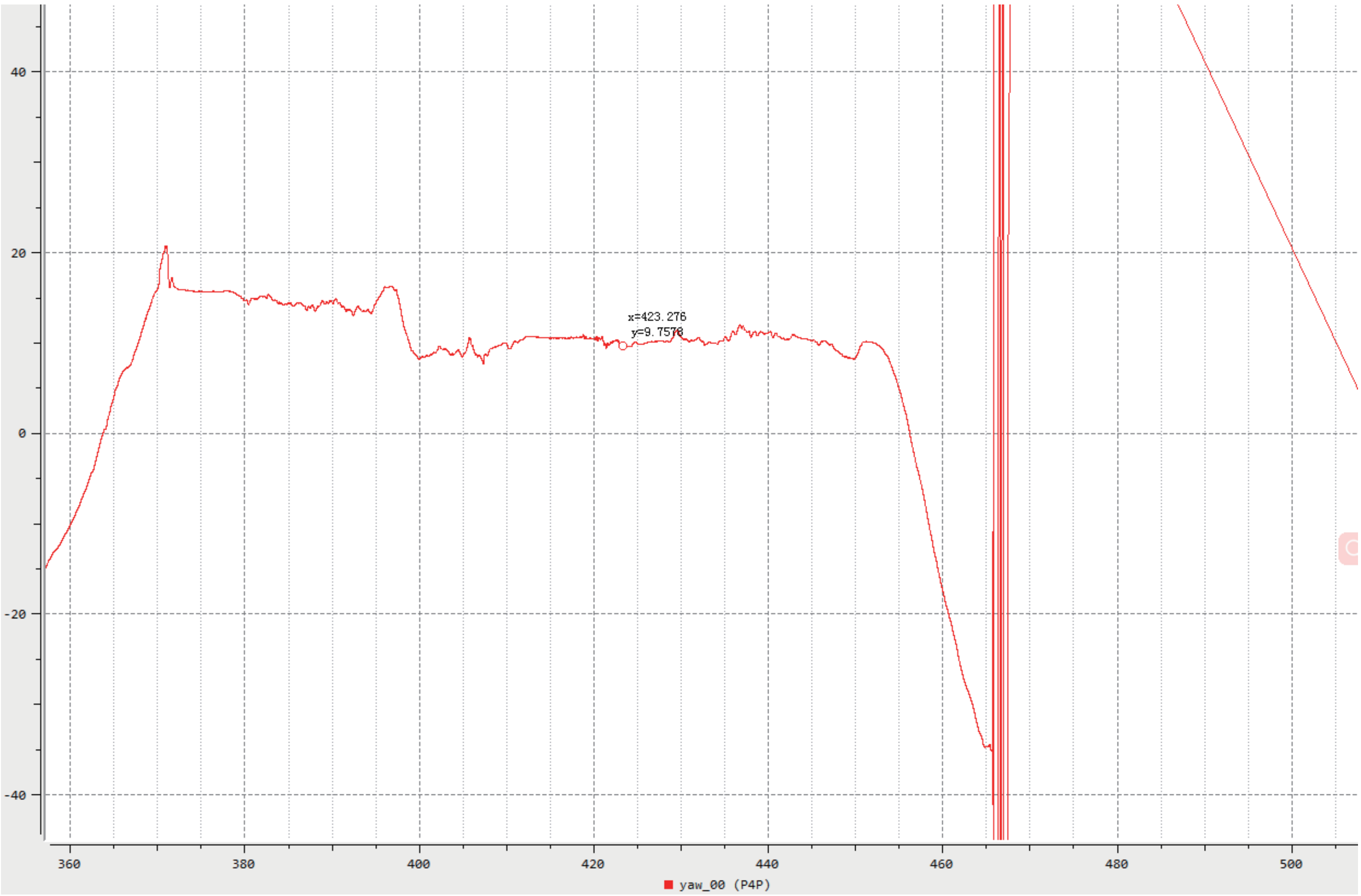


Figure 3.7

In figure 3.7, when the time is 423.27s, the yaw angle of the drone is 9.7°, which is 9.7° east by North. The yaw angle's value decreases significantly at 450s, indicating that the drone rotates anticlockwise.

Based on what we've discussed above, we can briefly determine the control status and effect of the drone. When a drone is under control, its attitude and speed will change accordingly after the control sticks are pushed.

V.Flight Controller Data Analysis Series Tutorials – Introduction to Attitude Mode and Crash Cases

In Attitude mode, the drone's attitude will be stabilized, but the drone's position and flight speed cannot be controlled. That is, the flight controller will prevent the drone from rolling over, but cannot guarantee the control of the speed and position (hovering in place). With a certain initial velocity and external forces, the drone's speed will change constantly, leaving an incorrect impression to the operator that the drone is out of control. Though the control sticks are not pushed, the drone will move horizontally. It is dangerous to fly the drone in Attitude mode with winds or in narrow spaces. This is the major cause of the crash cases reported by beginners.

Why not remove this risky flight mode? Actually, Attitude mode is available for the sake of the technology development. At the beginning, drones could only be controlled manually. When the GPS signal is weak and the vision systems fail to work properly, the drone will enter Attitude mode automatically. This operation cannot be avoided with the current technologies. But we believe that this situation will no longer happen if the positioning technology and sensors are improved in the future.

The drone may enter Attitude mode due to various reasons, for example, the GPS signal is weak, the environment is not ideal for the vision systems to work, the compass is interfered. Besides, some DJI drones support manually enabling Attitude mode by toggling the Flight Mode Switch on the remote controller to A-mode (for more details, refer to the User Manual of the specified product). To avoid enabling Attitude mode by mistake, "Multiple Flight Mode" is turned off for DJI drones by default, but can be changed in the DJI GO series app.

Figure 4.1 shows the attitude data of a drone.

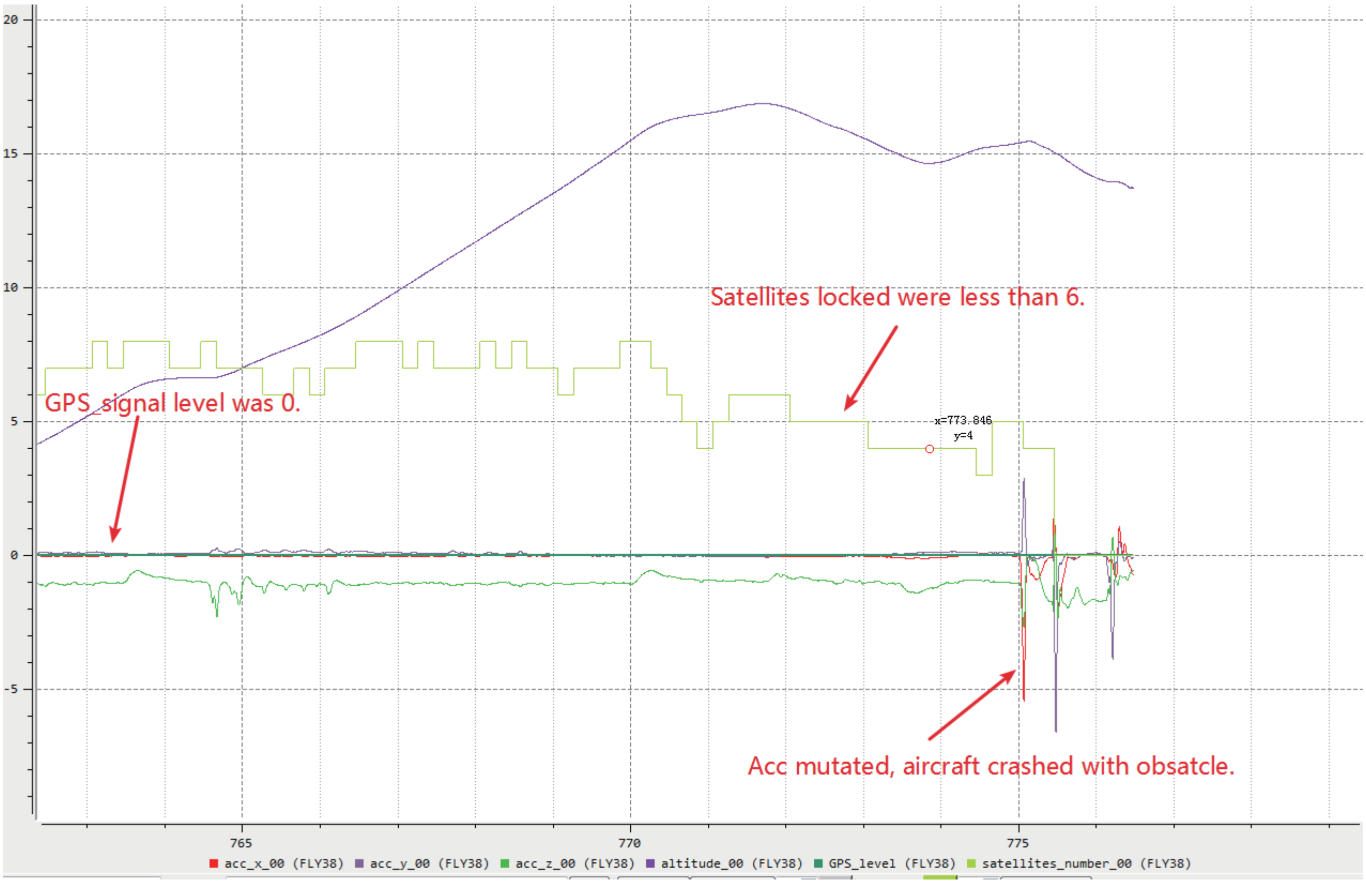


Figure 4.1

In figure 4.1, we can see that the drone crashes at 80s and the GPS signal level is 0 after comparing the values along the acceleration curve.

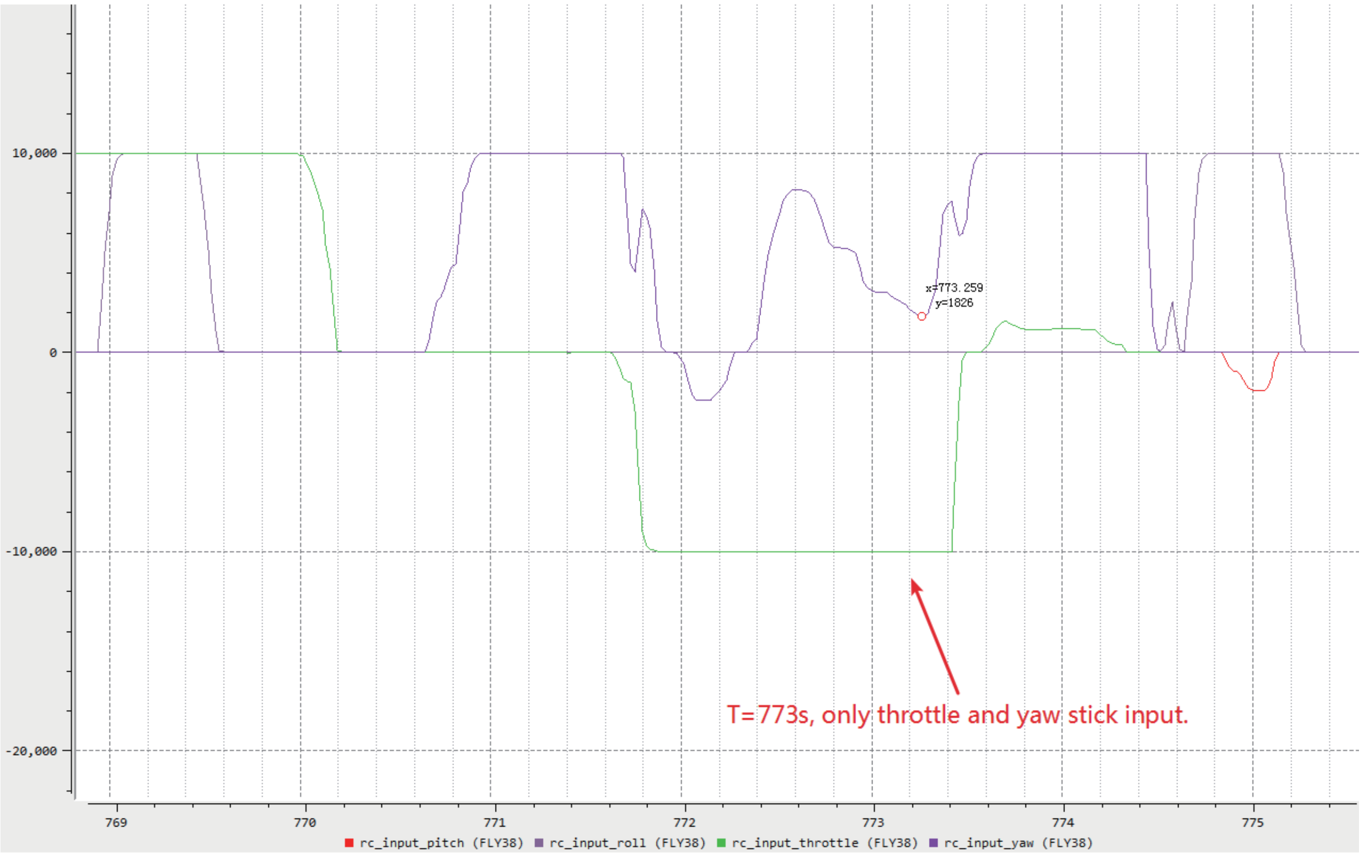


Figure 4.2

As shown in figure 4.2, only the yaw stick is pushed at 80s

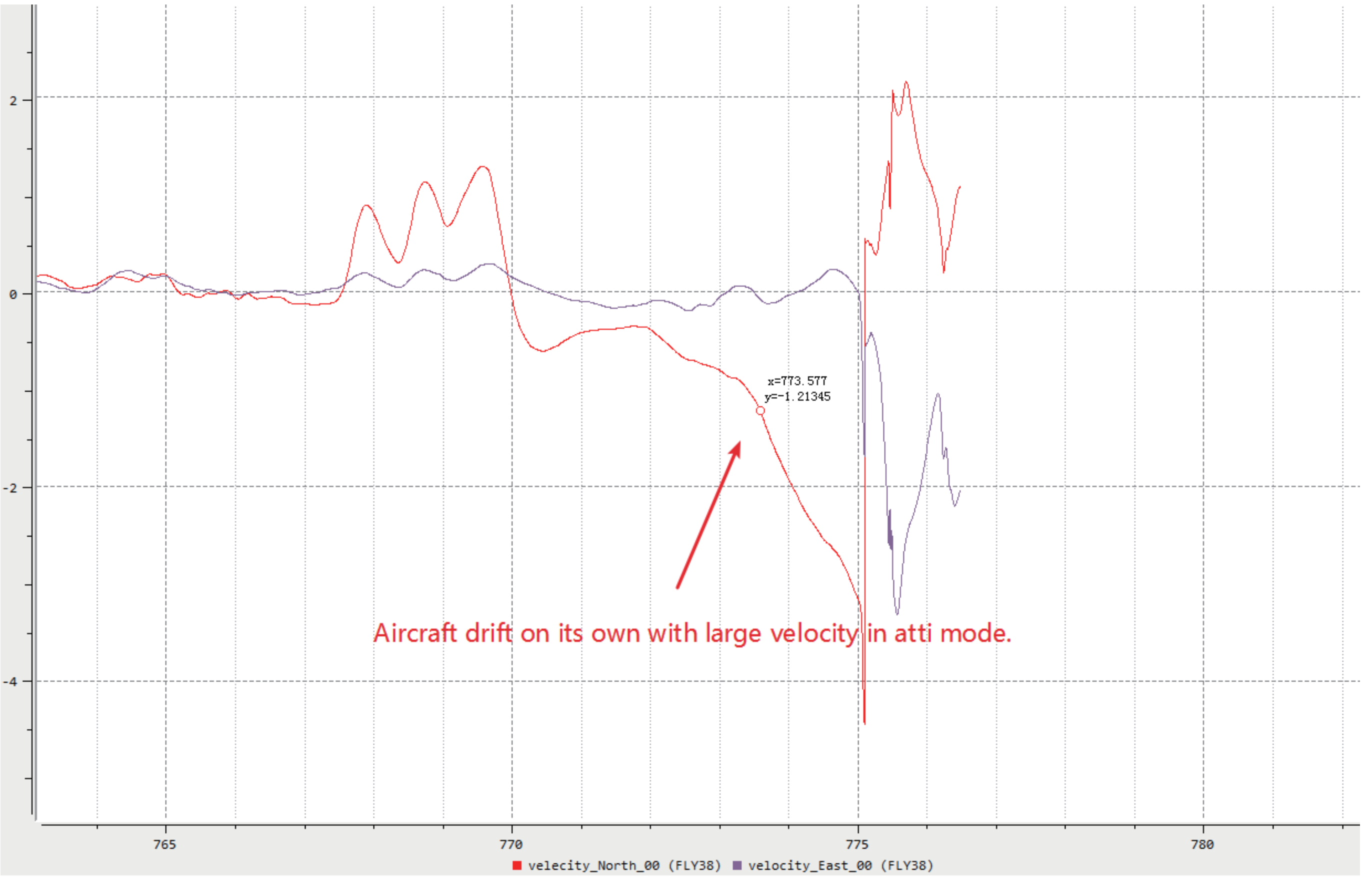


Figure 4.3

The drone moves at a certain speed in the horizontal direction, as shown in figure 4.3.

When the drone is flying in Attitude mode, only the drone's attitude will change as the control sticks are pushed. Note that whether the GPS signal is strong or not cannot be determined merely based on the searched satellites. It also relates to the satellite distribution, dilution of precision, etc. If the drone enters Attitude mode abnormally during flight, it is recommended to land it as soon as possible. Avoid flying the drone in a place where the GPS signal is weak, vision systems cannot work, and the interference is severe.

VI.Flight Controller Data Analysis Series Tutorials – Stopping Motors by Conducting the Combination Stick Command (CSC)

CSC refers to pushing the control sticks on the remote controller to the bottom inner or outer inner corners to start the motors, as shown in figure 5.1.

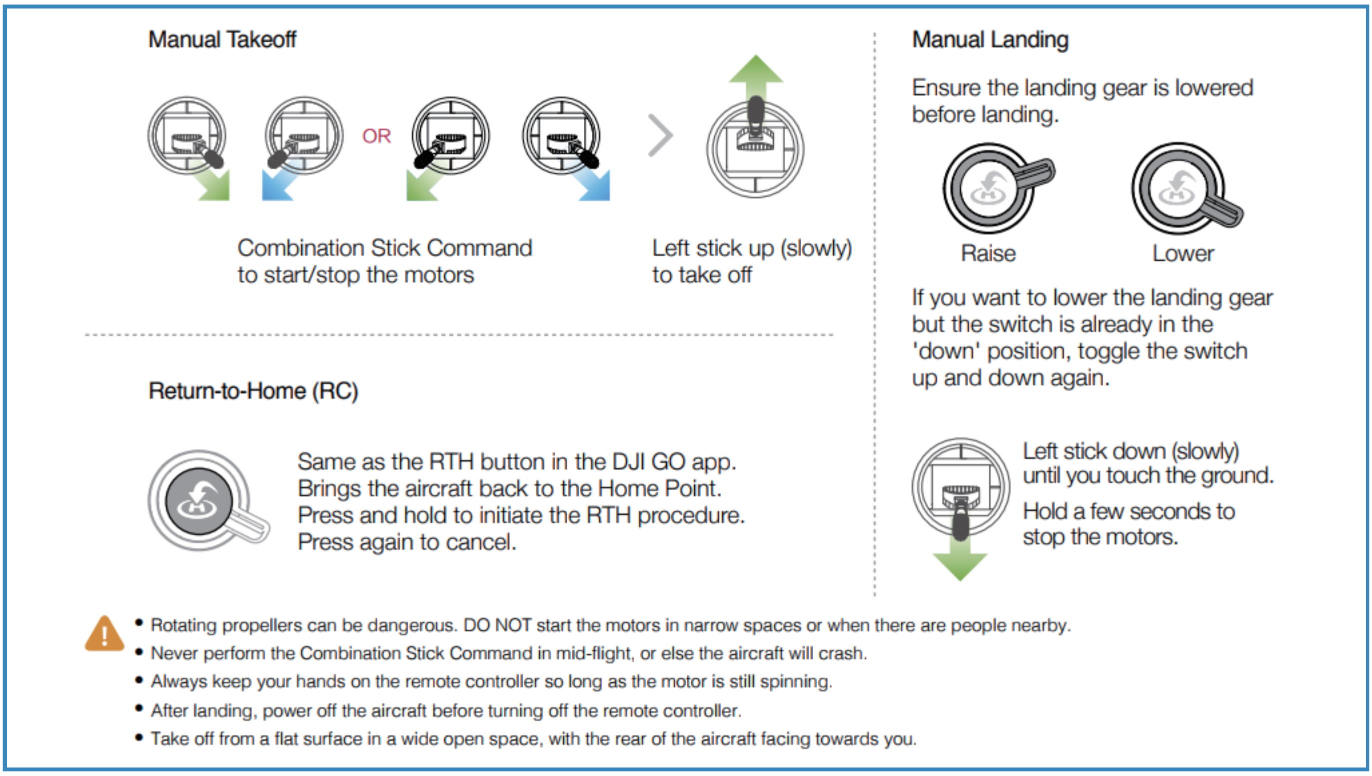


Figure 5.1

Methods for stopping motors in emergencies may vary depending on the aircraft models. Methods for stopping major DJI drones in emergencies are listed below.

Table 5.1 Methods for Stopping Major DJI Drones in Emergencies

Drone Model	Default Method	Remarks
Phantom 3 Series and Inspire 1 Series	Push both sticks to the bottom inner or outer corners.	Push the sticks forwards or backwards by 90% of their total travels for more than three seconds.
Phantom 4 Series and Inspire 2	Push the left stick to the bottom inner corner and press the Return Home (RTH) Button at the same time.	Push the left stick to the bottom inner corner and press the Return Home (RTH) Button at the same time.
Mavic Series	Set “Stop Motor Method” in DJI GO 4 to “For use in emergencies only”.	Set “Stop Motor Method” in DJI GO 4 to “CSC Maneuver”. Otherwise, motors can only be stopped by pushing sticks in emergencies.
Matrice 600 Series and Matrice 200 Series	Push the left stick to the bottom inner corner and press the Return Home (RTH) Button at the same time.	Push the left stick to the bottom inner corner and press the Return Home (RTH) Button at the same time.
A3 and N3 Series Flight Controllers	Push both sticks to the bottom inner or outer corners.	
Spark Series	Push both sticks to the bottom inner or outer corners.	

*The preceding methods for stopping motors in emergency situations only apply to those drones with the firmware versions when this passage is written (2017.09.27) and are subject to the User Manuals and release notes of the specified products if there are any updates.

It is risky to stop motors when the drone is flying in the air, as the drone will directly drop down. Before flying the drone, make sure that you are familiar with the method for stopping motors when the drone is flying to avoid conducting the method by mistake. If the sticks are pushed to stop motors mid-flight, we can find the following in the data: the stick output curves peak, the height curve suddenly decreases considerably, the accelerometer curves change significantly (the drone drops to the ground), and the motor start flag switches to 0.

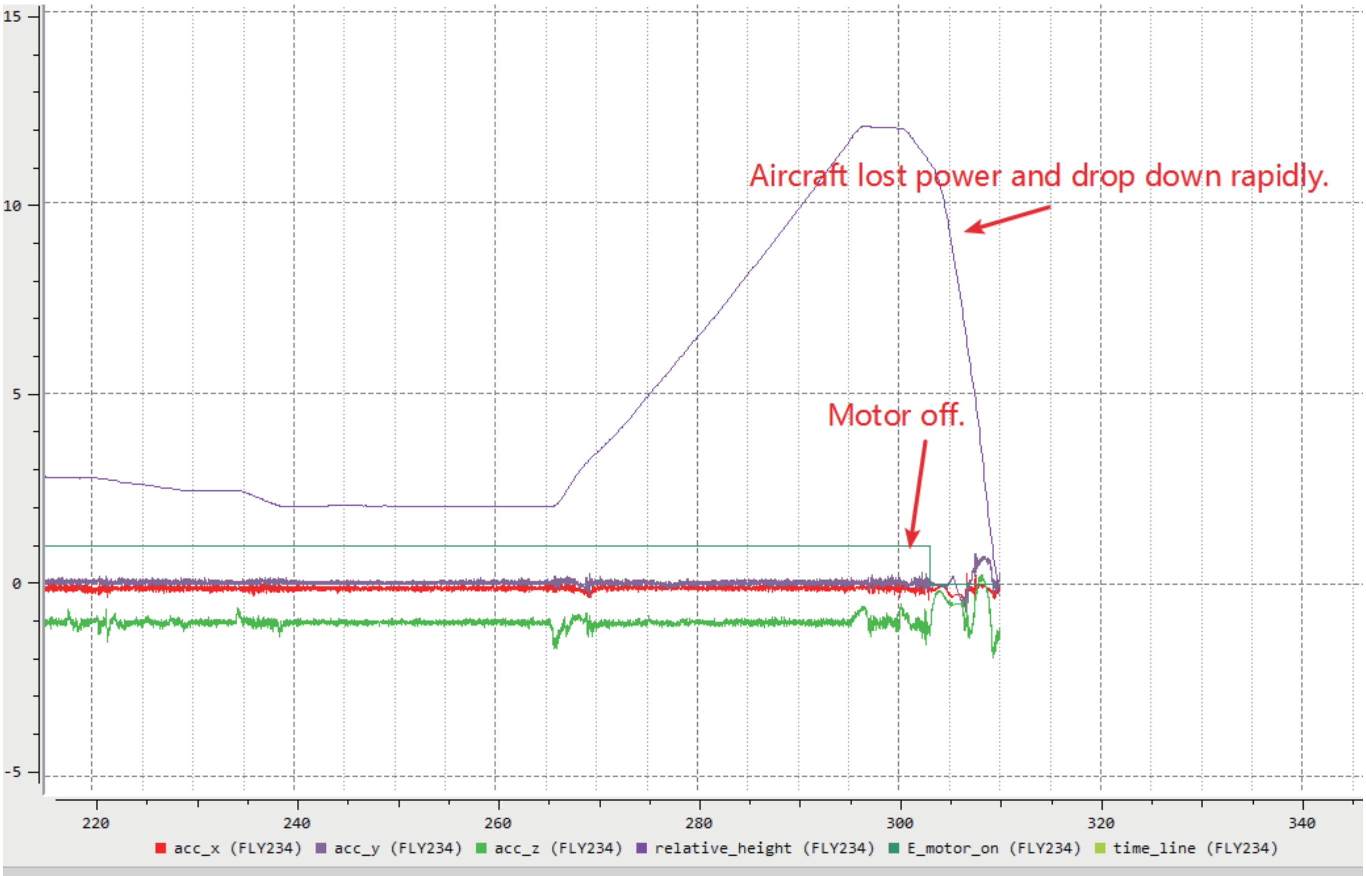


Figure 5.2

In figure 5.2, the drone becomes powerless and drops from the air at 683s.

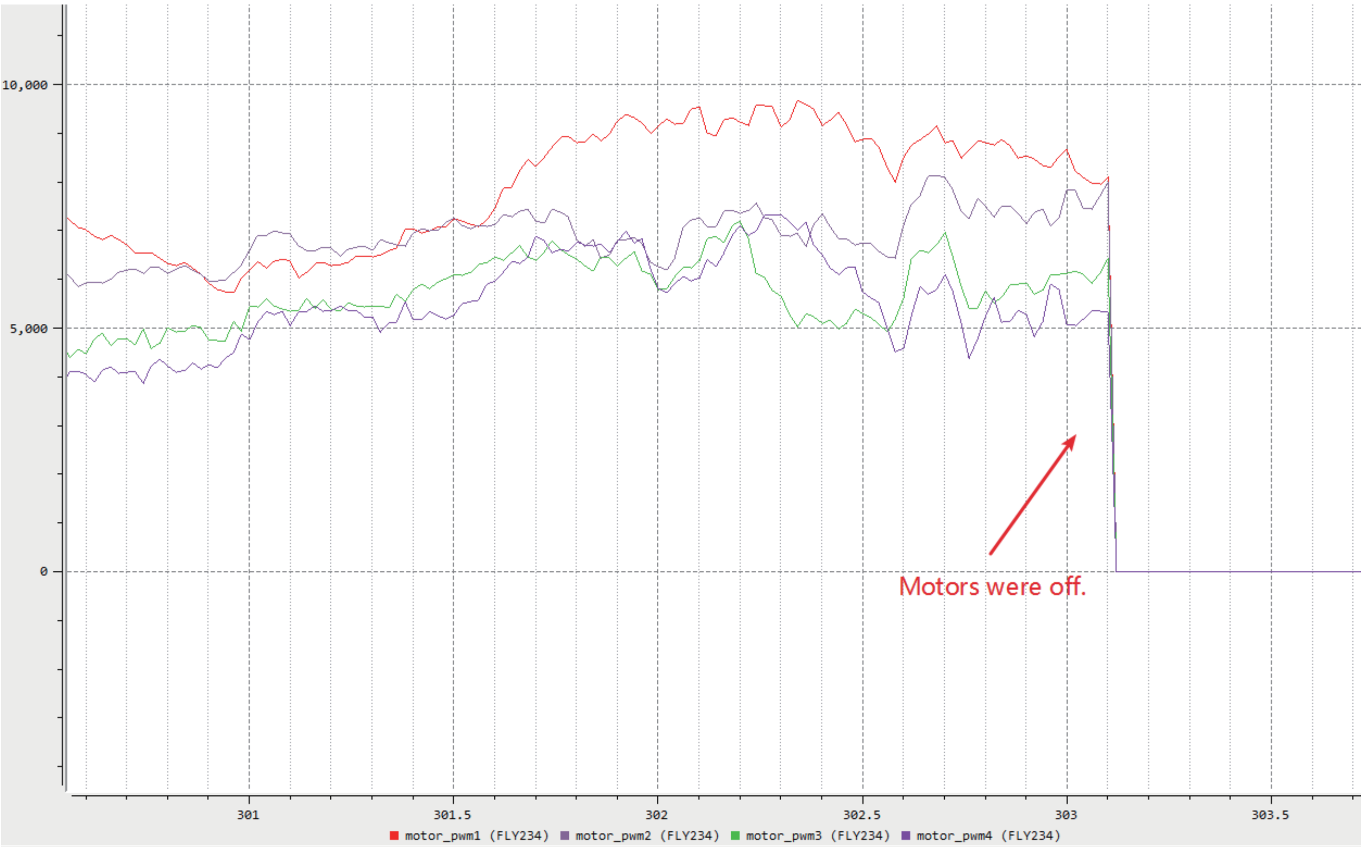


Figure 5.3

The motor output stops at 683s, as shown in figure 5.3

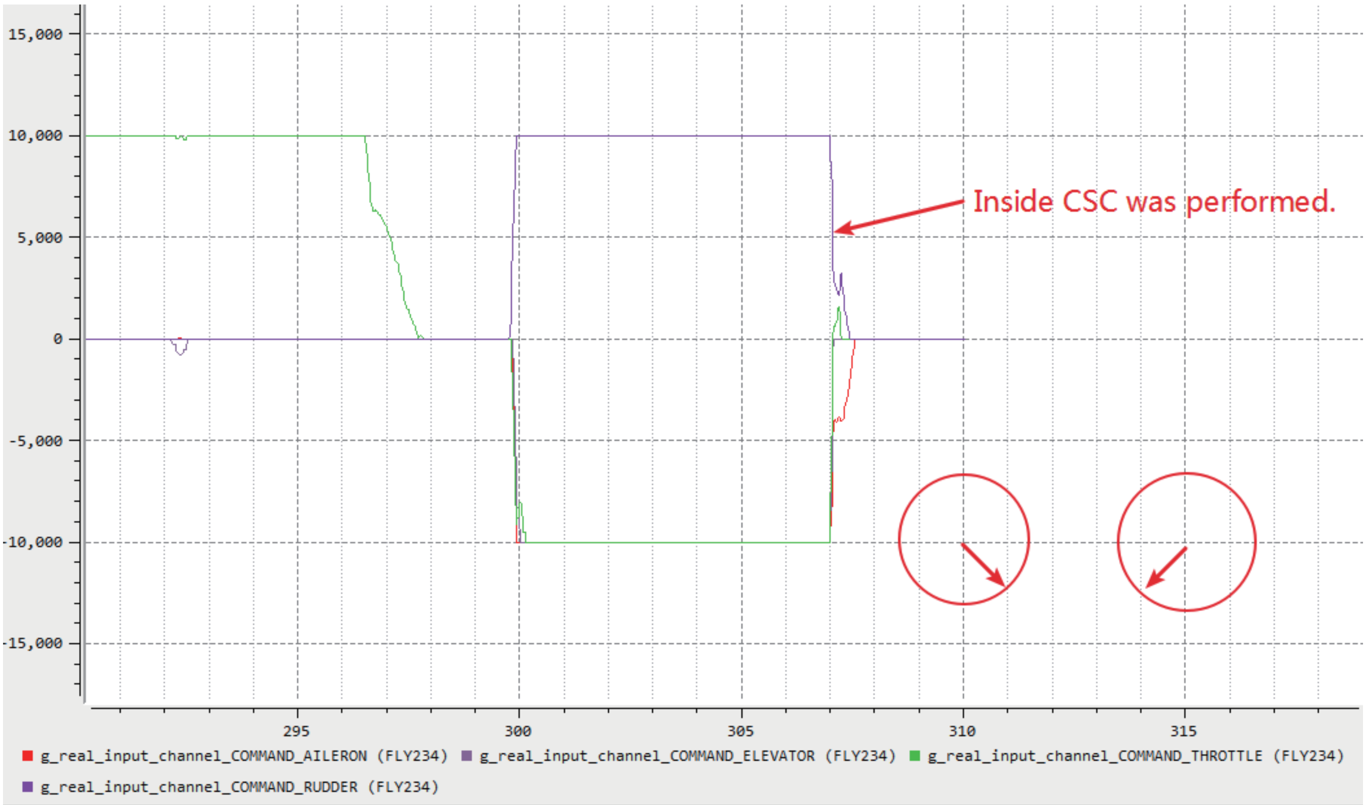


Figure 5.4

In figure 5.4, it can be found that the sticks are pushed to the bottom inner corners according to the curves for the sticks' output at 683s.

VII.Flight Controller Data Analysis Series Tutorials – Drone Under Control Crash Cases

After locating the crash data, determine whether the drone is under control by checking how much the control sticks are pushed and how the drone responds to the commands before the crash.

Operate the following steps to check the cause of a drone crash:

1) Check how much the control sticks are pushed, and pay special attention to the values before and after the crash. Small values can be neglected.
2) Check whether the drone responds to the remote controller's commands in a timely manner by comparing the stick output values, attitude status, and speed. If a drone is under control, it will tilt and fly towards the direction indicated by the pushed stick. Generally, if the values along the accelerometer curve for a specific axis are positive, the drone is flying in the direction corresponding to that axis.
3) Check whether the drone is flying to the direction as required based on the drone's yaw angle.

Figure 6.1 shows the crash data of a drone. Let's analyze this drone crash case.

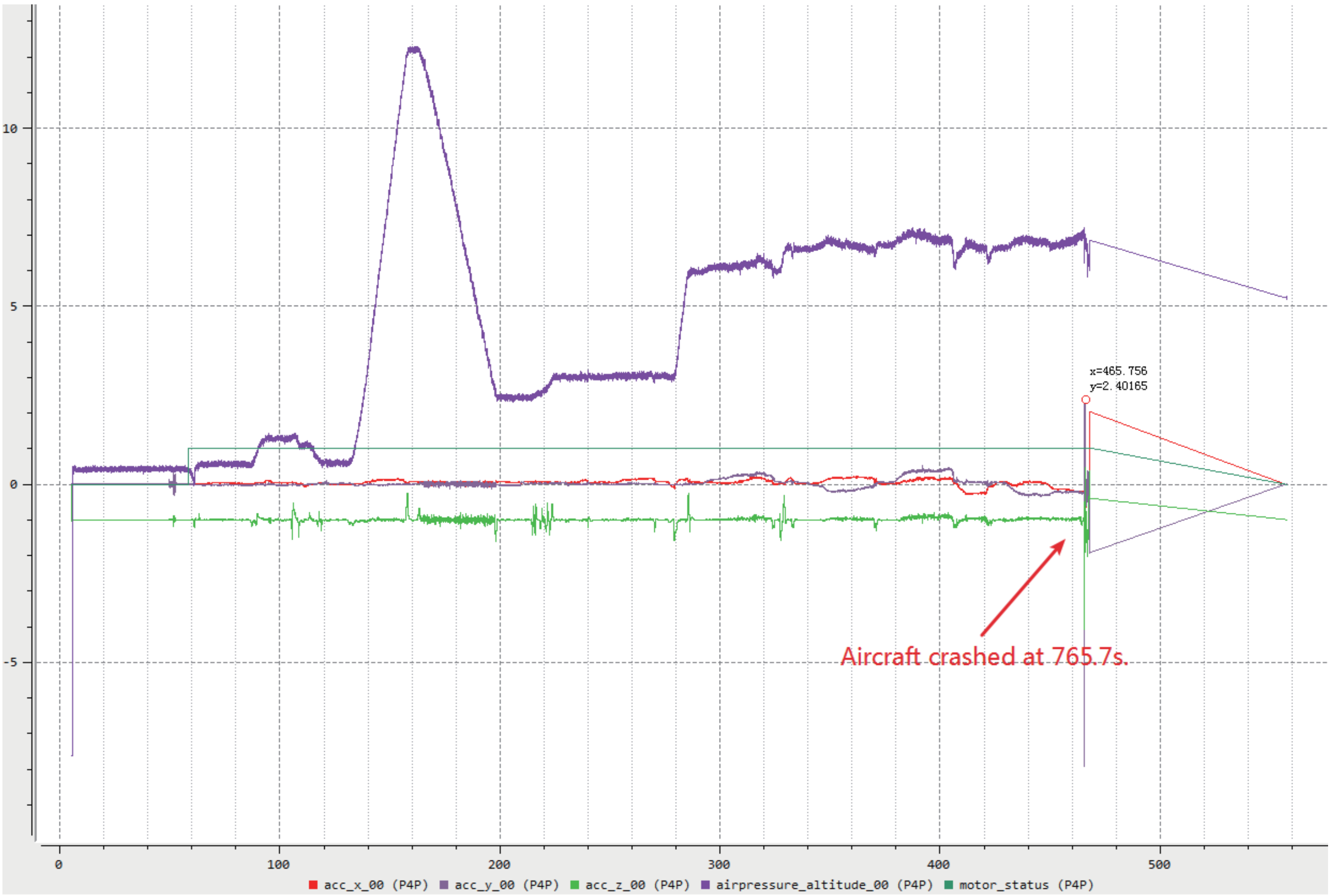


Figure 6.1

Step 1: After finding out the time when the crash occurred, check the stick output curves. It can be found that the pitch stick is pushed forwards, roll stick is pushed rightwards, throttle stick upwards and yaw stick leftward.

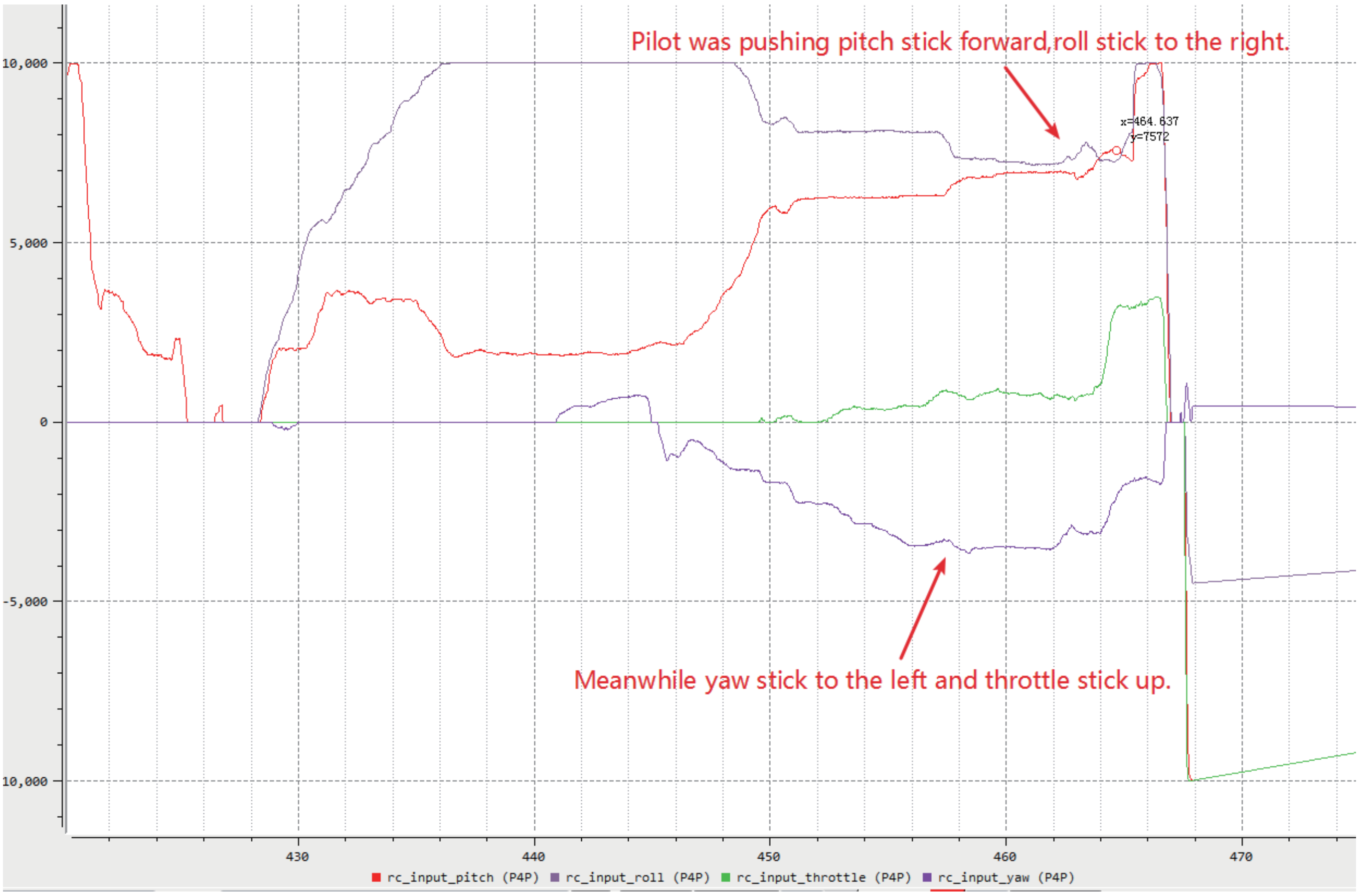


Figure 6.2

Step 2: From figure 6.3 & 6.4, we can tell that the drone responds to the control sticks' commands. It tilts forwards and rightwards (the attitude data values are negative, indicating that the drone tilts forwards) while flying to the north-east (the speed values in the north and east are positive and basically equal).

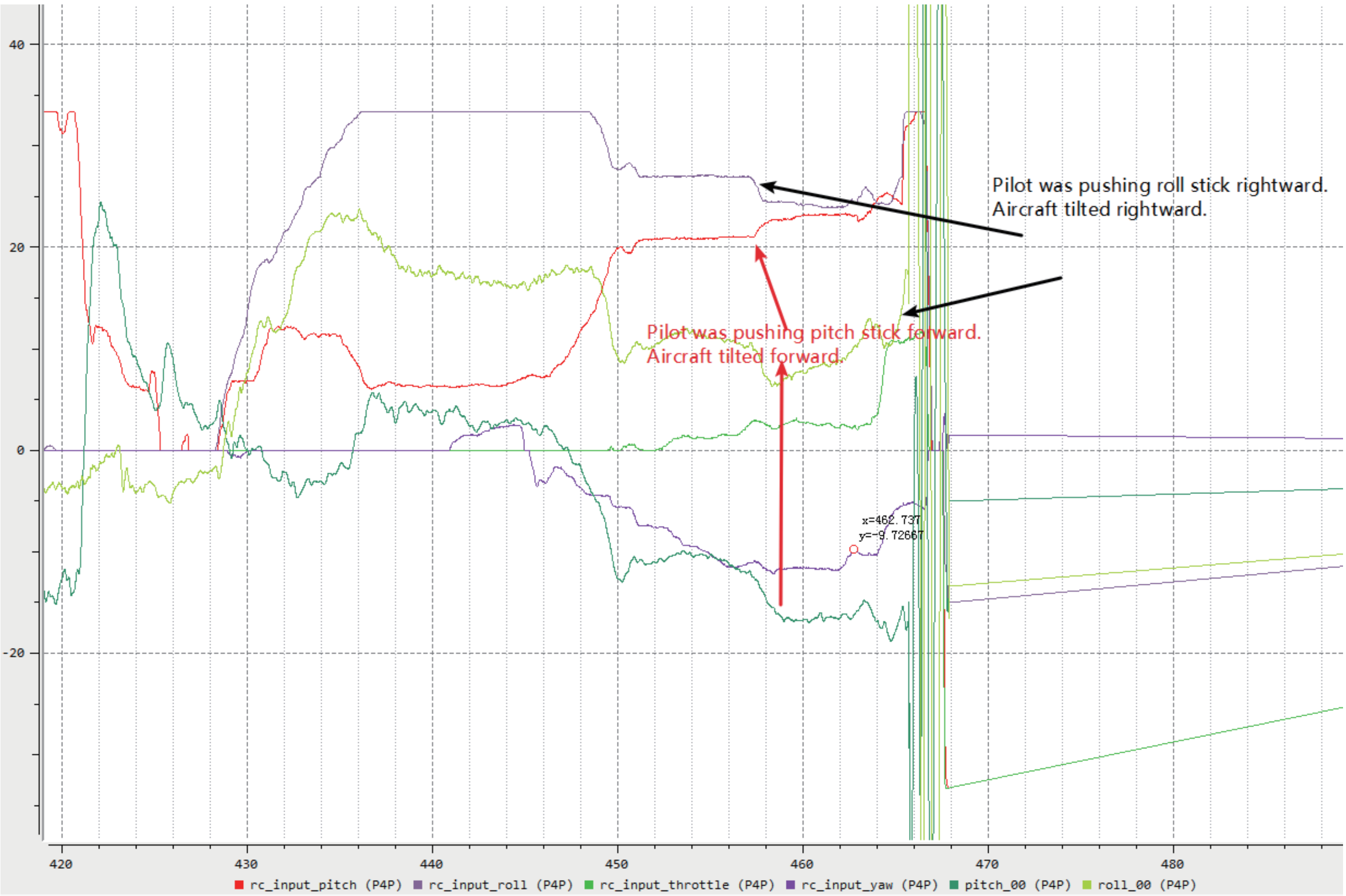


Figure 6.3

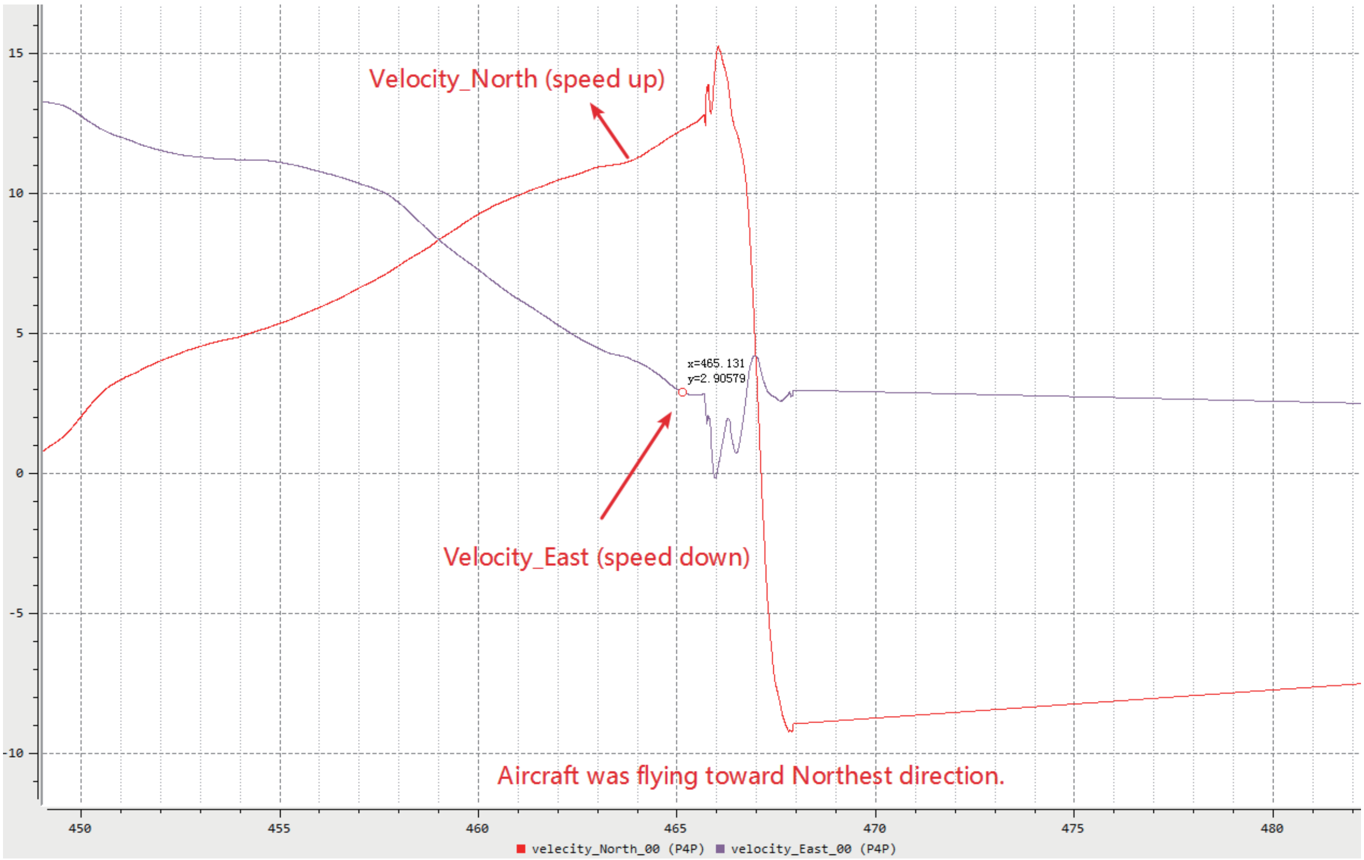


Figure 6.4

Step 3: Check the yaw angle value. As shown in figure 6.4, the yaw angle value is around -33.8. So the direction is 33.8° north by west.

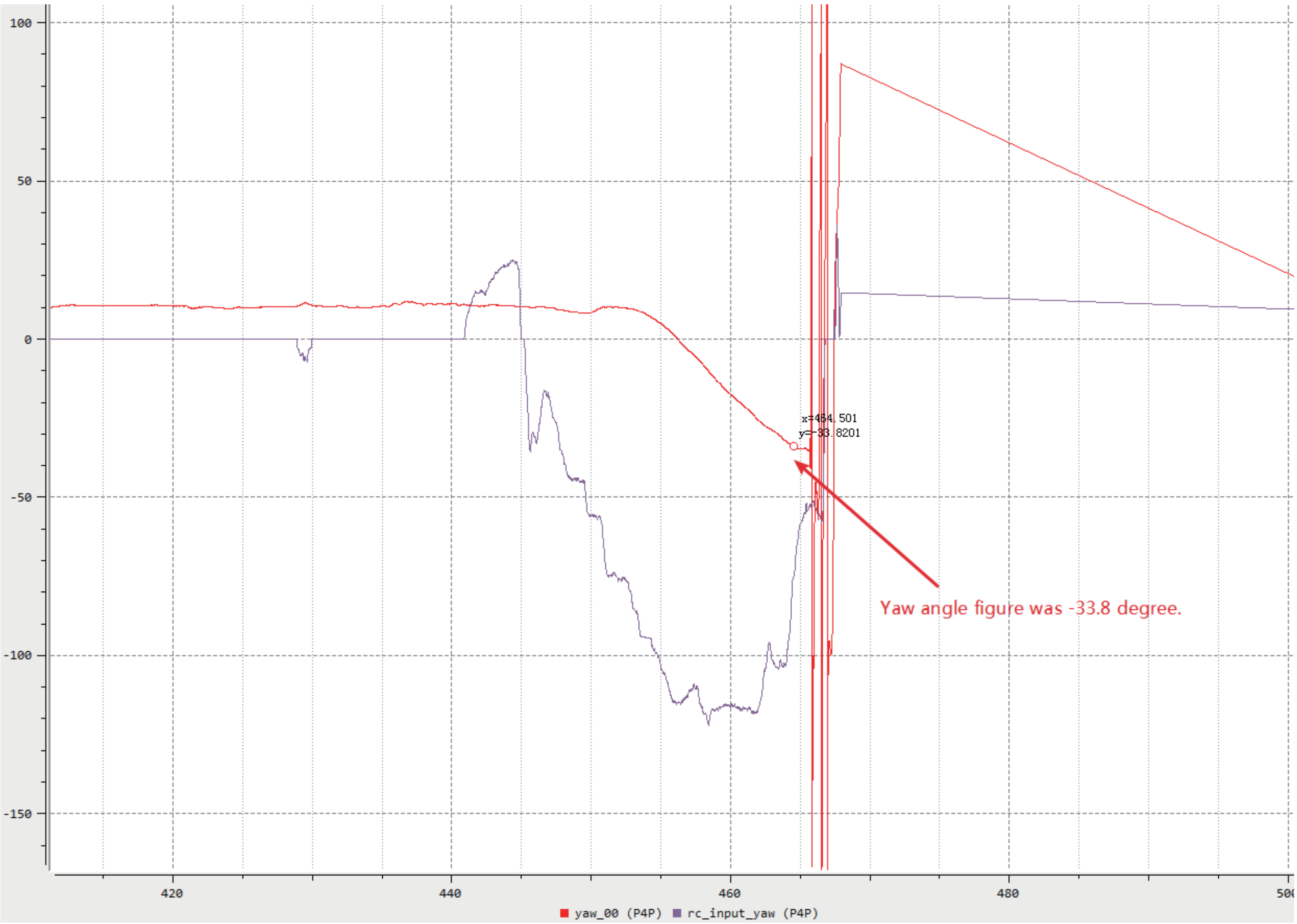


Figure 6.4 Drone's Yaw Angle

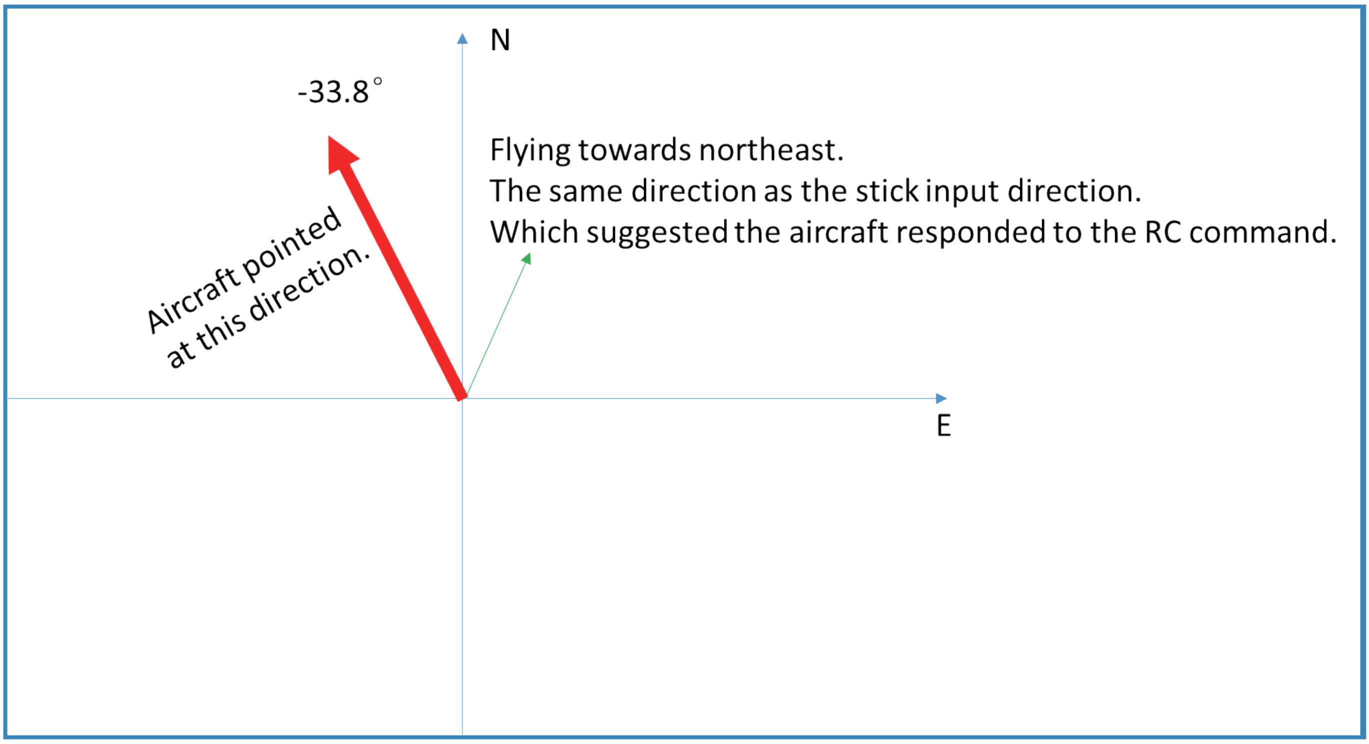


Figure 6.5

Step 4: It can be concluded that after the control sticks are pushed, the drone flies forwards and rightwards then crashes with an obstacle.

VIII.Flight Controller Data Analysis Series Tutorials – Compass Interference Cases

The compass provides navigation information to the drone. It plays a key role in controlling the drone's position and speed. It gets the yaw angle data of the drone by measuring the Earth's magnetic field. However, the Earth's magnetic field is very weak and can easily be interfered by the electromagnetic field. Strong magnetic fields, high-voltage lines, buildings, etc. will interfere with the Earth's magnetic field and affect the normal flying of the drone. You can check the mode_m value in DataViewer to determine whether the drone's compass is interfered during flight.

The magnetic field measured by the compass can be indicated by a three-dimensional vector (m_x, m_y, m_z) . e_mode_m in DataViewer refers to the length of this vector, that is $L=\sqrt{(m_x^2, m_y^2, m_z^2)}$. In a flight, theEarth's magnetic field is basically constant, so the magnetic field measured by the compass should also be constant. If e_mode_m in DataViewer changes significantly, the magnetic field around the drone may be affected by the environments.

After the compass in the drone is calibrated, e_mode_m in DataViewer will be 1500. In figure 7.1, e_mode_m's value falls between 1500 and 1600 before 496s, but it changes greatly in the following ten seconds. In common cases, if e_mode_m's value increases or decreases by 500, the compass suffers from strong magnetic interference.

Flying experiences will be affected if the compass is interfered severely, as the drone cannot hover accurately, but it is circling in place while hovering, or even crash. If the compass is interfered or the yaw angle of the drone cannot be controlled when the drone is flying close to some objects, move away from the objects immediately, or check whether there are large currents flowing around the compass module.

Besides, the compass of the A3 or N3 is built into the GPS module, as it will not be easily interfered by the currents of the third-party airframes after the GPS module is raised up.

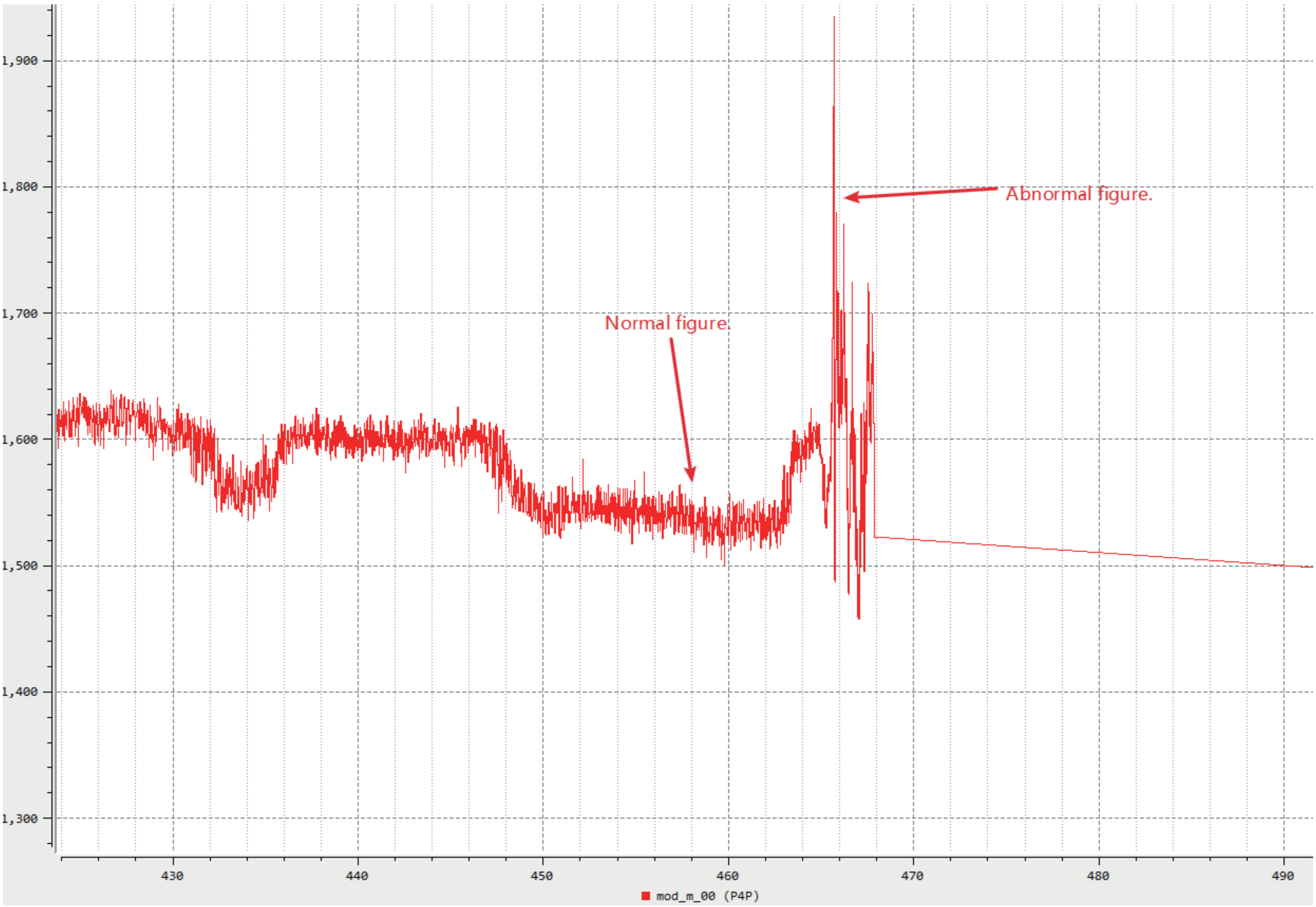


Figure 7.1

FAQ

1. Why does my drone not work after being connected to DJI Assistant 2?

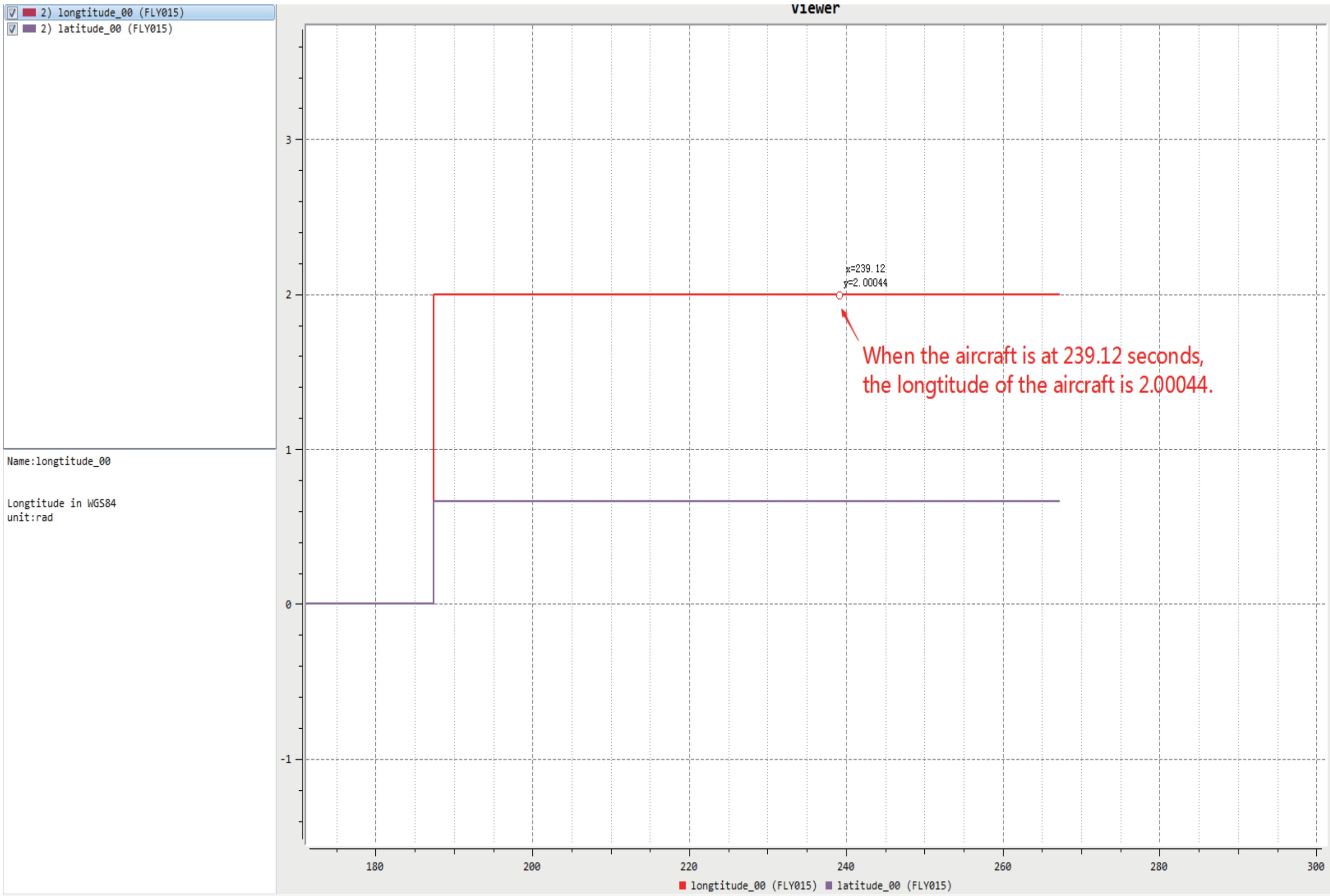
The drone is connected to the PC with a USB cable. If the USB cable is intact and the correct version of DJI Assistant 2 is running normally on the PC, then the USB port may be damaged. If the aircraft's USB port was damaged due to a crash, then no data can be exported from the drone. In this situation, it is recommended to send the drone to DJI's Service Center for diagnosis.

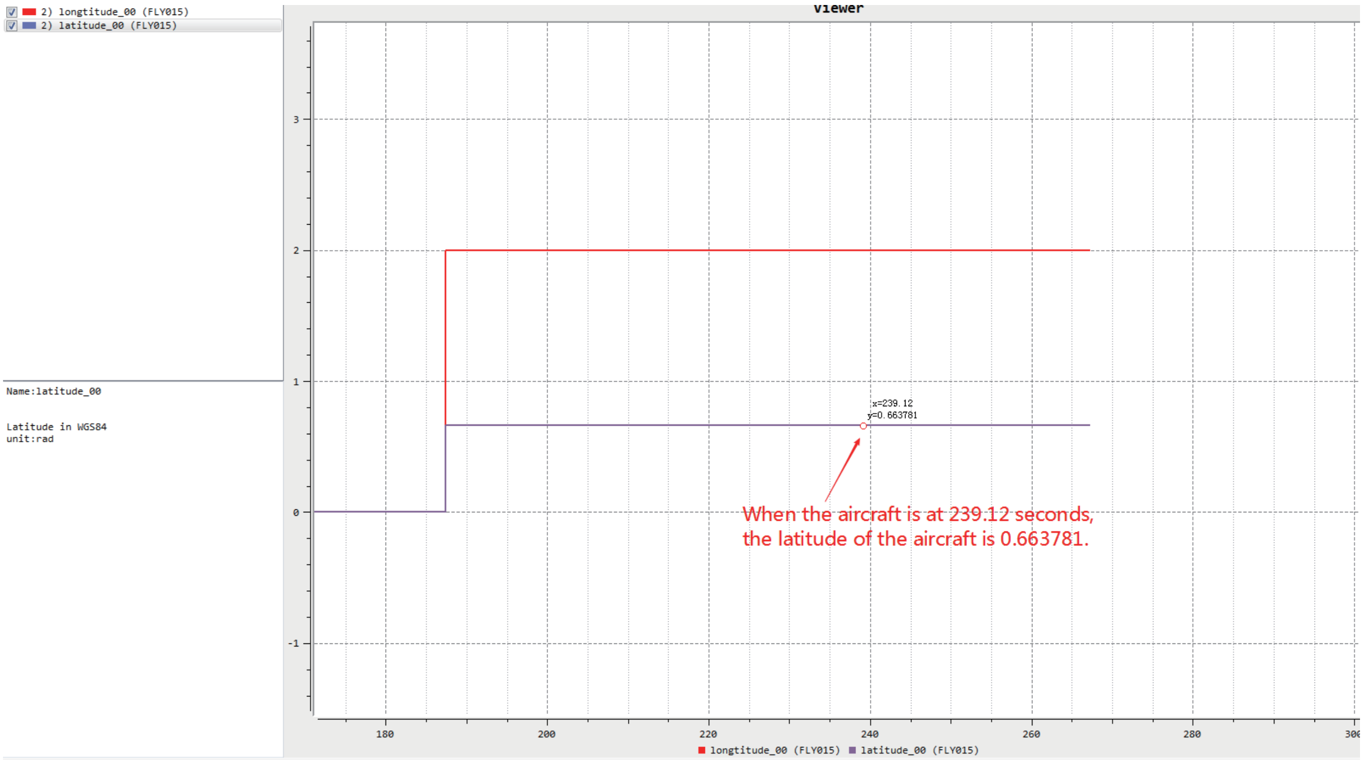
2. Why can I not find the crash data?

If the drone crashed severely, the crash data might not have been saved successfully because the aircraft powered off abnormally.

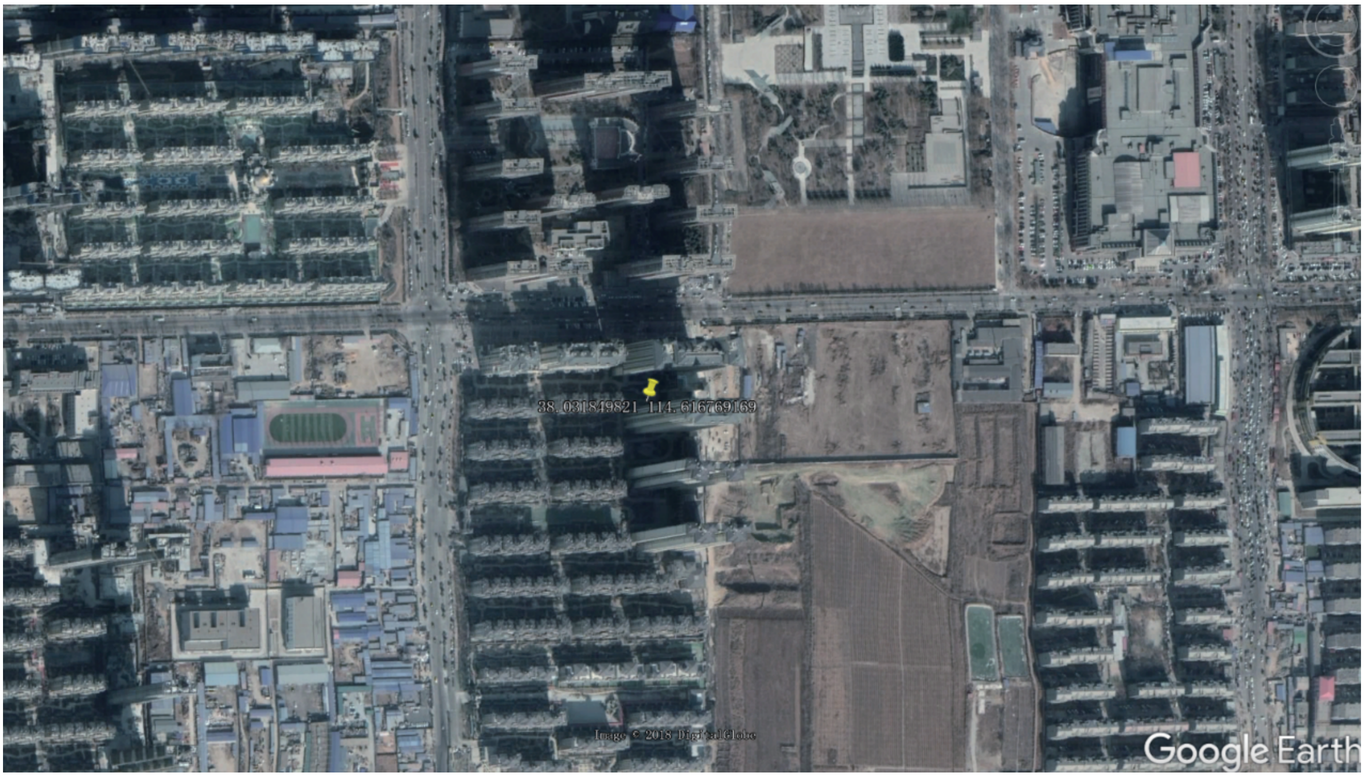
3. How can I obtain the GPS coordinates according to the flight data?

You can get the GPS coordinates through the longitude and latitude data in radians in the attitude data package. If you want to convert them to degrees which can be recognized by Google Earth, try this formula: Radians x 180/π.


2) longtitude_00 (FLY015)
2) latitude_00 (FLY015)
Name:longtitude_00
Longtitude in WGS84
unit:rad
viewer
x=239.12
y=2.00044
When the aircraft is at 239.12 seconds,
the longtitude of the aircraft is 2.00044.
longtitude_00 (FLY015)
latitude_00 (FLY015)

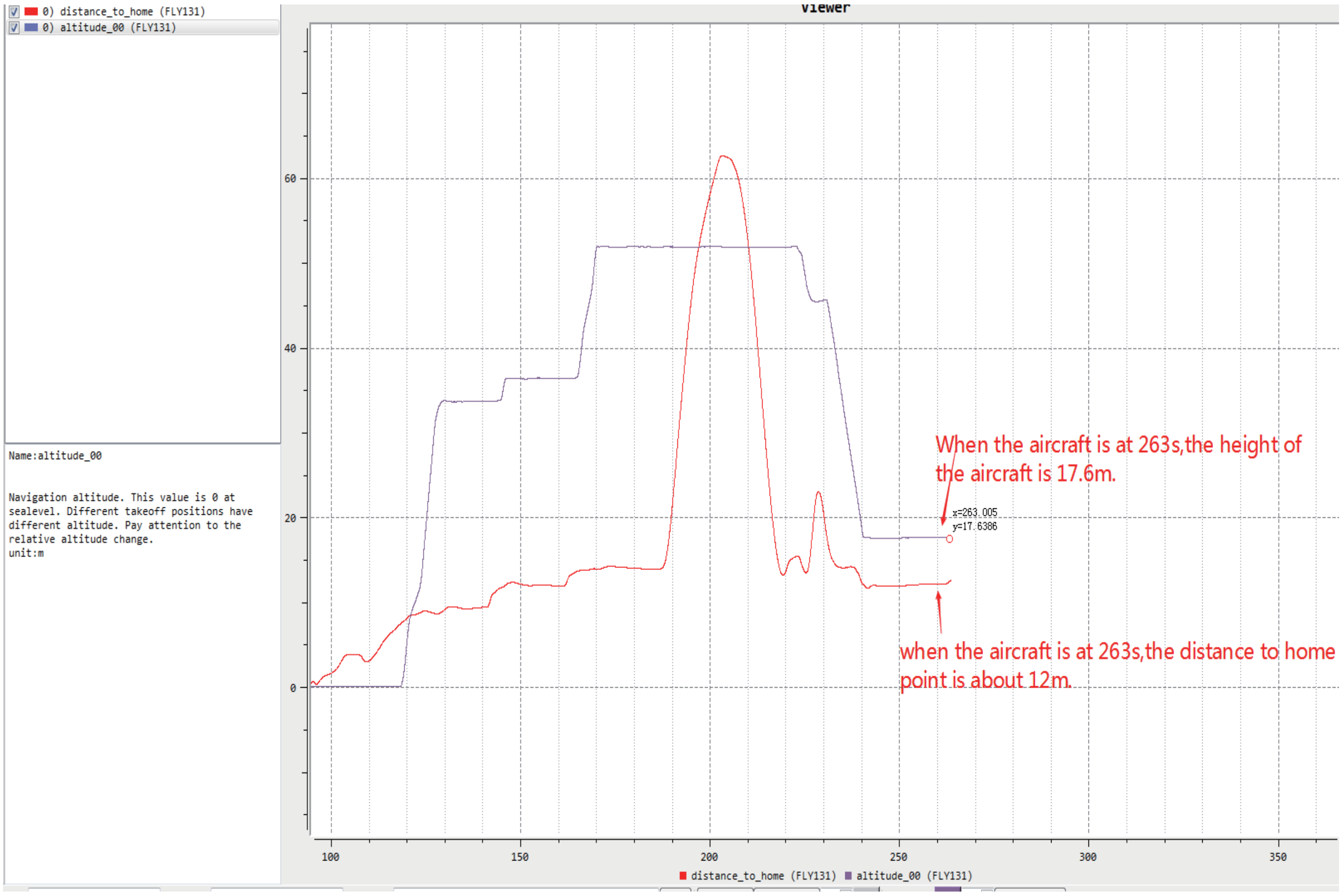

2) longtitude_00 (FLY015)
2) latitude_00 (FLY015)
Name:latitude_00
Latitude in WGS84
unit:rad
viewer
x=239.12
y=0.663781
When the aircraft is at 239.12 seconds,
the latitude of the aircraft is 0.663781.
longtitude_00 (FLY015)
latitude_00 (FLY015)

The two figures above show that the drone's longitude was 2.00044 radians and latitude was 0.663781 radians at 239.12 seconds. They are equivalent to 38.031849821 degrees of latitude and 114.616769169 degrees of longitude. Enter the coordinates in degrees in Google Earth or other map applications; then you can get the drone's location at that time on the map.



4. How can I know the flight distance and height of my drone through the flight controller's data?

You can find the flight distance (from the Home Point) and height in the attitude data package. Note that the height of the takeoff point needs to be deducted from the height data to get the drone's flight height. If the Home Point is not recorded successfully due to a poor GPS signal, the value of the distance curve will be 0.



5. Why can I not find the corresponding curves after loading a data file?

The curves mentioned in this article are for reference only. Available curves vary according to drone models. If some curves are not displayed in the software, please check the flight records in the app.

6. My drone crashed, but I could not find any changes to the accelerometer's value following the instructions in the tutorials.

New flight controller data will be generated every time the drone is powered on. So, when looking for the data, check whether the loaded data is consistent with the drone's actual situation, such as the takeoff height. Or check whether the height curve changed to determine whether the drone took off.

7. Why does the height value from the flight controller's data differ greatly from that in the app's flight record?

The height value shown in the app indicates the drone's height relative to the takeoff point, and the decimals are omitted. The height curve that we get with the flight controller's data is the raw height data measured by the barometer (which is relative to sea level). You need to deduct the height of the takeoff point to get the height close to that shown in the app.

8. Why is the drone’s location shown on the map greatly different from its actual location?

Please use the longitude and latitude data at the same time from the data curve. Otherwise, the drone’s location shown on the app may be inaccurate. Also, deviations may occur due to the different coordinate systems used by the map software.

The contents of this manual are subject to change without prior notice.

If you have any questions, send an email to support@dji.com