Power Line Inspection

Operation Manual

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DJI ENTERPRISE

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1. Feature Introduction

Power line inspection is one of the major features launched for the power industry on DJI's new-generation flagship drone, the DJI Matrice 400 (M400). The M400 is the first drone in DJI Enterprise applications with a built-in circular scanning LiDAR sensor on the aircraft body. Using this circular scanning LiDAR mounted on the top of the aircraft, the M400 can detect and identify small targets such as power line, enabling the drone to brake and detour around power line or follow them in flight. The former ensures flight safety, while the latter forms the basis of the power line inspection feature.



Figure 1 Circular scanning LiDAR on top of the aircraft

The power line inspection feature on the M400 does not require modeling of the line corridor or preparation of flight routes. The drone can automatically identify the sag and elevation changes of the power line and, based on parameters set by the user, maintain a constant distance from the power line while flying laterally and continuously capturing high-resolution photos of the power line.



Figure 2 M400 performing Power Line Inspection by flying laterally close to the power line

Note that in the industry, power line inspection is also commonly referred to as 'line-following flight' or 'side-flight line following.' The term 'line-following flight' should be distinguished from the line-following flight function of the Zenmuse L2 and L3 LiDAR payloads.

Table 1 Difference between power line inspection and line-following flight

Feature Name	Power Line Inspection	Line-Following Flight
Also Known As	Line-following flight; side-flight line following	Line-following modeling
Applicable Aircraft	M400	M400, M350 RTK, M300 RTK
Applicable Payloads	Zenmuse H30, Zenmuse H30T	Zenmuse L2, Zenmuse L3
Flight Method	Flies laterally close to one phase power line from the side of the corridor, maintaining a	Flies forward above the corridor along its direction, maintaining a constant height

	constant distance and automatically following power line sag and elevation changes.	difference from the ground line and automatically following corridor elevation changes and turns.
Purpose	Capture detailed photos of power lines and ground lines	Obtain a LiDAR point cloud model of the corridor and surrounding area

2. Application Scope

The power line inspection feature is applicable to different types of power lines and ground lines. See the table below for details.

Item	Description
Power line Material	Bare stranded power line. *Stable recognition and following cannot be guaranteed when used on insulated lines.
Power line Type	Ground line; power line: single, twin-bundle, quad-bundle, six-bundle, eight-bundle
Line Slope	<=60 degrees

3. Supported Aircraft

Currently, the power line inspection feature is available only on the M400 drone, and the supported payloads are limited to the Zenmuse H30 or H30T.

For feature updates and information about support for additional aircraft models, follow official DJI Enterprise information channels.

4. Tutorial

Choose a Suitable Operation Time

The power line inspection feature uses the Zenmuse H30 to perform continuous high-speed burst shooting while the drone flies laterally along the power line at high speed. Therefore, lighting conditions have a major impact on the quality of the photo results.

It is recommended to perform power line inspection in clear weather with sufficient lighting.

Set Global Parameters

Before entering the power line inspection feature, check several global parameter settings in Pilot 2.

Enable power line highlighting in Flight Settings.

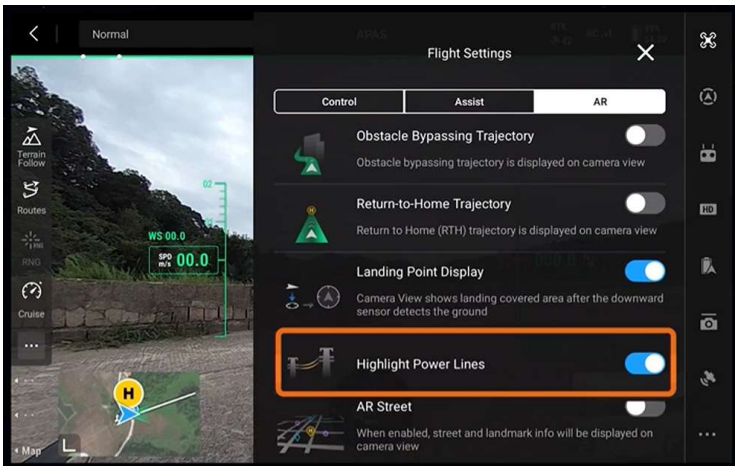


Figure 3 Enable AR highlighting for power lines

Check that obstacle sensing is set to Bypass or Brake.

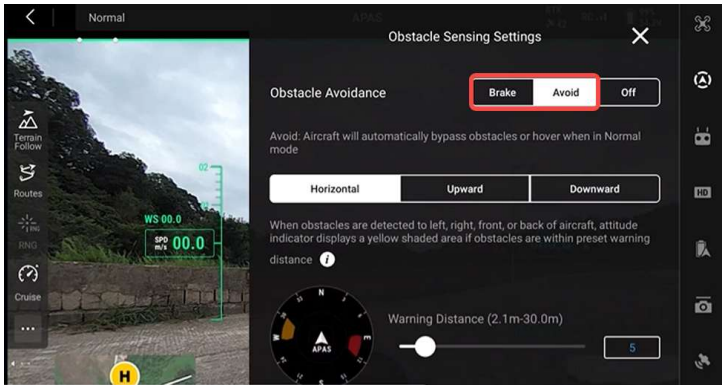


Figure 4 Enable drone obstacle avoidance

FAQ: If Bypass is selected, will the drone bypass obstacles during power line inspection?

No. Whether the setting is Bypass or Brake, the drone will brake during power line inspection. This is to ensure the quality of operation results. During power line inspection, the drone maintains a constant distance and angle for detailed photography. During obstacle bypassing, the drone would no longer be aimed at the target power line. Even if bypassing were successful, the photos captured during that section would be unusable. Therefore, the drone will only brake.

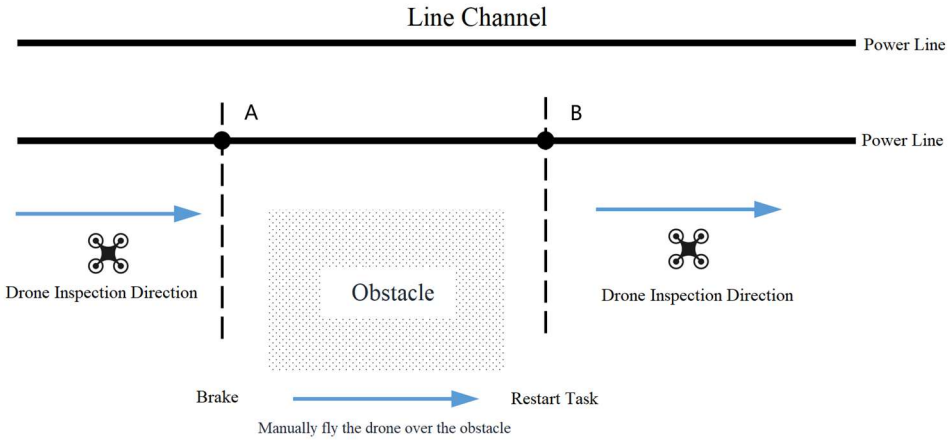


Figure 5 Manual supplementary shooting after braking

When an obstacle is too close to the corridor, the drone may trigger braking during lateral power line inspection. In this case, manually fly the drone over the obstacle and manually capture supplementary photos of the missing power line section, shown as section A-B in the figure. Then restart the mission from a safe position and continue automatic flight. Obstacles in the vertical direction may also trigger braking, and the same method can be used to bypass them.

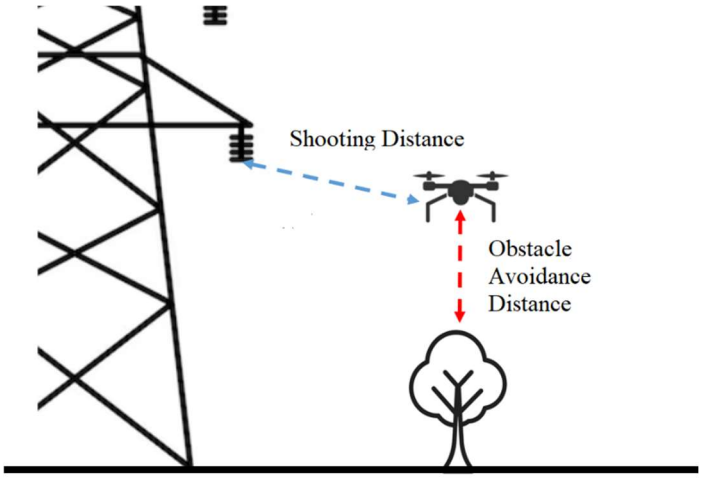


Figure 6 Obstacles in all directions in space may trigger braking

Check that the photo resolution of the Zenmuse H30 gimbal camera is set to 4K.

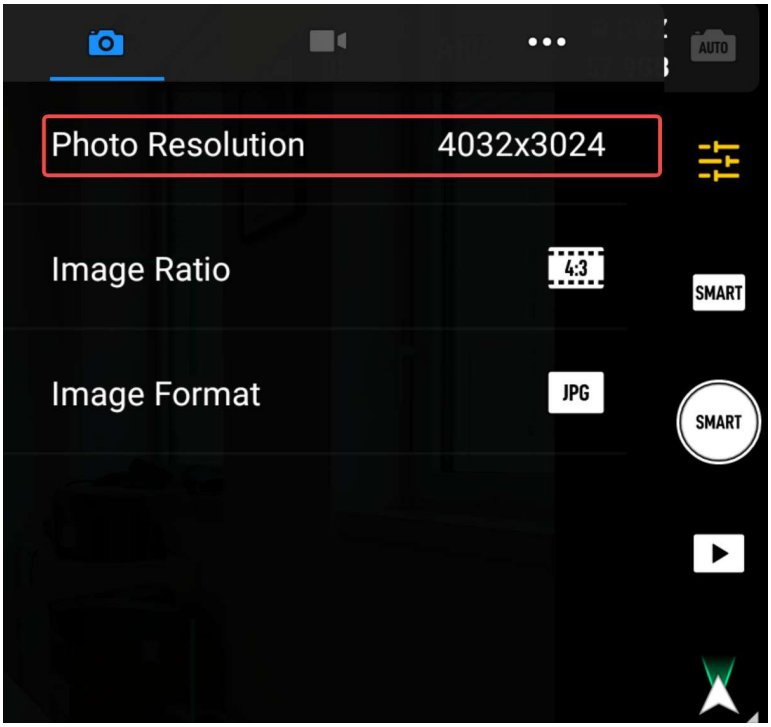


Figure 7 Set Zenmuse H30 photo resolution

FAQ: Will changing the photo resolution to 8K produce better results?

No. Increasing the resolution provides limited improvement to final image quality, but consumes a large amount of hardware performance and reduces the photo interval, which does not meet the requirements for continuous photography during lateral flight. Therefore, the power line inspection feature does not support 8K mode.

Set Mission Name, Shooting Distance, and Shooting Angle



Figure 8 Step 1 settings

After entering the feature, first configure Step 1:

Folder Name: This is the folder name under which inspection results will be saved on the memory card. Template input and custom input are both supported. For example, '220 kV Test Line N3 Tower Left Phase Large Side' means the mission starts at Tower N3, follows the left phase power line, and flies toward the larger tower-number side.

Power line Type: Options include ground line, single power line, twin-bundle, quad-bundle, six-bundle, and eight-bundle. Different bundle types affect the default camera zoom ratio in later steps. Select the correct type based on the actual situation.

Flight Distance and Pitch Angle: Flight distance refers to the straight-line normal distance between the drone and the target power line. It can be set from 5 m to 10 m. Pitch angle refers to the upward angle of the drone gimbal looking at the target power line. It can be adjusted from 0 to 35 degrees, from level view to 35 degrees upward.

Flight distance and pitch angle together determine the drone's position relative to the target power line during inspection. Figure 9 shows the horizontal and vertical distances between the drone and the power line under a parameter combination of 10 m shooting distance and 20 degrees pitch angle. Familiarity with these values can help assess flight safety during Power Line Inspection.

Manual Pitch Angle Control allows the user to adjust the gimbal pitch angle in real time during flight. Since front-back occlusion can easily occur between subpower lines of multi-bundle power lines, this option can be enabled.

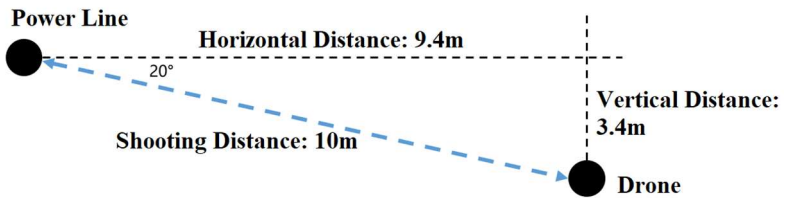


Figure 9 Spatial relationship of shooting distance

FAQ: Why is downward shooting of power lines not supported?

The M400 relies on the circular scanning LiDAR on top of the aircraft for power line recognition and following. When the target power line is lower than the drone, the LiDAR cannot detect the power line and

therefore cannot perform downward shooting. You can also see the LiDAR sensing range more intuitively in Figure 13 later in this manual. In most cases, upward shooting provides a cleaner sky background and helps highlight the subject.

FAQ: How do I determine the most suitable flight distance and pitch angle?

Flight distance affects both operational safety and efficiency. Flight safety includes not only trees and buildings beside the corridor, but also the hazardous distance to side-phase power lines when using single-circuit parallel stringing or triangular stringing. This is explained in detail in the next section. The impact on efficiency is explained later in the camera parameter section. In general, first-time users can set the distance to the closest value, 5 m. After gradually understanding the feature principles and becoming familiar with operation, the flight distance can be increased for higher operational efficiency.

For pitch angle, the main consideration is front-back occlusion between sub power lines. First-time users can keep the default value and enable Manual Pitch Angle Control, then adjust it during flight according to the actual situation. Experienced users can also enter the most suitable angle based on the actual line conditions.

Select the Target Power Line

After entering Step 2, the app automatically switches to the FPV view for target line selection. If you are not used to operating the drone using the FPV view, it is recommended to practice first in an open area.

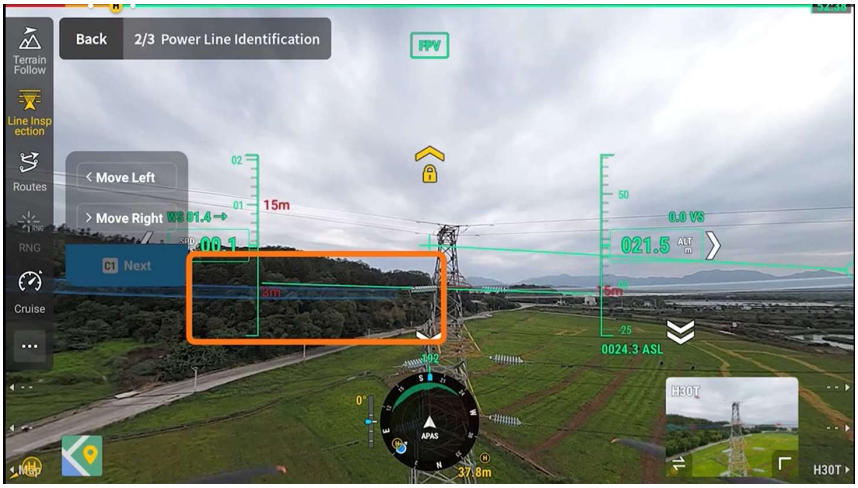


Figure 10 Step 2: Select the target power line

In the FPV view, power lines recognized by the drone are displayed with white and blue AR overlays. Blue indicates the power line with the shortest straight-line distance to the drone among all power lines. This is the target power line selected by the feature. White indicates other candidate power lines. If the blue result is not the phase power line you want to inspect, adjust the drone's forward/backward and up/down position, and move the drone closer to the correct target until the correct target turns blue.

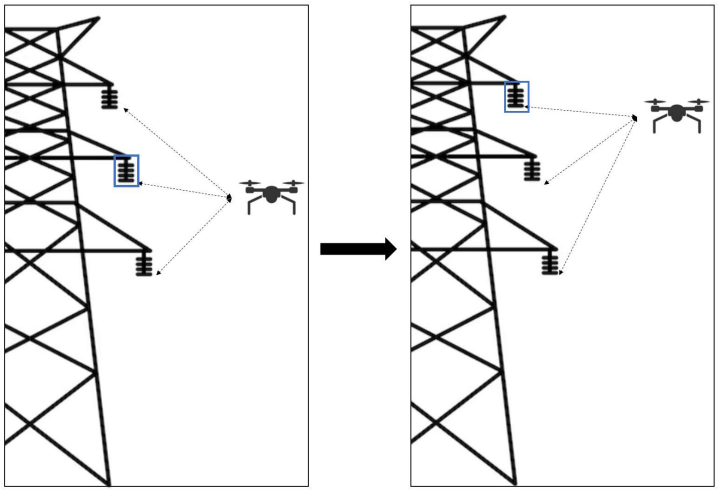


Figure 11 Adjust the drone up and down to change the selected target from the middle phase to the upper phase

After selecting the inspection direction, tap Next. The drone will calculate the correct shooting position based on the target power line's position and the shooting distance and angle set by the user, then automatically and slowly fly to that position. Refer to Figure 9 above for the positional relationship between the drone and power line.



Figure 12 After tapping Next, the drone slowly flies to the mission start position

Note that selecting the target power line on lines with large slope changes requires some skill. Figure 13 shows the sensing range of the circular scanning LiDAR on top of the M400. Power line recognition is also concentrated in this area, that is, upward from the top of the aircraft.

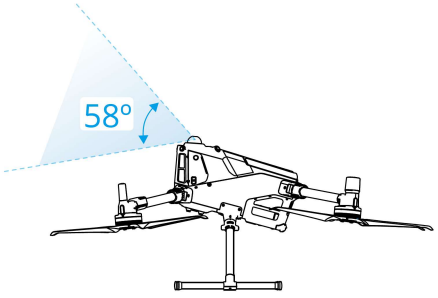


Figure 13 Sensing range of the M400 circular scanning LiDAR while hovering

Therefore, power lines located below the aircraft body may not be recognized as targets. For example, in Figure 14, when the aircraft is level with the suspension point of a straight-line tower, the rising line on the right is within the sensing range of the circular scanning LiDAR and is correctly recognized as a target. The descending line on the left is outside the sensing range and cannot be recognized as a white candidate target. In this case, if you want the drone to inspect the descending line on the left, lower the drone appropriately and move it in the direction of the red arrow in the figure until the descending line is detected.



Figure 14 Downward lines cannot be recognized

FAQ: Can the M400 power line inspection feature be used on middle-phase power lines?

First, the power line inspection feature itself does not distinguish tower types or stringing methods. After understanding the previous explanation of shooting distance and target selection, we can now answer this question in detail.

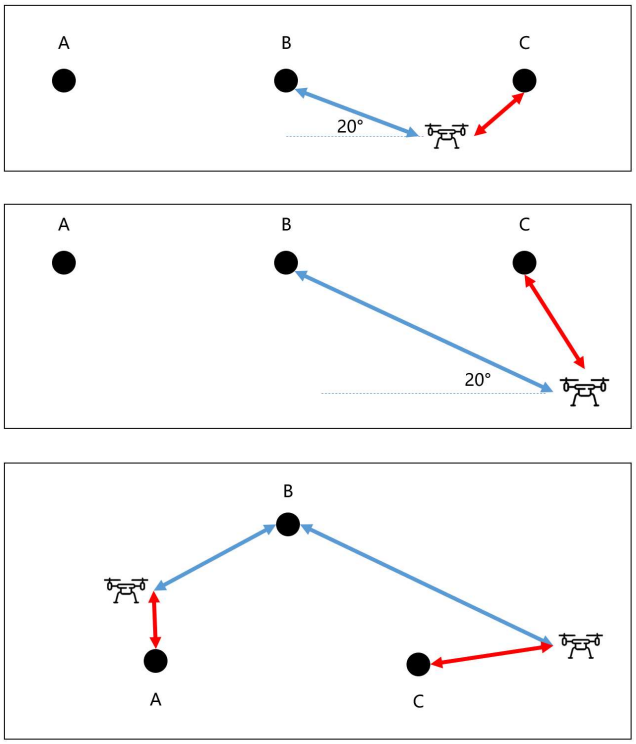


Figure 15 Risk illustration for parallel stringing (top and middle) and triangular stringing (bottom)

In the figure above, blue indicates the shooting distance, and red indicates the hazardous distance between the drone and the side-phase power line. Depending on whether the shooting distance is the minimum 5 m or

maximum 10 m, the positional relationship between the drone and the side phase may differ. If the distance is too short, collision risks may occur.

Warning: Middle-phase power line inspection is not recommended. Because the phase-to-phase distance and the aircraft's clearance from adjacent phase lines may be difficult to determine accurately, this operation may create significant collision risk.

Adjust Camera Parameters

After the drone reaches the mission start position, it enters Step 3 for camera parameter settings. The app automatically switches back to the H30 zoom camera view and adjusts to a default zoom ratio based on the power line bundle configuration and shooting distance set by the user. At this point, the drone no longer responds to control stick input from the remote controller. If you need to move the drone, return to the previous step or exit the feature.

Camera parameter adjustment can be roughly divided into three categories. These parameters are also coupled with each other. The following section explains a logical parameter adjustment process to help you better understand the feature and develop operational experience.

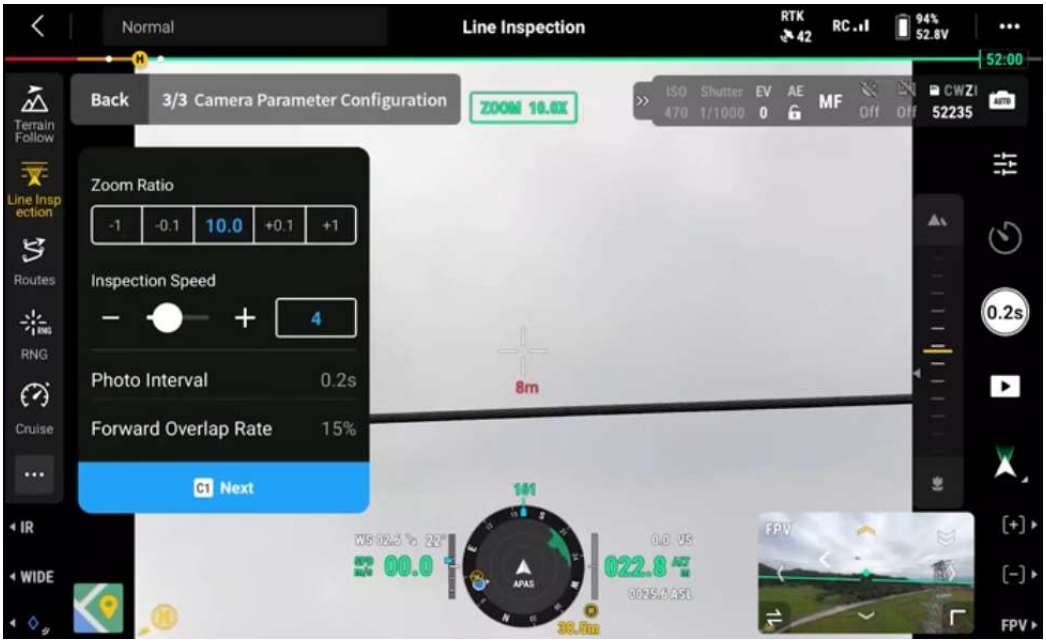


Figure 16 Step 3 camera parameter adjustment interface

Zoom Ratio

First adjust to a suitable zoom ratio so that the target power line occupies an appropriate proportion of the image. If the zoom ratio is too low, the power line texture will not be clear enough to identify defects. If the zoom ratio is too high, the power line length captured in a single photo will be too short, limiting flight speed. At the same time, in the vertical direction, the power line is also more likely to shake out of the frame during flight, causing missed shots.

*A higher zoom ratio does not always produce better results. If the zoom ratio is too high, each photo captures a shorter section of the power line, which may reduce inspection efficiency and increase the risk of missed shots during flight.

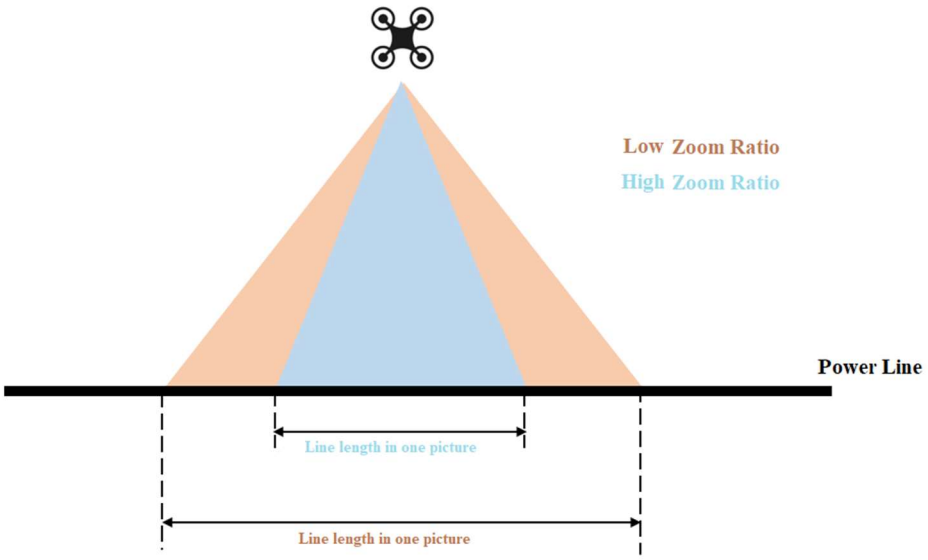


Figure 17 The higher the zoom ratio, the narrower the camera field of view

Inspection Speed and Shooting Interval

Inspection speed can be adjusted from 1 to 10 m/s. Its value is closely coupled with the zoom ratio, so speed adjustment is also placed in Step 3 camera parameter adjustment. During power line inspection, the overlap rate between adjacent photos is fixed at 15%. Under this premise, a faster inspection speed requires a shorter shooting interval.

When inspection speed is increased, the app first reduces the shooting interval until it reaches the lower limit of 0.2 seconds. If the inspection speed continues to increase at this point, the app displays a risk warning: 'Camera zoom ratio or flight speed is too high; the power line will be missed.' In this case, reduce the inspection speed or decrease the zoom ratio.

When inspection speed is reduced, the app increases the shooting interval to reduce data volume.

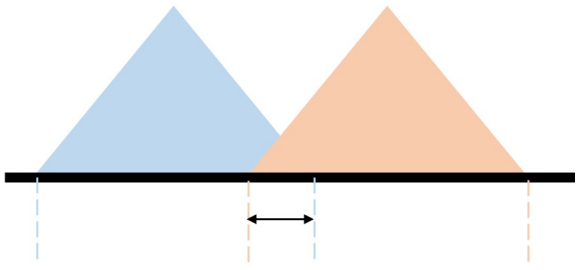


Figure 18 Overlap rate between two adjacent photos is fixed at 15%

Exposure Compensation EV and Focus

Focus mode can be selected between AFS, single autofocus, and MF, manual focus. AFS is recommended. Tap the power line in the image to focus. If repeated attempts produce poor results, switch to MF and use the slider on the right for manual focus.

Exposure compensation EV usually needs to be increased in most scenarios. Background sky overexposure may be acceptable if the power line texture remains bright, clear, and properly exposed for inspection. Adjust EV until the power line texture is bright and clearly visible.

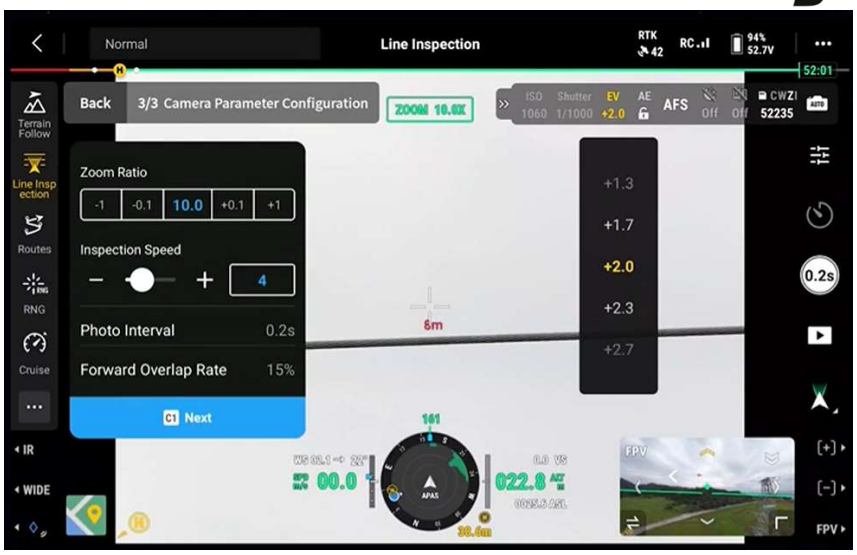


Figure 19 Adjust EV until the power line texture is bright and clear

Start the Mission

After completing the above settings, tap Next. The H30 camera automatically adjusts the pitch angle for focus calibration. After calibration is complete, the drone starts flying laterally along the power line and continuously captures power line photos.

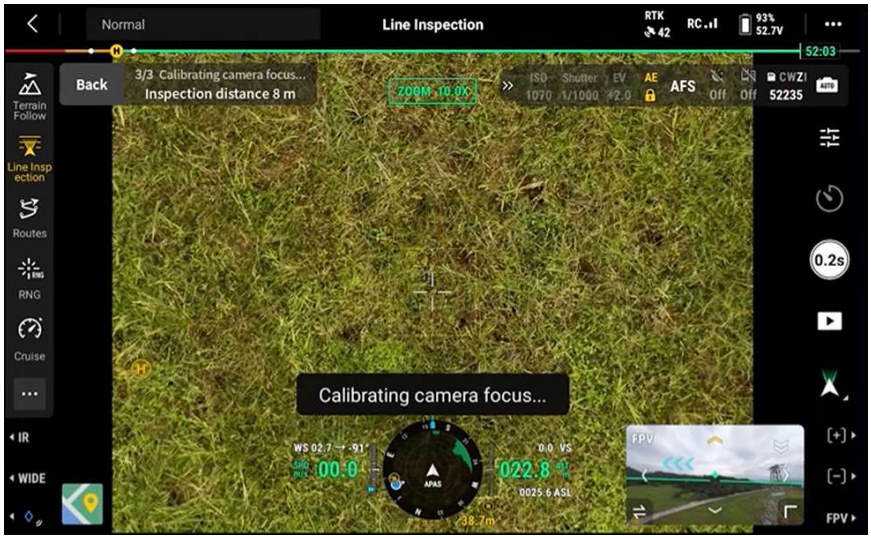


Figure 20 Automatic camera calibration

During flight, the power line may move up and down in the image. This is caused by slight vibration being magnified at high zoom. As long as the power line does not move out of the frame, there is no need to worry. Otherwise, reduce the zoom ratio and restart the mission.

If Manual Pitch Angle Control was enabled in Step 1, you can adjust the pitch angle with the dial during flight according to the actual situation. For example, in Figure 21, front-back occlusion between sub power lines is observed on an eight-bundle power line. Adjusting the pitch angle from 23 degrees to 16 degrees improves the occlusion.

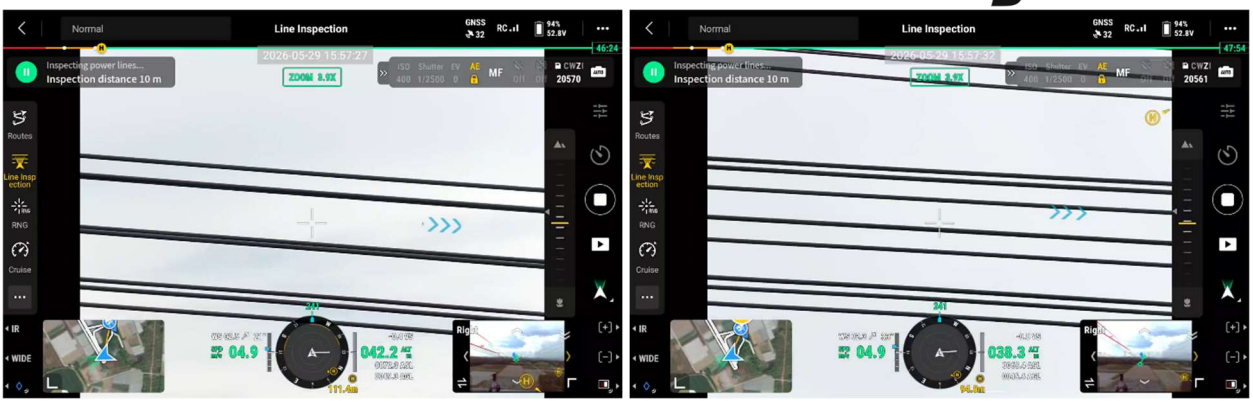


Figure 21 Adjust the angle in real time to avoid occlusion between sub power lines

If flight is stable and real-time shooting angle adjustment is not needed, the flight assistance image can be switched to the main screen to monitor flight safety in real time.



Figure 22 The operator should monitor the flight assistance image

Automatic Mission Completion

Under normal conditions, the drone automatically stops when it reaches the power line-end suspension point of the insulator. For tension insulators, however, there is a certain probability that the drone may mistakenly recognize the insulator as a power line and continue flying past the suspension point. When inspecting the inner-side line of a tension tower, the aircraft may continue past the suspension point before obstacle sensing triggers braking. The operator must closely monitor the aircraft and be prepared to take manual control or terminate the mission if required.

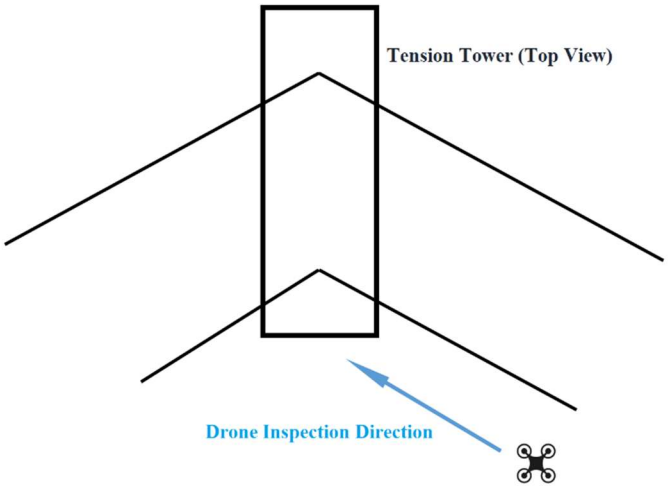


Figure 23 Inner-side line inspection requires close pilot monitoring due to reduced clearance and increased operational risk.

After completing one mission, you can enter the album in the app, select some photos, and download the originals to the remote controller to check the quality of inspection results. If the results do not meet requirements, adjust parameters and rework promptly.

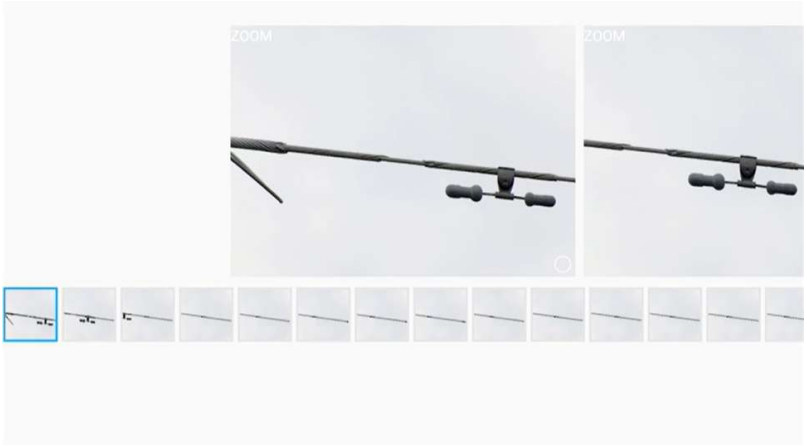


Figure 24 Download original photos in the app album for check

Conveniently Start the Next Mission

Currently, M400 Power line inspection does not support automatic tower crossing or phase switching. After completing inspection of one phase over an entire span, manually move to the next span of the same phase, or to the next phase within the same span, and start the feature again for inspection.

Considering that parameters such as power line bundle count and lighting conditions are usually the same or change only slightly during continuous operations, the power line inspection feature automatically remembers the previous parameter template within one flight sortie, marked by changing the drone battery. This includes mission name, shooting distance, camera parameters, and so on. After the inspector moves the drone to the inspection start point of the next phase power line, a large amount of parameter adjustment can be skipped, allowing the next mission to start quickly.

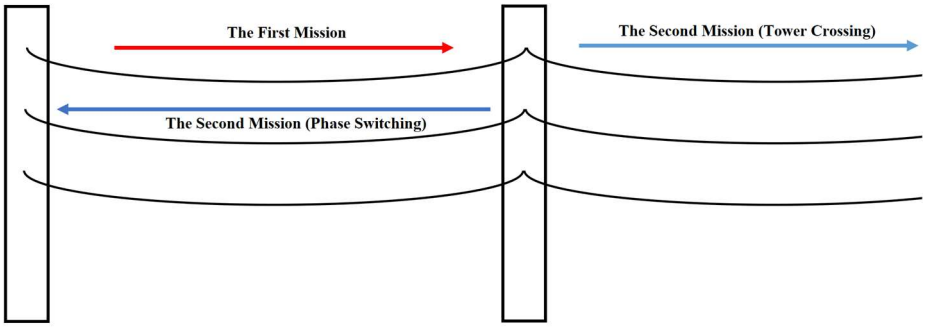


Figure 25 Parameter templates can be remembered for subsequent missions

5. Sample Photos

This section shows shooting results of the Power Line Inspection feature under different line conditions. It also provides several typical unqualified samples and suggestions for image quality adjustment.

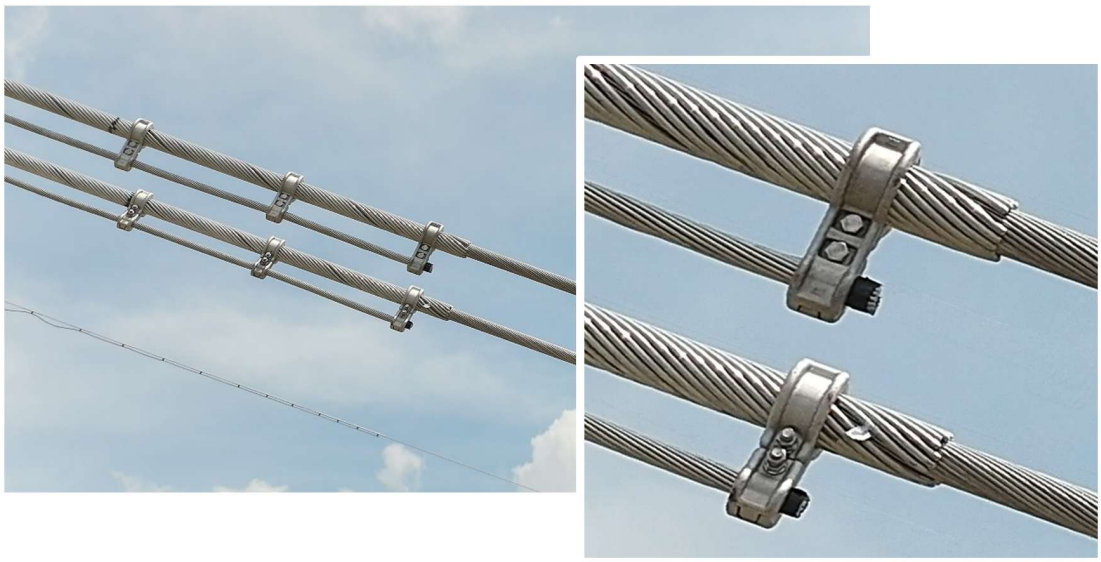


Figure 26 Twin-bundle power line



Figure 27 Ground line

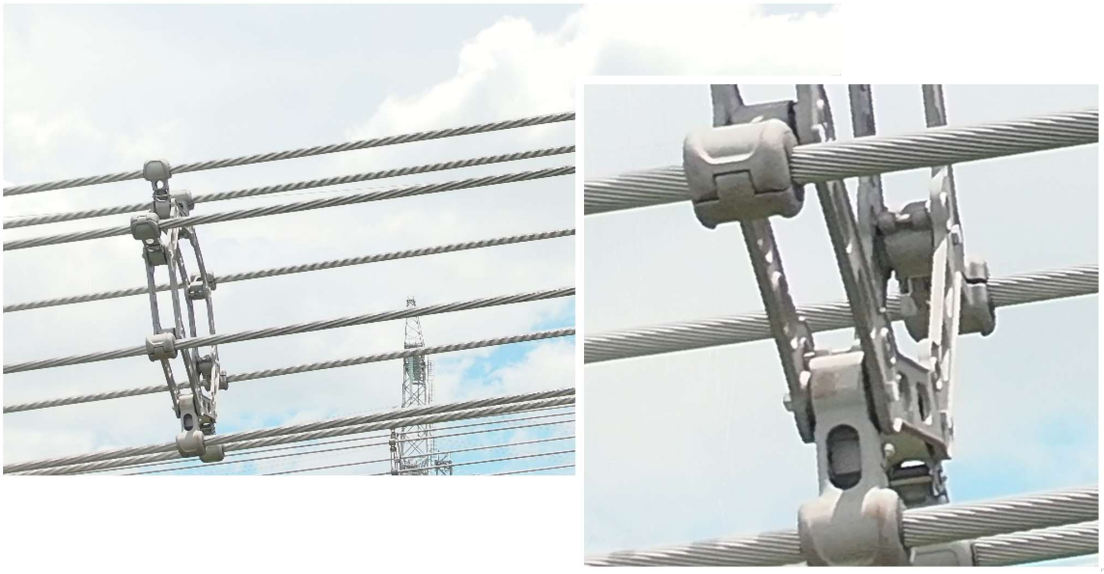


Figure 28 Eight-bundle power line and spacer

Line Type	Shooting Distance	Flight Speed	Zoom Ratio
Twin-bundle power line	7 m	5 m/s	3x
Ground line	5 m	5 m/s	2.5x
Eight-bundle power line and spacer	5 m	10 m/s	2x

The following are several typical unqualified samples.



Figure 29 Too dark image

In the image above, the exposure is obviously too dark. Increase the EV level. If the image still cannot appear bright at the highest setting, lighting conditions may be insufficient. It is recommended to operate in clear weather.



Figure 30 Not clear image

In the image above, the zoom ratio is insufficient, and the power line texture is not clear enough. Try increasing the zoom ratio.



Figure 31 Excessive noise in image

In the image above, there is excessive image noise. This is often caused by insufficient lighting and excessive flight speed.



Figure 32 Severe motion blur

In the image above, motion blur is severe. This is often caused by insufficient lighting and excessive flight speed.

*The power line inspection feature performs more stably when ambient lighting is sufficient. During cloudy operations, the camera increases ISO. When ISO is too high, >=3200, image noise and detail loss increase significantly. If flight speed is also high, motion blur may occur. In this case, follow the principle of sacrificing operational efficiency to ensure result quality: reduce shooting distance, increase zoom ratio, and reduce flight speed. All of these helps lower camera ISO.

6. FAQ

Can the Zenmuse H20 series be used for power line inspection?

No. The Zenmuse H20 series does not support mounting on the M400 drone, and its performance cannot meet the requirements for precise shooting during high-speed flight.

Does power line inspection require RTK to be enabled?

RTK is not mandatory. The drone can automatically follow the line's elevation changes and fly laterally without relying on pre-built models or high-precision routes. However, during subsequent data processing, if photo POS information is needed to locate defects, for example to generate a review waypoint route based on the POS information of defect photos, it is recommended to enable RTK for more accurate positioning.

Can power line inspection save wide-angle and infrared photos at the same time?

Not supported at this time.