USER GUIDE

PHEREFIX

SPCraft5

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SPCraft5

SPCRAFT5 USV USER GUIDE

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Contents

1. Overview

1.1 Introduction to SPCraft5 USV

SPCraft5 is designed around a fully modular, plug-and-play system architecture.
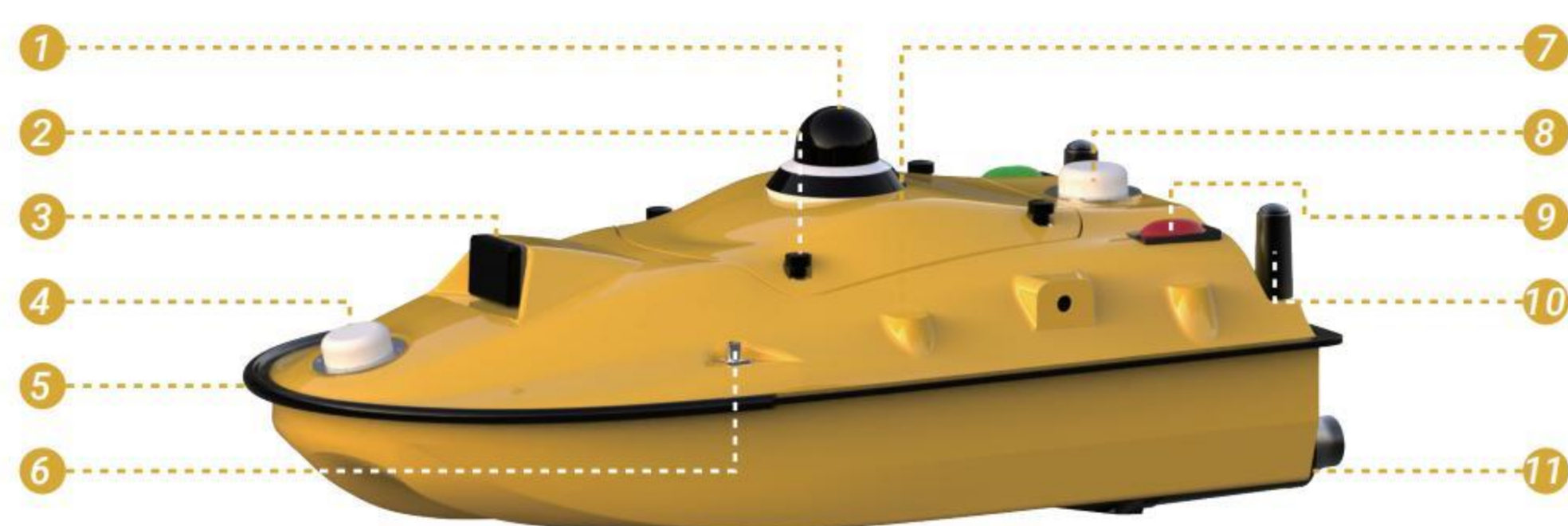
The platform brings together seven line-replaceable components—a hull structure, mission-control core, propulsion module, collision-avoidance suite, high-accuracy positioning package, wireless telemetry link, and a hot-swappable power system—into one sealed, integrated unit.

Its shore-based control element is a dedicated Android long-range telemetry controller that consolidates differential-correction uplink, live data downlink, and remote-operation functions into a single device.

All onboard operations and post-mission workflows are managed through iSail, an all-in-one vessel-control and hydrographic-processing software suite.

Detailed descriptions of each hardware component and software module are presented in the following sections.

1.2 Hull & Hardware

❶ 360° panoramic camera
❷ Hatch knob
❸ Collision-avoidance radar
❹ Directional antenna
❺ Rubber fender strip
❻ Radio-antenna port
❼ Hull expansion deck
❽ GNSS positioning antenna
❾ Indicator light
❿ 2.4 GHz / 4G antenna
⓫ Thruster
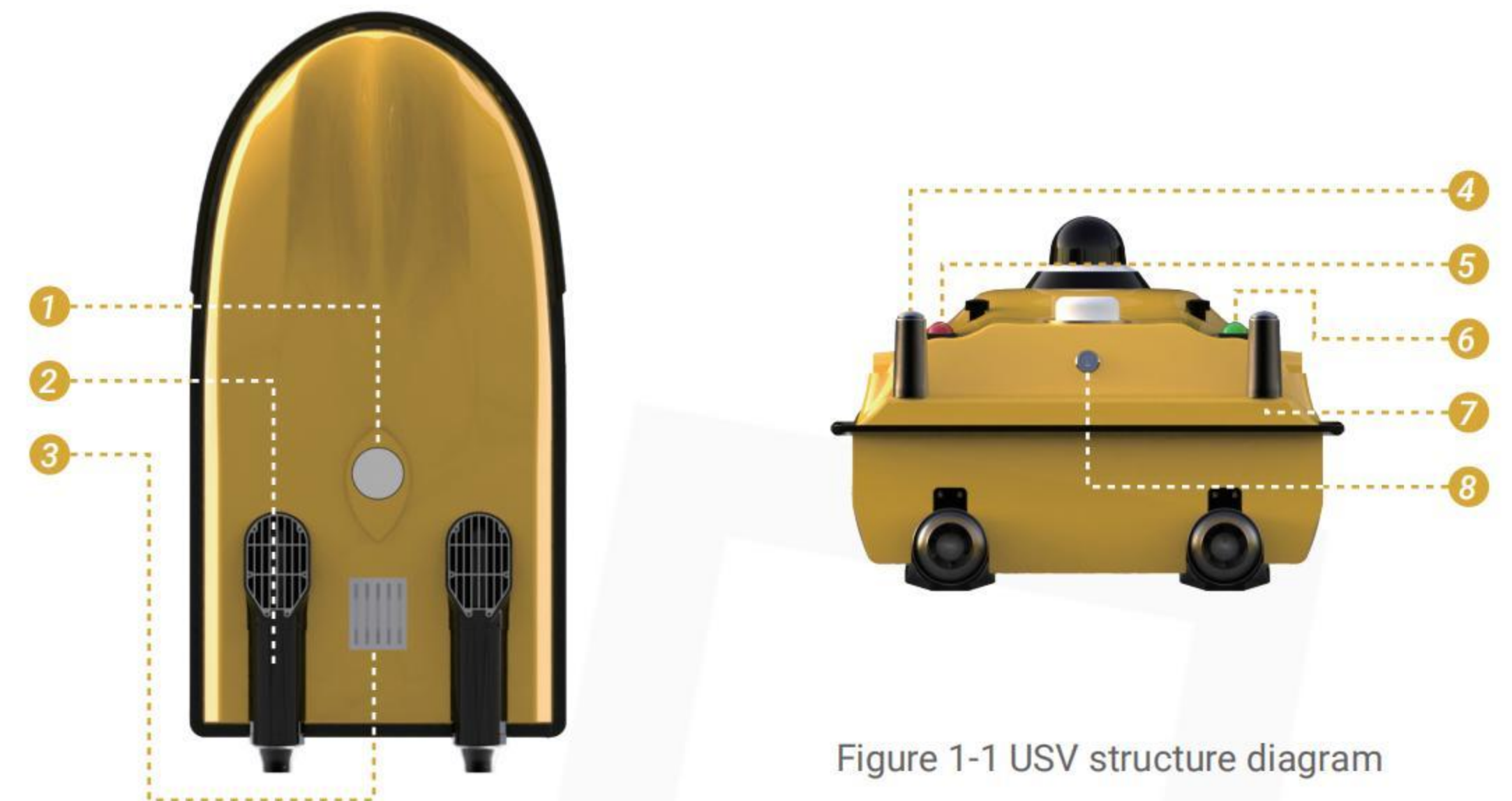
Figure 1-1 USV structure diagram

❶ Single-beam echosounder (SBES)
❷ Thruster
❸ Heat-dissipating subsea mounting & expansion rail
❹ 4G antenna
❺ Power/RC-link indicator light
❻ Differential-fix indicator light
❼ 2.4 G antenna
❽ One-key start button

1.3 Introduction to the G20 Remote Controller

(1) The G20 remote controller is powered by a 6 nm octa-core Qualcomm processor running 64-bit Android 13. Its high-power dual-band 2.4 GHz / 5.8 GHz radio system supports long-range, low-latency transmission of high-definition video with strong resistance to interference.

(2) A built-in 7-inch, high-brightness HD display (1920 × 1200) provides real-time visual feedback from onboard sensors and survey payloads. Dual internal cooling fans ensure stable thermal performance during extended field operations.

(3) Connectivity options include a SIM card slot, USB port, and Type-C interface, supporting differential-correction uplink, data recording, and peripheral integration.
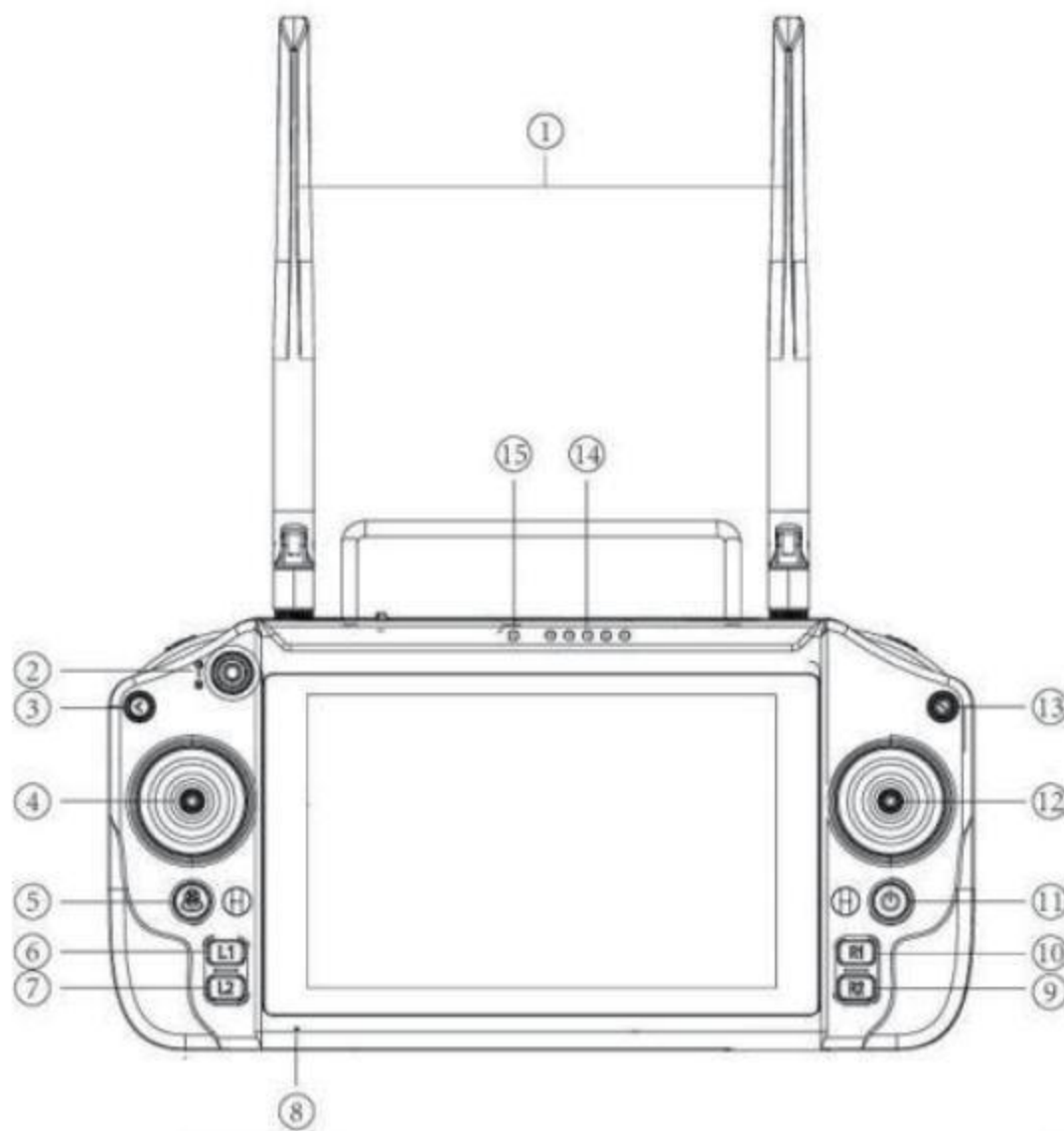
(4) A high-energy-density lithium-ion battery provides 6 to 8 hours of continuous operation per charge.

(5) Constructed from meteorological-grade silicone, matte rubber, and ABS materials, the G20 incorporates dust-resistant protection for its housing, control switches, and external interfaces, ensuring dependable performance in demanding environments.
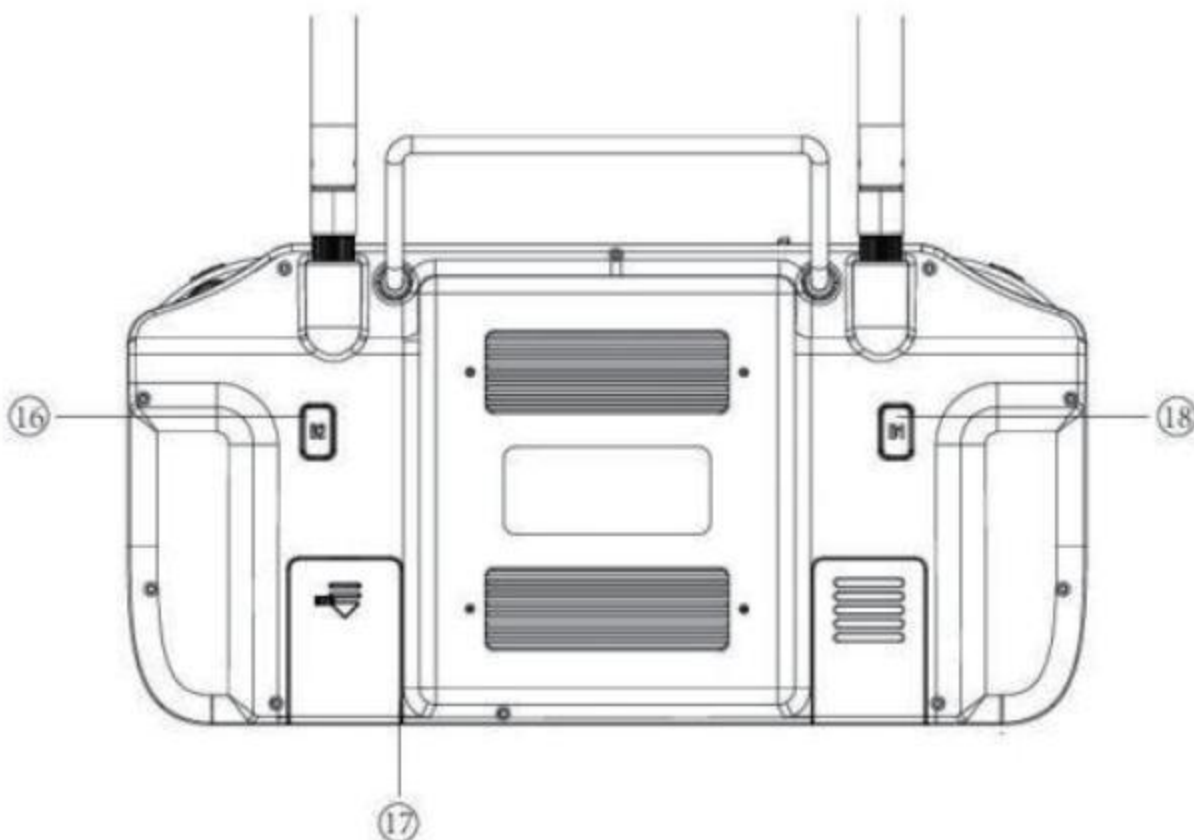

Figure 1-2 Controller

G20 Controller Specifications			
Model	H20	Channels	16
Operating voltage	4.2 V (internal battery)	RF power	23 dBm @CE/FCC
Band	2.4 GHz	Dynamic FHSS	Hopping enabled
Dimensions	277 mm (L) * 138 mm (W) * 96 mm (H)	Weight	1.2 kg
Endurance	6–8 h	Battery	20000 mAh
Firmware update	OTA / on-line	Charge port	TYPE-C
RAM	4 GB	Internal storage	64 GB

1.4 Controller Operations

Item	Label	Item	Label
1	2.4 GHz antenna	9	R2 – USV status shortcut
2	3-position toggle switch (FWD: Auto / MID: Hold / AFT: Manual)	10	R1 – vessel-control parameters shortcut
3	Back key	11	Power key
4	Left stick (forward/reverse control)	12	Right stick (port/starboard control)
5	Return-to-home (RTH) key	13	Data-logging stop key
6	L1 – mission-planning shortcut	14	Battery Indicator Light
7	L2 – safety-settings shortcut	15	Linking Indicator Light
8	Microphone		

Item	Label	Item	Label
16	B2 key (reserved)	21	Lanyard eyelet
17	TF-card / SIM-card slot	22	TYPE-C port
18	B1 key (reserved)	23	USB port
19	Spring-return thumb-wheel for gimbal pan control	24	Photo-capture key
20	Camera-view toggle key		

1.5 Operating Environment

a. Ambient temperature: −10 °C to +45 °C

b. Storage temperature: −20 °C to +50 °C

c. Relative humidity: ≤ 85 % RH

d. Atmospheric pressure: 86 kPa − 106 kPa

e. The area must be free of explosive, corrosive, conductive media, damaging gases, excess moisture, and mould.

f. The site must protect against rain, snow, and wind-blown sand or dust.

1.6 Power Supply & Safety Notes

a. The G20 ground station uses a built-in rechargeable Li-ion battery and supports charging via a standard Type-C port with any certified USB charger.

b. If smoke, odor, or electrolyte leakage occurs during charging, stop immediately and contact authorised service staff.

c. Keep the charging area away from children to avoid electric-shock risks.

d. Do not charge in environments above 60 °C.

e. Only use certified, professional-grade chargers.

f. Antennas are fragile—avoid impact or excessive force.

1.7 Pre-operation Checks

a. Ensure the controller battery is sufficiently charged.

b. Confirm all antennas are correctly positioned for optimal performance.

c. Do not operate the device under the influence of alcohol or impairing substances.

2. Hardware Operation

2.1 Accessory Installation

a. Install the battery, connect the aviation power plug, and switch the battery ON.

b. Attach the main-camera Ethernet and power cables.

c. Close the hatch and tighten the thumb screws.

2.2 Pre-Launch Checks

(1) Power On
USV:
Press and hold the stern power button for 3 seconds until the indicator flashes rapidly, then release.
After ~10 seconds, the light becomes solid, indicating the mission computer has fully booted.
Controller:
Power on the G20 controller, open the iSail app, and connect to the USV via the video link.
A solid red LED on the port side of the hull confirms a successful connection.
(2) Thruster Airflow Check
Use stick commands to confirm blower direction:

Use stick commands to confirm blower direction:

① Forward (left stick forward): both thrusters exhaust aft.

② Reverse (left stick back): no airflow from either thruster.

③ Port turn (right stick left): port thruster—no airflow; starboard thruster—exhaust aft.

④ Starboard turn (right stick right): port thruster—exhaust forward; starboard thruster—no airflow.

(3) Power-on self-test (POST)

After the iSail video-link is established the vessel runs its POST; all items must pass before launch.

2.3 Battery Charging Procedure

(1) Charge both the lithium battery pack and the controller only with the supplied dedicated charger.

(2) Mating procedure:

① Align and fully seat the charger plug into the battery port first.

② Then insert the charger mains plug into 220 V AC.

LED logic:

    POWER LED only → no battery connected

    CHARGE LED red → charging

    CHARGE LED green → charge complete; battery ready for use

(3) Battery care

a. New batteries are shipped with ≥30 % SOC; bring to 100 % within two months.

b. Recharge immediately when the one-bar (low-battery) indicator appears.

c. A fully-charged battery may be stored for up to six months; recharge again after this period.

3.Software Operations

3.1 Software overview

iSail is a dedicated control and post-processing suite for unmanned surface vehicles, supporting multiple survey modes for fully autonomous operation. It provides hull control, route planning, status monitoring, safety alerts, online upgrades, and real-time triple-view video over 4G or data-link connections.

The system integrates external sensors directly in the app without requiring a computer. Post-processing includes depth-trace overlays and multiple correction options to ensure accuracy and reliability. iSail is designed for precise measurement, simplified workflows, and quick field deployment.

(1) Technical specifications

Operating environment: G20 Controller (Android 13).

(2) Installation & Uninstall

Installation:

Copy the iSail control app (*.apk) to the Download folder on the G20 controller.

Open the file manager, navigate to Download, and tap the iSail apk to begin installation.

Once completed, the iSail app icon will appear on the home screen.

Figure 3.1-1 iSail App

Uninstall:

Long-press the iSail icon, drag it to the uninstall area, and tap OK when prompted to remove the app.

(3) Version check and update

When the app launches with network access, it automatically checks the server for updates. If a newer version exists, an update prompt will appear. If not connected to Wi-Fi, the handset will ask whether to continue the download.

(The G20 controller is supplied with the iSail USV control app pre-installed. If the app is not present, please contact technical support for reinstallation.

Note: Many functions require mobile data, and the vessel receives network RTK corrections via the Internet. Ensure a stable network connection during operation.

3.2 Connection Setup

(1) Launch the iSail app and, on the home screen, tap the iBoat button in the lower-right corner to open the USV connection dialog. Select Video-Link → Connect or 4G → Connect.
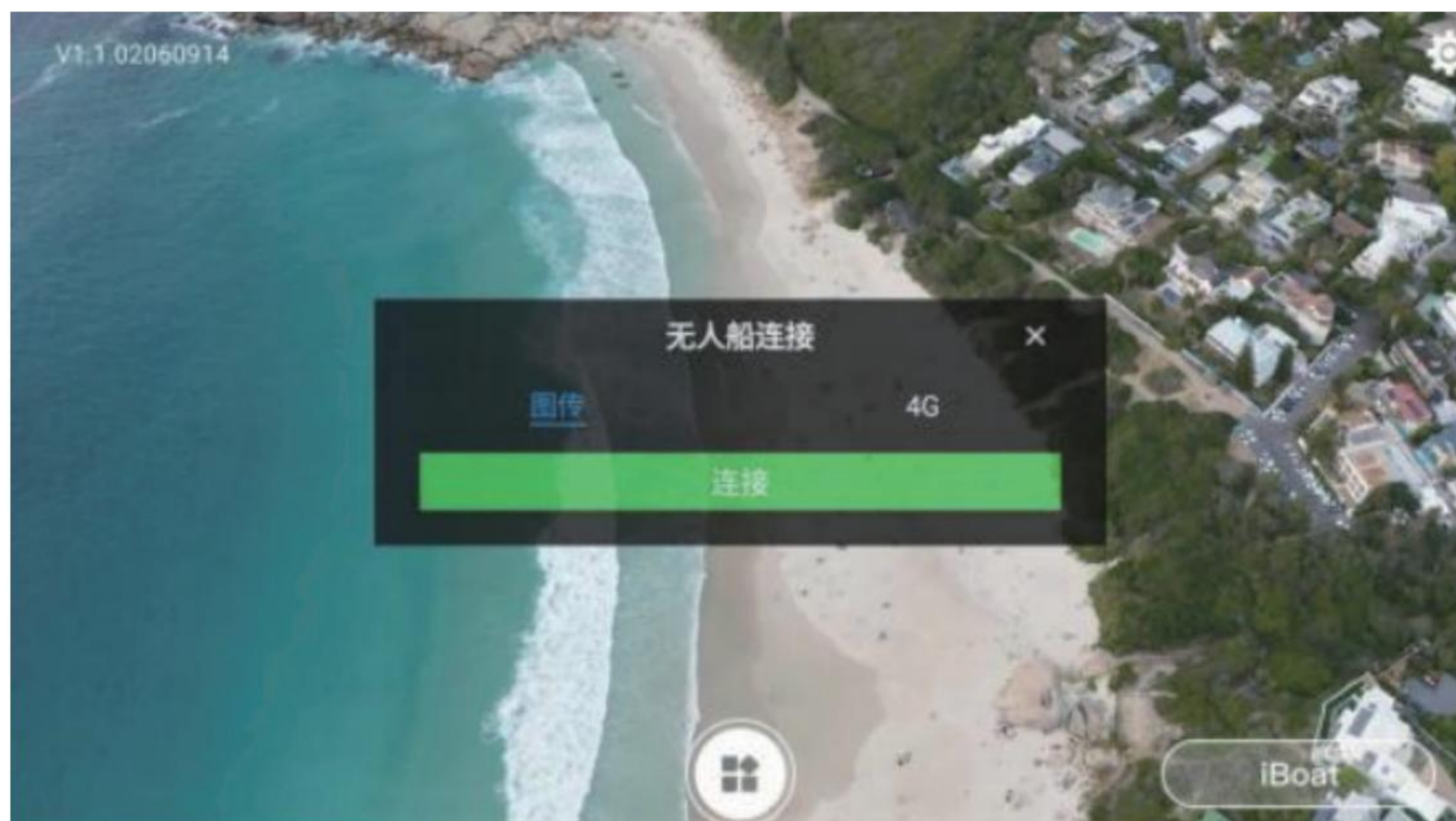

Figure 3.2-1 Connection1

(2) The USV supports two connection modes—4G and video-link (default: video-link).

In 4G mode, the vessel ID is its SN number, and the password is "ubinavi2023".

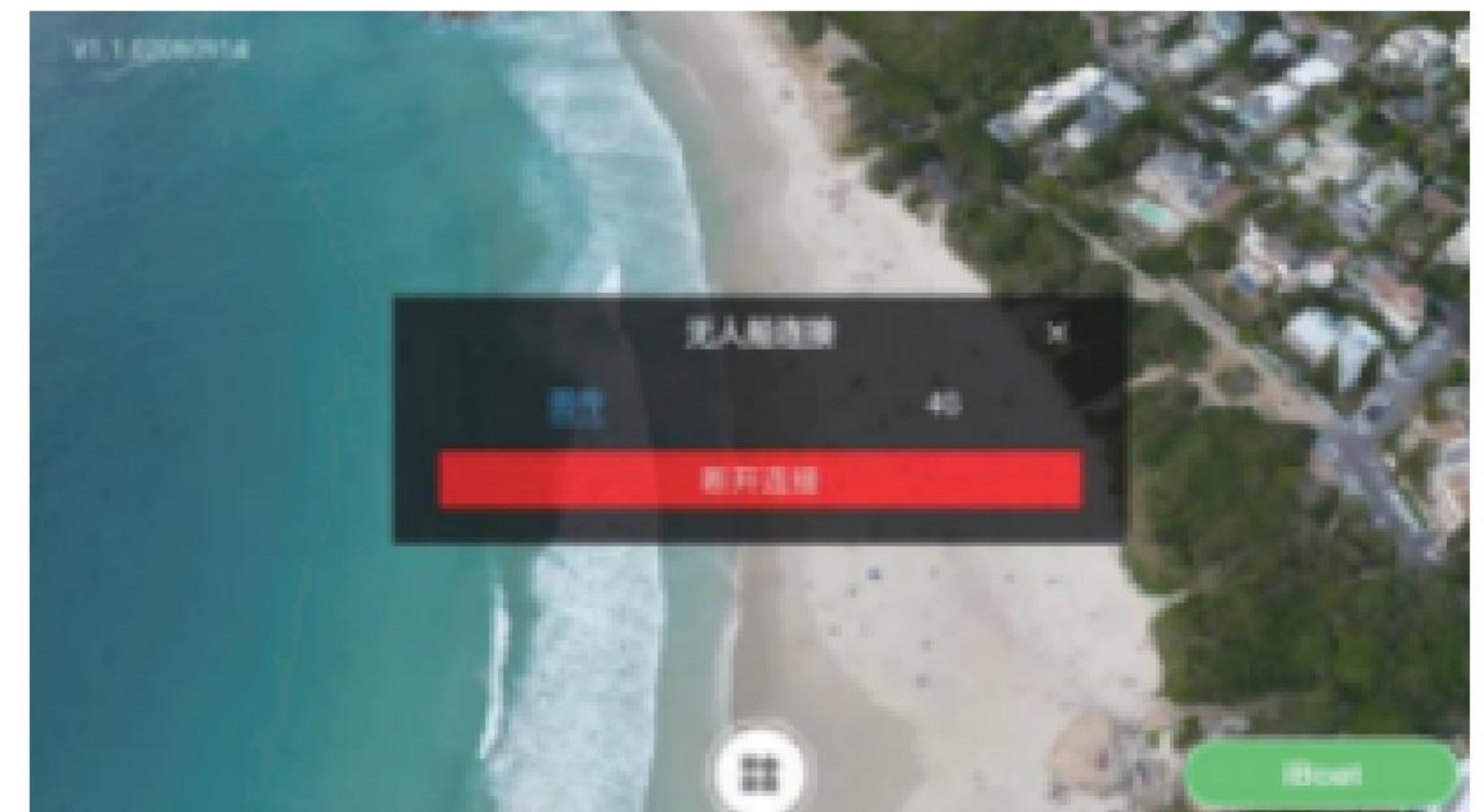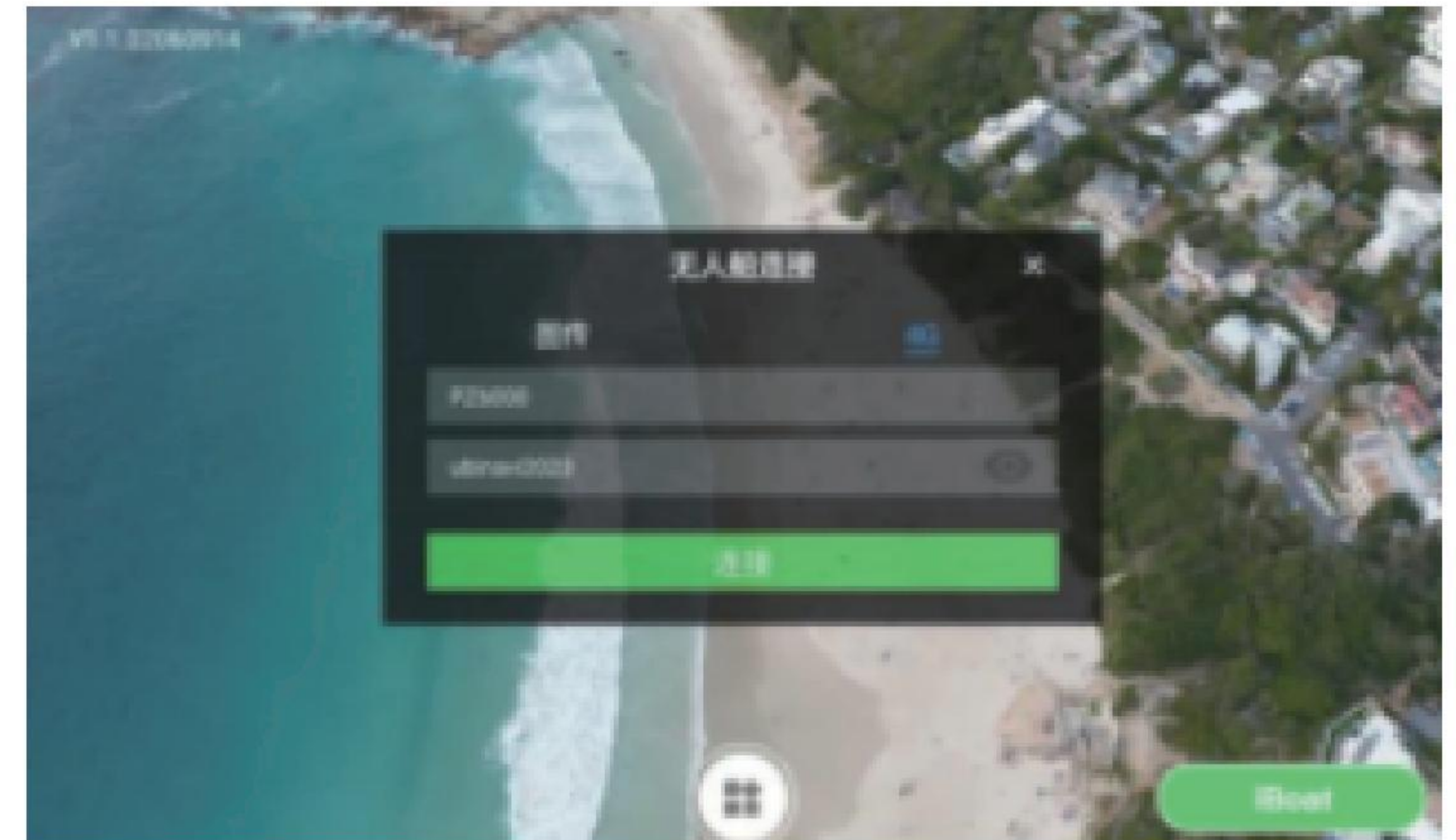Once connected, the button changes to "Disconnect".

Figure 3.2-2 Connection2

3.3 New Project

(1) Tap the function button at the bottom of the screen to open the project list, then tap "New Project".
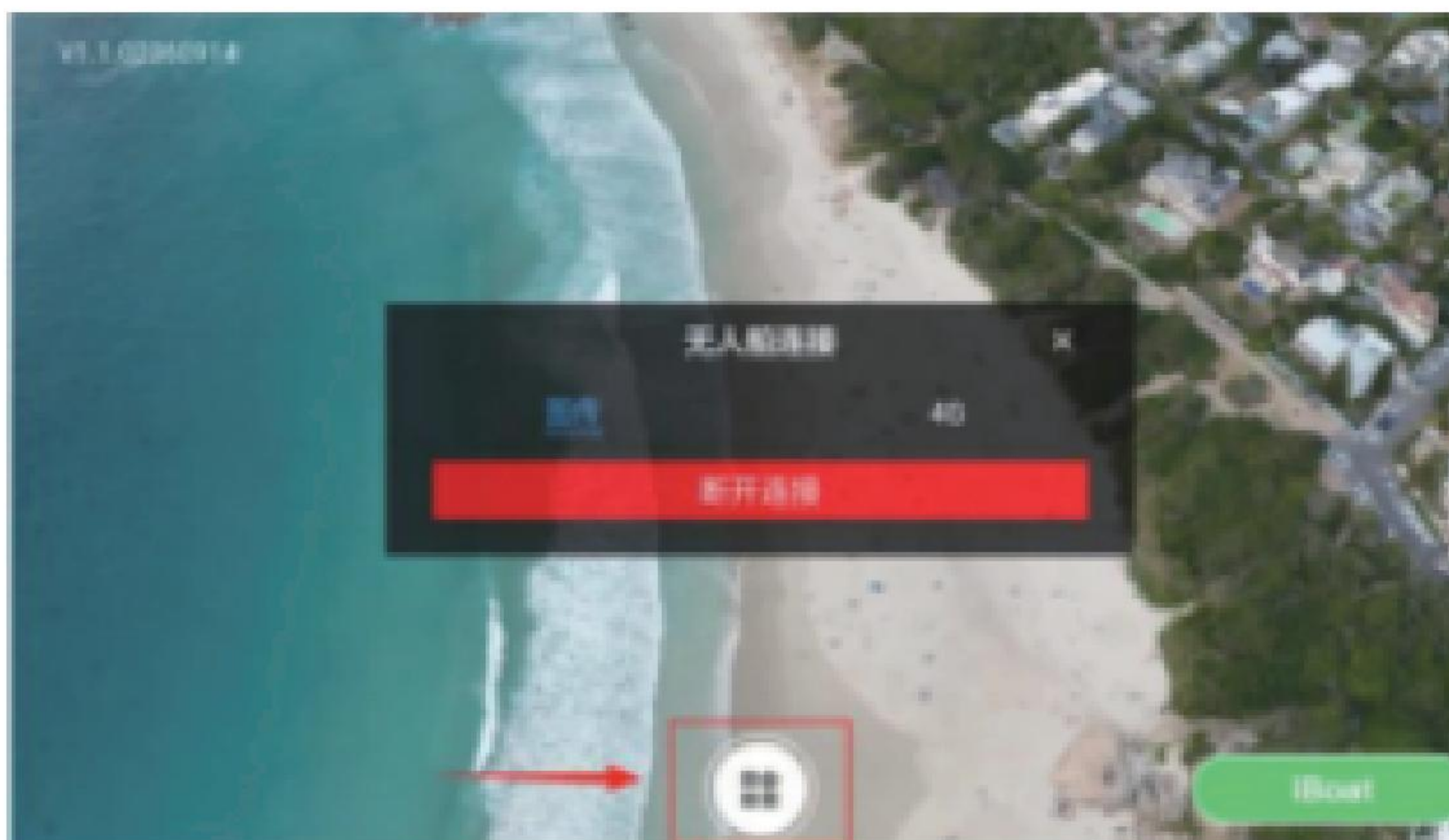
Figure 3.3-1 New Project

(3) Select the coordinate system, set the central meridian and other project parameters, then tap [Confirm] to create the project and enter the main app interface.
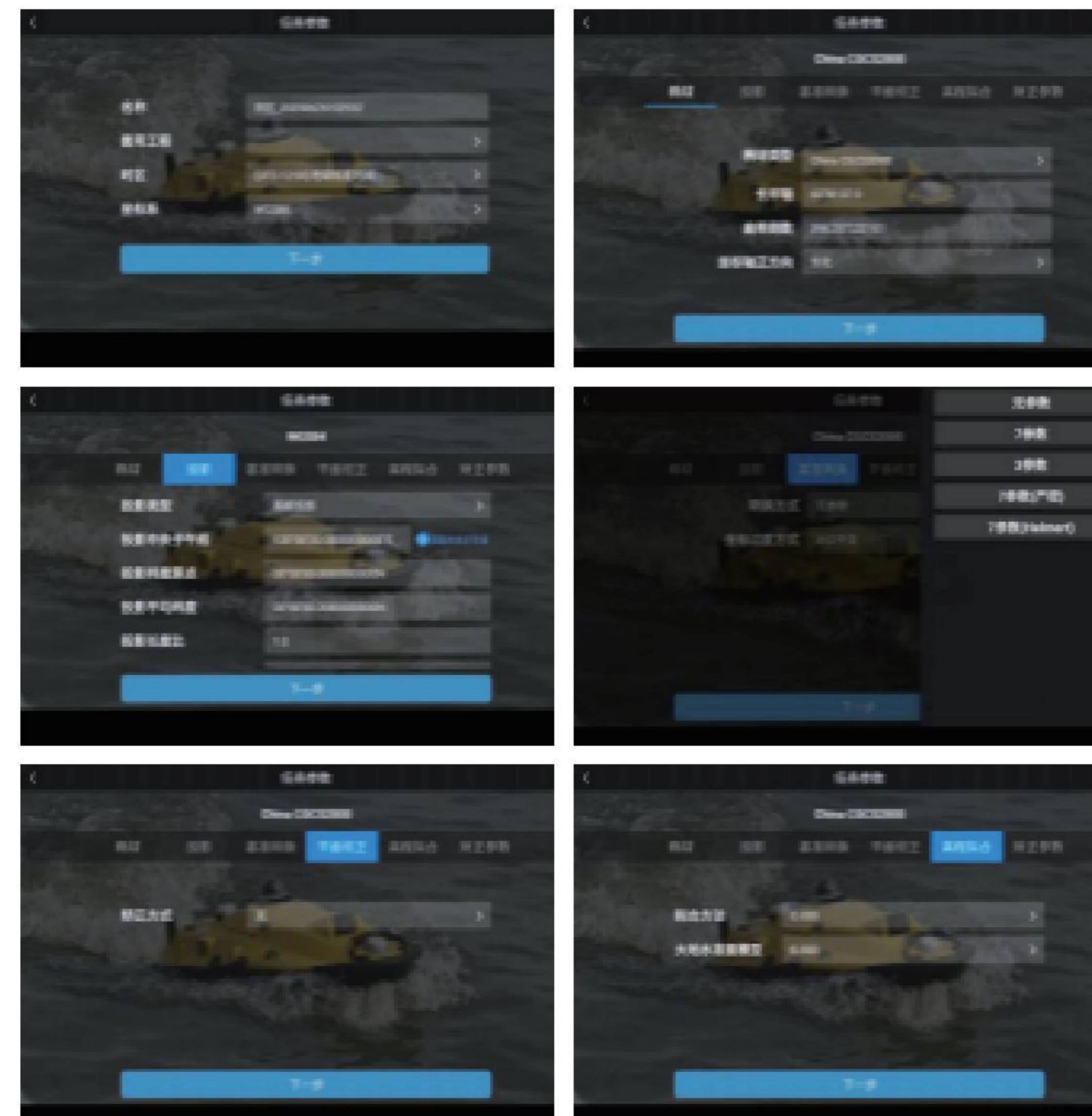

Figure 3.3-2 Project parameter settings

3.4 USV Self-Test

When the USV connects and the vessel-control interface opens for the first time, the system will prompt a power-on self-test. Tap [Confirm] to continue.

Figure 3.4-1 USV Self-Test

USV Control 4G Network Signal:

Displays the real-time quality of the USV's control network.

≥ 80%: full signal (3 bars)

≥ 60%: 2 bars

≥ 40%: 1 bar

Below this: 0 bars

GNSS Solution Mode: Position-fix status indicated by color: White (Single); Yellow (Float) and Green (Fixed).

Echosounder: Green (Successful Connection); Red (Failed).

Propulsion: Green (Successful Connection); Red (Failed).

Camera: Green (Successful Connection); Red (Failed).

Collision-avoidance module: Green (Successful Connection); Red (Failed).

Controller: Green (Successful Connection); Red (Failed).

USV Battery: Green (Successful Connection); Red (Failed).

USV battery status: 50% green, 10−50% yellow, ≤10% red.

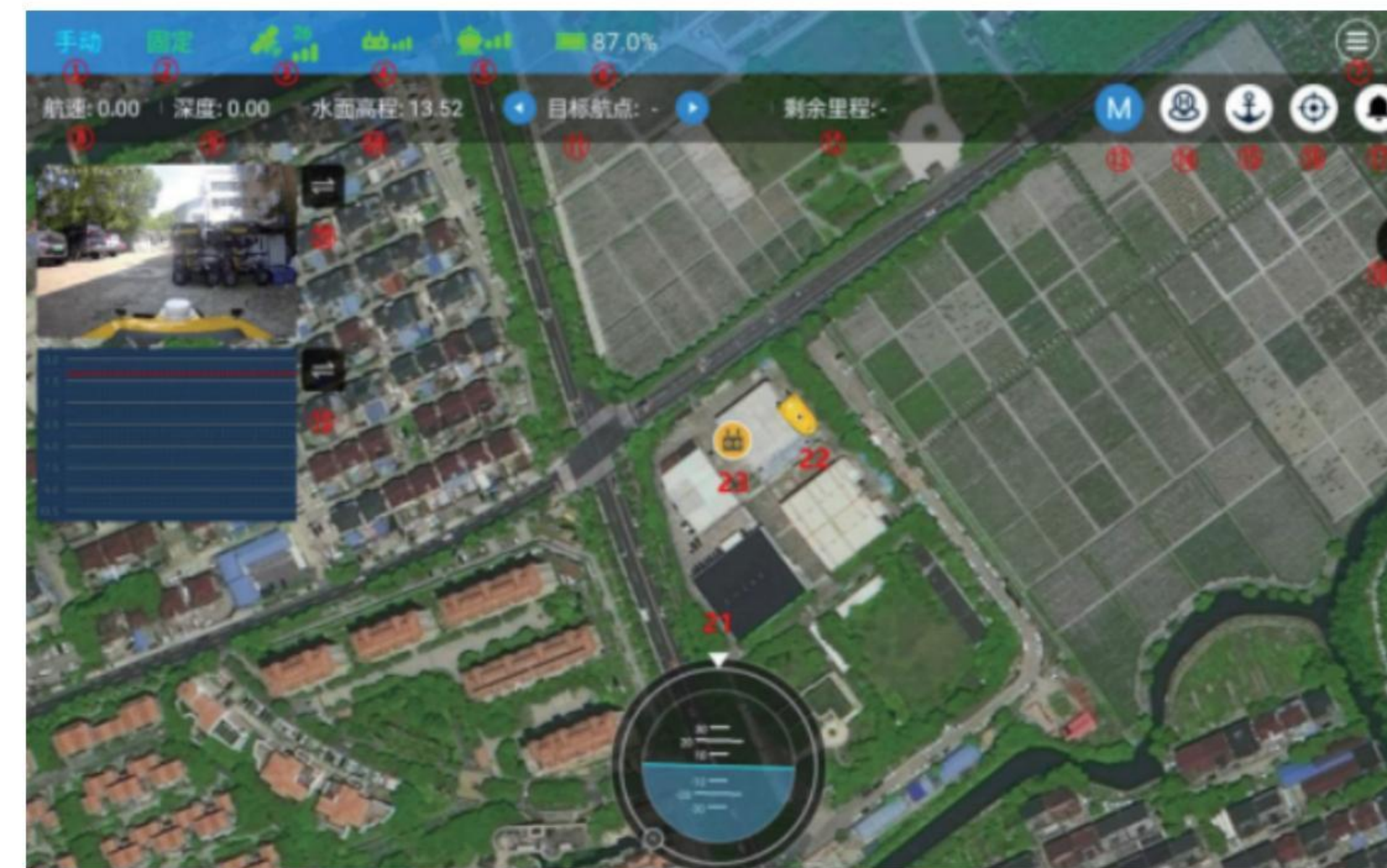## 3.5 USV-Control Interface Overview

Figure 3.5-1 USV-Control Interface

Navigation Mode — Shows the USV's current navigation mode.

Position Solution Status — Single / Float / Fixed.

① Satellite Status — Displays satellite acquisition status and number of satellites tracked.

② Remote Controller Status — Indicates controller connection and signal strength.

③ USV Network Status — Shows the vessel's network connection and signal quality.

④ Battery Status — Displays the USV's current battery level and percentage.

⑤ Device Settings — Opens the settings menu, including Route Planning, Control Parameters, DM Control, Recording, Differential Settings, USV Info, Layer Management, MPDM, Security, and Other Settings.

⑥ Speed — Shows the USV's current speed.

⑦ Depth — Displays the water depth at the USV's location.

⑧ Distance — Displays the current water-surface elevation.

⑨ Waypoint — Shows the active waypoint; use left/right arrows to select another waypoint.

⑩ Remain — Displays the remaining distance to complete the mission route.

⑪ Auto / Manual – Switches between autonomous and manual steering modes.

⑫ RTH / Cancel RTH – Enables or cancels Return-to-Home mode.

⑬ Hold / Cancel Hold – Activates or deactivates station-keeping (hover) mode.

⑭ Auto-Center – Turns vessel auto-centering on or off.

⑮ Real-Time Messages – Temporary pop-up alerts (e.g., Shallow water) display for 5 seconds and are logged in the bell-icon message list; tap the bell to open/close the log.

⑯ Sounding Quick-Keys – Opens the shortcut panel for echosounder controls.

⑰ Echosounder Waveform – Real-time depth-trace display.

⑱ Camera Feed – Live video from the onboard camera.

⑲ Hull Attitude – Real-time heading, roll, and pitch.

⑳ USV Icon – Displays the USV's live position on the satellite map.

㉑ Remote Controller Icon – Displays the remote controller's live position on the satellite map.

3.6 Route Planning

(1) Manual Route Planning

To set up a new route, open the function panel by tapping the three-line icon in the upper-right corner of the vessel-control screen, then select Route Planning.
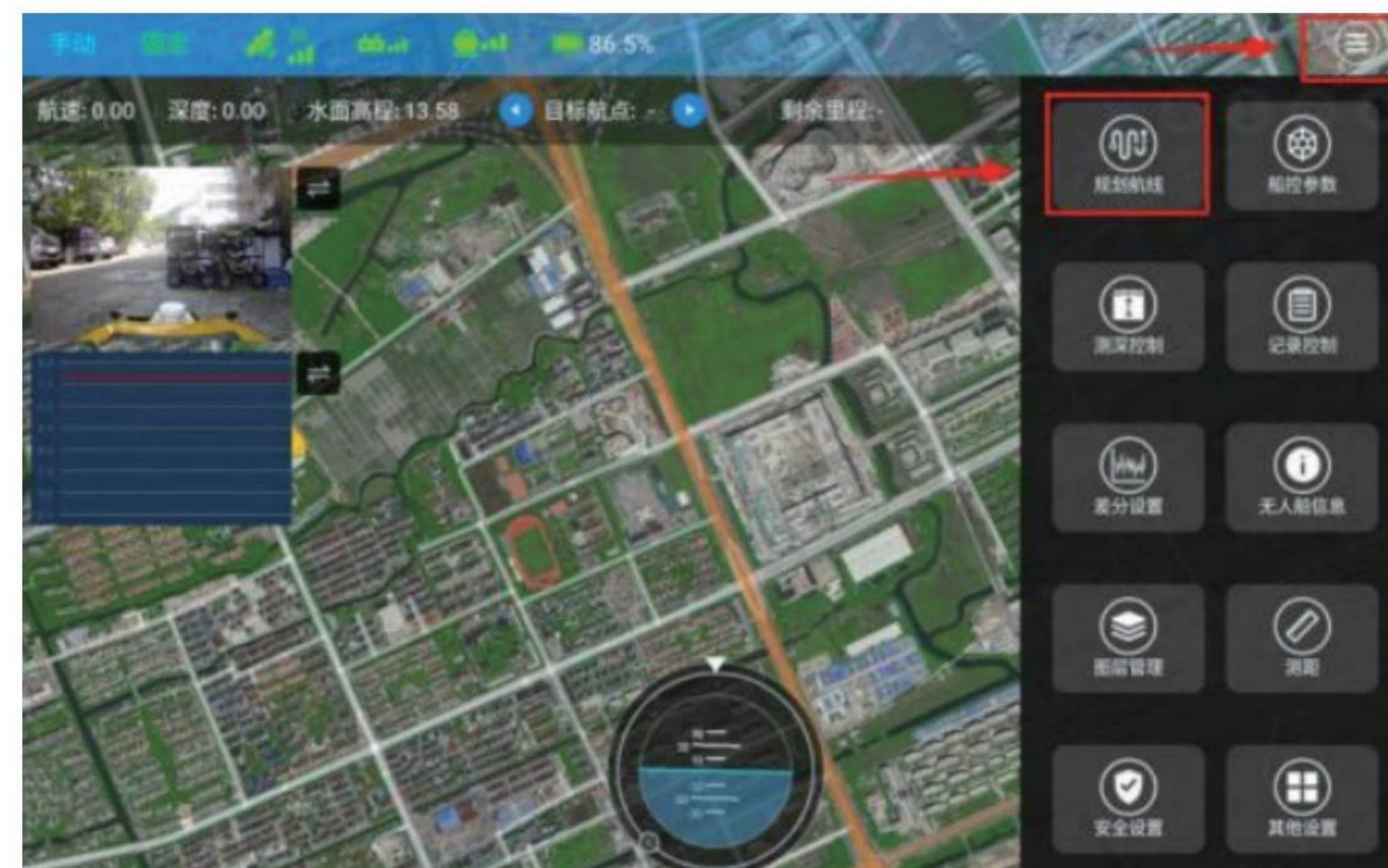

Figure 3.6-1 Route Planning

Tap the first function icon on the top-left. When the icon is highlighted, you can tap multiple points on the satellite map to create mission waypoints. Each tap adds a waypoint sequentially, defining the sailing path and direction.

The bidirectional-arrow button swaps the order of the planned waypoints (red label 1 in the figure).

Current waypoint operations include deleting a single waypoint (red label 3) or deleting all waypoints (red label 2).

Tap the icon indicated by the red arrow on the right to view the latitude and longitude of the selected waypoint.
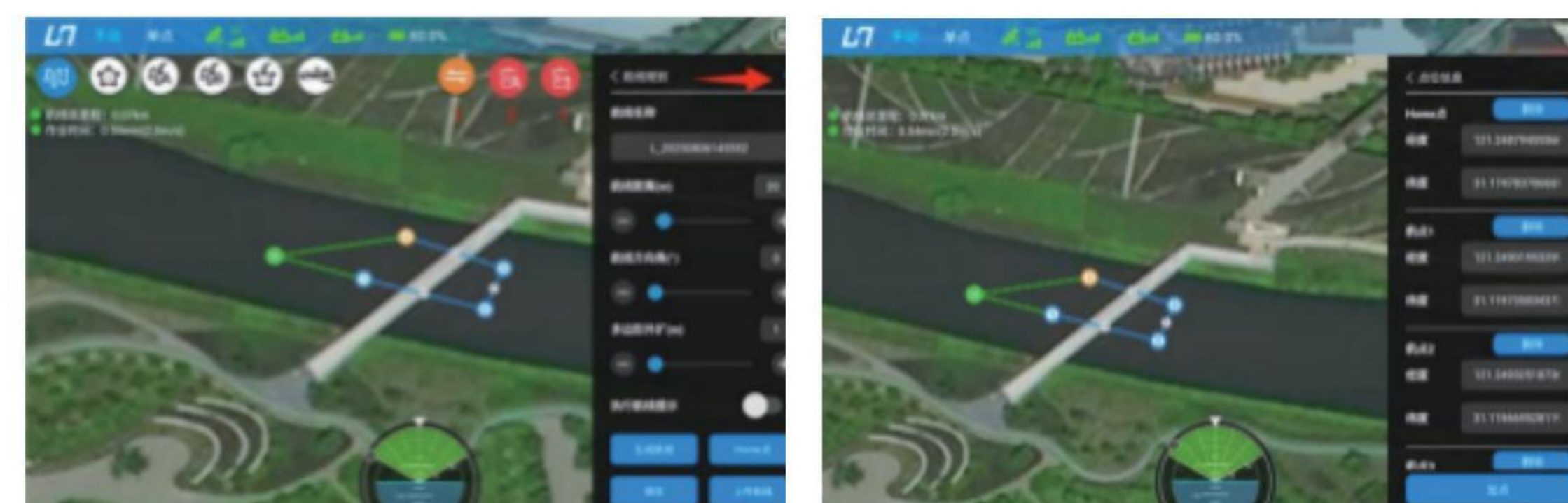

Figure 3.6-2 Manual route planning function operation

(2)Polygon Route Planning

Tap the second icon on the top-left to enter polygon-planning mode. Tap on the map to add polygon boundary points—three taps form a triangle, and additional taps extend the polygon.

After defining the area, tap Generate Route on the right to create the default survey lines, or adjust parameters such as line spacing, heading angle, and polygon offset before generating. With the polygon-edit tool enabled, you can drag points to adjust the shape or delete individual points.
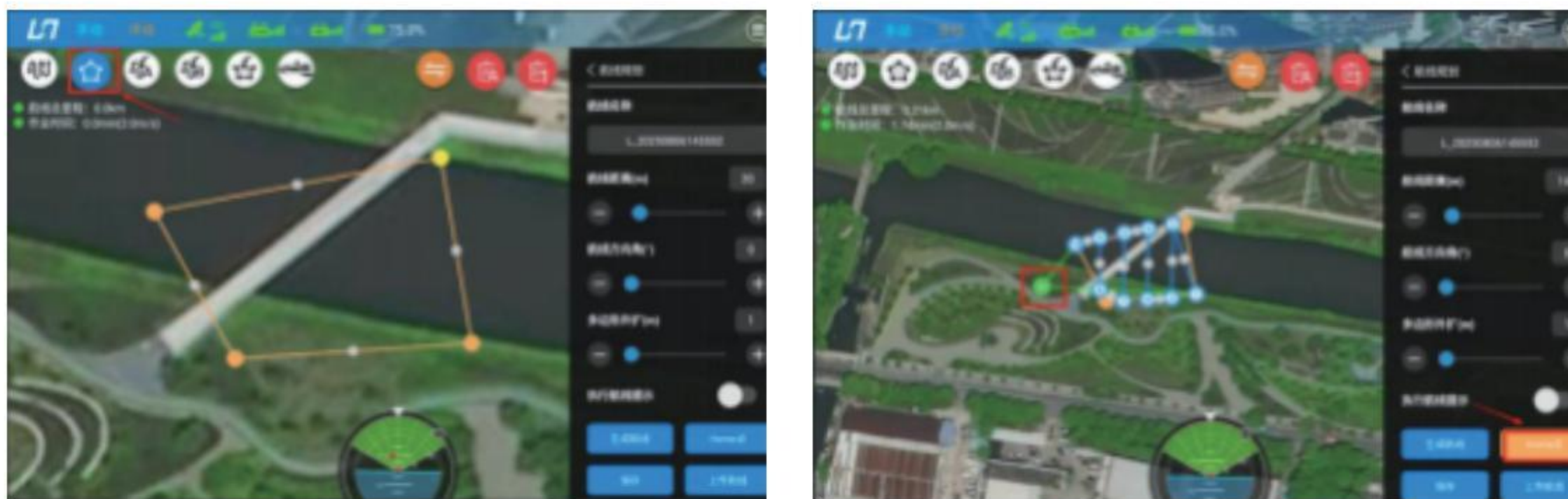

Figure 3.6-3 Manual route planning function operation

(3)Download route from USV to controller

Icon 5 in the route-planning toolbar downloads the route currently stored on the USV to the controller's local memory.

Figure 3.6-4 Download route from USV to controller

(4) Load route from local storage

Icon 6 in the route-planning toolbar loads a previously saved route file from the controller's local storage onto the map.

Figure 3.6-5 Load route from local storage

(5) Import boundary

Icon 7 in the route-planning toolbar imports boundary files (KML/DXF) from local storage.
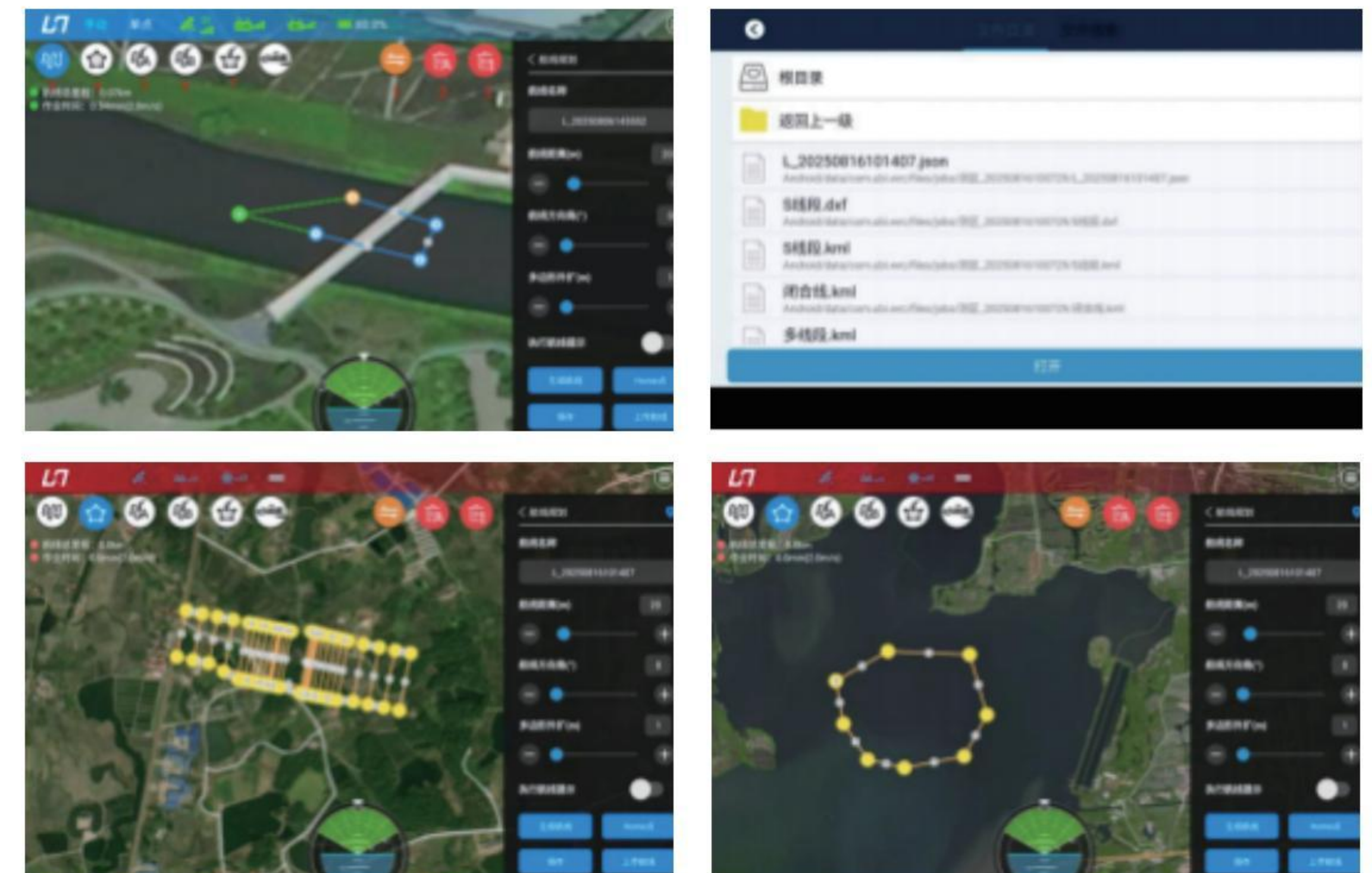

Figure 3.6-6 Import boundary

(6) Set Home Point

In Route Planning, tap the Home Point button to enter selection mode, then tap a location on the map to place it. Tap Home Point again to confirm and exit.
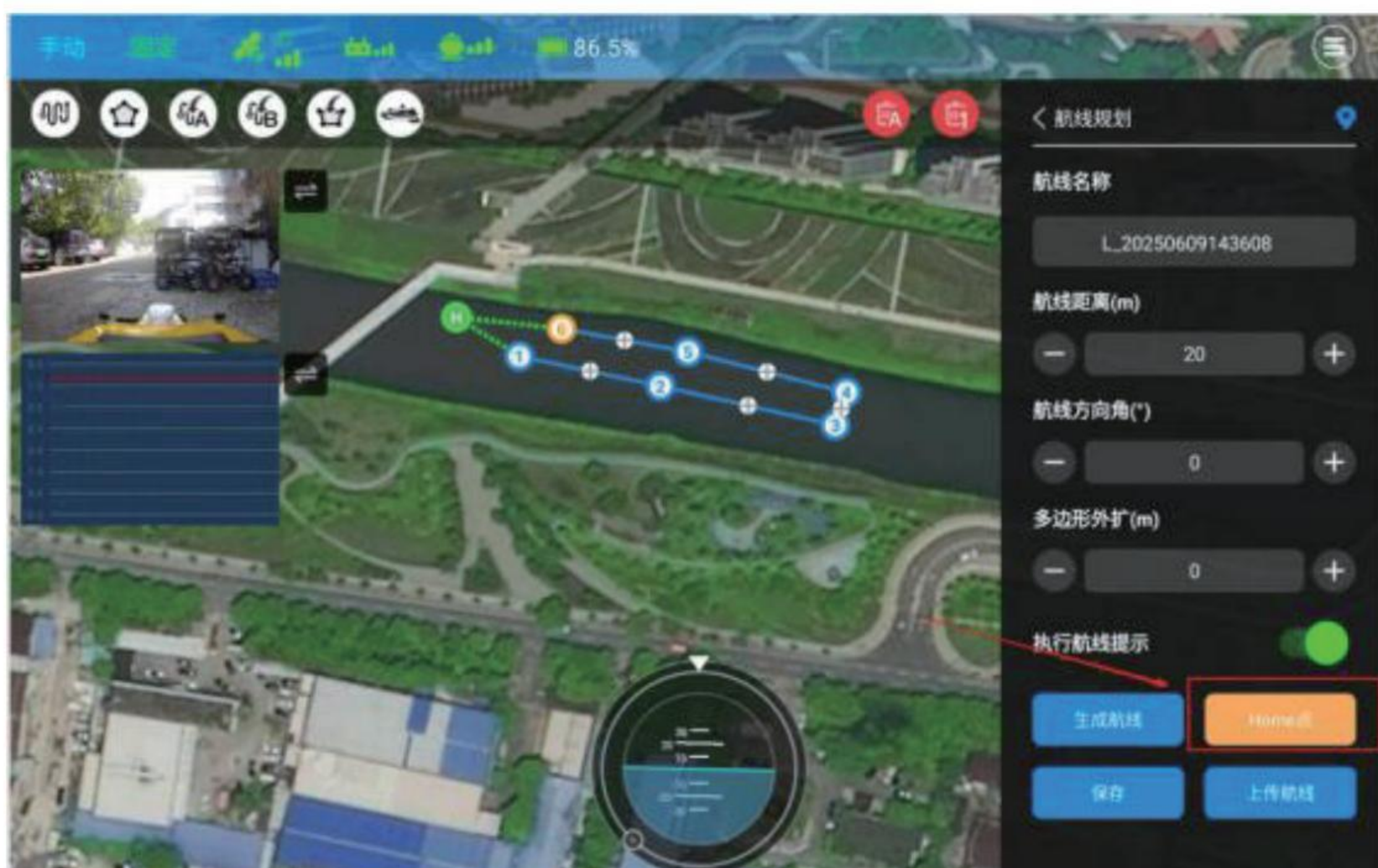
Figure 3.6-7 Setting Home Point

(Note: The Home point must be set before the route can be uploaded to the USV.)

(7) Waypoint Assignment

You can step the target waypoint forward/backward from the main vessel-control screen, or tap "Waypoint" to open the full list for direct selection or editing.

Figure 3.6-8 Setting Waypoint

3.7 Parameter Settings

Tap the three-bar icon in the upper-right corner of the main screen to access and configure all USV parameters.
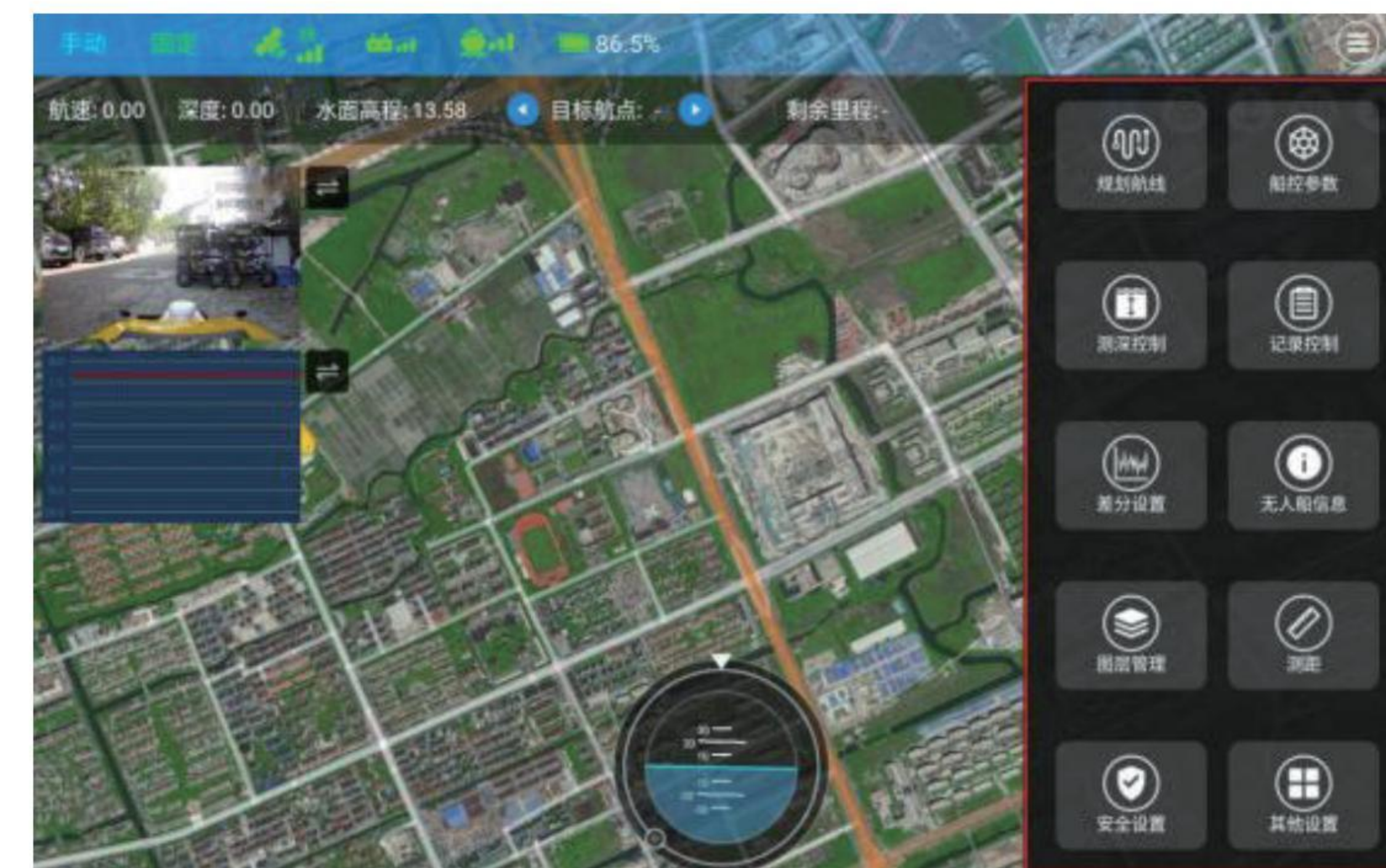

Figure 3.7-1 USV parameter settings

(1) Ship Control Parameters

Set the cruise speed by tapping "+" or "−" in 0.5 m/s steps, or type in a value. The change applies instantly.

Figure 3.7-2 Ship Control Parameter Settings

(2) Depth Sounding Control

Configure echosounder parameters: temperature, sound velocity, gain, and depth filter.

Draft: Fixed hull value (read-only).

Temperature: Enter manually; the app can calculate sound velocity from temperature.

Sound Velocity: Enter manually; can also be computed from temperature and salinity.

Auto Obtain Process: When enabled, depth logging starts automatically with the route.

Mileage: Display scale adjusts automatically to current depth.

Gain (Auto/Manual): Controls transmit power; choose auto tracking or set manually.

Depth Filter: Filters out signals outside the defined depth range to reduce noise.

Figure 3.7-3 Depth Sounding Control

(3) Record Control

Defines how depth points are written to the real-time depth file.

Logging rules:

Distance logging: logs one point every set distance (e.g., 1 m).

Time logging: logs one point at fixed intervals (e.g., every 1 s).

Solution status:

Fixed: record only RTK-fixed data.

Float: record fixed + float data.

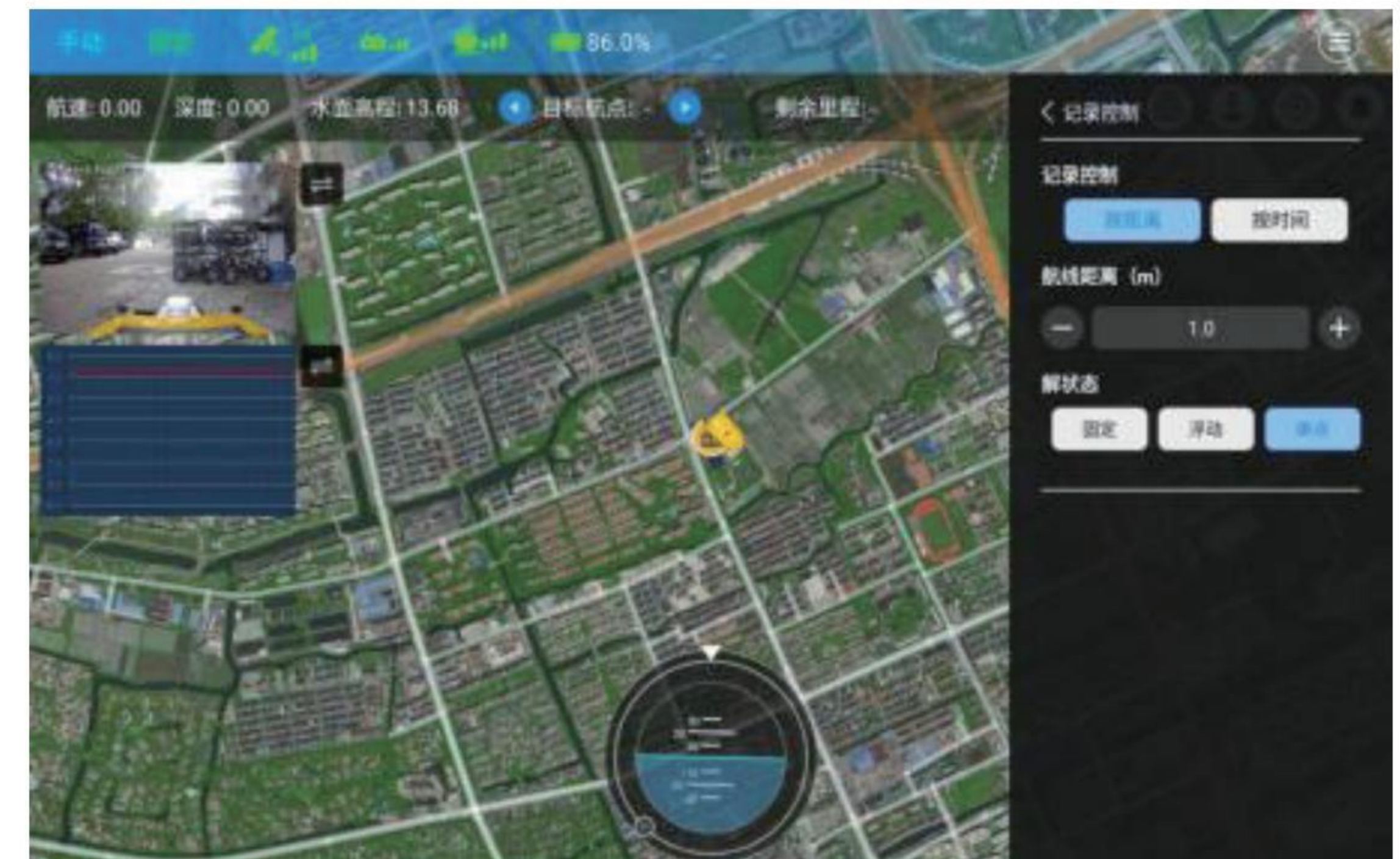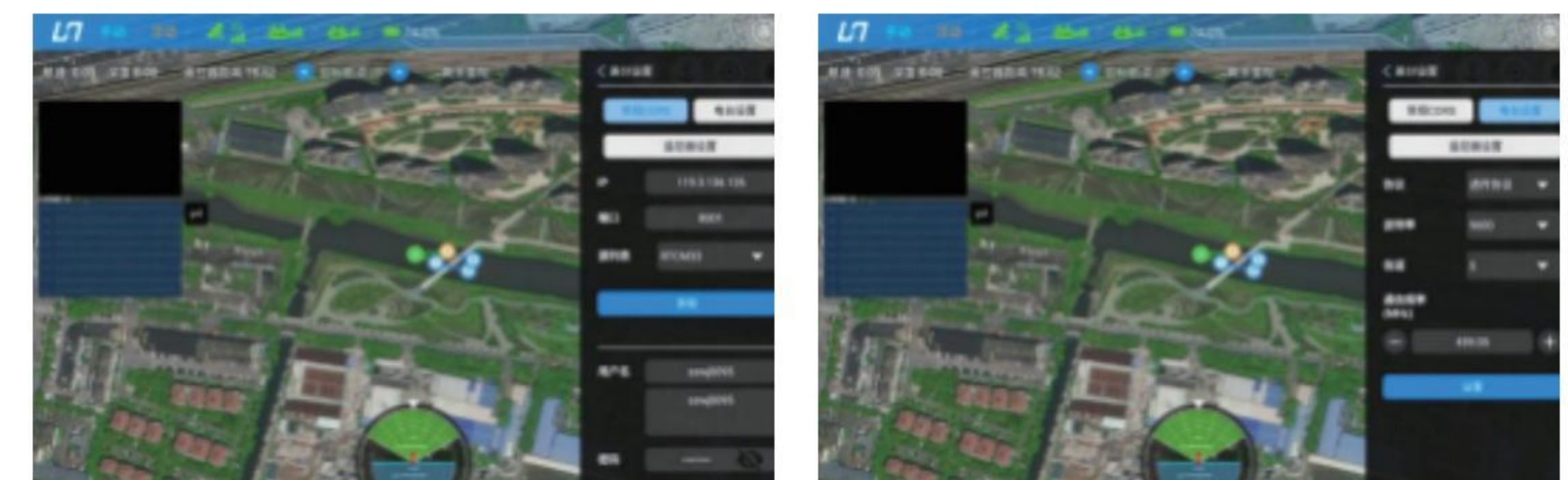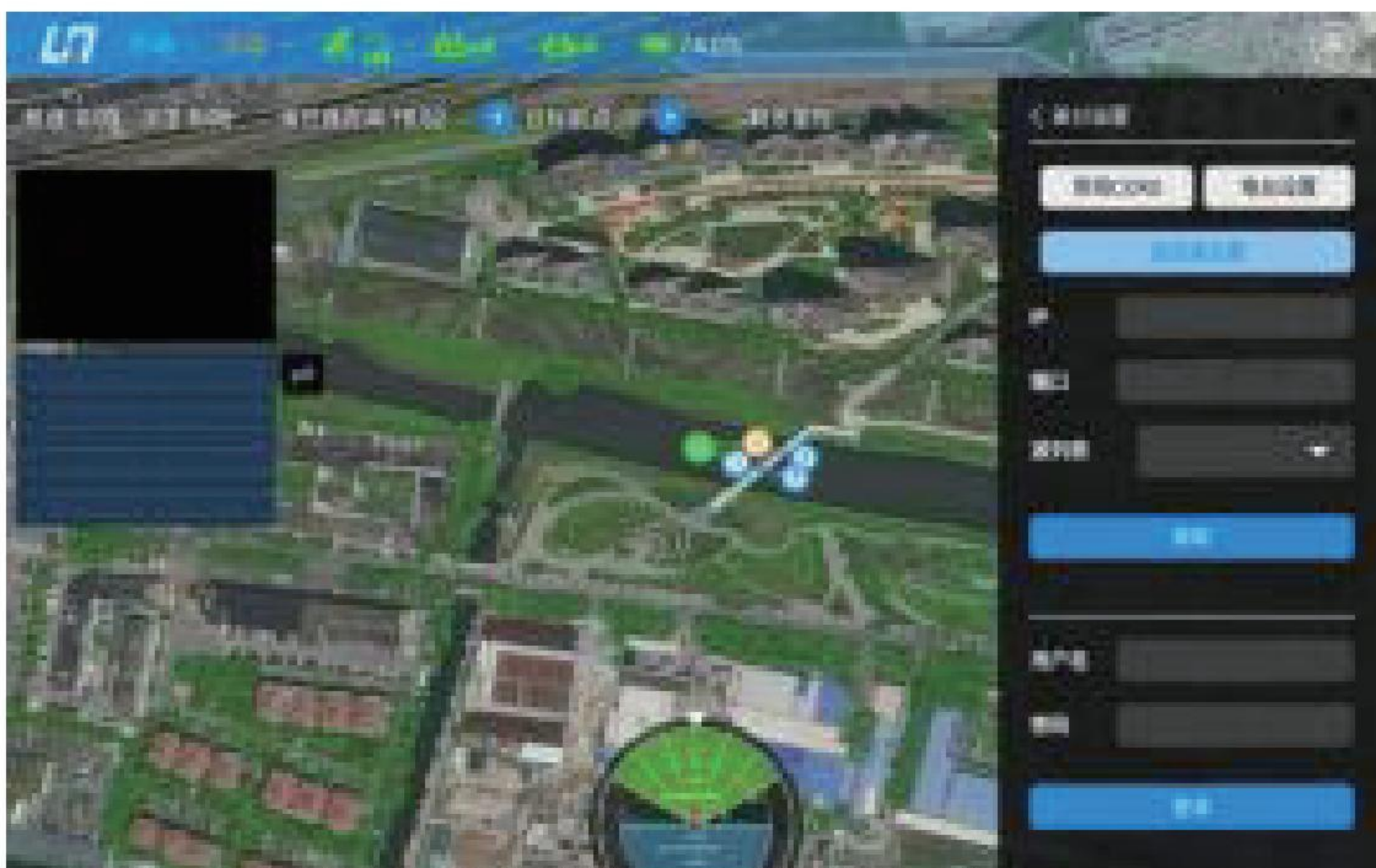Single: record all data types (fixed, float, INS, single).

Figure 3.7-4 Record Control Settings

(4) Differential Settings

Configure differential-correction sources, including the USV's CORS login, the controller's network CORS login, and radio-modem credentials.

Figure 3.7-5 Differential Settings

(5) USV Info

Displays key vessel diagnostics, including GNSS position, attitude, hull type, battery level, navigation state, sounding status, thruster status, and other real-time system data.

Figure 3.7-6 USV Parameters

(6) Layer Management

Includes the Measurement Point and Boundary Line layers. Tap a layer to toggle its visibility on the map.
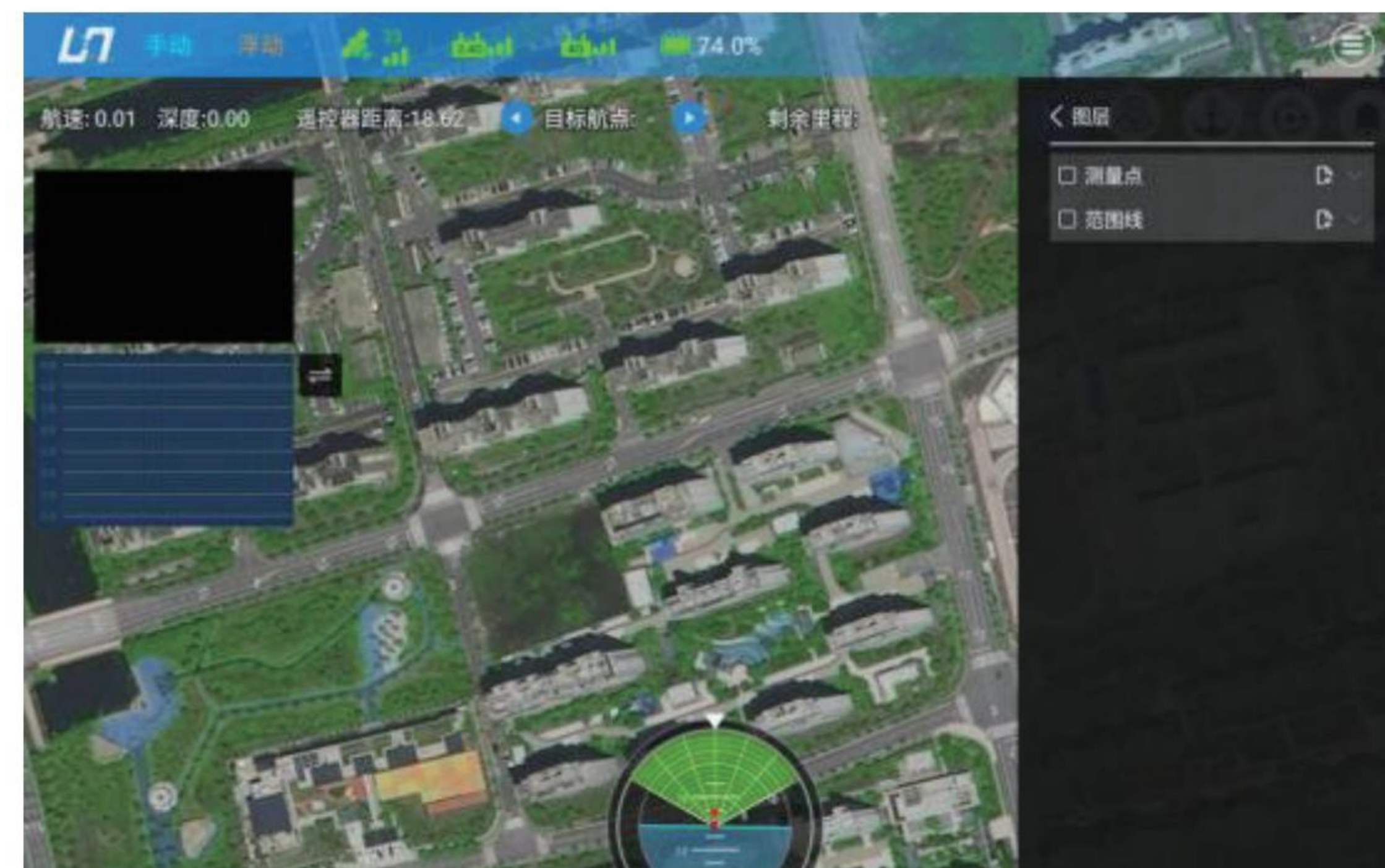

Figure 3.7-7 Layer Management

(7) MDPM

Tap any two points on the satellite map to display the distance and angle between them.

Figure 3.7-8 MPDM

(8)Security Setting

a. Auto Obstacle Avoidance – the USV autonomously detours or stops when an obstacle is detected.

b. Shallow-Water Retreat – the USV automatically reverses when depth becomes shallower than the preset limit.

c. Return on Disconnection – the USV returns to Home if the controller link is lost beyond the configured timeout.

d. Low-Battery Return – the USV returns to Home when battery level drops below the set threshold.

Figure 3.7-9 Security Settings

(9)Other Settings

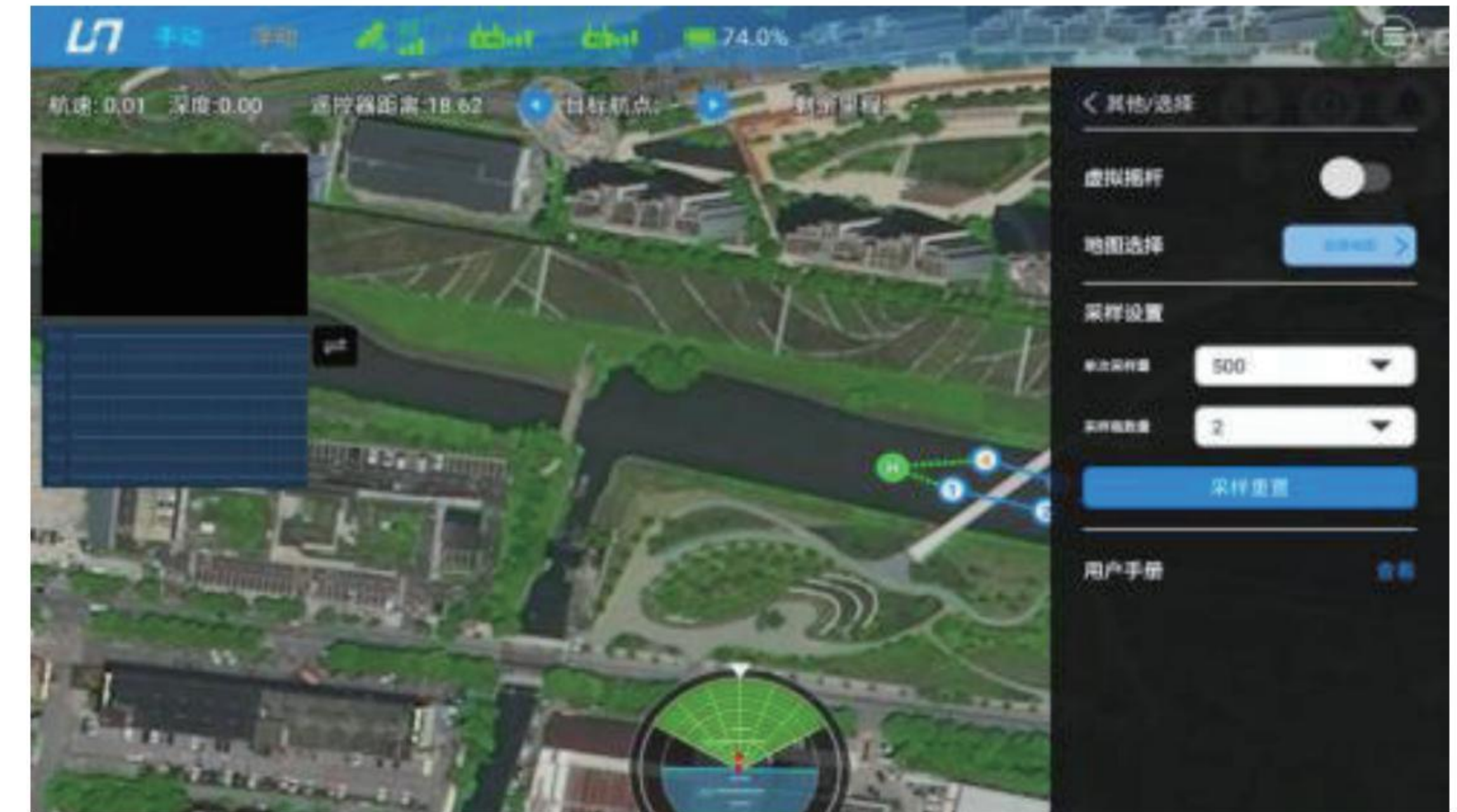Virtual joystick, Map Selection, and other auxiliary functions.

Figure 3.7-10 Other Settings

3.8 Depth Sounding Control

Tap the echosounder slide-out panel on the right.

Transmit Sonar – starts the echosounder.

Start Depth Logging – begins recording depth points.

Pause Logging – temporarily stops recording.
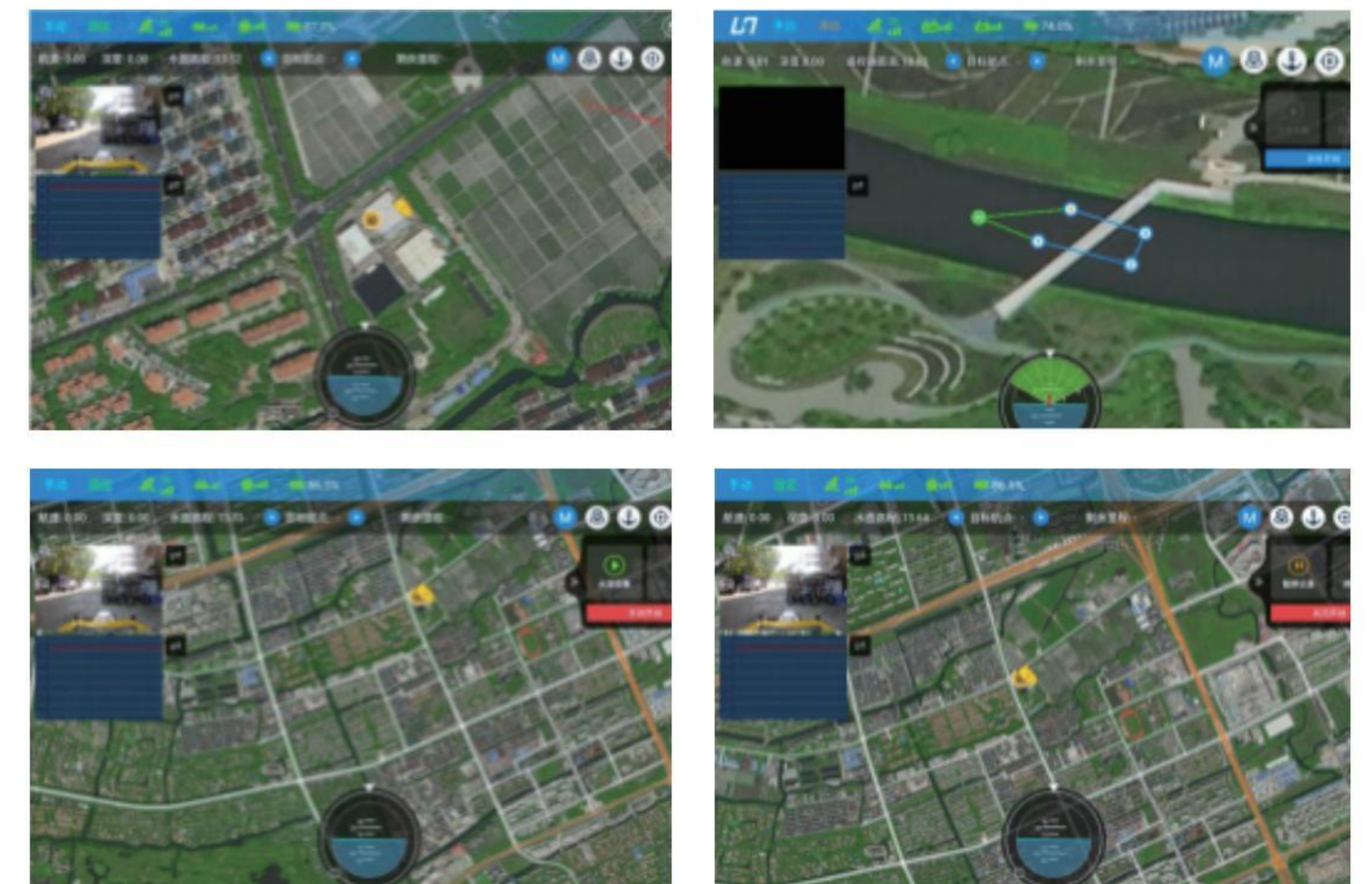
Stop Logging – ends logging and saves the depth file.

Figure 3.8-1 Depth Sounding Control

3.9 Camera Control

Tap the camera view in the upper-left corner to enter the camera interface; split-screen display is available.
Bottom-right index 1: Video recording
Index 2: Photo capture
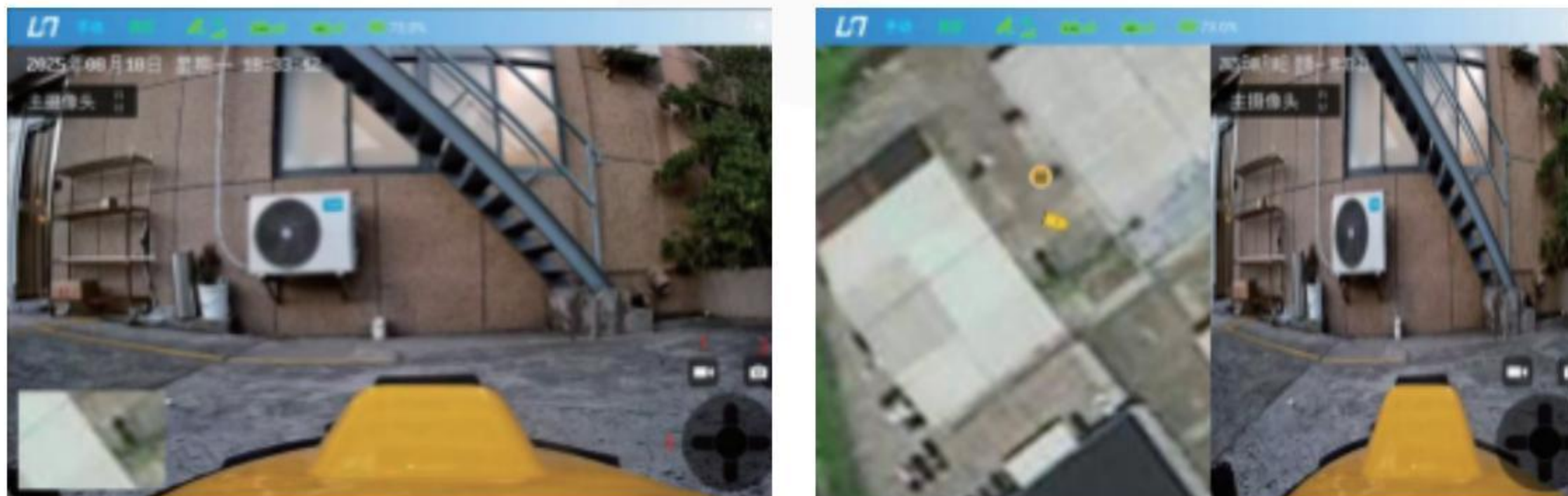Index 3: Adjust gimbal pan/tilt angle

Figure 3.9-1 Camera Control

3.10 Data Post-Processing

In Project Manager select the corresponding project and tap [Data Processing] to enter the interface.

Figure 3.10-1 Data Processing

(1) View Description
① Right-side Depth View:
Green dots: water-surface elevation
Yellow dots: recorded depth points
Red dots: echo returns
Selecting any depth point highlights its corresponding position on the survey line in the left-hand map.

Figure 3.10-2 Left-side map view

② Left-side map view
Pan, zoom and scroll with drag and pinch gestures.
Survey points are colour-coded by depth: shallow-to-deep runs red−orange−yellow−green−cyan−blue−purple.

(2) Function buttons
1 Line List − lists every recorded line in the project.
2 Undo − reverses last edit (point move / delete / feature-line add-delete).
3 Redo − restores last undone edit.
4 Delete − activate, then pick any depth points to remove; deleted points turn grey and cannot be re-selected.
5 Insert Point − manually interpolate: click inside the depth view to add a new record at the chosen time/depth; new point displays in yellow.
6 Prev Line − load previous line for editing.
7 Next Line − load next line for editing.
8 Tide Correction − import tide file (*.tid); the tid time span must cover the survey period. After import, water-surface elevations are replaced by the tid values.

9 Sounding Setup – edit transducer draft and sound-velocity values.

10 Project Parameters – open project-settings dialog.

11 Attitude Correction – apply roll and pitch corrections to the data.

12 Sampling Setup – limit the data set and choose sampling method (feature or interval).

13 Distance Sampling – at every X m interval, export the depth point intersected by the interval line.

14 Deepest (equal interval) – at every X m interval, export the deepest point within the interval.

15 Shallowest (equal interval) – at every X m interval, export the shallowest point within the interval.

16 Mean (equal interval) – at every X m interval, export the mean of all depth values within the interval.

17 Data Export – write processed data to file.

18 Merge Files – combine selected lines into a single output file.

19 Save Header – display and store header information string.

20 File Type – choose export format: txt, dat or csv.

21 File Format – select which header fields to include in the exported file.

22 UI Settings (gear icon, upper-right):

23 Depth Interval – set vertical depth-axis step.

24 Time Interval – set horizontal time-axis step.

25 Time Width – keep time interval fixed while stretching the visible time span to prevent points from overlapping and becoming un-selectable.

(3) Gesture Shortcuts

① Drag a point up or down in the depth view to adjust its depth; horizontal movement is fixed.

② Swipe diagonally from upper-left to lower-right in the depth view to multi-select points (similar to lasso selection on a PC).
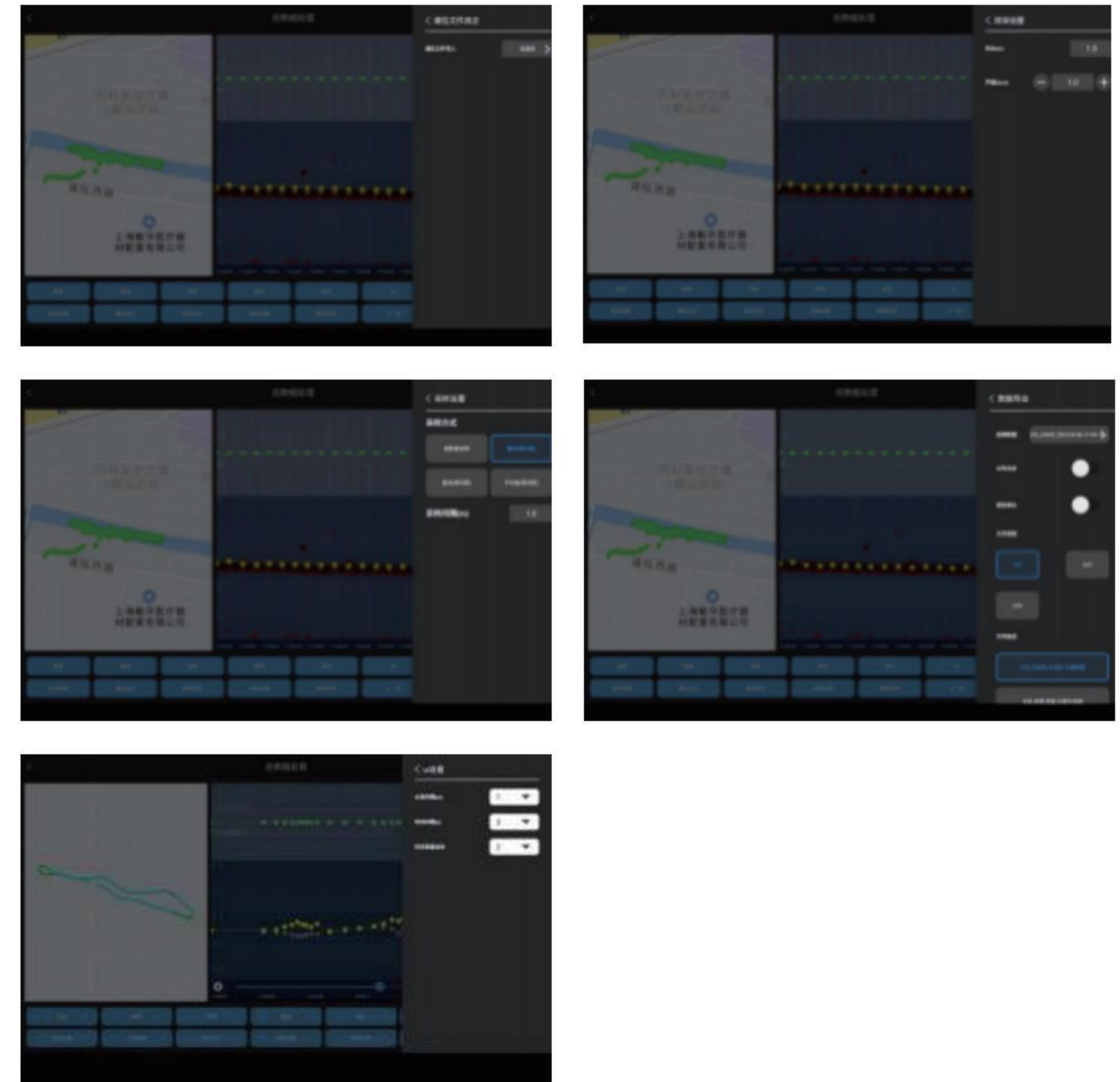

Figure 3.10-3 Data Processing

4. Quick-Start Guide

(1) Power Up

USV: Hold the stern power button for 3 seconds until the LED flashes rapidly; release and wait ~10 seconds for the solid light (system ready).

Controller: Turn on the G20, launch iSail, and connect via video-link. A solid red LED on the port side of the hull confirms a successful link.

(2) Create a Survey Project

Tap the bottom toolbar → Project → New Project; enter the project name and coordinate system.

In the project list, open Project Parameters → Projection; set the central meridian and any available 7-parameter transformation values.

(3) Plan and Execute a Line

Open the top-right menu → Sounding Control → enable Auto Log.

Go to Route Planning; draw and confirm the survey line, tap Upload Route, then swipe Execute to start.

The USV will follow the line and depth data will log automatically.

5. Specification

ITEM		SPECIFICATION
HULL	Hull Dimensions	980*520*254mm
	Material	Polyester carbon fiber Composite, Kevlar fabric
	Draft	8.5 cm
	Self-weight	Hull: 7kg, Total weight: 30kg (including base peripherals, boat controller, and battery)
	Maximum Payload	35kg
	Wave Resistance Rating	Wind force 3, wave height 2
	IP Rating	IP67
	GNSS	Built-in GNSS positioning and orientation dual antenna
	Indicator Lights	Dual-color indicator lights display remote control signal status and GNSS positioning status
	Video	360° omnidirectional night vision camera
	Obstacle Avoidance Range	Pitching*Azimuth: 120°*120°, Range: 0.10~20m (Optional upgrade to 40m range)
POWER	Power Type	Electric
	Motor Type	Brushless motor
	Steering Type	Differential steering without servo, supports reverse
	Motor Power	Rated Power 900W
	Motor Speed	Rated 5300 RPM
	Motor Mounting Method	Plug-and-play design for easy replacement
	Battery Specifications	33.6V 25Ah*2 rechargeable ternary lithium battery, 21700 cells

ITEM		SPECIFICATION
POWER	Battery Replacement	Supports hot-swap replacement without powering down
	Operating Time	3 hours per battery set (2m/s) 7 hours (1.5m/s)
	Range	Range at economical speed: 38km
	Maximum Speed	7 m/s, supports safe passage through 4 m/s current cross-sections
DEPTH MEASUREMENT	Frequency	200 kHz
	Beam Angle	8°
	Depth Range	0.15-200m (Extended range available as an option)
	Resolution	8 mm
	Stability Rate	±2 cm (CEP 0.95 @ 10 m)
	Depth Measurement Accuracy	±1 cm + 0.1% D (Where D is the water depth value)
	Supply Voltage	9V-28V
	Sound Velocity Adjustment Range	0 m/s to 1700 m/s
	Power Consumption	5-10W
CONTROL	Operating System	Linux
	Base Station Communication	Radio (optional) & Network & CORS 0.15-200m (Extended range available as an option)
	Data Communication	4G & 2.4G & Radio (Optional)
	Video Communication	4G & 2.4G
	SIM Card Slot	Nano Card Slot
	Interface	2x RJ45 Ethernet ports, 2x RS232 serial ports, 2x RS485 serial ports
POSITIONING	Satellite System	BDS (BDS-2: B1I, B2I, B3I; BDS-3: B1I, B31), GPS (L1C/A, L2P, L2C) GLONASS (G1, G2), Galileo (E1, E5b), QZSS* (L1C/A, L2C), SBAS* (L1C/A), and other full-system multi-frequency signal tracking
	Cold Start	<30s
	Initialization Time	<5s (D<10km)
	Single-point Positioning Accuracy	Horizontal ≤3m, Vertical ≤1.5m
	Depth Measurement Accuracy	Horizontal: 40cm + 1ppm, Vertical: 80cm + 1ppm
	RTK Positioning Accuracy	Horizontal: ±8mm + 1ppm, Vertical: ±15mm + 1ppm
	CORS Differential Source	Supports network CORS
	Radio Differential	Supports TT450 protocol/ Transparent Transmission Protocol, etc.
	Directional Accuracy	Accuracy: 0.1° (1m baseline)
	Inertial Navigation Accuracy	6°/h, 1m accuracy at 20-second decay rate, supports continuous autonomous navigation and surveying under bridges
	IMU Update Rate	200Hz