ALPHA ARK USER MANUAL

Contents

Chapter 1 Preface

1.1 Introduction

This manual takes ALPHA ARK for example, to explain how to install, set up and use the USV system, as well as the use of the accessories. We recommend that you read and follow all installation, operation, and maintenance information carefully before using the product.

1.2 Disclaimer

Before using this product, any user should read this statement carefully. Once you use this product, it will be deemed that you have recognized and accepted all the contents of this statement.

This product is not suitable for minors.

When using this product, please stay away from people, fragile and dangerous items. When using this product, our company will not be liable for compensation for personal injury, property loss, etc. (including direct or indirect damage) caused by the following reasons:

(1) The driver causes damage under the condition of drinking, taking drugs, drug anesthesia, dizziness, fatigue, nausea, etc. and other physical or mental conditions.

(2) The driver's subjective intention to cause personal injury, property loss, etc. Compensation for any mental damage caused by the accident.

(3) Failed to assemble or operate this product according to the correct guidance of this manual.

(4) Other damages caused by self-modification or replacement of accessories or parts not produced by our company, resulting in poor operation of the entire unmanned boat.

(5) Damage caused by using products not produced by our company or imitating our products.

(6) Damage caused by driver's operating errors or subjective judgment errors.

(7) The unmanned boat itself is not operating properly due to natural wear and tear, corrosion, aging of the lines, etc.

(8) The unmanned boat issues an abnormal warning but still does not return, resulting in damage to the boat.

(9) Damage caused by forcibly driving the unmanned boat despite knowing that it is in an abnormal state (such as water or other unknown substances, not properly assembled, obvious failure of major components, obvious defects or missing accessories).

(10) Damage caused by driving the unmanned boat in a magnetic field interference area, radio

interference area, prohibited area stipulated by the government, or when the driver's vision is backlit, blocked by obstacles, blurred vision, poor eyesight, etc., and other conditions that are not suitable for operation.

(11) Driving in bad weather, such as rain, wind, snow, hail, etc.

(12) The unmanned boat encounters collision, capsizing, fire, explosion, lightning strike, storm, tornado, heavy rain, flood, tsunami, ground subsidence, ice subsidence, cliff collapse, avalanche, hail, mudslide, landslide, earthquake, etc.

(13) Any data, audio or video materials obtained by the driver using the unmanned boat, and damages caused by infringement.

(14) Regarding batteries, such as damage caused by improper matching and use of protection circuits, battery packs, and chargers.

(15) Accident losses caused by failure to keep away from electromagnetic interference during use of the unmanned boat, friction and collision with other objects during use, aging or damage of parts but not timely replacement and repair, etc.

(16) Other losses that are not within the scope of our company's responsibility.

(17) Losses caused by illegal (unqualified) driving.

1.3 Cautions

- It is forbidden to use this product to engage in illegal activities.
- It is forbidden to use this product before carefully reading the entire content of this document.
- Non-professionals are forbidden to use this product.

1.4 Copyrights

1.5 Services

This manual is subject to update without prior notice.

You can check the latest version of the user manual on our official website.

Chapter 2. Composition of ALPHA ARK

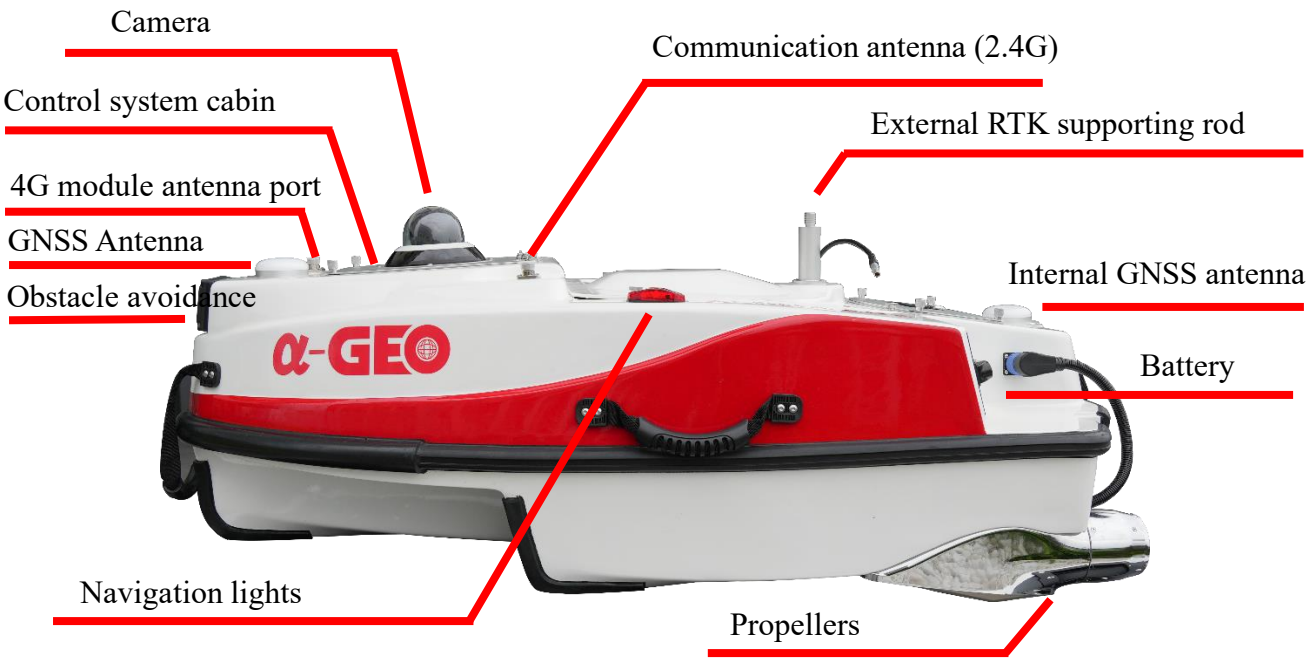
2.1 Composition of USV

ALPHA ARK is modular design, with a sturdy hull and stable performance. It combines network bridge, LTE 4G, and radio communications, high accurate automatic navigation algorithm and manual remote-control technology. ALPHAGEO USV solution will bring you an efficient and safe project experience.

It is a portable professional USV with a unique moon pool design: a separate hole is designed in the middle of the hull for easy replacement of equipment. Customers can freely replace other types of equipment. ALPHA ARK can be loaded with Echo Sounder, ADCP, portable SBP and some other survey equipment.

The ALPHA ARK unmanned boat measurement system is mainly composed of the boat hull, power supply system, control system, navigation system, communication system, power system, camera and onboard echo sounder.

2.2 Hardware components



NO.	Components	Descriptions
(1)	Control system cabin	Installing the boat control system
(2)	Communication antenna (2.4G)	Communicate with remote controller
(3)	Camera	Monitor the surrounding environment in real time
(4)	RTK supporting rod	Mounting the RTK receiver
(5)	Obstacle avoidance	Sense obstacles in the environment and avoid them to ensure safe operation of the equipment
(6)	Battery	Power supply for USV and the other components
(7)	Moon pool	Install echo-sounder, or the other devices
(8)	Navigation lights	Ensure that the position of the USV can be identified in dim light environments
(9)	Propellers	Providing power to USV
(10)	4G module antenna port	Mount the antenna for the internal GSM module
(11)	Internal GNSS antenna	Internal GNSS positioning

Chapter 3 Cautions & Pre-Settings

Before starting the measurement, you have to take attention to the precautions and regulations.

3.1 Environment requirement

(1) You should choose a relatively clean area without large floating objects to avoid the propeller being entangled with garbage and causing the unmanned boat to stop sailing.

(2) Without application, it is prohibited to sail on the route or in the waters where navigation is prohibited by relevant departments.

3.2 Parts installation

1) Check each accessory according to the accessory list, and start the installation according to the installation steps if no problem found out in the first check. Before the installation, ensure that the USV battery and remote controller are fully charged.
2) Install the battery of unmanned boat, connect the cables to power supply interfaces on the battery, the two sides are power supply interfaces for the propeller, and the upper one is for control system.
3) Mount RTK receiver onto the support rod, and connect the cable to RTK 5-pin LEMO port.
4) Mount the communication to the corresponding interface.
5) Check each interface again. If there is any looseness, please reinstall and tighten it.

3.3 Inspections and precautions of pre-sail

1) Find a suitable place to launch the boat.
2) Ensure that the battery of the boat and the controller battery are sufficient for navigation.
3) Check whether the hull of the unmanned boat is damaged. If damaged, stop using it and contact the manufacturer in time.
4) Check whether the antenna of the unmanned boat is installed correctly.
5) Start the boat.

   Try to keep the hull level when starting.

   Turn on the controller power at first.

   Then turn on the boat power, and wait for the boat to initialize (Along with beeps).

   Then connect to the control software and check whether all parameters are displayed normally.

6) Gently push the controller joystick to check whether the propeller of the boat is rotating. Put your hand 10cm away from the stern, when the two propellers are rotating, you can clearly feel the wind blowing backwards. Push the control lever to the left, the left propeller should rotate in the opposite direction, and feel it with your hand, there is no wind blowing backwards, at the same time, the right propeller should rotate faster, and feel the wind force increasing with your hand. Similarly, push the control lever to the right to check.

7) Observe whether there are floating objects that are easy to entangle in the water area, and be careful to avoid them.

3.4 Basic sailing

a) First, turn on the controller switch, and put the thruster control stick in the middle position, and keep the unlock switch in the upper position.

b) Put the stern of the unmanned boat into the water first, then slowly put the entire unmanned boat into the water, turn on the power of the unmanned boat, and wait for the unmanned boat to initialize.

c) When the screen shows that the initialization is complete, you can control the unmanned boat to sail through the controller.

d) After finishing surveying job, slowly return the unmanned boat to the shore (to avoid collision), turn off the power of the unmanned boat, then turn off the controller, and recycle the unmanned boat for storage.

3.5 Pre-use settings

Connect the remote controller to a WiFi hotspot, which is shared by a mobile phone.

Chapter 4 Remote controller

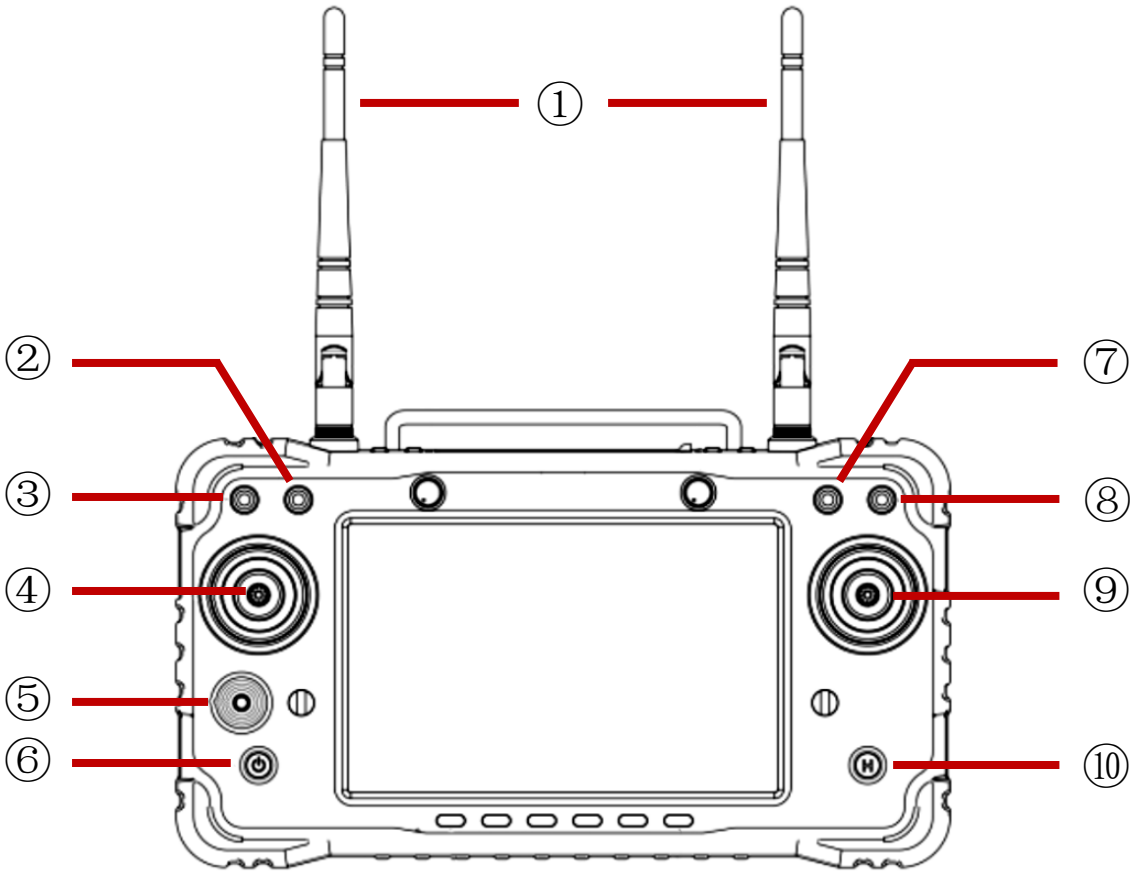
4.1 About controller

(1) The H16 controller uses a radio communication device operating in the 2.4GHz frequency band, and the controller and receiver must be paired for use. The factory default control mode of controller is that left hand control throttle. The controller complies with CE standards.

(2) The maximum communication distance of the controller is about 2000 meters.

(3) There must be no obstacles between the controller antenna and the receiver antenna, otherwise the distance will be greatly shortened.

4.2 Buttons



NO.	Components	Descriptions
①	2.4G 3DB Antenna	Communicate with USV
②	SW2	Auto/Manual switch
③	SW1	Lock or unlock the controller to control USV
④	Left lever x1, y1	Engine control
⑤	Gimbal rocker x3, y3	Reserve lever for UAV
⑥	Power button	Power on/off controller
⑦	SW3	Navigation light switch
⑧	SW4	
⑨	Right lever x2, y2	Direction control
⑩	Reserve button	

Long press on the power button to power on the controller.

Left lever x1, y1 is the engine control lever, push the lever upward to control the unmanned boat to move forward; push the lever downward to control the unmanned boat to move backward.

SW1, it is the lock/unlock switch, if the lever is in the middle or the lowest position, it is in a locked state., and the unmanned boat is locked, the propellers will stop immediately and cannot sail. When the SW1 lever is in the highest position, it is in an unlocked state, controller or ground station can control the boat to travel. In case of an emergency on the boat, this key can be used to lock the boat.

SW2, it is the navigation mode selection, if the SW2 lever is in the highest position, it is in automatic mode. In this mode, the navigation route can be planned. When the lever is in the lowest position, it is in manual mode, the operator can manually control the unmanned boat to move, but cannot perform operations such as route planning.

Right lever x2, y2 is the direction control lever, push the lever left and right to control the boat to turn left or right.

5.3 Power-on precautions

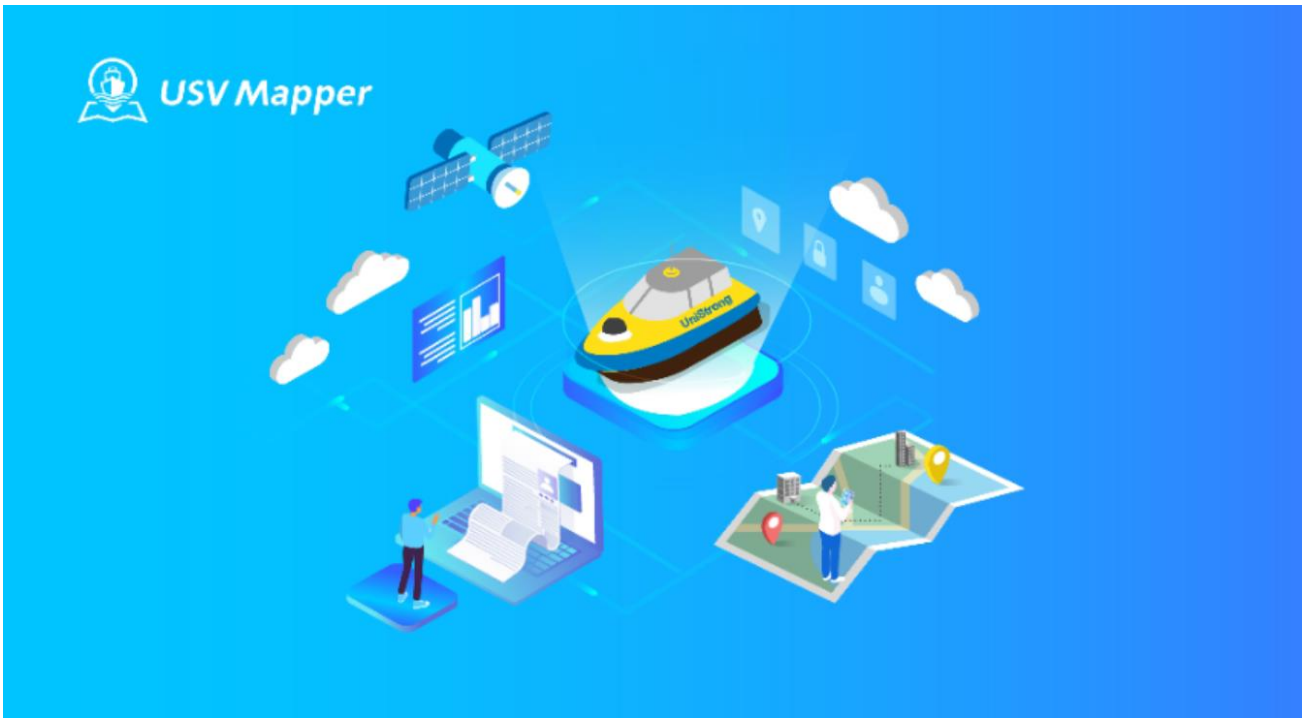
Before using the controller, please keep the controller switches should be in the following states:

(1) The engine control lever is in the "middle" position.

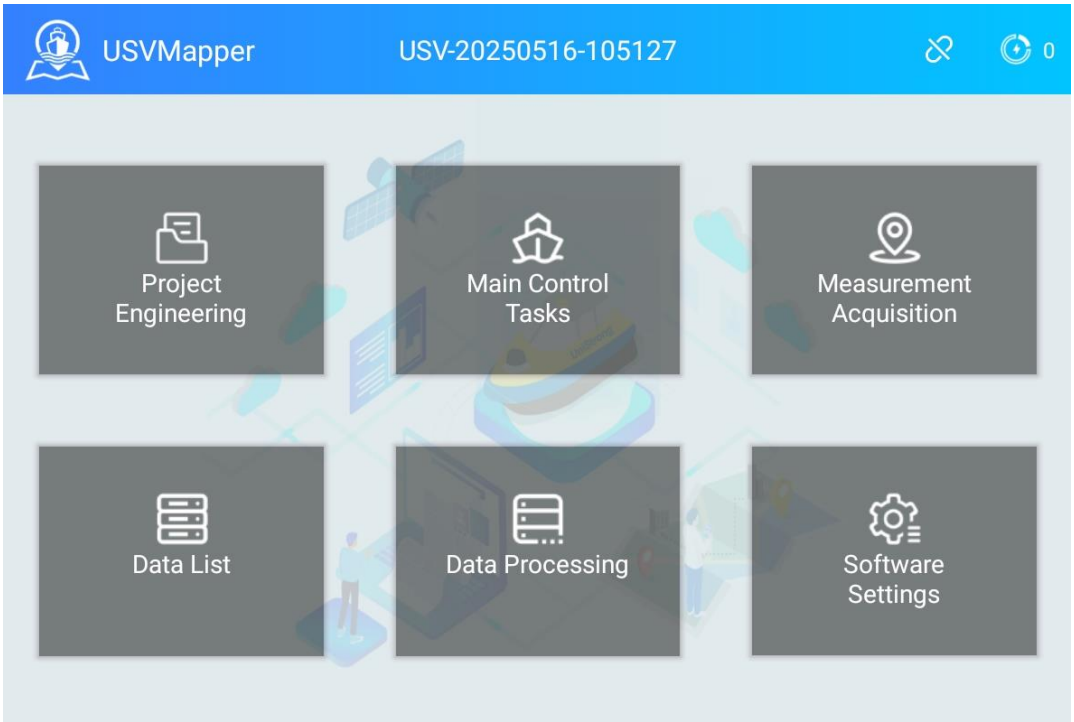
(2) Keep the Lock/Unlock switch lever in the lower position, it is in the unlock state.

Chapter 5. USVMapper software

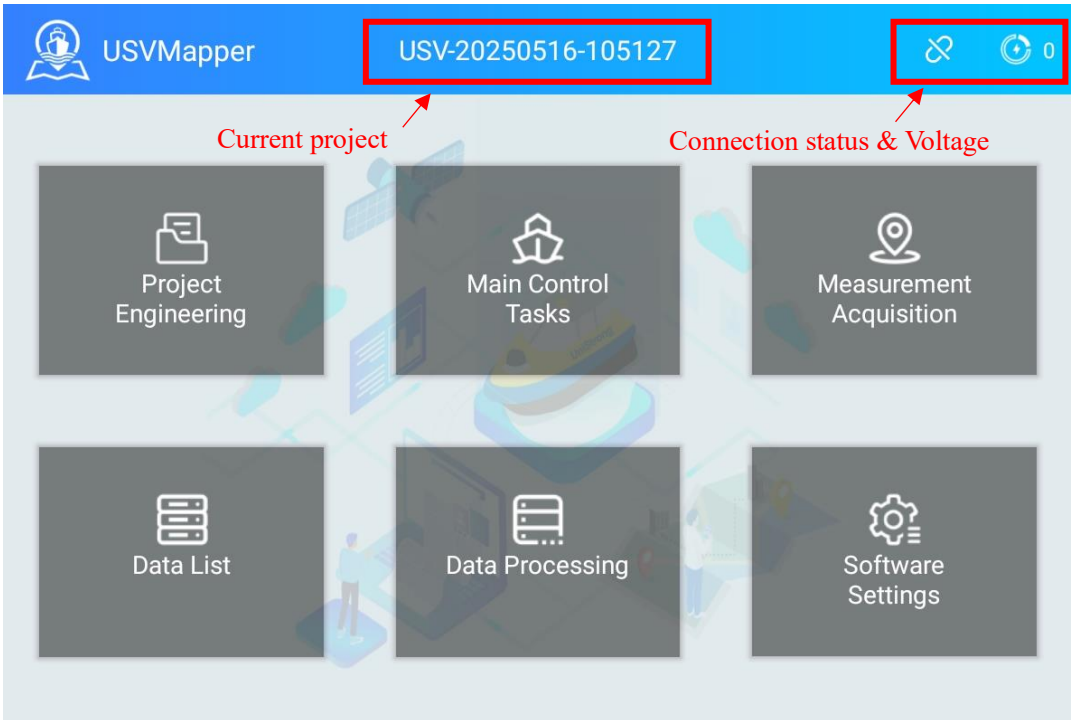
"USVMapper" is an industry application measurement and control software designed and developed for ARK-S small unmanned boat. It supports route import, hand-drawn routes, route planning and other modes. Hand-drawn routes are routes that users draw manually. Route planning is when users draw an area for planning. Importing files generates route tasks with one click. It supports surveying mode, hydrological mode, semi-automatic mode and fully automatic mode, allowing unmanned boat to automatically perform measurement operations and adapt to the complex needs of various scenarios.



5.1. Software main interface



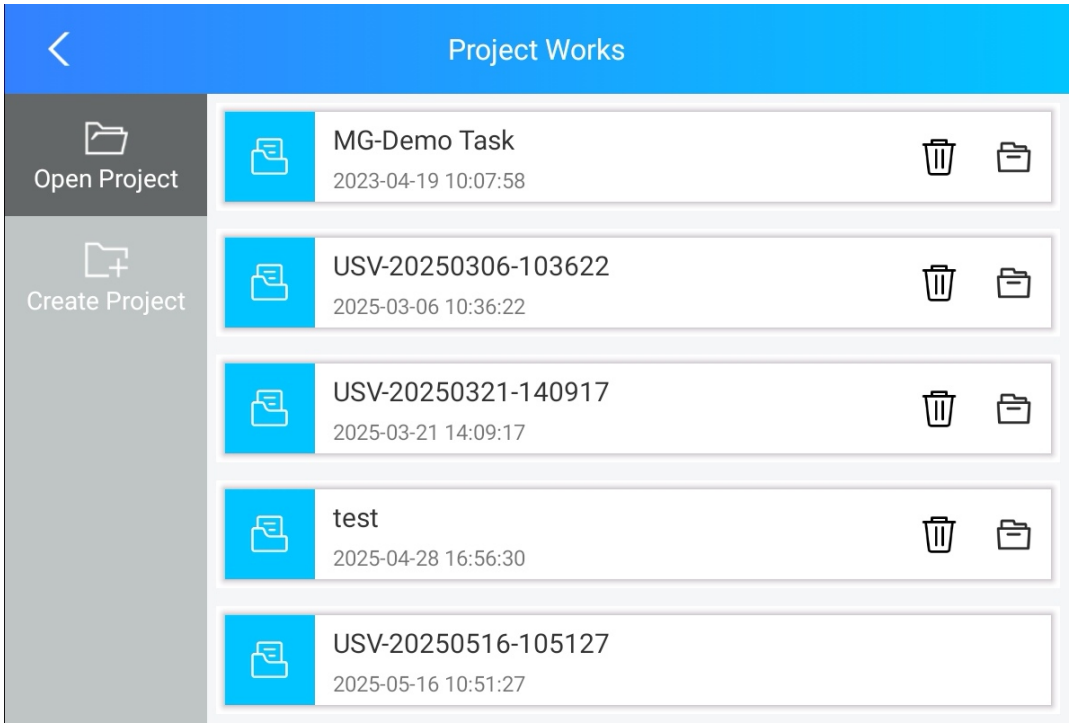
The main interface displays 6 main function modules. At the middle of the top of main interface, the name of current project is displayed there. And the connection status between controller and unmanned boat and battery voltage of boat are displayed at the upper right corner of main interface.



(1) Project Engineering: Create and open engineering projects.

(2) Main Control Tasks: With vector map as the background, it supports route planning, return, cruise, hovering, obstacle avoidance and other operations.
(3) Measurement and Acquisition: With vector map as the background, it supports adjusting boat speed, measurement and collection and other operations.
(4) Data List: Supports viewing historical data of measurements.
(5) Data Processing: Supports water depth sampling and data export.
(6) Software Settings: Supports coordinate system settings, connection settings, collection settings, instrument settings, hull settings, unit settings, CORS differential settings, video settings, and other settings.

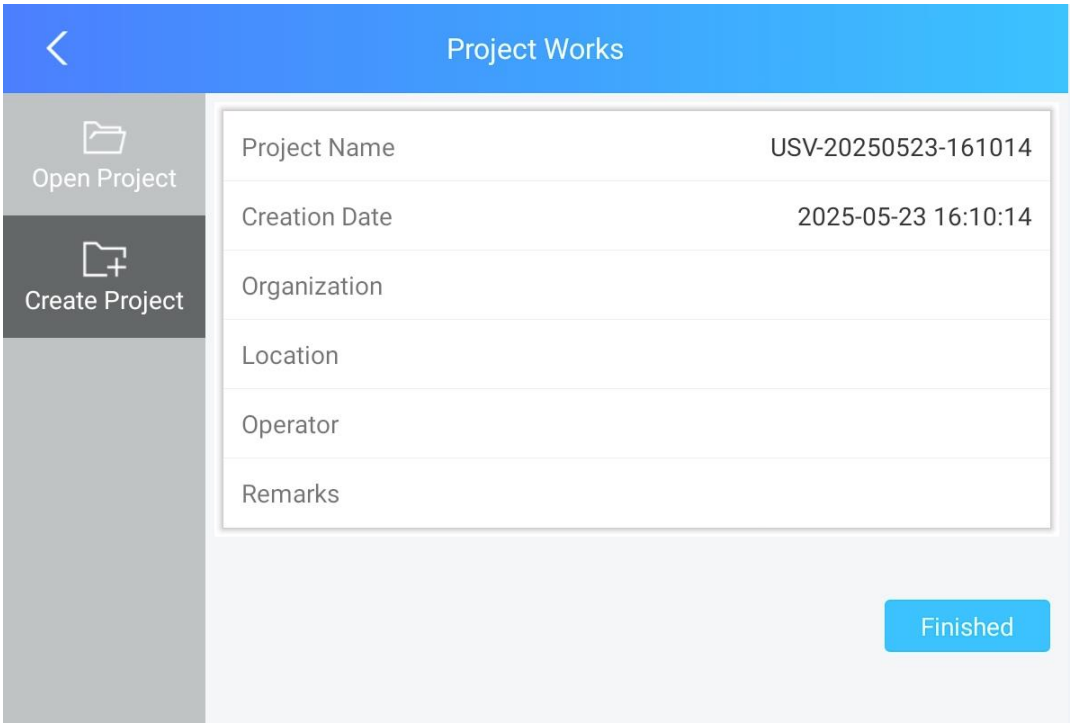
5.2. Project engineering



Open Project: The interface displays all projects. If there is no icon on the right side of the list, it means that the current project is in use.

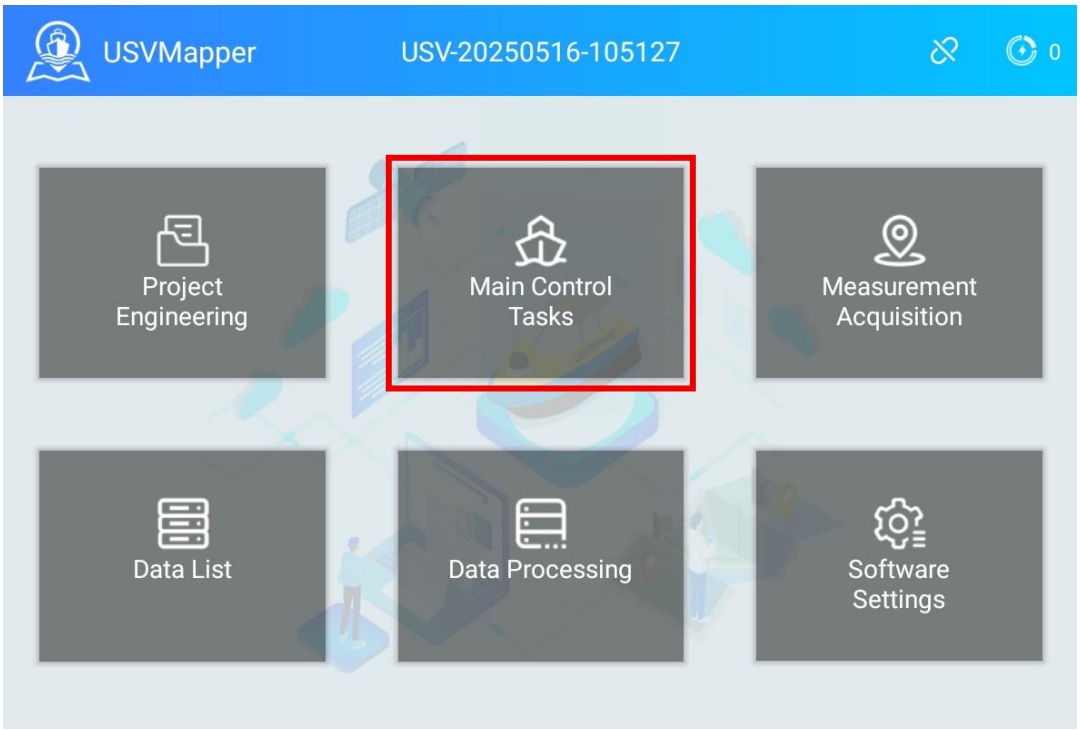
Click this button to delete the project.

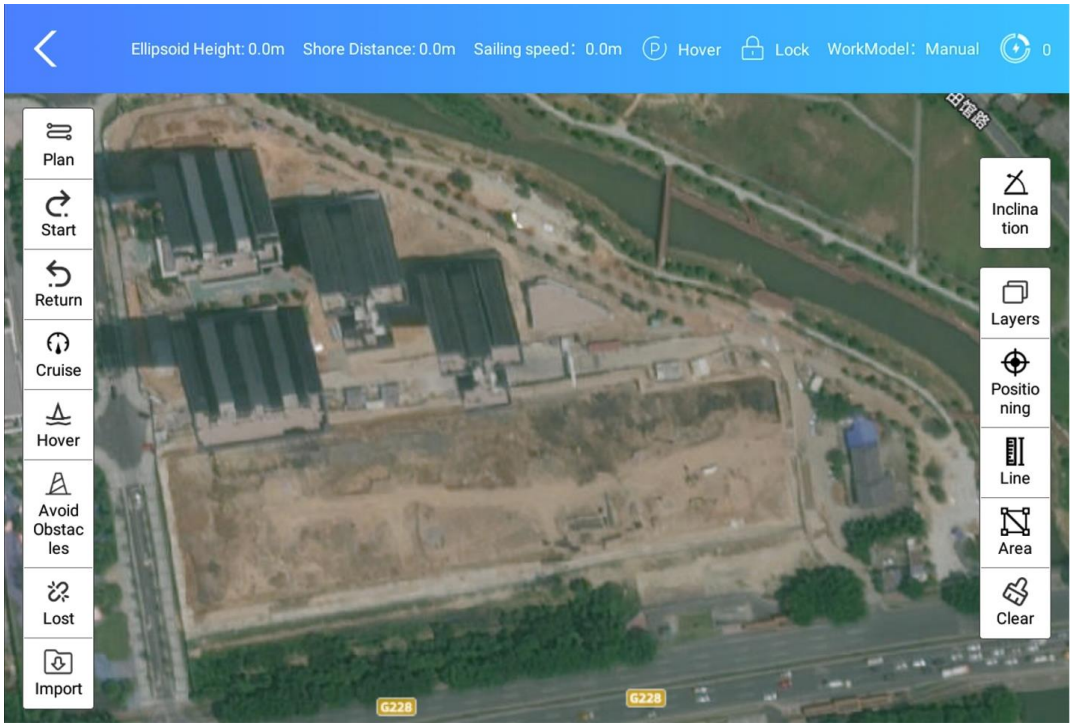
Click this button to open the project.



Create Project: The project name is usually with the current date and time, which can better identify which day's data is, the other fields, you can select to input, then click the "**Finish**" button to create the project and automatically open it, after that the interface will jump to the software setting interface.

5.3. Main control tasks





(1) Plan: There are two modes for planning routes: 1. Draw an area manually, click “Plan Route”, and the software will automatically plan a route in the area based on the spacing and angle. The spacing and angle can be adjusted. After complete planning route, click “Save Route”. 2. Draw a route manually, and click “Save Route”.

(2) Start: After clicking “Start”, the saved route history will be displayed on the right, select any route, configure the startup parameters again, like starting point, auto return, speed and so on, and click [Confirm] to start the measurement.

(3) Return: Enter the coordinate selection mode, move the map to the return location, automatically obtain the current point coordinates, and click [Confirm].

(4) Cruise: You can adjust the cruise speed, click [Confirm].

(5) Hover: Enter the hover mode with one click.

(6) Obstacle avoidance: You can manually adjust the obstacle avoidance distance, click [Confirm].

(7) Lost: Select the loss of connection action, return if loss of connection, or wait if loss of connection.

(8) Import: Supports importing KML and dxf files, dxf is the route, kml is the boundary range.

(9) Layers: Controls the display of collected data.

(10) Map: Controls the display of vector maps and satellite maps.

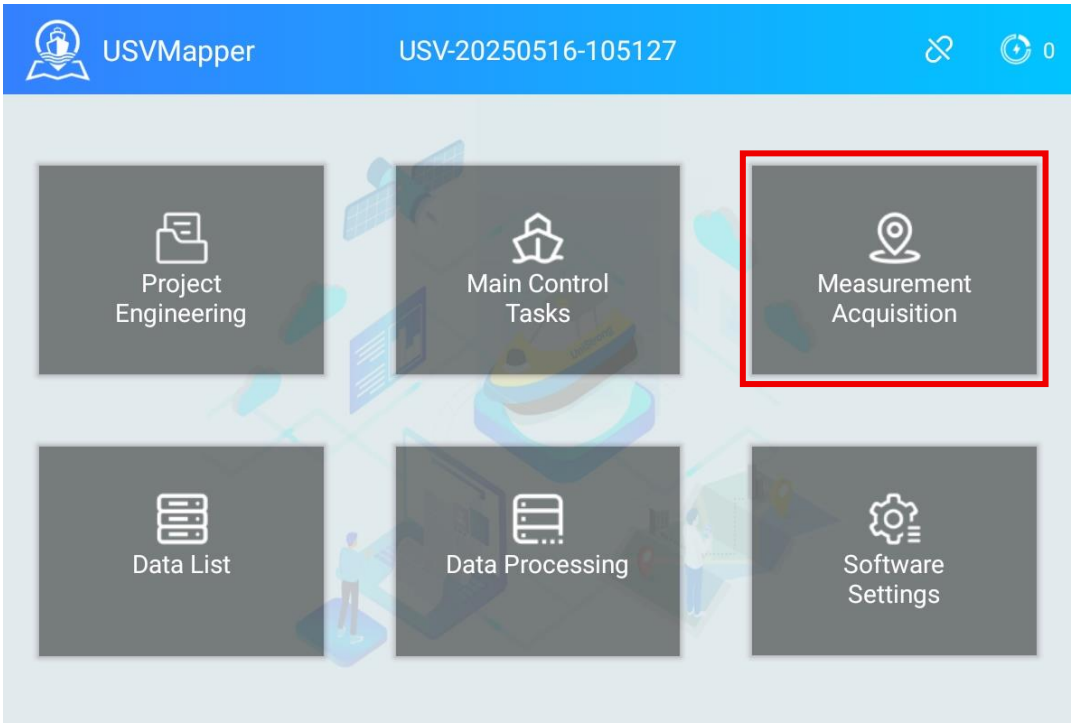
(11) Positioning: Locates the position of the unmanned ship.

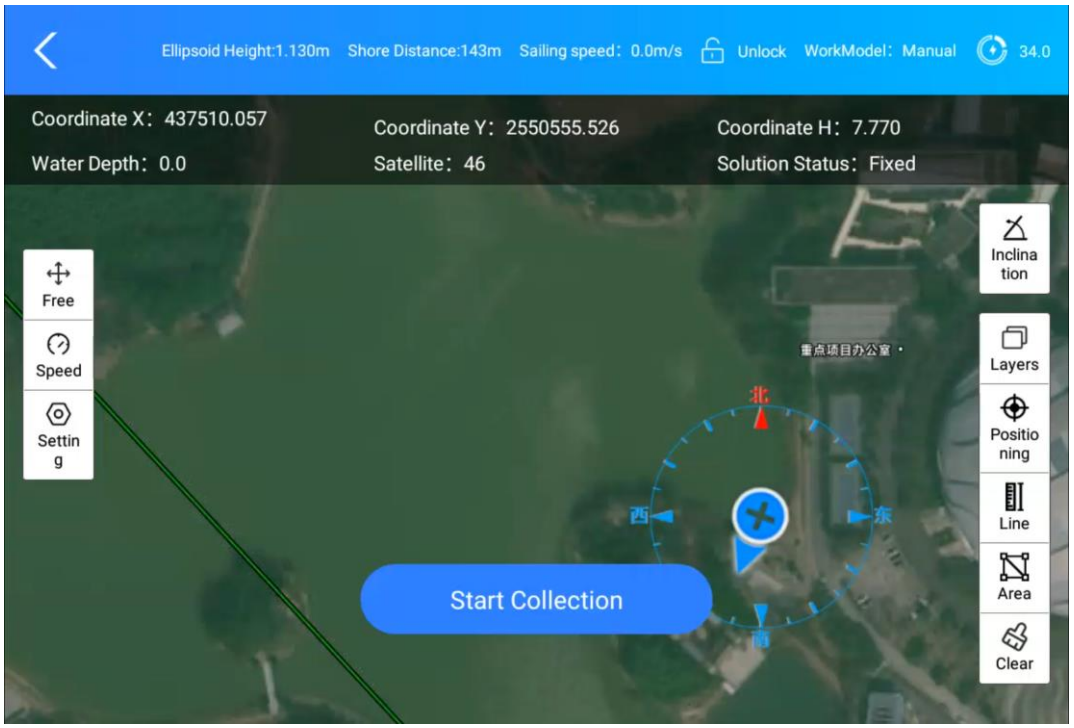
(12) Line: Click to enter the line measurement mode, draw points on the map, and calculate the length.

(13) Area: Click to enter the area measurement mode, draw points on the map, and calculate the length and area.

(14) Clear: Clear the temporary map drawing.

5.4. Measurement acquisition





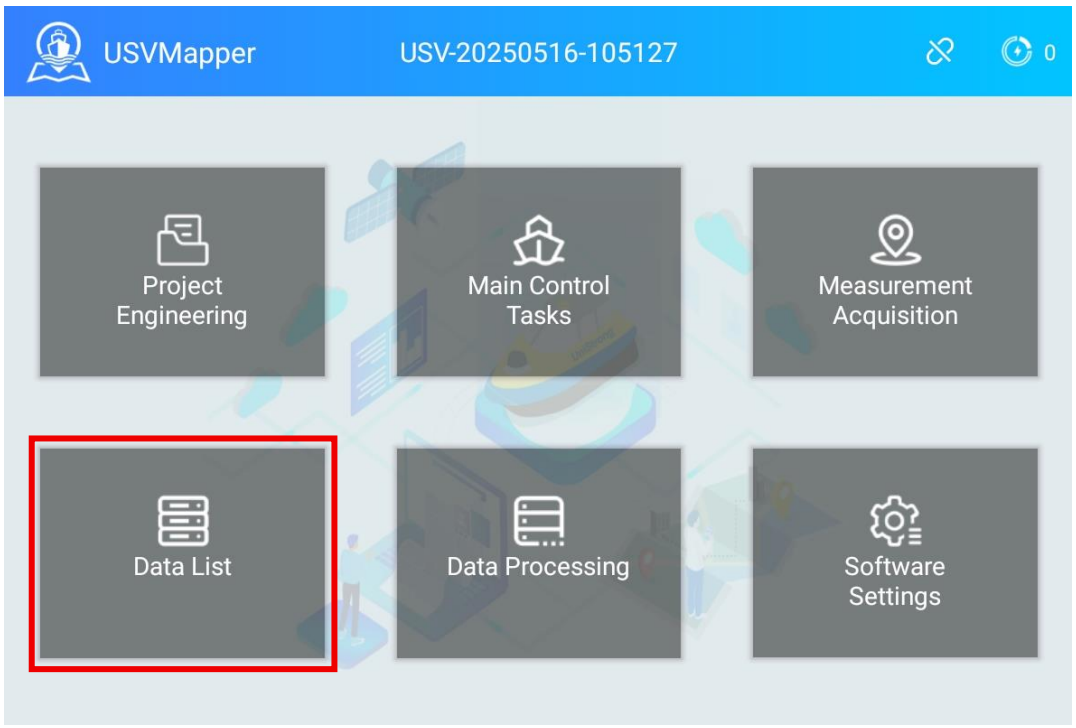
Click “Start Collection” to automatically start saving the measured points and water depth.

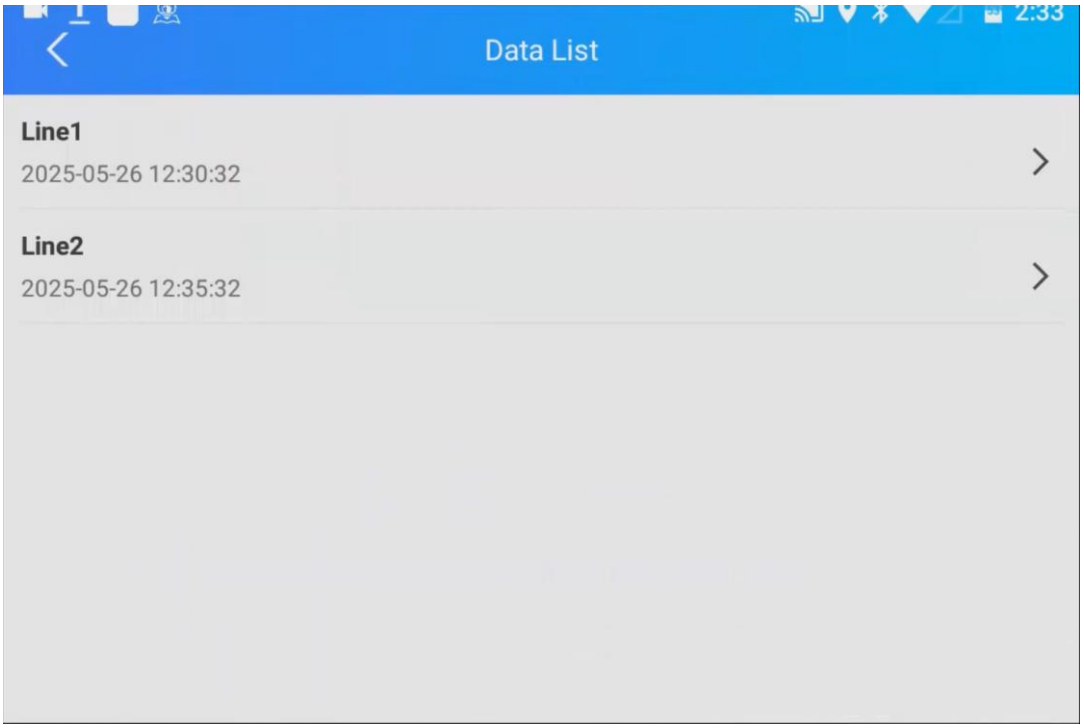
(1) Free: There are free and follow modes for the map. “Follow” means moving the map automatically to the center in real time according to the measured points.

(2) Speed: Adjust the speed of the unmanned boat.

(3) Setting: Enter the collection settings interface.

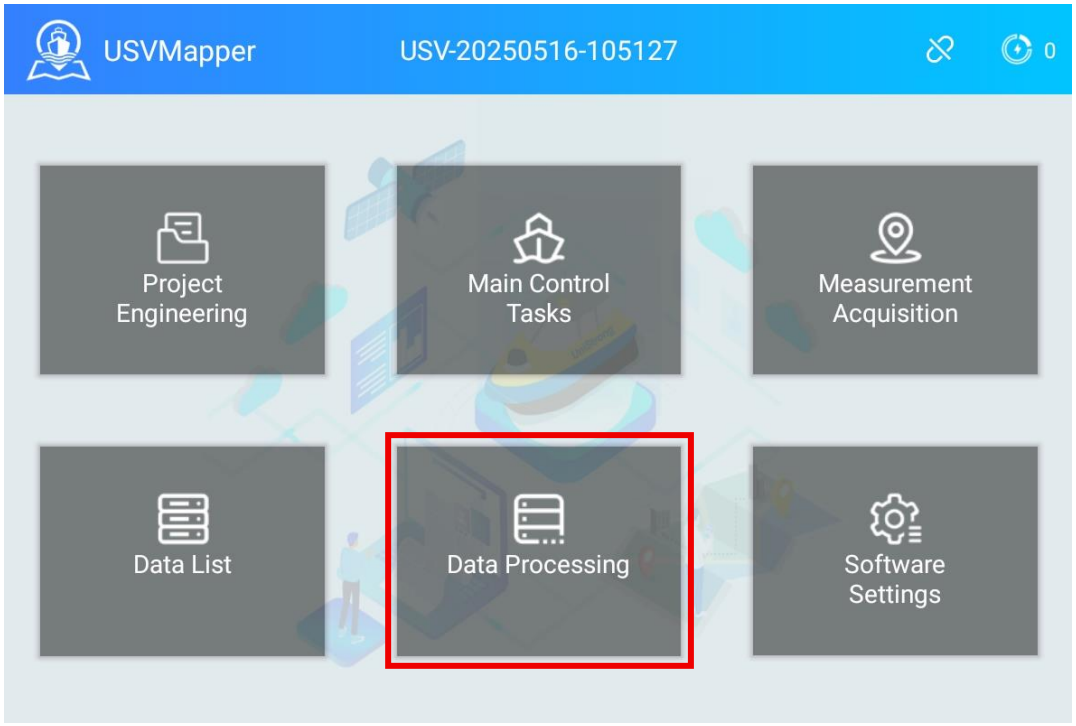
5.5. Data list

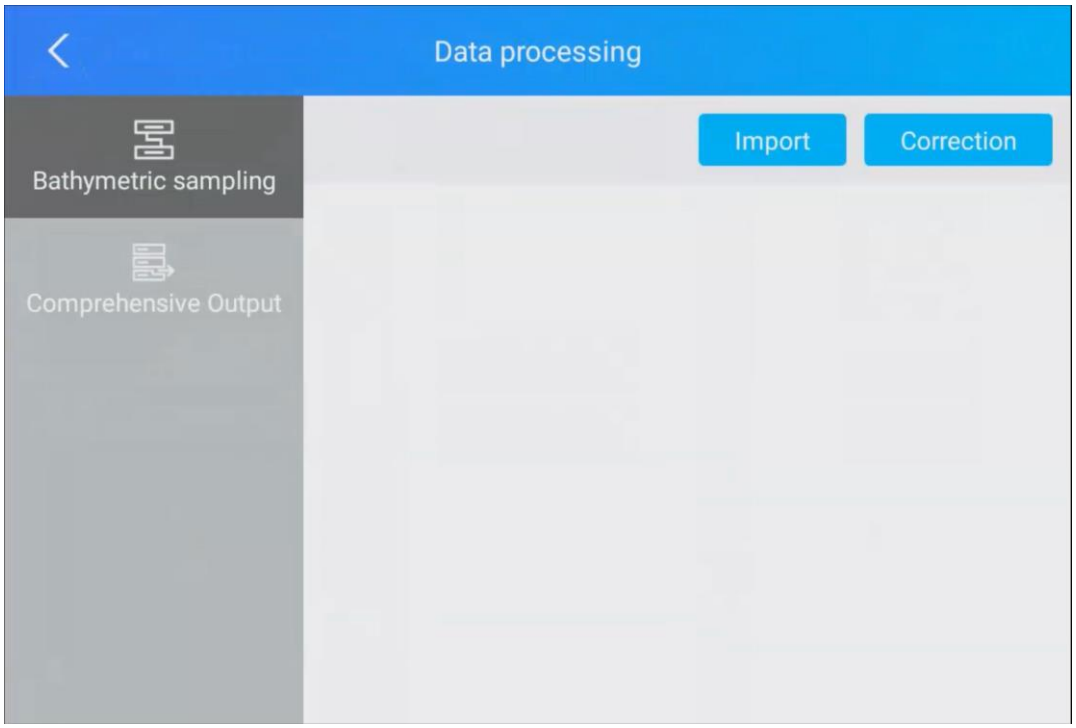


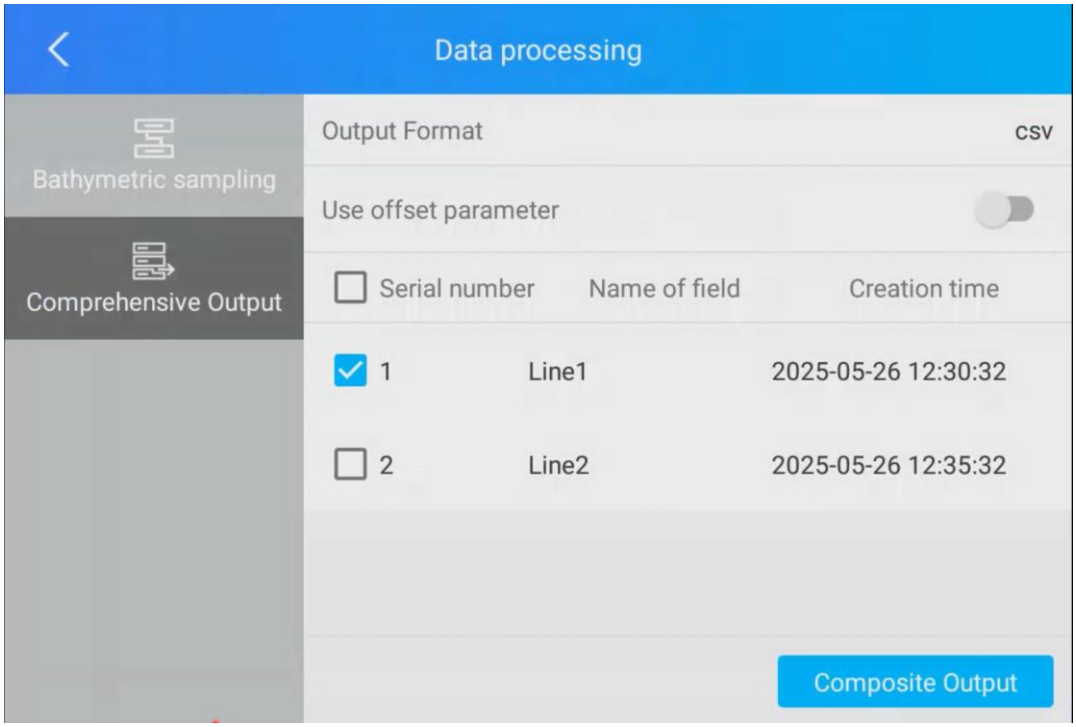


Displays historical data of measurement. Select an item and long press it to view and delete it.

5.6. Data processing

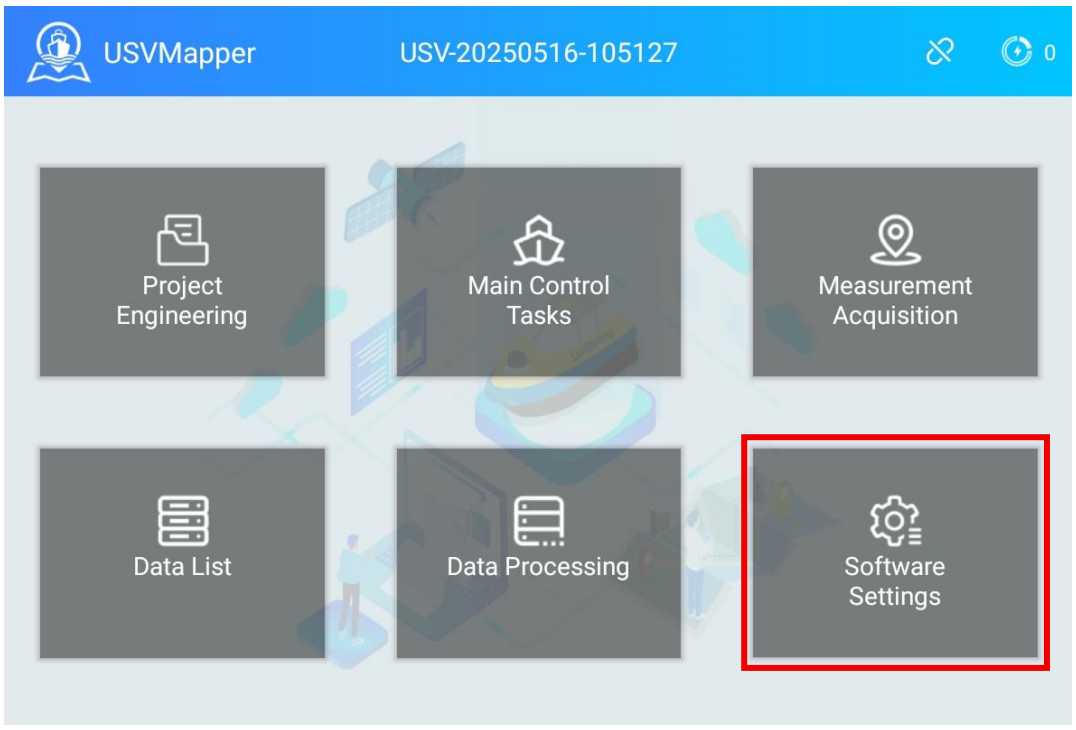


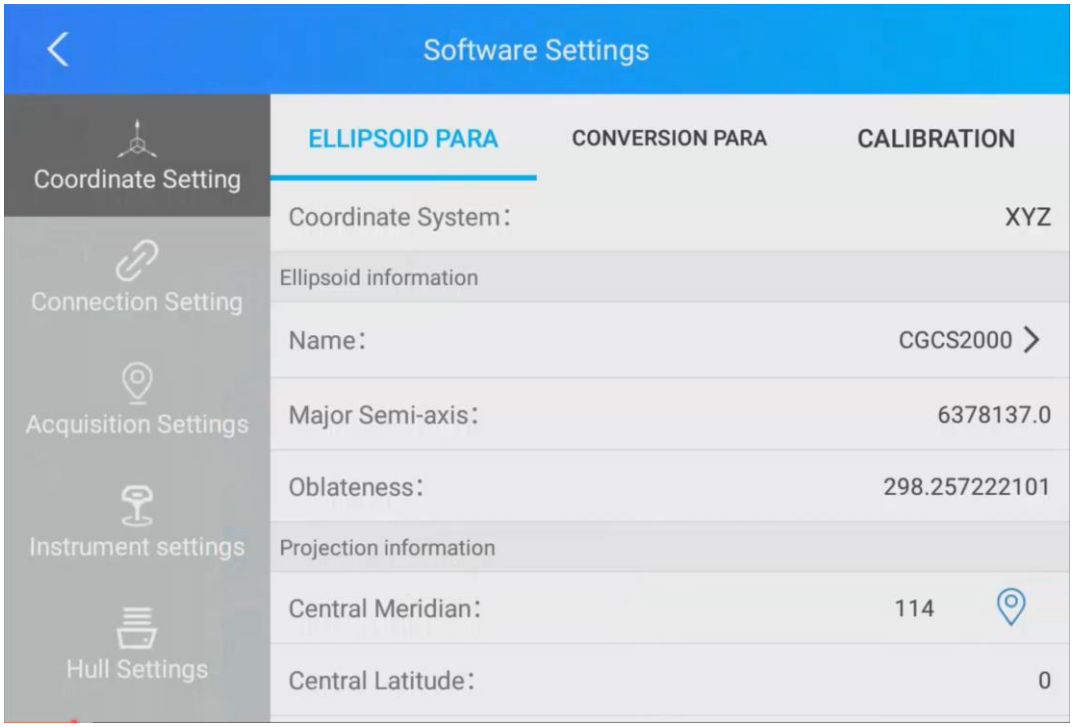




(1) Bathymetric sampling: Click “Import”, select the collected water depth data for display, and click “Correction” to automatically correct the values with large differences.
(2) Comprehensive output: Select the output format, and choose the output data, click “Comprehensive Output” to export.

5.7. Software settings





(1) Coordinate setting: Set the current coordinate system, including ellipsoid parameters, projection, central meridian, etc.

(2) Connection setting: Enter the IP and port to connect to the unmanned boat.

(3) Collection setting: Set the collection conditions.

(4) Instrument setting: Set the antenna height and depth sounder draft value.

(5) Hull setting: Set the offset value of the positioning antenna and the switch of the navigation light.

(6) Unit setting: Set the unit type such as speed, distance, angle, etc.

(7) CORS difference: Set the correction data for unmanned boat via network Ntrip.

(8) Video settings: Enter the unmanned boat video address for real-time viewing.

(9) Other settings: Check the software version, and update the software and the control system.

Chapter 6 Basic Operation

6.1 Using Built-in RTK

6.1.1 Ensure All Accessories of the USV Are Complete

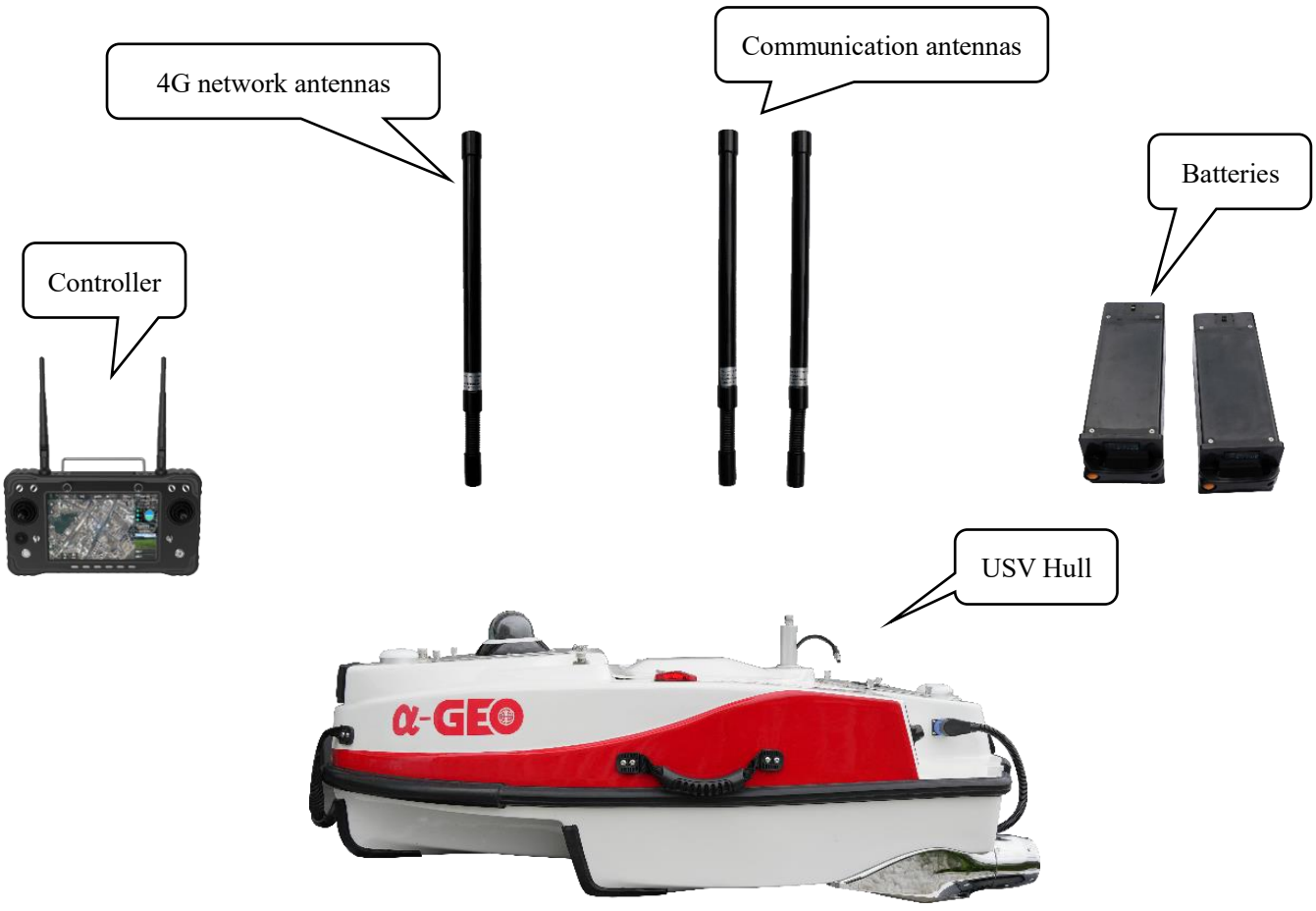
a) USV hull.

b) Batteries—Check if the battery is sufficiently charged. Press the battery button on the battery to view the remaining power capacity, displayed as a percentage according to the light up indicators.

c) Two 2.4G antennas— For communication with the remote controller.

d) One 4G antenna—For network communication via the 4G module.

e) Remote controller.

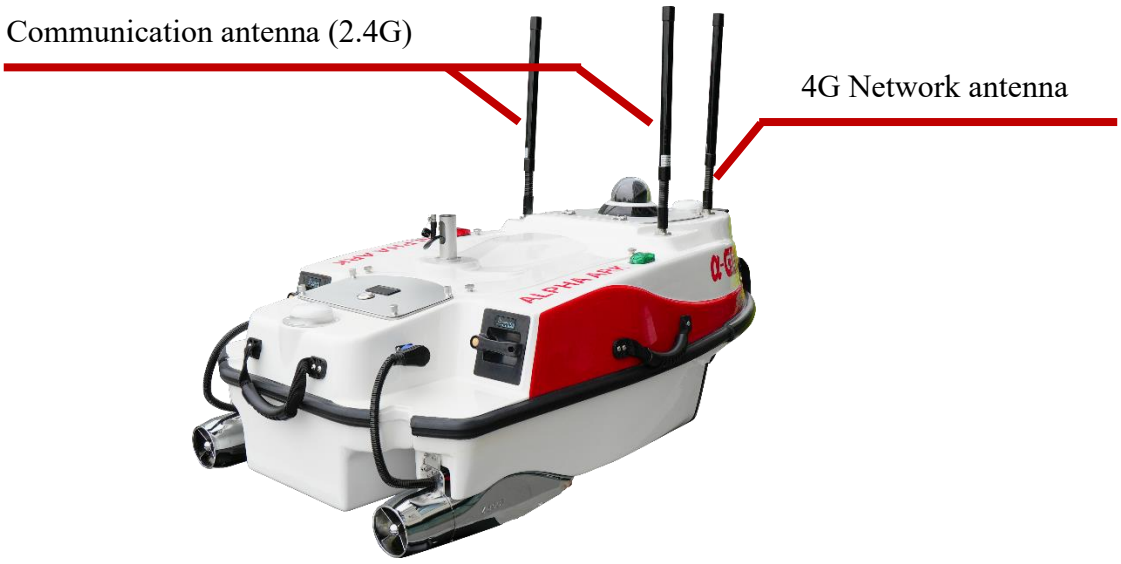


6.1.2 Pre-Launch Hardware Checks

1) Install the battery into the battery compartment of the USV and ensure it is securely fastened.

2) Mount the two 2.4G communication antennas to their corresponding ports (the two ports on the left and right sides of the vessel).

3) Mount the 4G communication antennas to its corresponding ports (the port on the right sides at the front of vessel).



4) Install the SIM card:

   a) Open the camera compartment, which contains the vessel control device and the 4G module.

   b) Use a needle to press the yellow button next to the SIM card slot to eject the tray.

   c) Place the SIM card on the tray (note: a standard-sized SIM card is required).

   d) Insert the tray with the SIM card back into the slot.

e) Tighten the camera cover securely.

5) On the remote controller, move the **SW1** toggle switch upward to the unlock position (when the toggle is in the middle or lowest position, the USV is locked, and the propellers will immediately stop working, preventing movement—this can be used in emergencies).

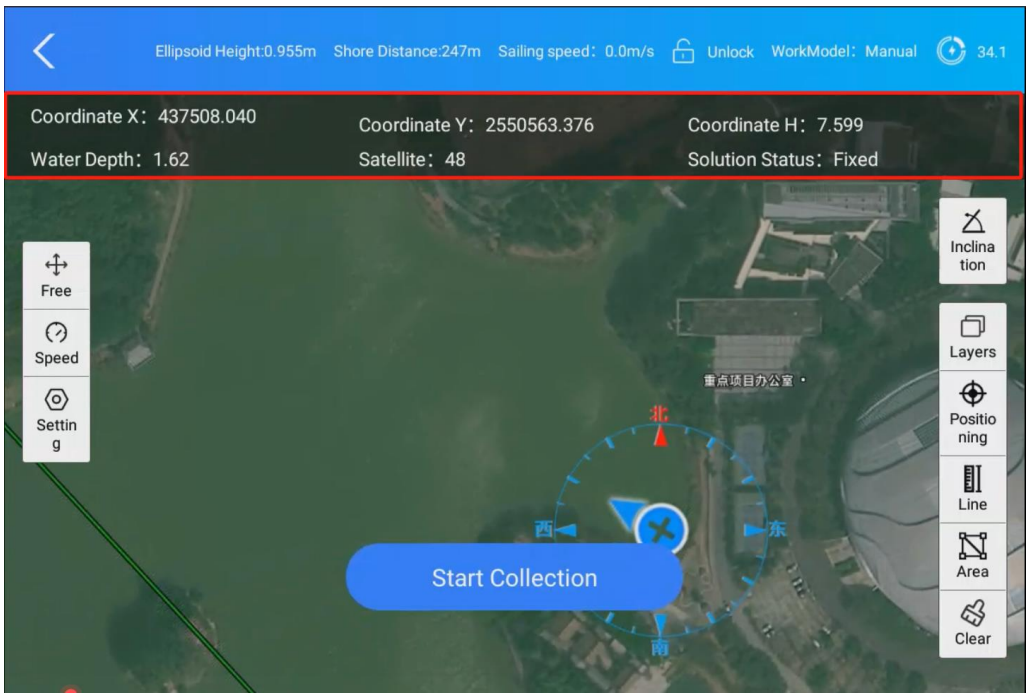
6) On the remote controller, move the **SW2** toggle switch upward to the manual mode position (the lowest position is for automatic mode).

7) Turn on the remote controller first by pressing and holding the power button for 3-5 seconds until the indicator light turns on.

8) After the remote controller is powered on, press the power button on the USV to activate it. The USV will perform a self-check upon startup, which lasts approximately 1 minute.

9) Once the USV completes the self-check, it will automatically connect to the remote controller. You can verify the connection by checking the signal indicator on the remote controller—if the signal bars are full, the connection is successful.

10) Run the **USVMapper** software to view the USV's positioning status, connection status, and battery level (displayed in volts in the upper-right corner of the interface).

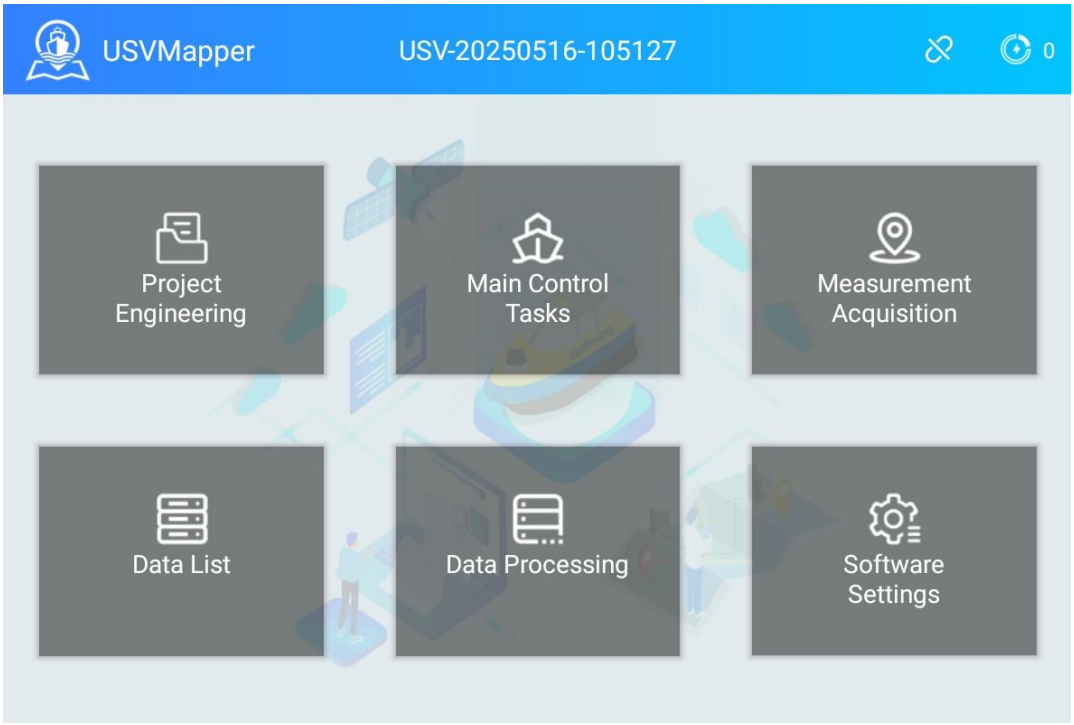


11) Gently move the throttle joystick on the left side of the remote controller to test the propulsion system.

12) After confirming that the propulsion system is functioning properly, the USV can be launched into the water. If the survey area is a river, complete all software configurations onshore before placing the USV in the water to prevent it from drifting away with the current before setup is finalized.

6.1.3 Software Operation

The software consists of six main menus, including **Project Engineering**, **Main Control Tasks**, **Measurement Acquisition**, **Data List**, **Data Processing**, and **Software Settings**.



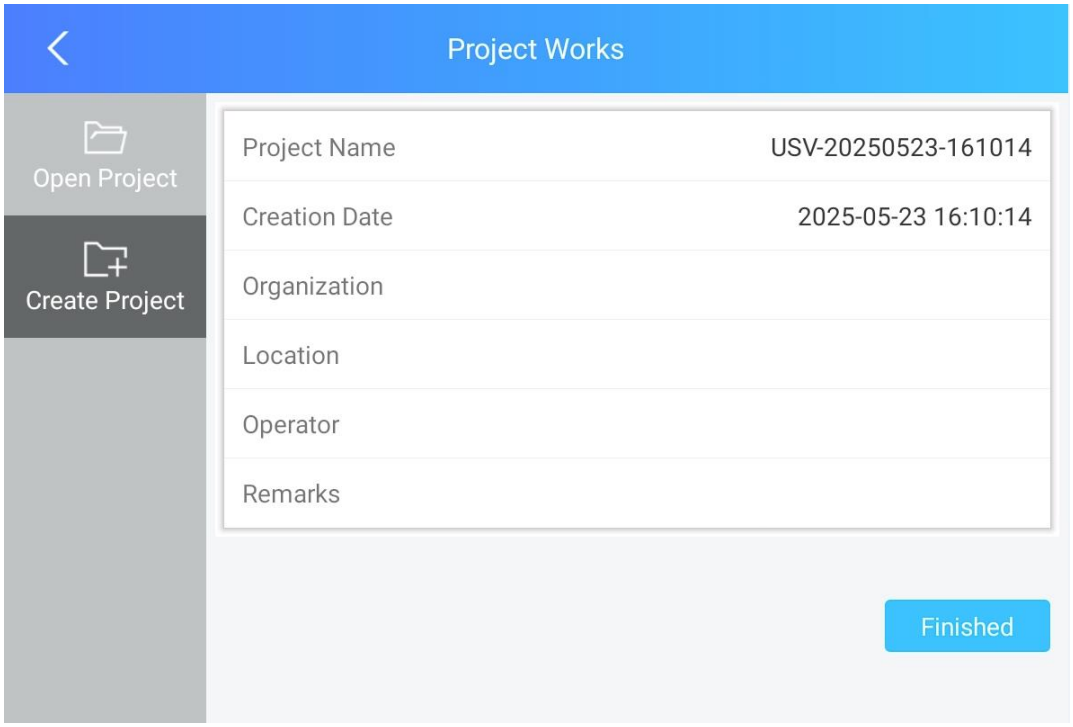
6.1.3.1 Creating or Opening a Project

First, open or create a new project. Click on the **Project** menu to enter the interface, then select **New Project**.

The project name is automatically generated in the format **USV + current date and time** by default, which helps distinguish between different projects. We recommend using this default naming convention. However, if the customer prefers, they can modify it.

***Important Note**: The project name **must not contain special characters** (such as **%**, **&**, etc.) or **spaces**. If such characters or spaces are included, the software may fail to read the project name correctly, leading to errors.*

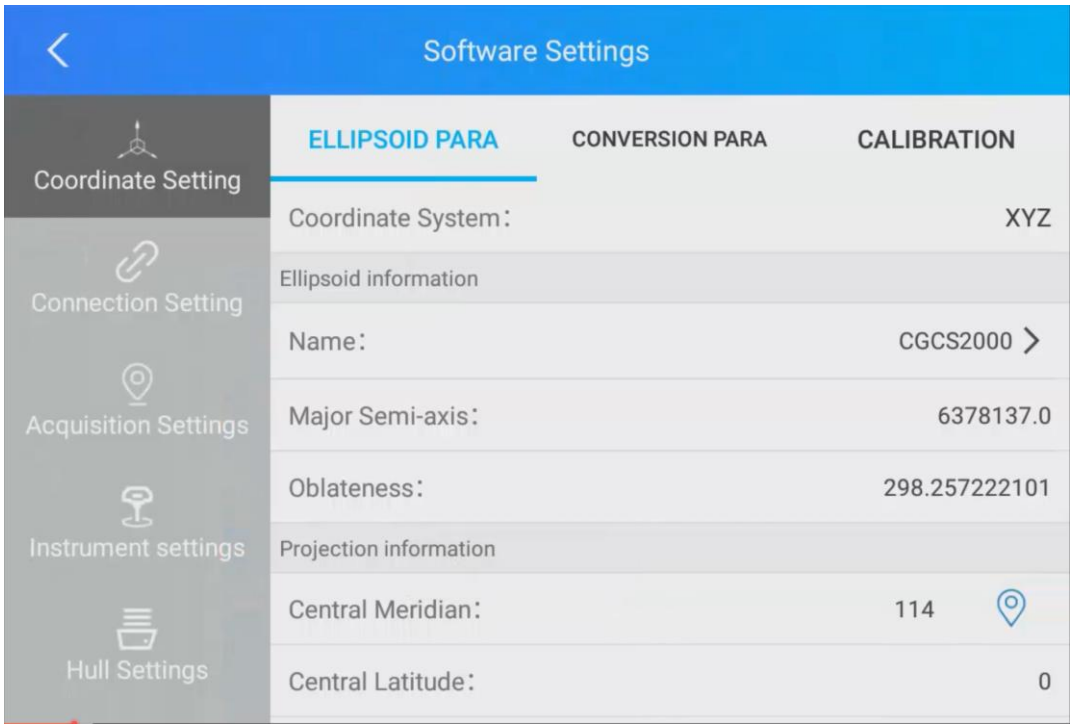
Other information is optional. After filling in the details, click the **Finish** button to generate the new project file.



6.1.3.2 Coordinate System Settings

After the project data is loaded, the software will automatically switch to the **Settings** interface. In this section, we need to configure the **Coordinate System Settings**, **Connection Settings**, **Acquisition Settings**, **Instrument Settings**, **Hull Settings**, and **Other Settings**.

First, set up the **Coordinate System** parameters according to the local coordinate system in use, like the Ellipsoid parameters, central meridian and so on.



6.1.3.3 Connection Settings

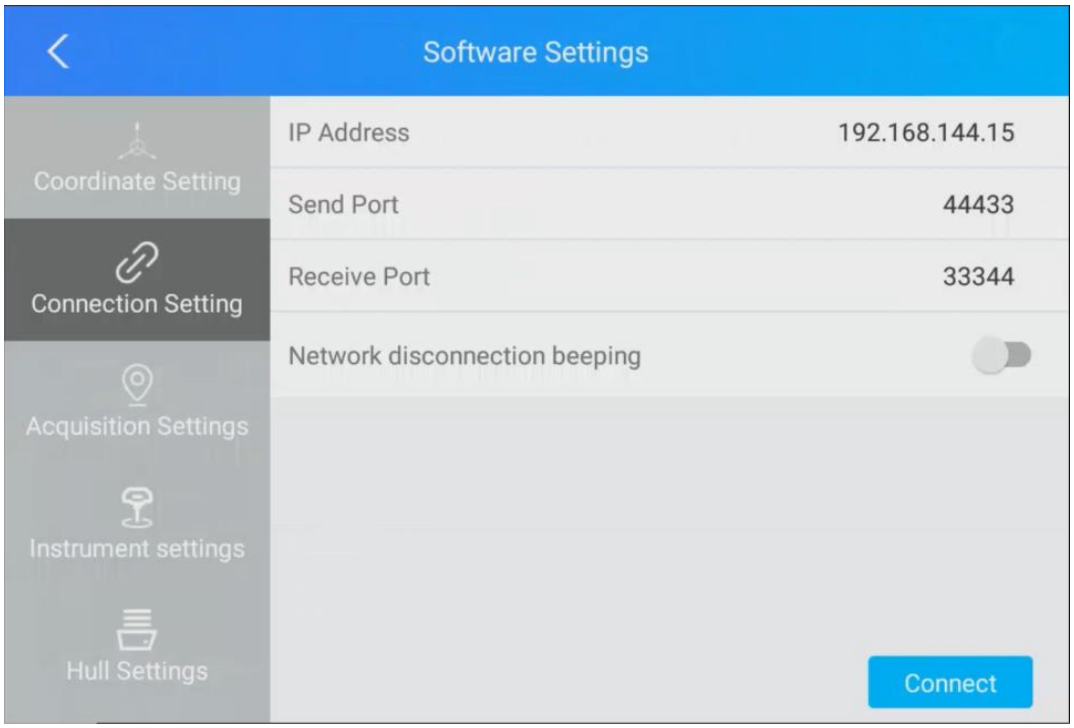
Next is the setup for connecting the remote controller and the USV. If it is the first time connecting to the USV, navigate to the **Connection Settings** page. If a default IP address and port are already available, simply click the **Connect** button to establish the connection.

If no IP address and port are configured, manually enter:

- **IP Address**: 192.168.144.15
- **Send Port**: 44433
- **Receive Port**: 33344

After entering these details, click the **Connect** button to establish communication between the remote controller and the USV.

Note: Normally, we conduct a pre-test of the USV, so the IP address and ports are usually pre-configured. In most cases, no additional setup is required here. Simply check whether the communication signal on the remote controller shows full bars to confirm a successful connection.



6.1.3.4 Acquisition Settings

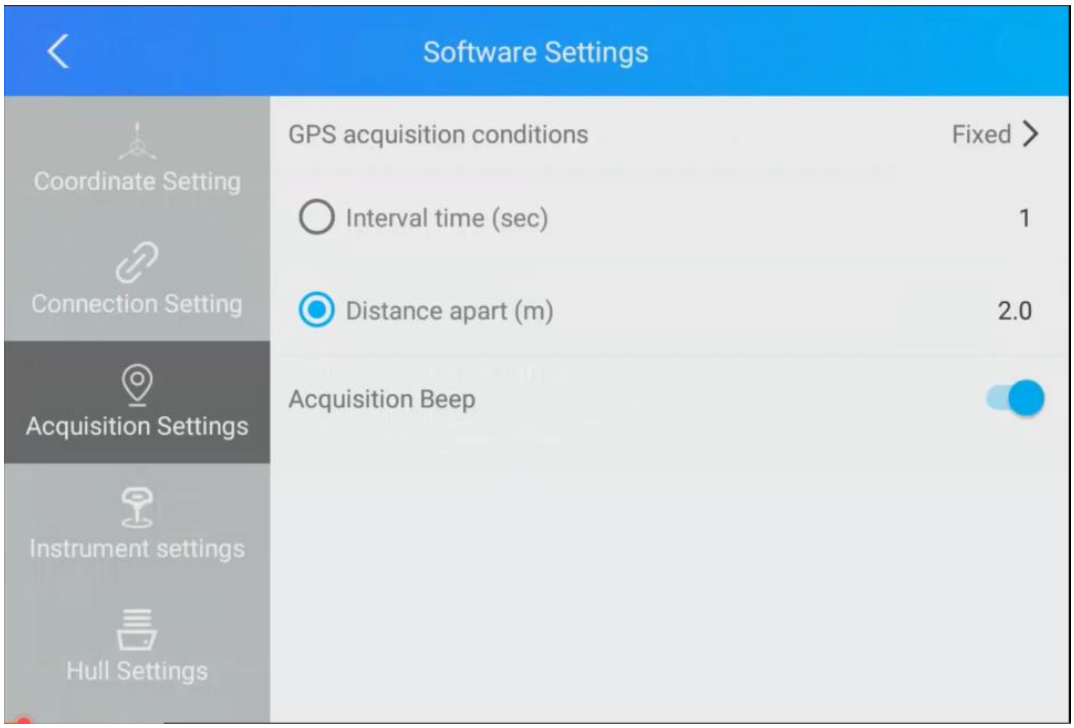
Acquisition Settings refer to the configuration of data acquisition conditions. For example, GPS acquisition conditions settings—whether to use **Fixed Solution** or **Single Point Solution**.

Next is the **Collection Interval**, which offers two modes:

1. **Interval Time**: Collects data at fixed time intervals in seconds.

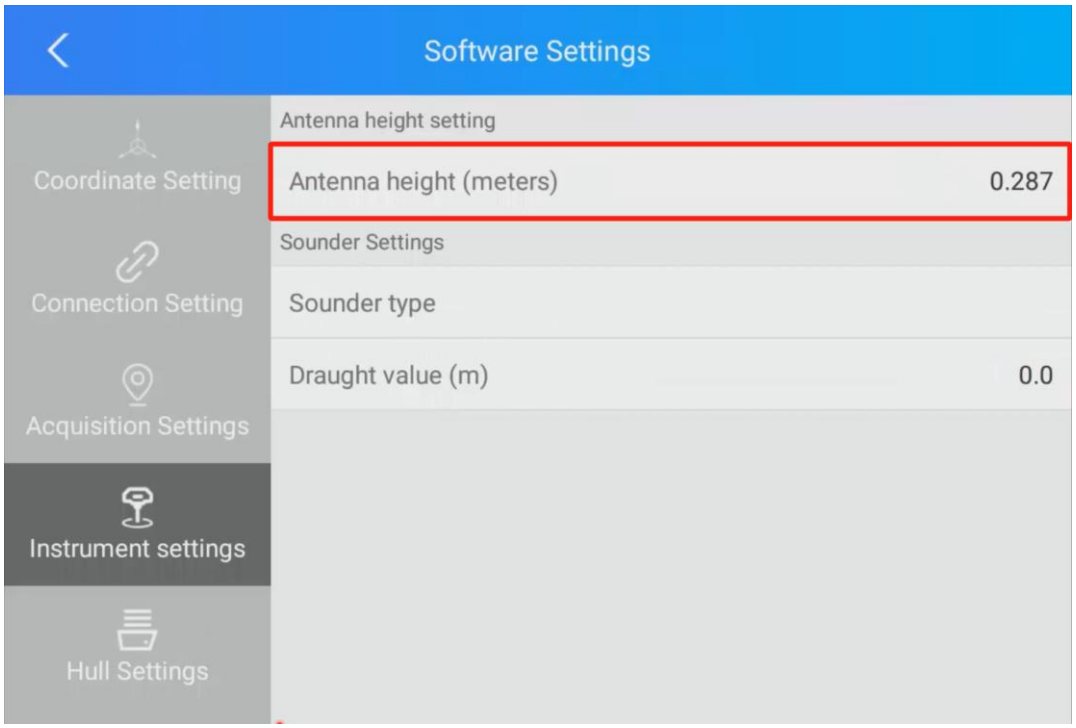
2. **Distance apart**: Collects data at predefined distance intervals.

We recommend using **distance interval collection** for optimal results.



6.1.3.5 Instrument Settings

Instrument Settings primarily involve configuring the **RTK antenna height**. The default value of **0.287 meters** refers to the height from the **bottom of the echo sounder to the GNSS antenna**, so this is the **fixed value** of using the internal RTK module. No setting here is required for the draft value.

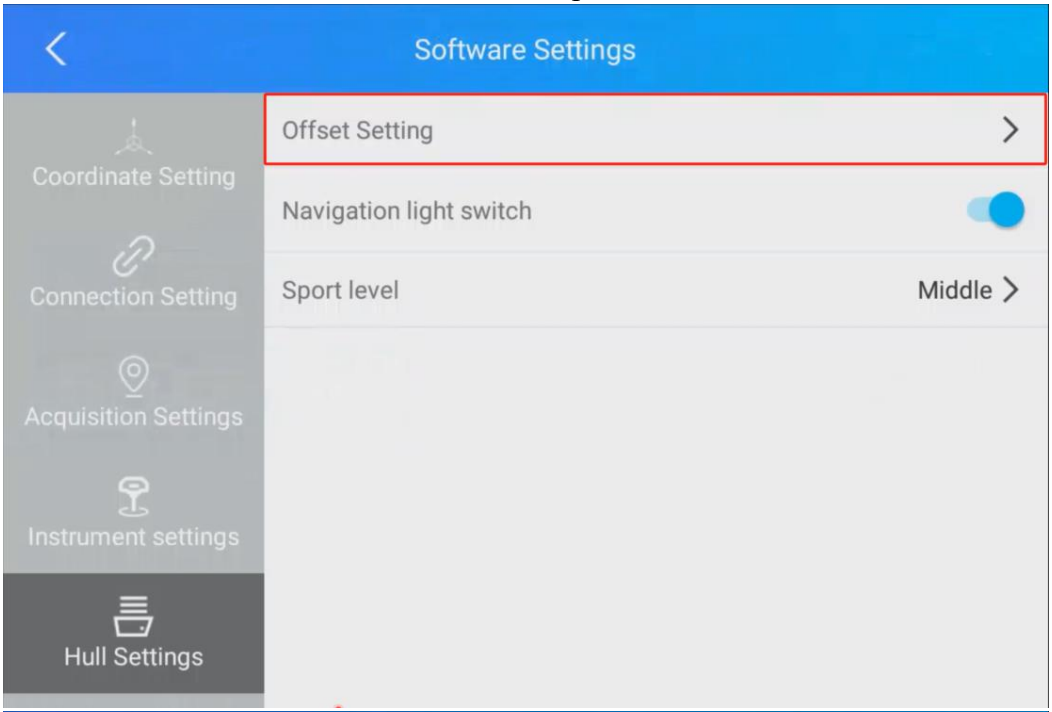


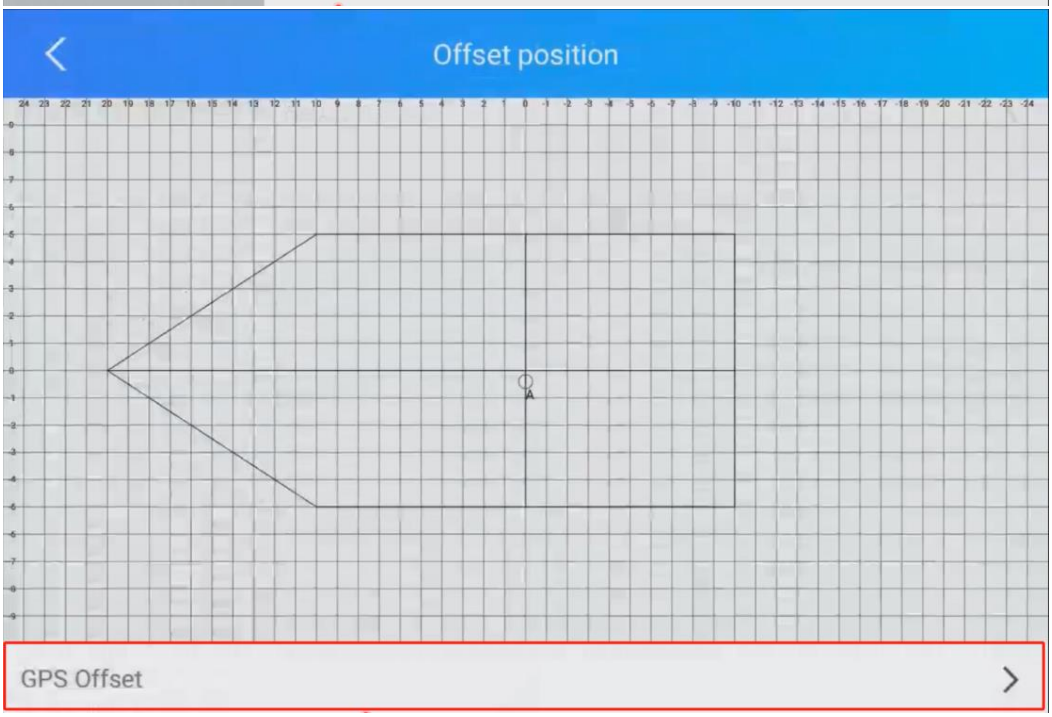
6.1.3.6 Hull Settings

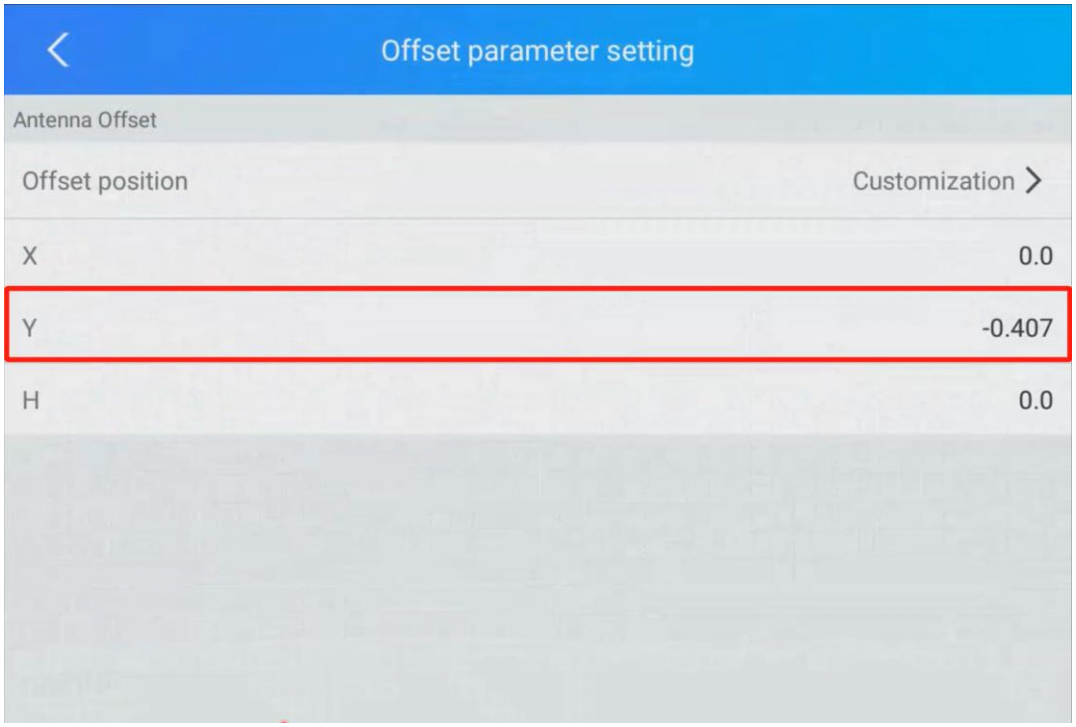
Hull Settings primarily involve adjusting the **RTK position offset** to align it directly above the echo sounder. Since the RTK is not installed precisely above the echo sounder, an offset value must be applied to correct its position. To configure this:

1. Click **"Offset Setting → GPS Offset → Y"**.
2. Set the **Y-value to -0.407** (no other values need adjustment).

This ensures the RTK data is referenced to the correct position above the echo sounder.

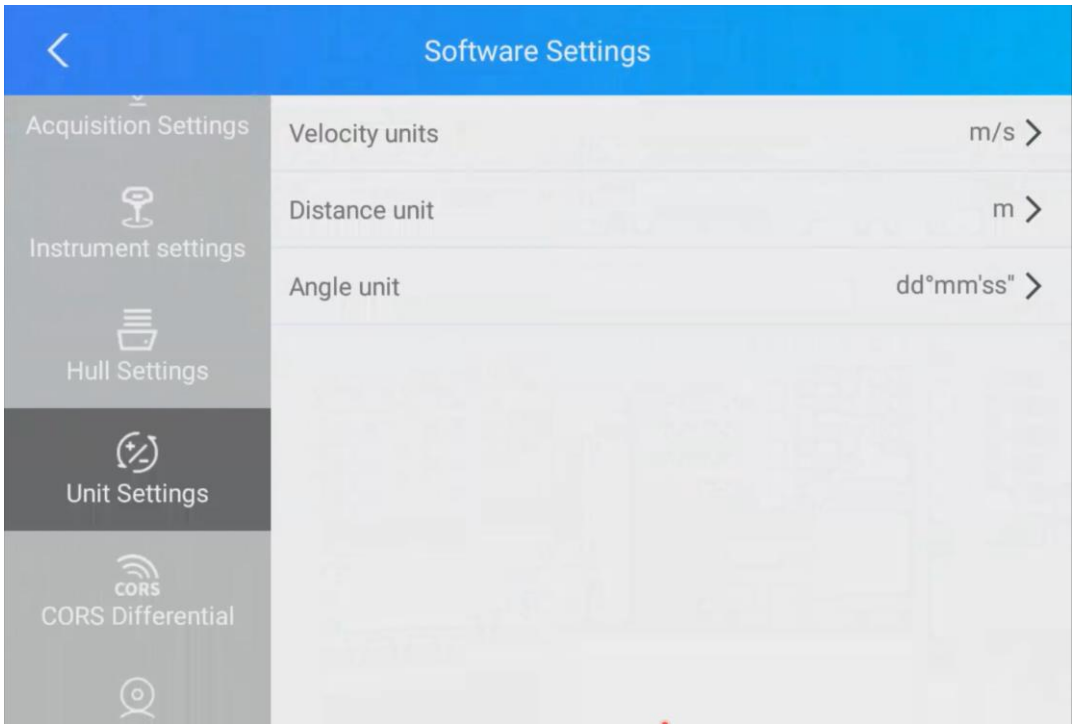






6.1.3.7 Unit Settings

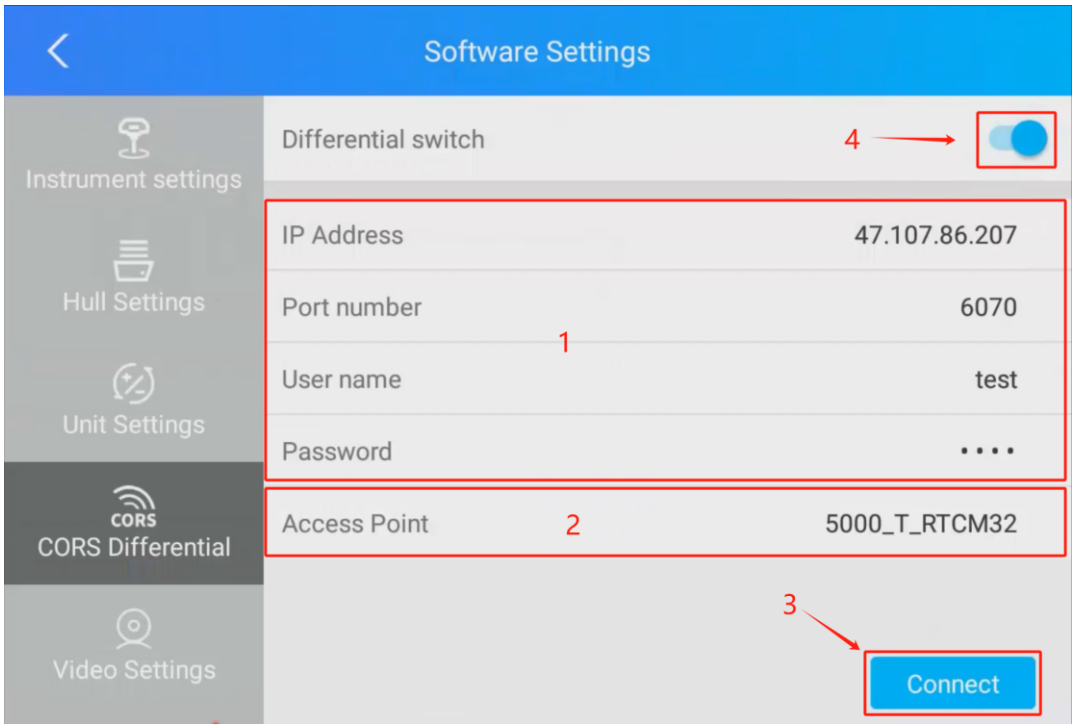
Unit Settings: No configuration is required by default. However, you may customize the settings based on your preferences, such as the angle unit.



6.1.3.8 CORS Differential

Ensure the remote controller is connected to a Wi-Fi hotspot with internet access.

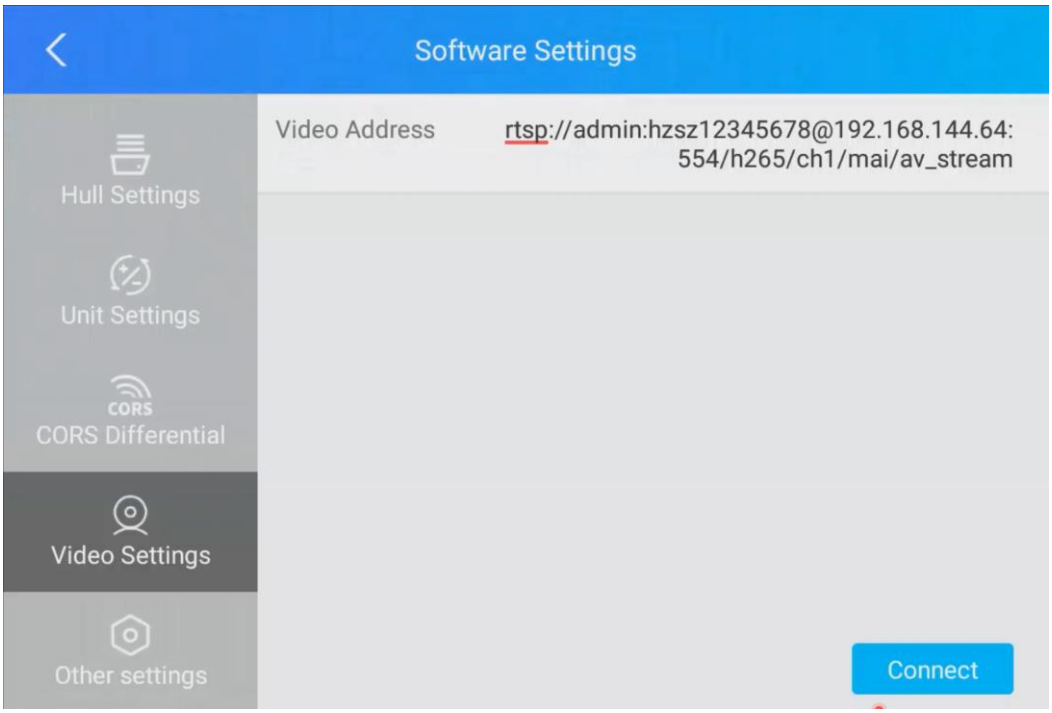
1. Enter the local CORS account.
2. Click “**Access point**” to download the mountpoint list, then select an appropriate mountpoint.
3. Click the “**Connect**” button.
4. Toggle the “Differential switch” to enable corrections.



6.1.3.9 Video Settings

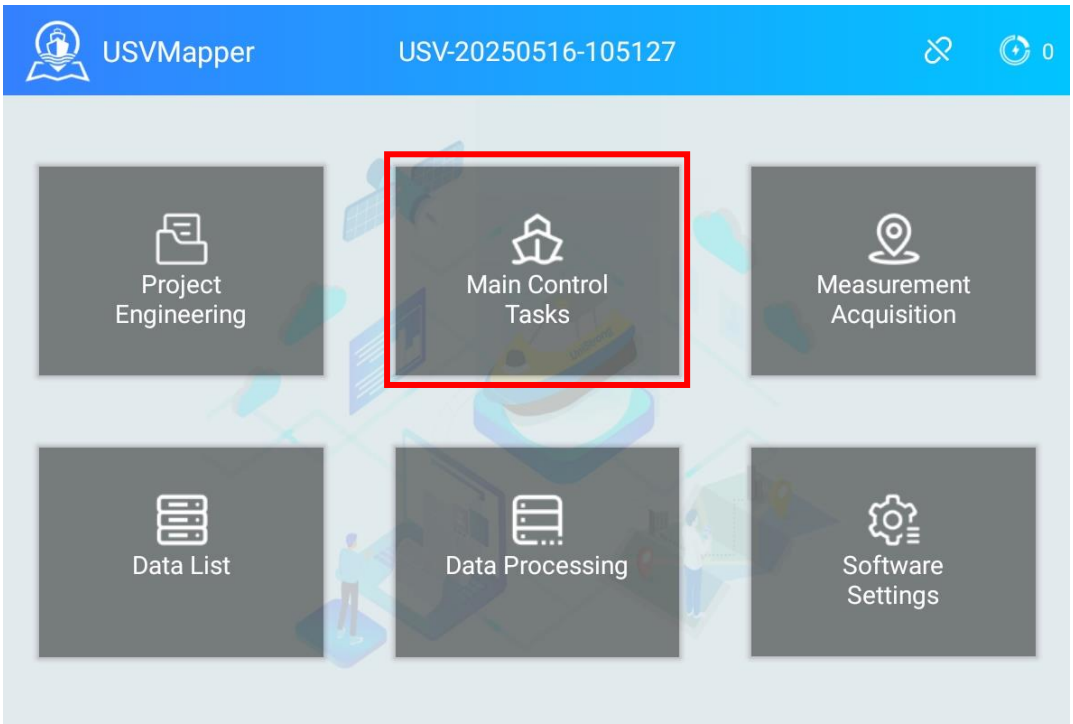
Video Settings: This section is primarily used to retrieve and display the live feed from the USV's camera on the remote controller's screen. Simply paste the camera's **IP address** into the designated field and click **"Connect"**.

Camera IP Address: rtsp://admin:hzsz12345678@192.168.144.64:554/h265/ch1/main/av_stream

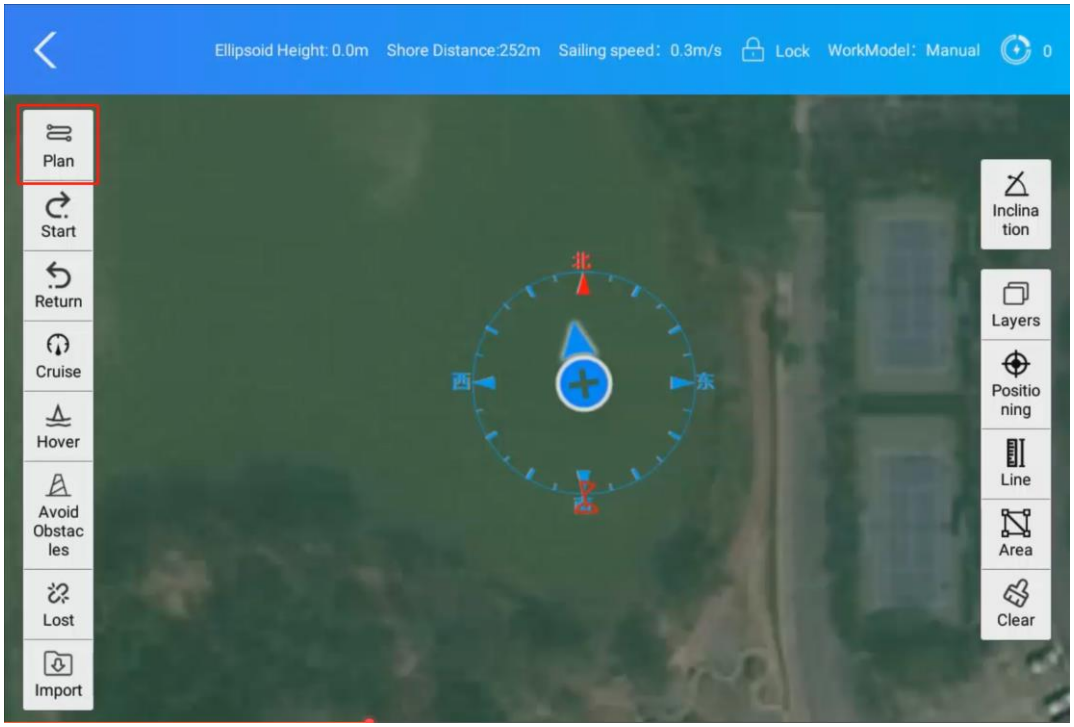


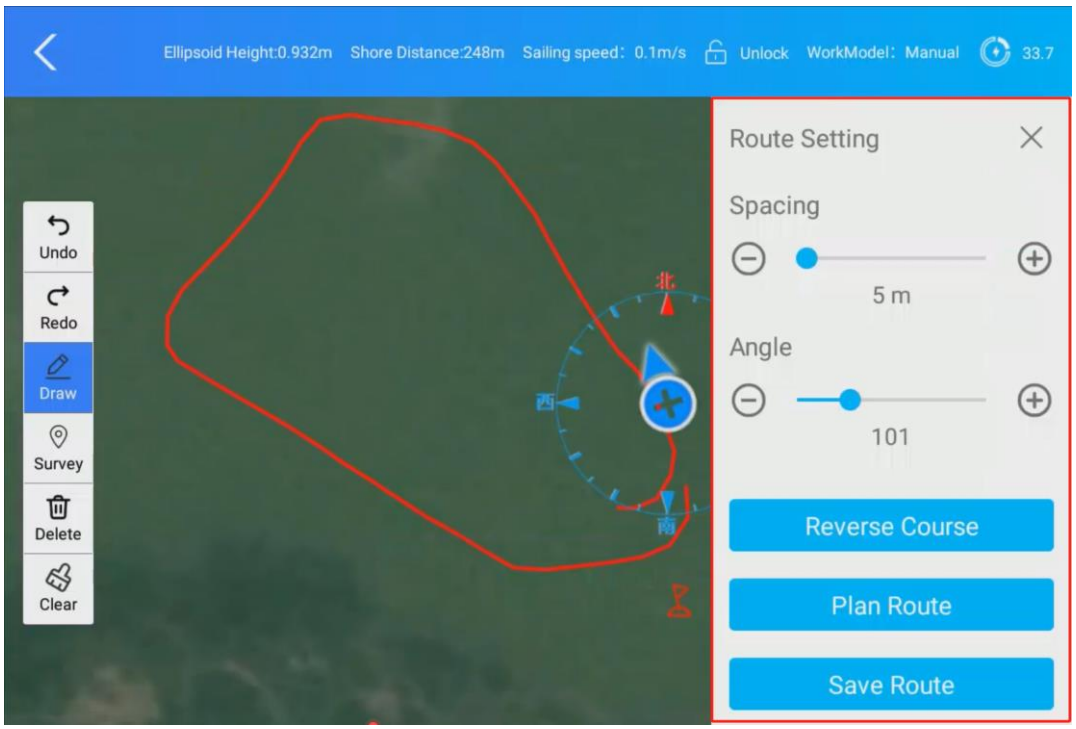
6.1.3.10 Route Planning

Return to the **main interface**, click the **Main Control Tasks** menu to enter the Main Control Tasks interface.



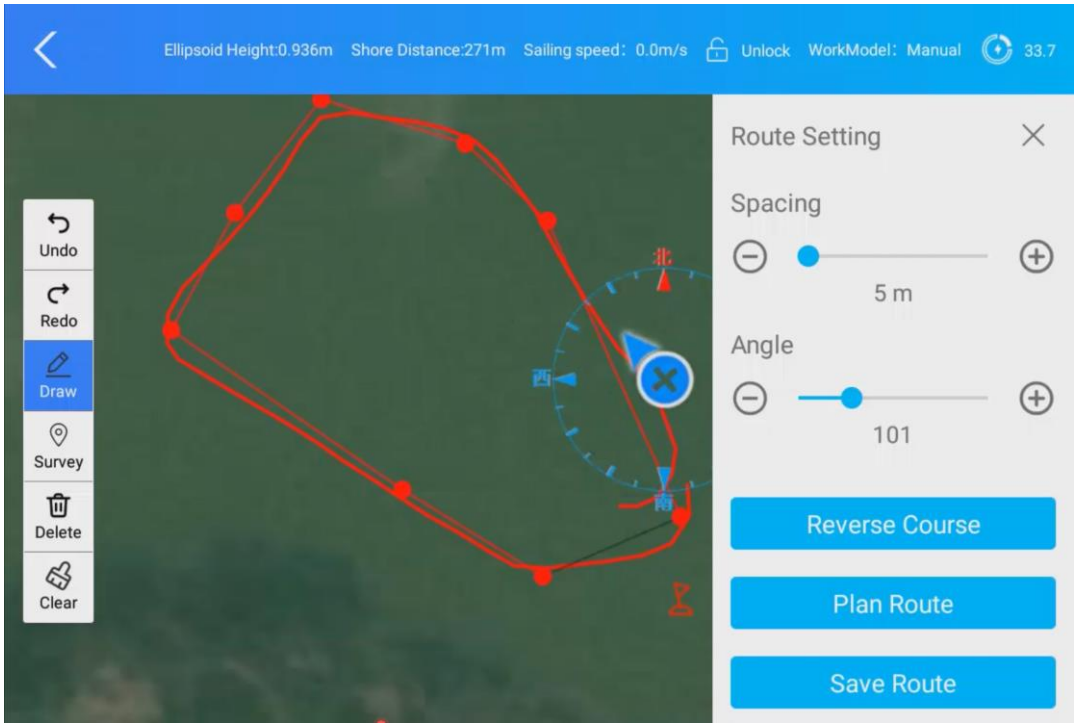
After entering Main Control Tasks interface, zoom in on the map to the target survey area. Click the **"Plan"** button, and a set of route settings (e.g., line spacing and angle) will appear on the right side of the interface.





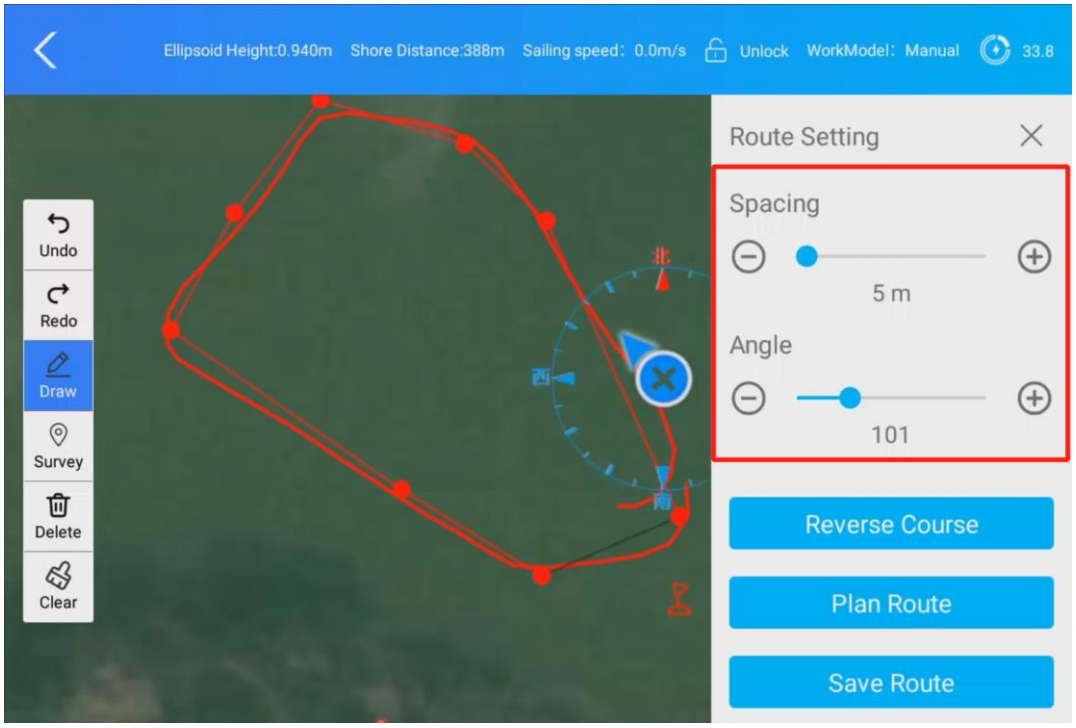
Click the **"Draw"** button, then outline the survey area on the map.

Note: *If the map is inaccurate, we recommend first using the USV to manually trace the shoreline and define the survey area.*



After defining the area, set the **line spacing** (default: 5m) and adjust the **angle** to optimize the survey line orientation.

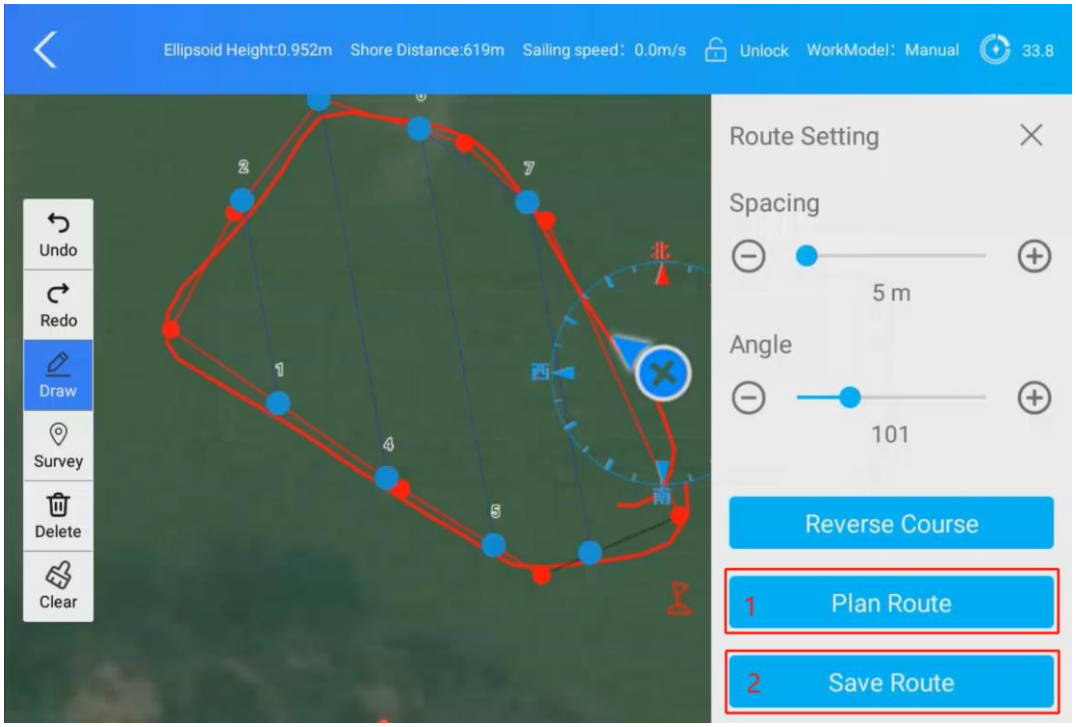
Note: *Avoid setting the spacing too small, as it must account for the USV's turning radius.*

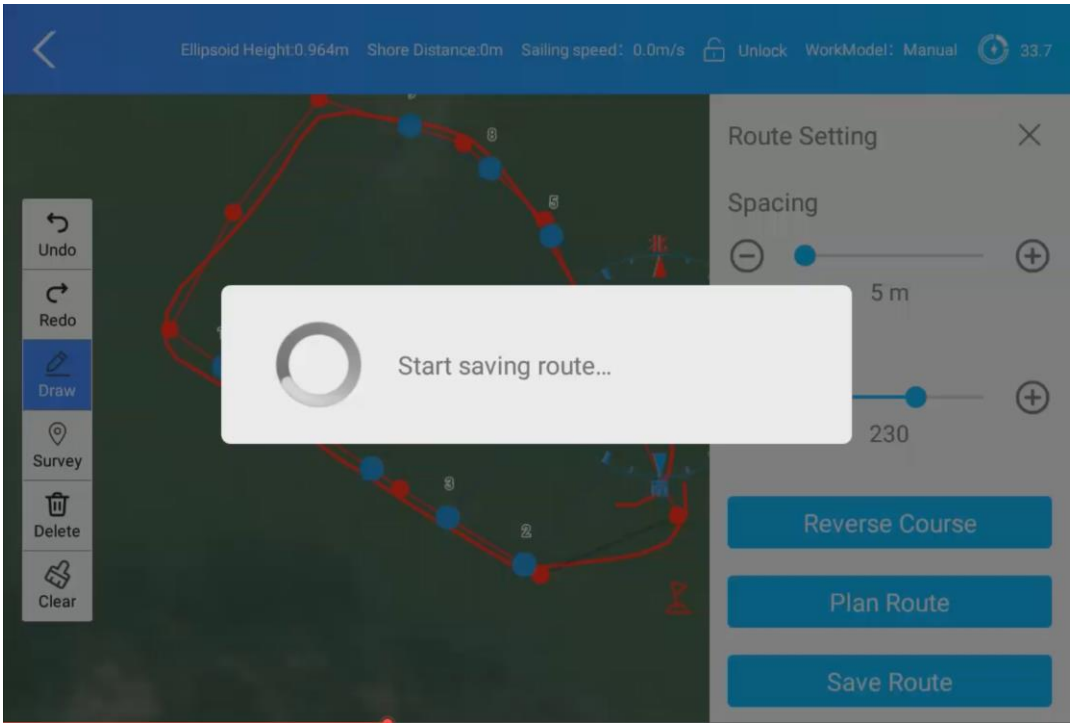


Click the **"Plan Route"** button to generate the route based on the configured parameters.

If the angle appears suboptimal, adjust it and click **"Plan Route"** *again to regenerate.*

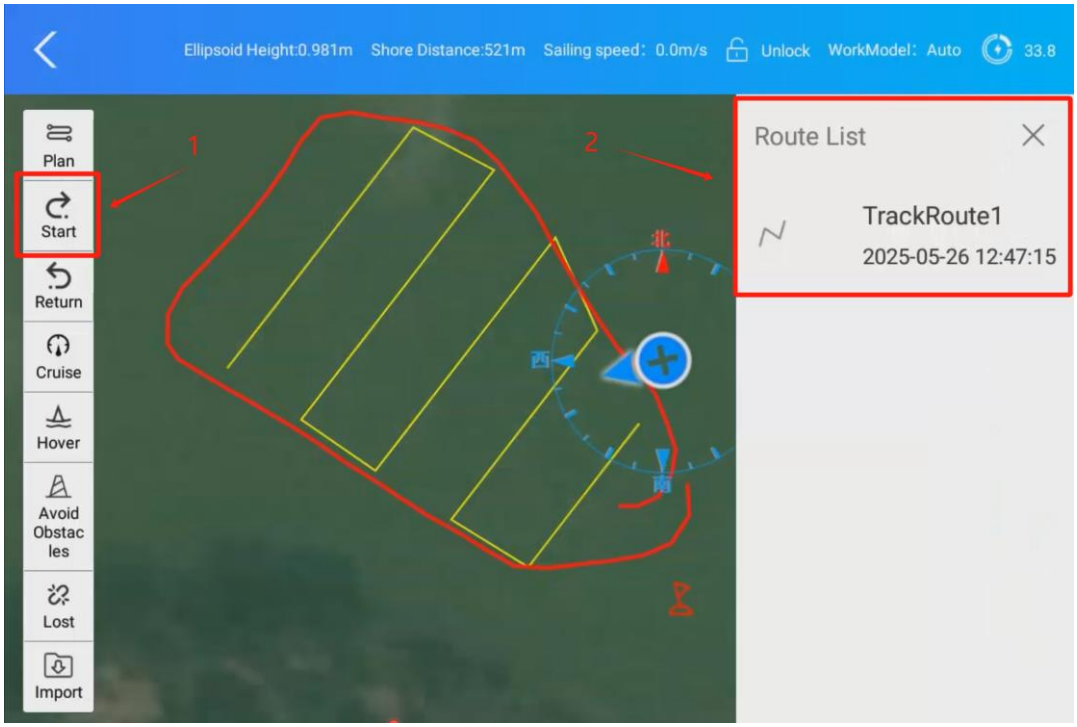
Once satisfied, click **"Save Route"** to store the planned route.





6.1.3.11 Mission Settings

Click the **"Start"** button to display the planned route on the right panel. Select the route file to load it on the survey area.



Start Node Number: Set the departure location for the USV to begin data collection, usually we set the number 1 as the starting waypoint.

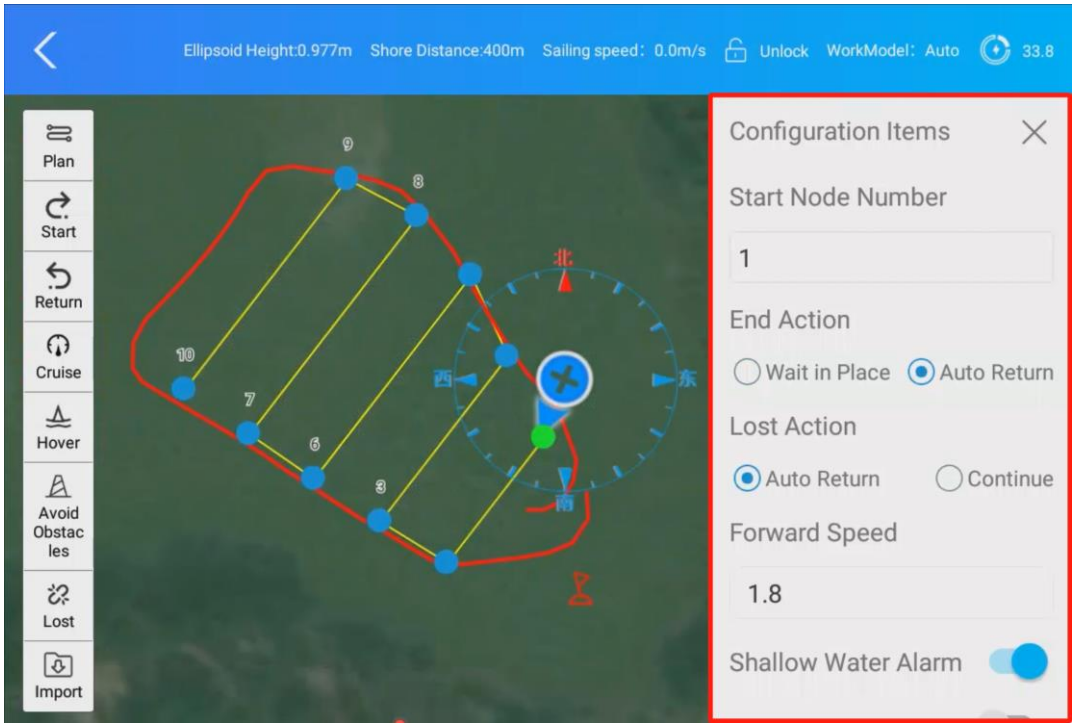
End Action: What action of USV after the mission finish, select **Auto Return** for the end action.

Lost Action: What action of USV if the communication signal lost, select **Auto Return** if communication is lost.

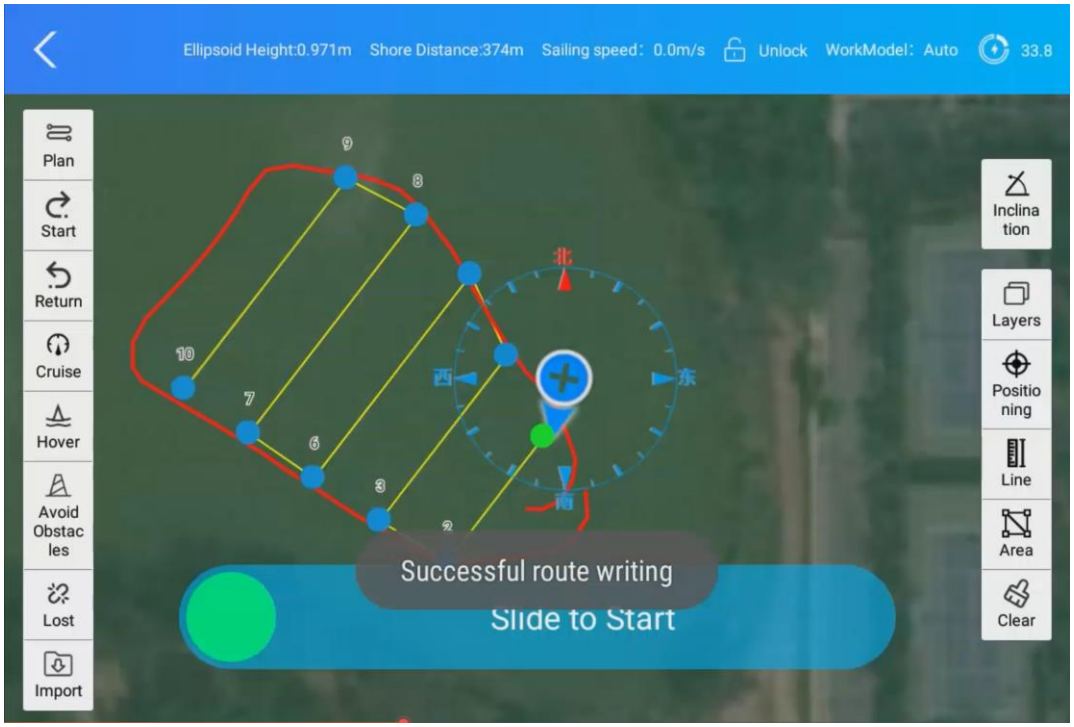
Forward Speed: This is the cruising speed of USV for the mission execution. Usually the cruising speed is set at the range **1.5m/s ~ 2.0m/s**, default is **1.8 m/s**.

Avoid excessive speed, as it may cause the USV's bow to lift, compromising depth sounder signal quality.

Click **"Confirmation"** to finalize settings.


Ellipsoid Height:0.977m
Shore Distance:400m
Sailing speed：0.0m/s
Unlock
WorkModel：Auto
33.8
Plan
Start
Return
Cruise
Hover
Avoid Obstacles
Lost
Import
Configuration Items
Start Node Number
1
End Action
Wait in Place
Auto Return
Lost Action
Auto Return
Continue
Forward Speed
1.8
Shallow Water Alarm

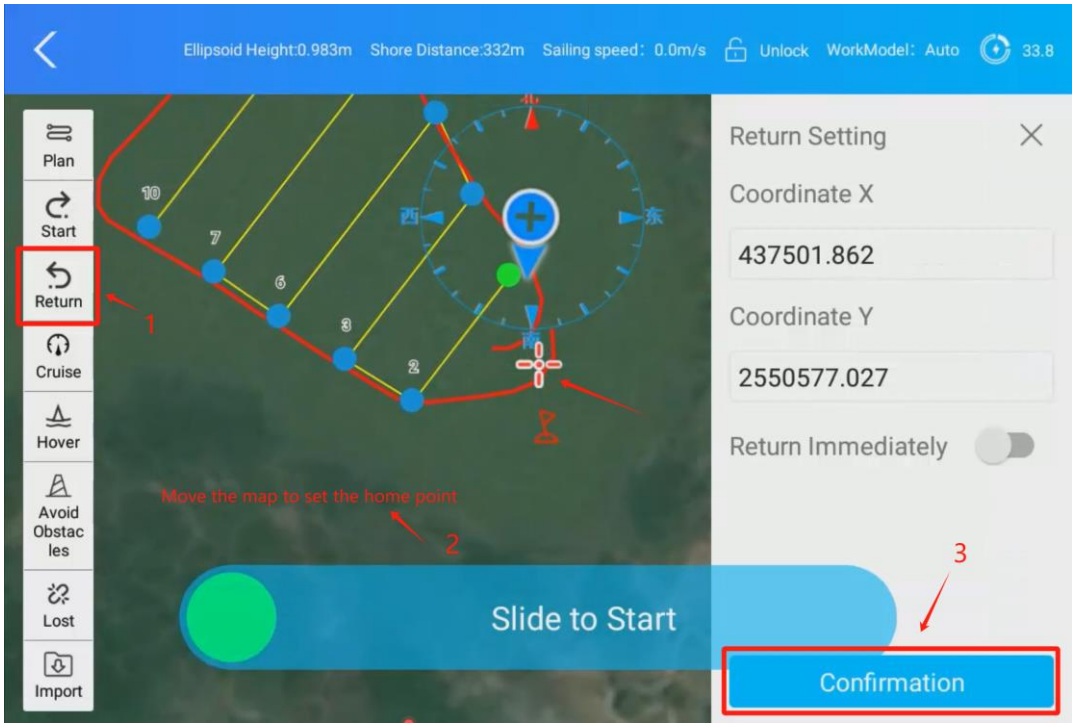

Ellipsoid Height:0.981m
Shore Distance:396m
Sailing speed：0.0m/s
Unlock
WorkModel：Auto
33.8
Plan
Start
Return
Cruise
Hover
Avoid Obstacles
Lost
Import
1
End Action
Wait in Place
Auto Return
Lost Action
Auto Return
Continue
Forward Speed
1.8
Shallow Water Alarm
Reverse Sail
Confirmation

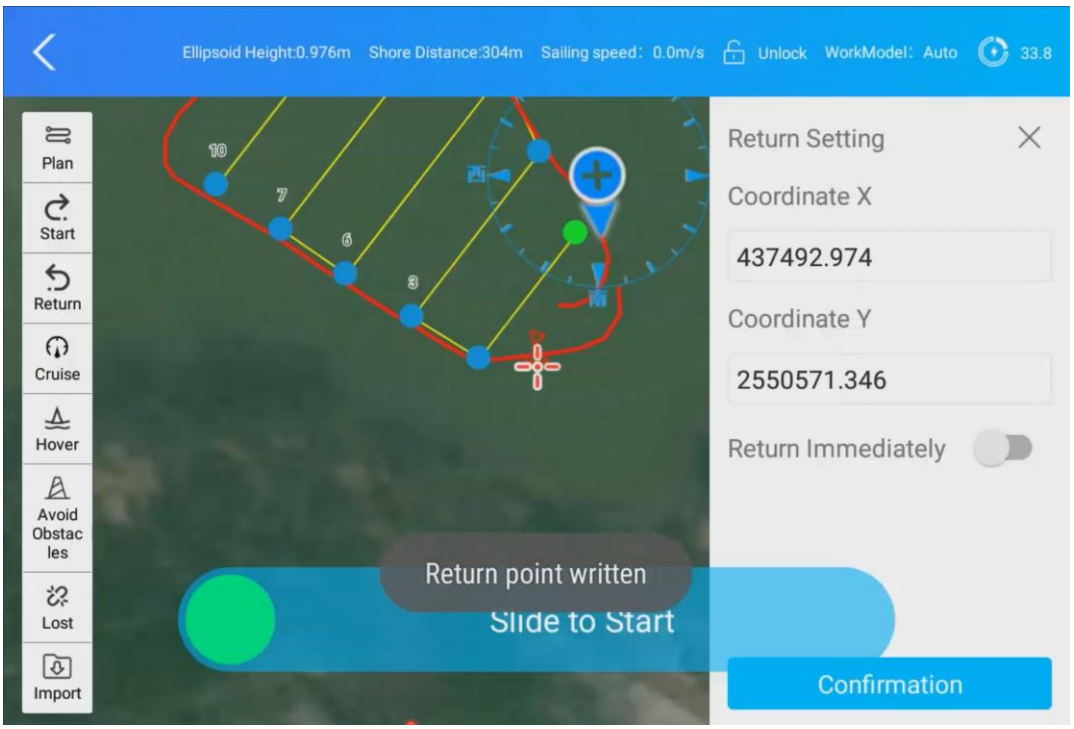


Manually control the USV to face the bow outward, avoiding pointing it toward the shore to prevent unnecessary damage. Then set the **SW2 toggle switch** on the remote controller to **Auto mode**.

6.1.3.12 Setting the Home Point

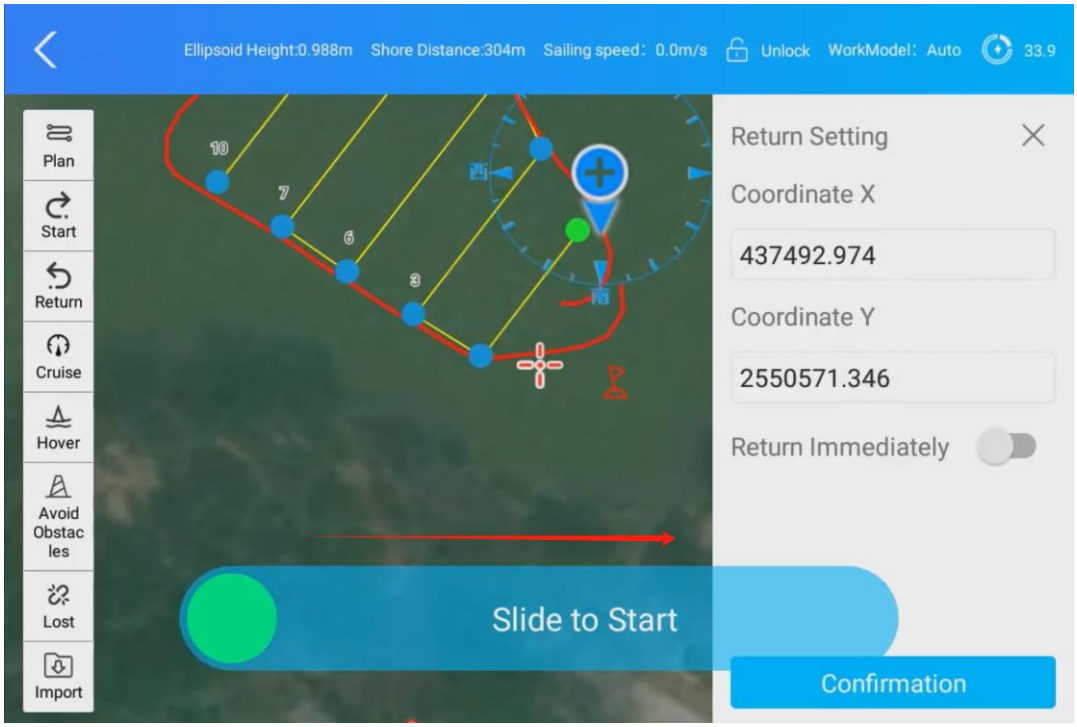
Click the **"Return"** button, then move the map to adapt the crosshair cursor (it always locates at the center of map) to select the desired return point. The right-side information panel will display the coordinate details. Once a suitable return point is confirmed, click the **"Confirmation"** button to finalize the selection.

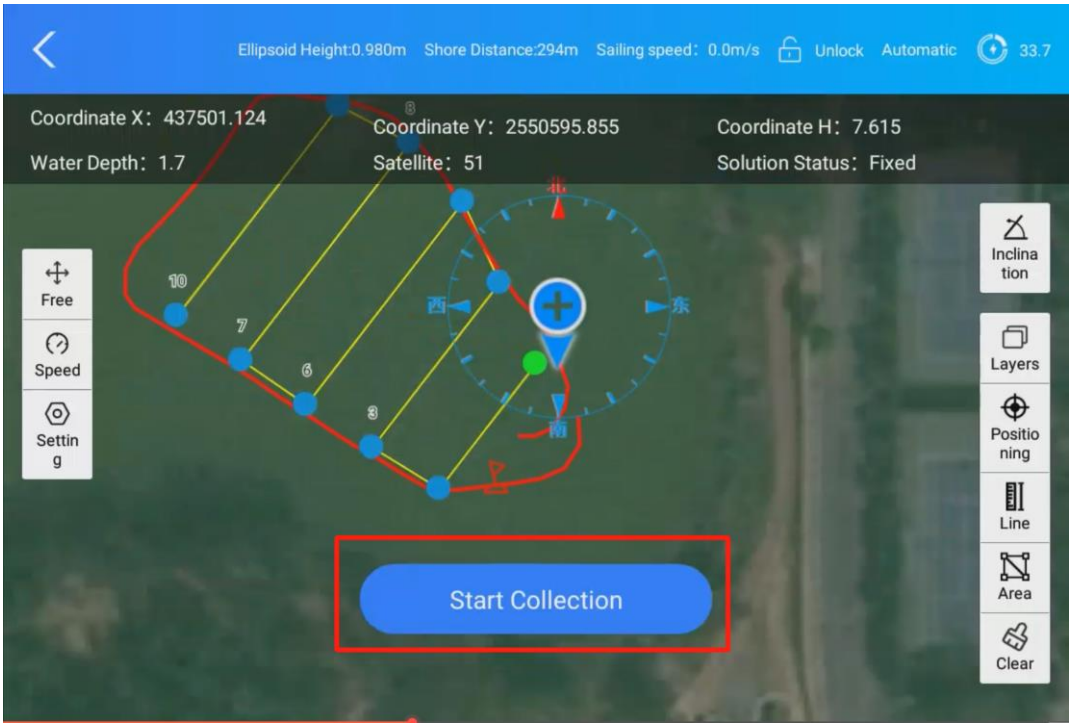




6.1.3.13 Mission Execution

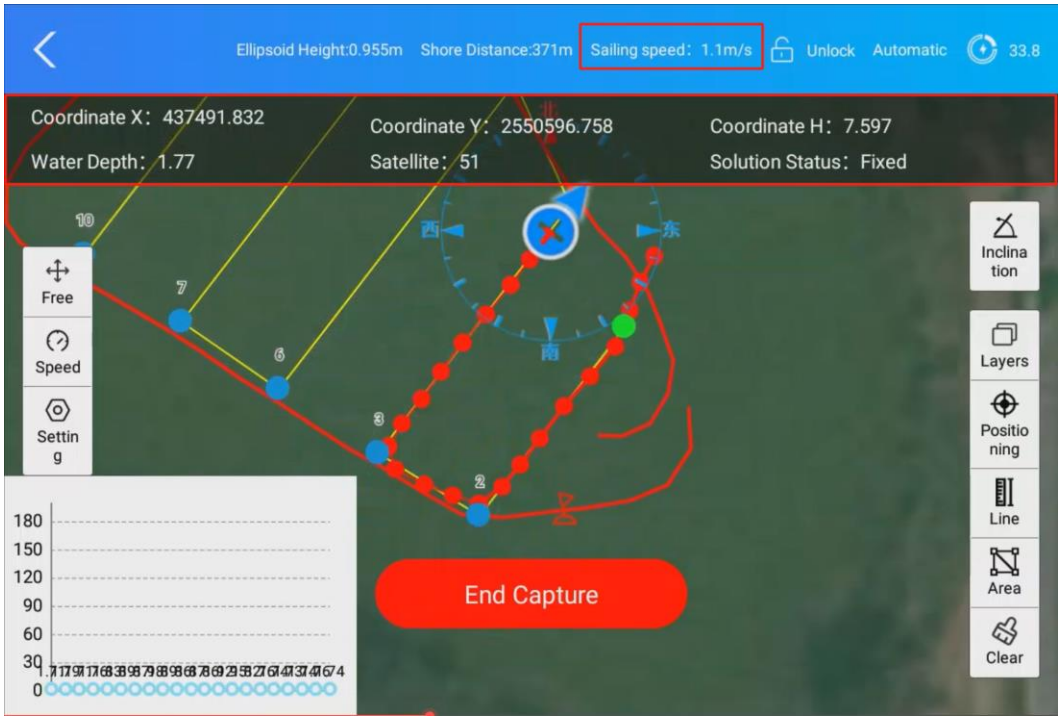
After the return point is confirmed, then slide the toggle button to start the mission. The USV will automatically navigate to the starting waypoint, and the software will simultaneously switch to the **Measurement Acquisition interface**. Click the **"Start Collection"** button to begin data acquisition.


Ellipsoid Height:0.988m
Shore Distance:304m
Sailing speed：0.0m/s
Unlock
WorkModel：Auto
33.9
Plan
Start
Return
Cruise
Hover
Avoid Obstacles
Lost
Import
Return Setting
Coordinate X
437492.974
Coordinate Y
2550571.346
Return Immediately
Slide to Start
Confirmation


Ellipsoid Height:0.980m
Shore Distance:294m
Sailing speed：0.0m/s
Unlock
Automatic
33.7
Coordinate X：437501.124
Coordinate Y：2550595.855
Coordinate H：7.615
Water Depth：1.7
Satellite：51
Solution Status：Fixed
Free
Speed
Setting
Inclination
Layers
Positioning
Line
Area
Clear
Start Collection

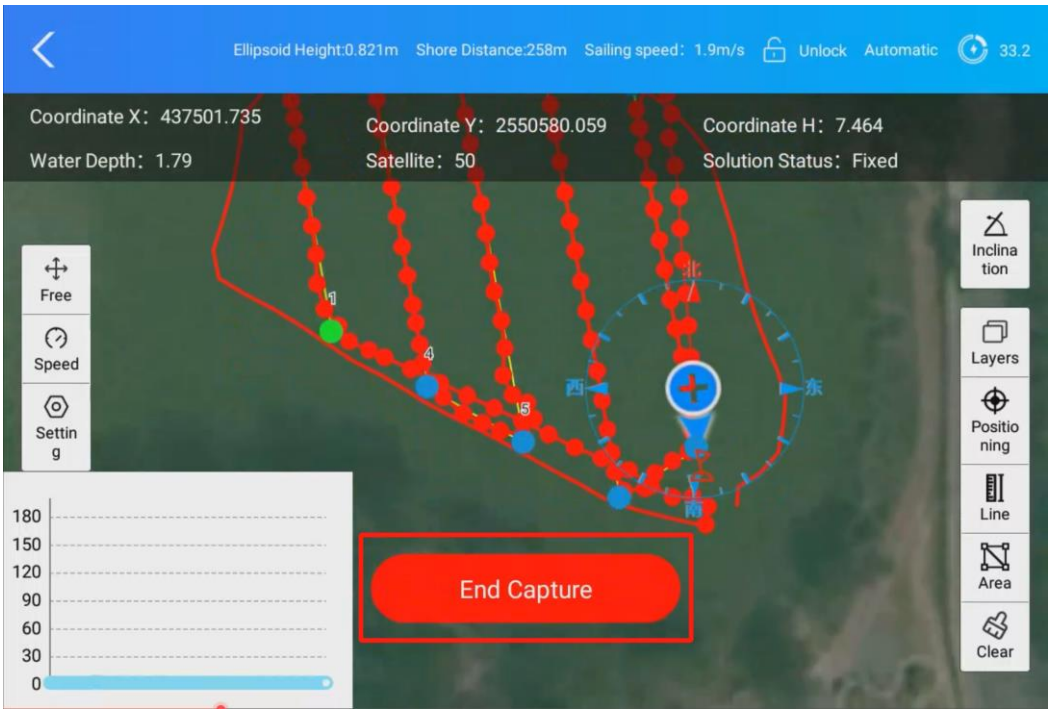
During the collection process, monitor the following parameters in real-time:

- **Water depth**
- **RTK solution status** (Fixed/Float/Single)
- **USV navigation status** (speed, heading, and position)



Upon mission completion, the USV will automatically navigate to the preset return point. Click the **"End Capture"** button to finish data collection.

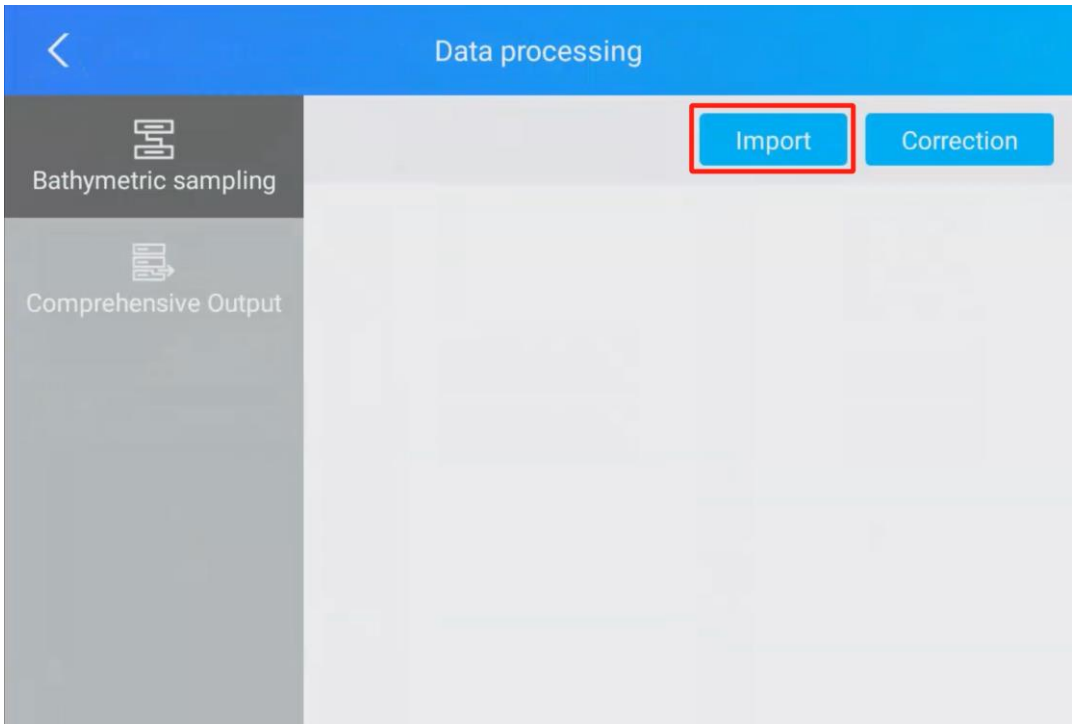
Once the USV reaches the return point, switch the remote controller to **Manual Mode**. Gently steer the USV toward the shore for safe retrieval.

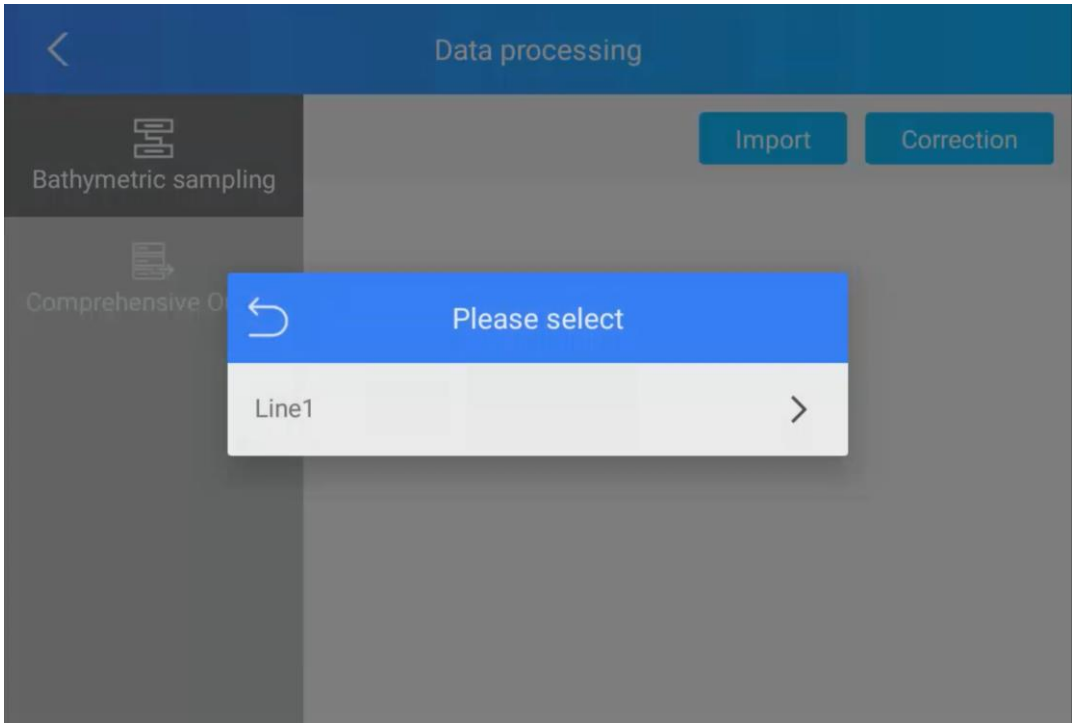


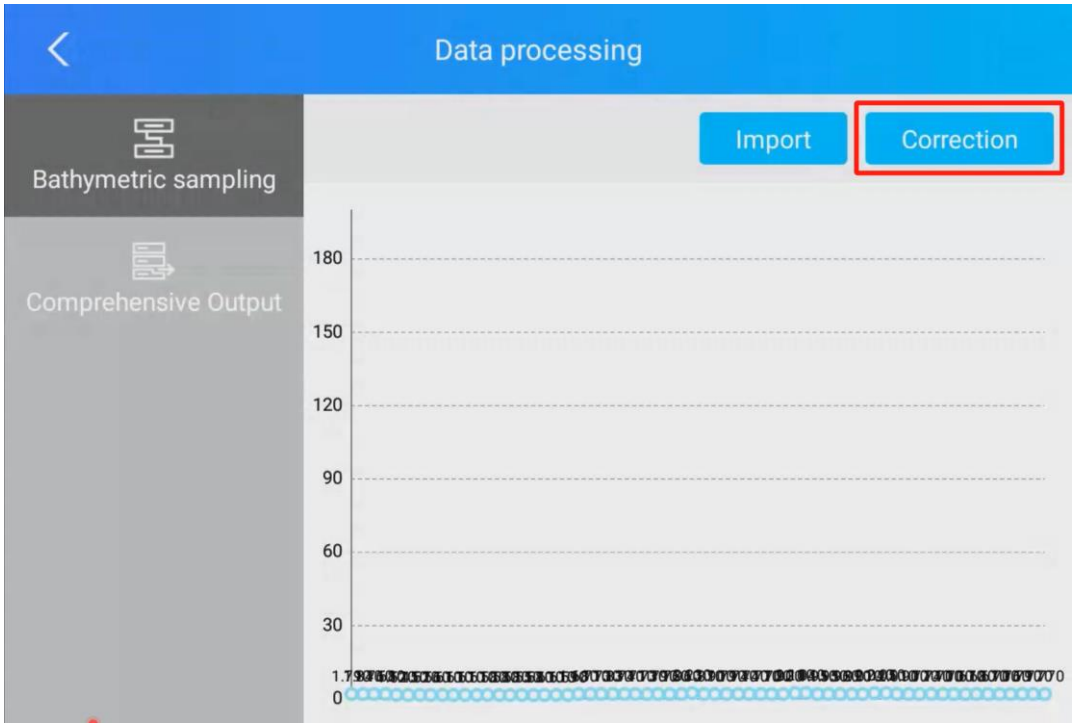
6.1.3.14 Data Processing

After completing data collection, click the **Data Processing** menu to enter the data processing interface.

Go to Bathymetric Sampling Interface and click the **"Import"** button to load depth data. If anomalous depth values (e.g., outliers) are detected, click the **"Correction"** button to automatically adjust anomalous depth measurements.

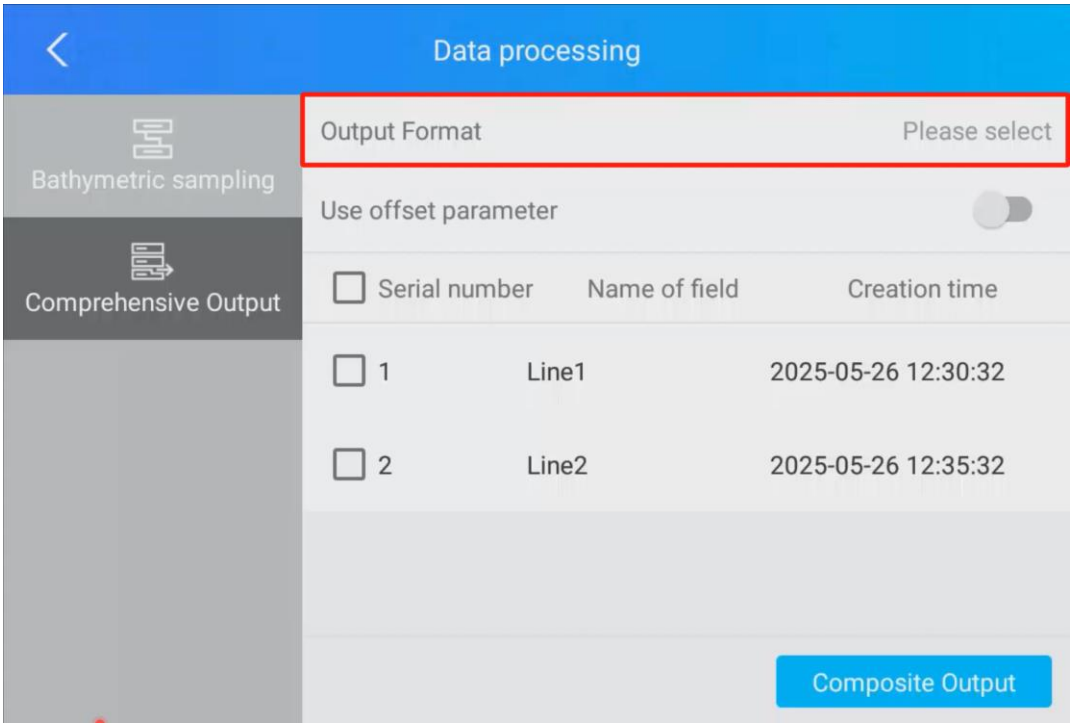


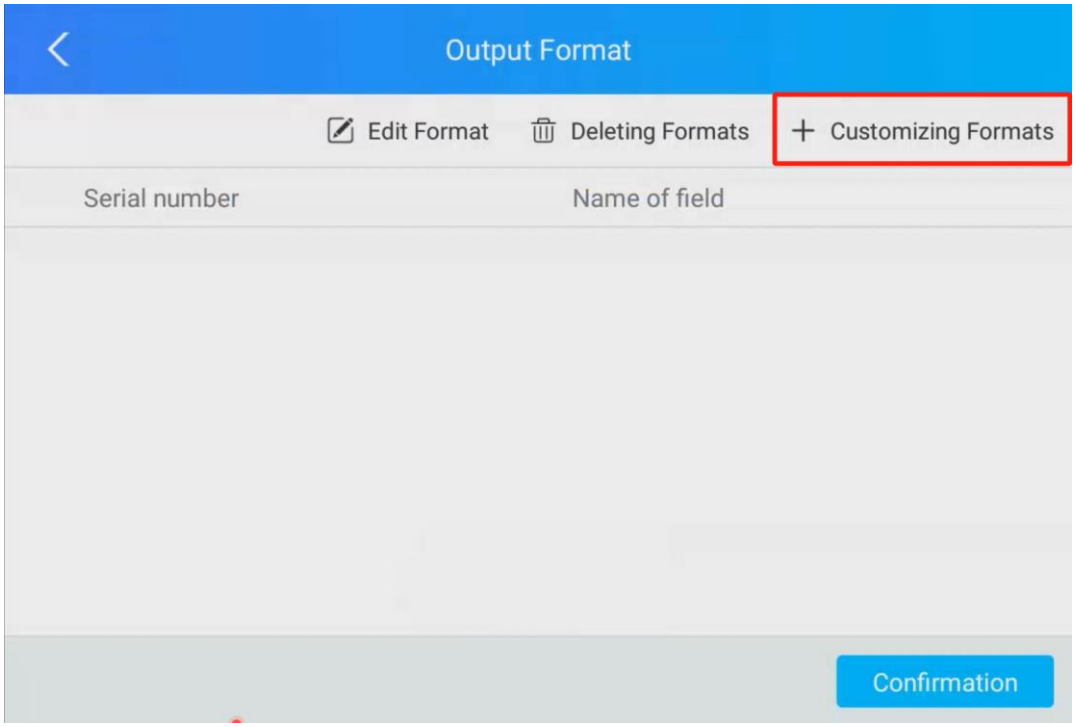

Data processing
Bathymetric sampling
Import
Correction
Please select
Line1


Data processing
Bathymetric sampling
Import
Correction
Comprehensive Output
180
150
120
90
60
30
0

6.1.3.15 Comprehensive Output

Go to the **Comprehensive Output** interface, click **"Output Format"** to enter the format definition menu, select **Customizing Formats**.





Set **Name of Field** to CSV, choose CSV as the **Extension**.

Check the following fields for inclusion:

Point Name

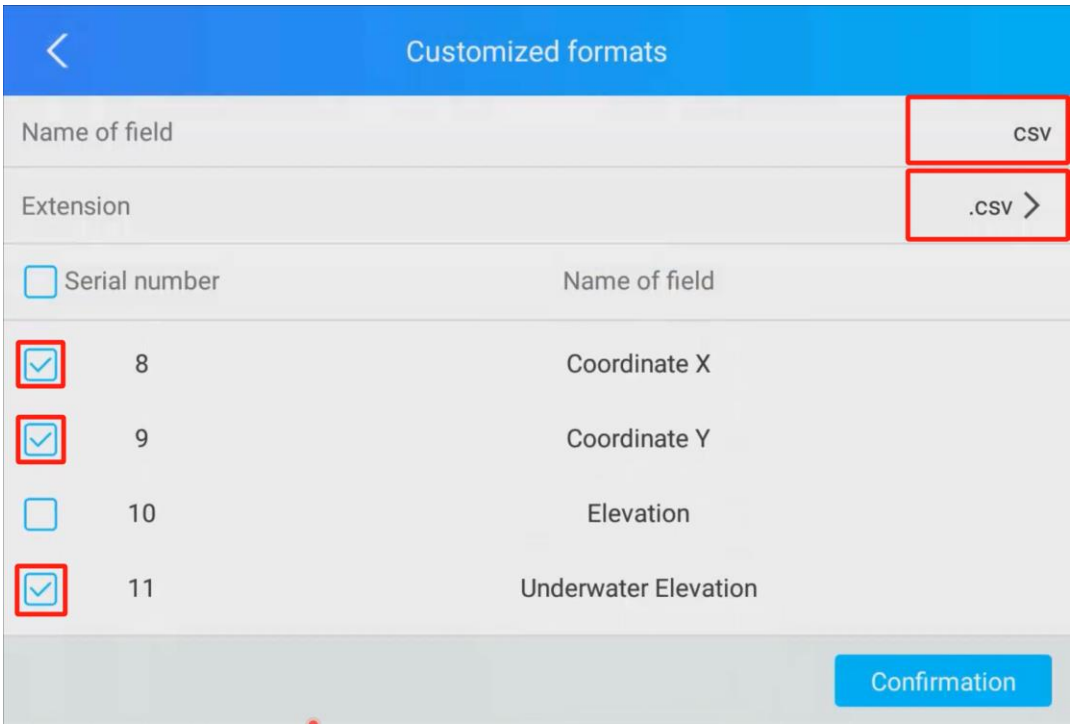
Coordinate Y (e.g., Latitude)

Coordinate X (e.g., Longitude)

Underwater Elevation

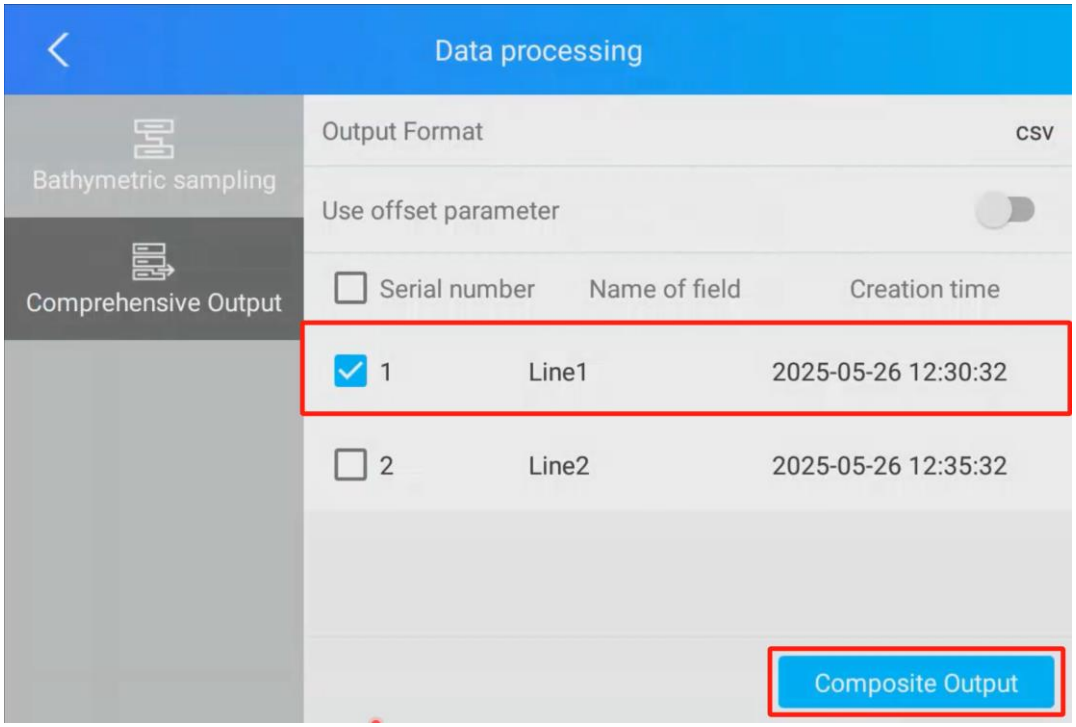
Raw Water Depth

Click "**Confirmation**" to save the format.

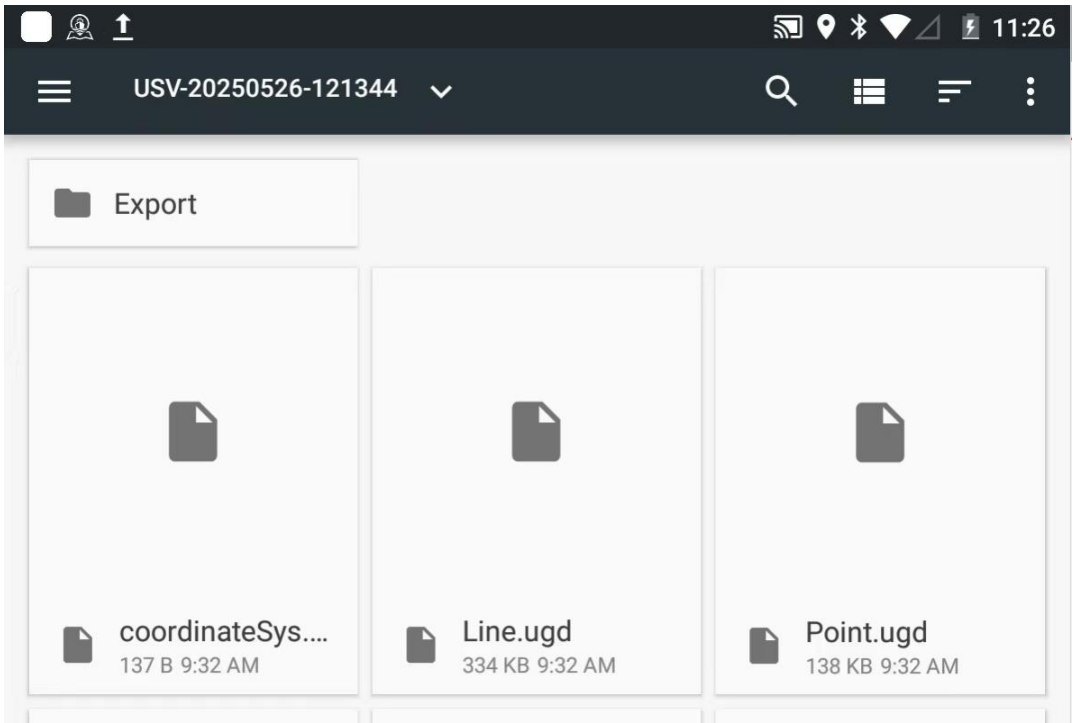


Back in the **Output Format** menu, select the newly defined CSV format and click "**Confirmation**" button.

Back in Comprehensive Output interface, choose the processed survey route, then click **Composite Output**.



The exported file you can find in the directory as Settings—Storage—Internal shared storage—Other—USVMapper—Task—Project(project name)—Export.



6.2 Using External RTK

6.2.1 Ensure All Accessories of the USV Are Complete

a) USV hull.

b) Batteries—Check if the battery is sufficiently charged. Press the battery button on the battery to view the remaining power capacity, displayed as a percentage according to the light up indicators.

c) Two 2.4G antennas— For communication with the remote controller.

d) One 4G antenna—For network communication via the 4G module.

e) Remote controller.

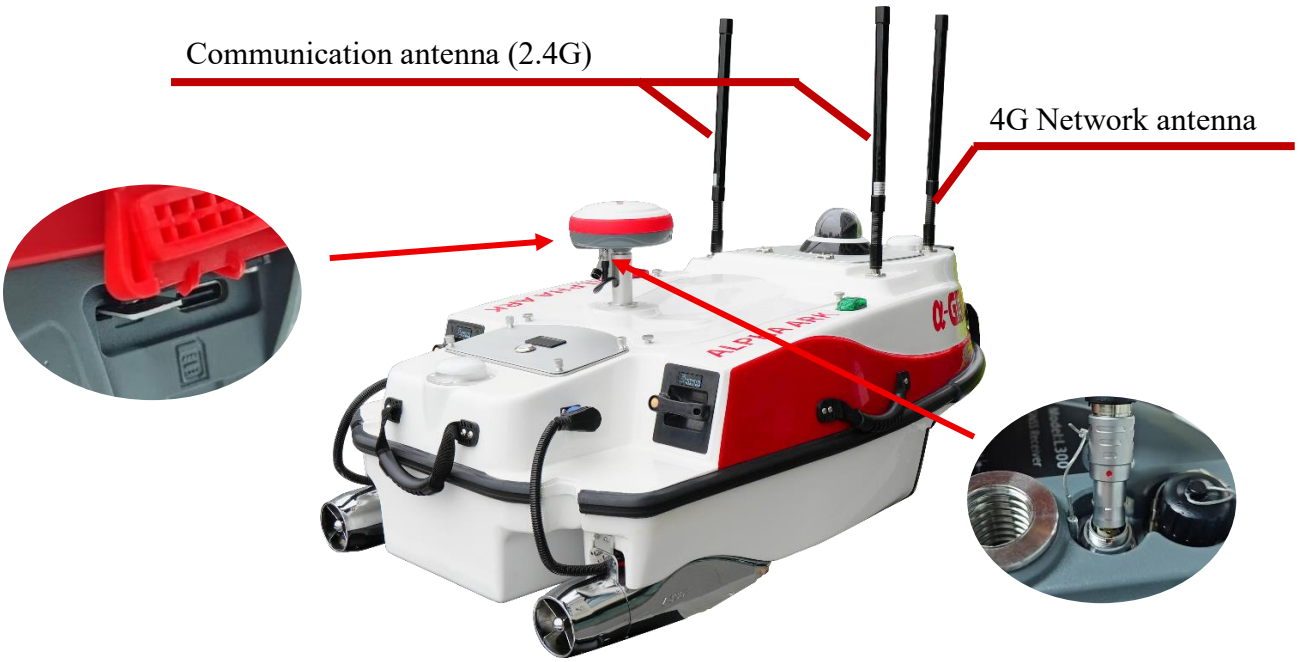
f) GNSS RTK receiver.

6.2.2 Pre-Launch Hardware Checks

1) Install the battery into the battery compartment of the USV and ensure it is securely fastened.

2) Mount the two 2.4G communication antennas to their corresponding ports (the two ports on the left and right sides of the vessel).

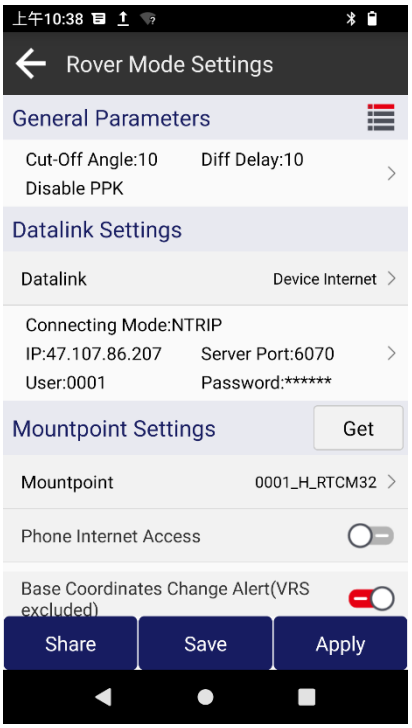
3) Mount the 4G communication antennas to its corresponding ports (the port on the right sides at the front of vessel).

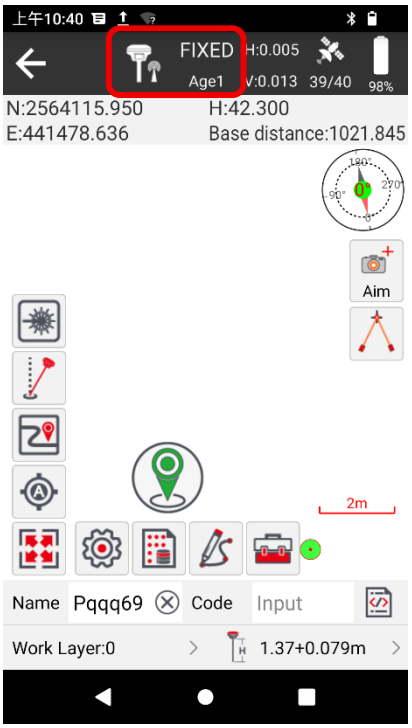


4) Install the SIM card to GNSS RTK receiver sim card slot.

5) Mount the RTK receiver onto the support rod and plug the communication cable to the LEMO-5 serial port of receiver. *Please note that the red dot must be matched to each other.*

6) Use the RTK control software to configure the RTK receiver to obtain correction from CORS station and achieve fixed solution.

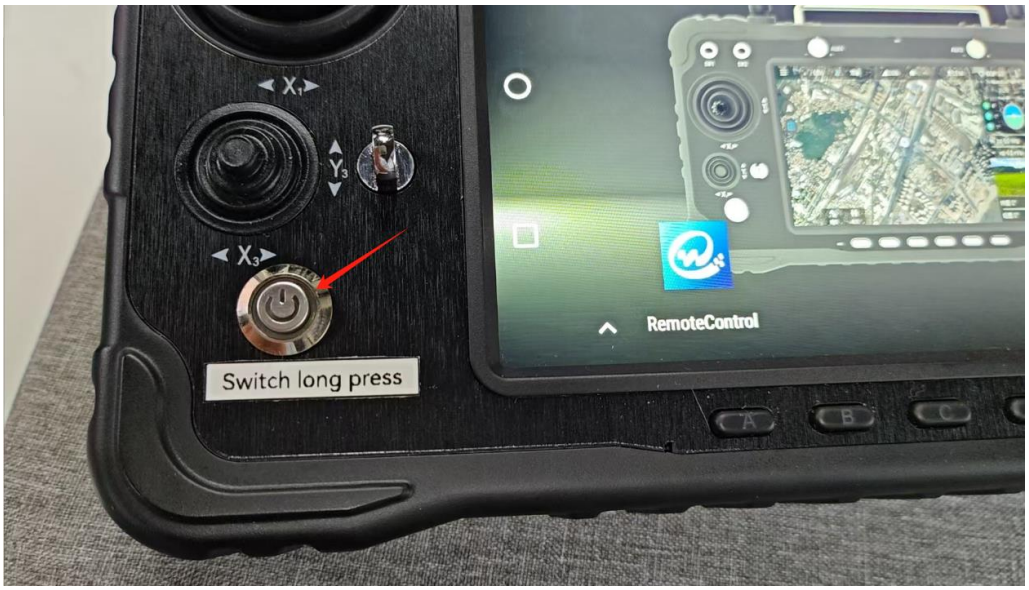




7) On the remote controller, move the SW1 toggle switch upward to the unlock position (when the toggle is in the middle or lowest position, the USV is locked, and the propellers will immediately stop working, preventing movement—this can be used in emergencies).

8) On the remote controller, move the SW2 toggle switch upward to the manual mode position (the lowest position is for automatic mode).

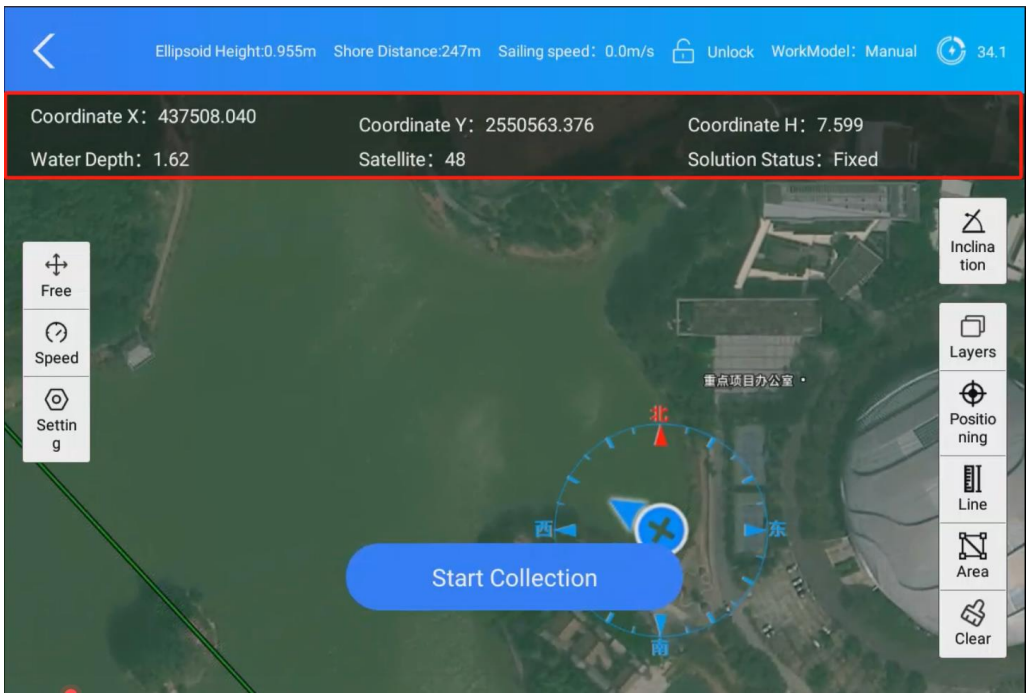
9) Turn on the remote controller first by pressing and holding the power button for 3-5 seconds until the indicator light turns on.



10) After the remote controller is powered on, press the power button on the USV to activate it. The USV will perform a self-check upon startup, which lasts approximately 1 minute.

11) Once the USV completes the self-check, it will automatically connect to the remote controller. You can verify the connection by checking the signal indicator on the remote controller—if the signal bars are full, the connection is successful.

12) Run the **USVMapper** software to view the USV's positioning status, connection status, and battery level (displayed in volts in the upper-right corner of the interface).

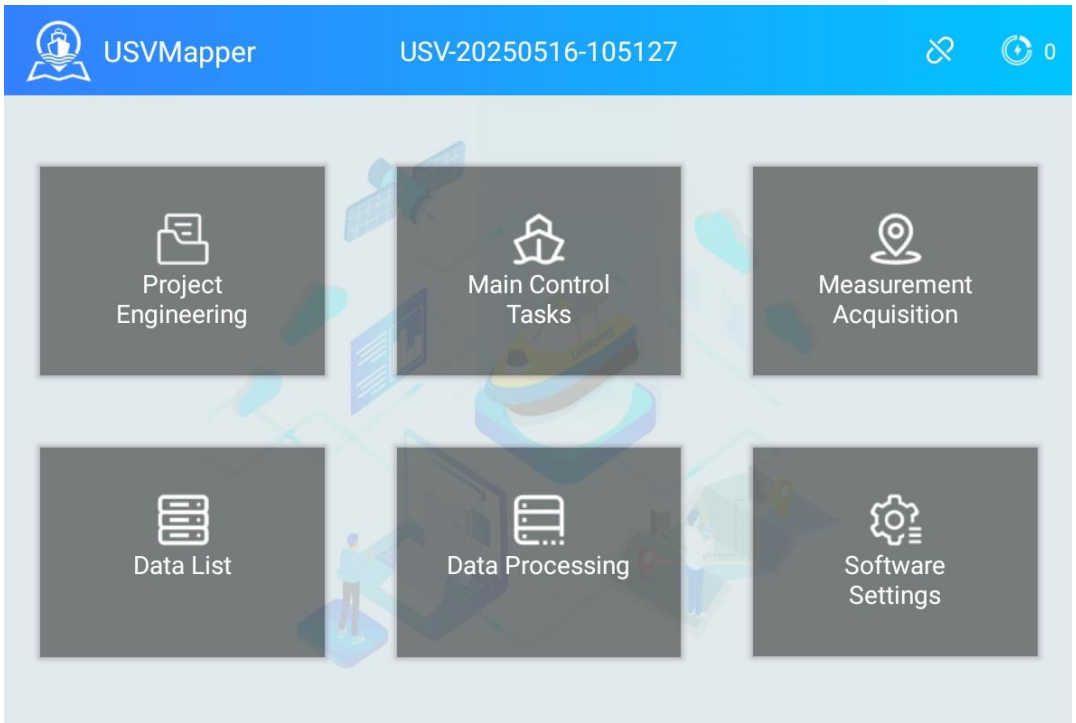


13) Gently move the throttle joystick on the left side of the remote controller to test the propulsion system.

14) After confirming that the propulsion system is functioning properly, the USV can be launched into the water. If the survey area is a river, complete all software configurations onshore before placing the USV in the water to prevent it from drifting away with the current before setup is finalized.

6.2.3 Software Operation

The software consists of six main menus, including **Project Engineering**, **Main Control Tasks**, **Measurement Acquisition**, **Data List**, **Data Processing**, and **Software Settings**.



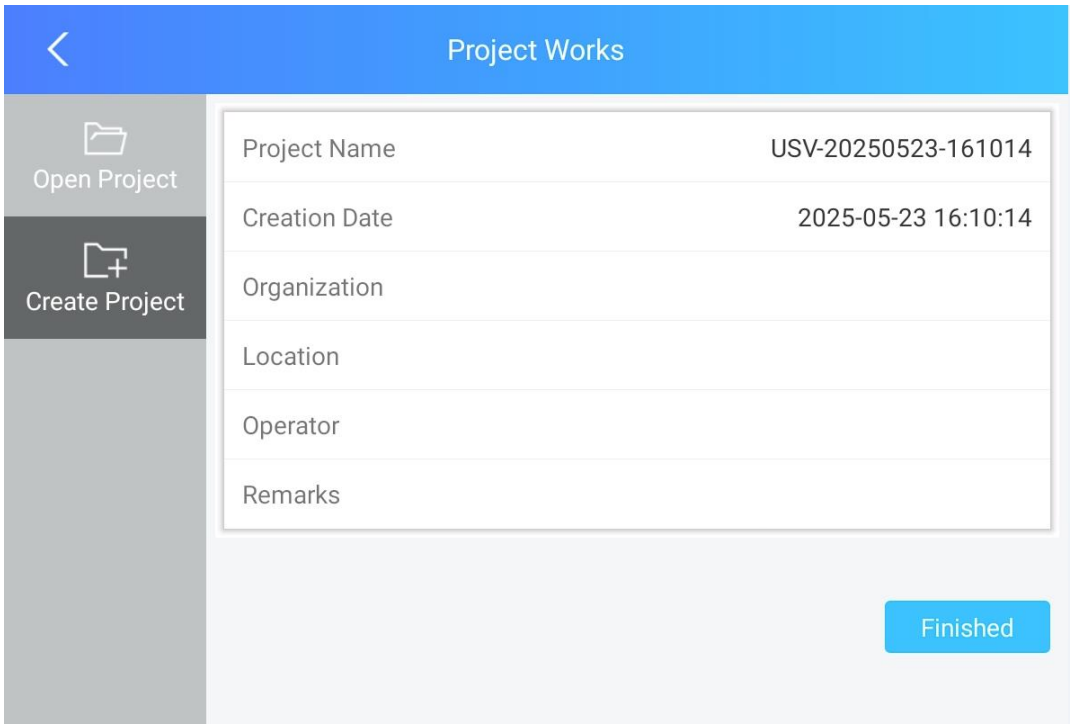
6.2.3.1 Creating or Opening a Project

First, open or create a new project. Click on the **Project** menu to enter the interface, then select **New Project**.

The project name is automatically generated in the format **USV + current date and time** by default, which helps distinguish between different projects. We recommend using this default naming convention. However, if the customer prefers, they can modify it.

Important Note: The project name **must not contain special characters** (such as **%**, **&**, etc.) or **spaces**. If such characters or spaces are included, the software may fail to read the project name correctly, leading to errors.

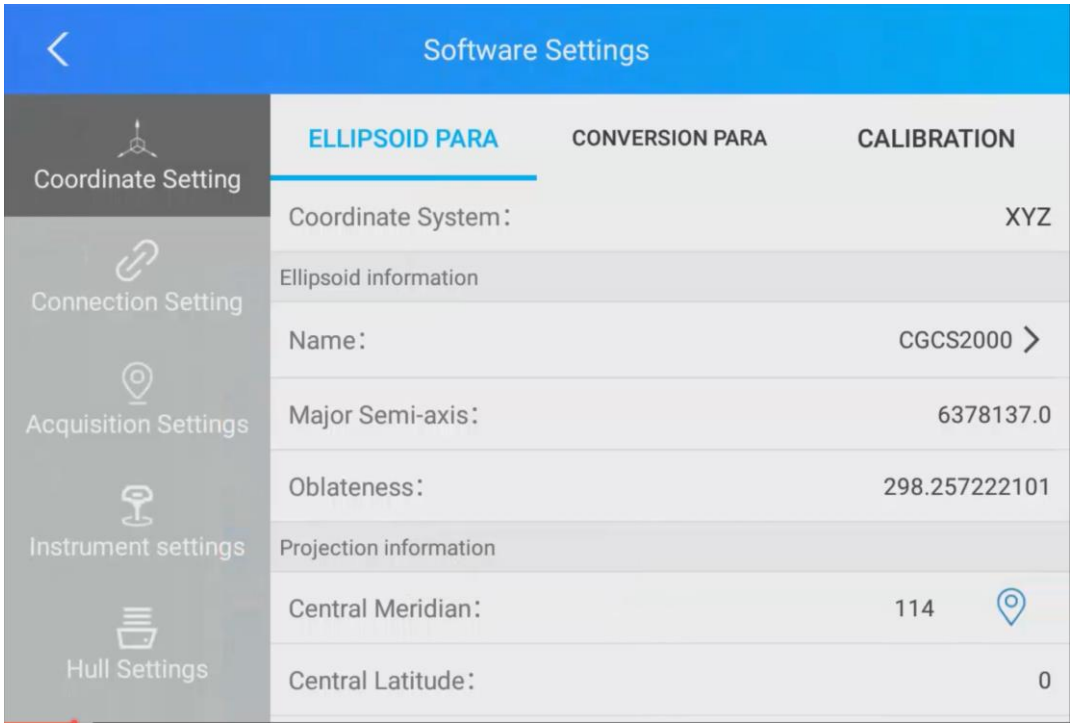
Other information is optional. After filling in the details, click the **Finish** button to generate the new project file.



6.2.3.2 Coordinate System Settings

After the project data is loaded, the software will automatically switch to the **Settings** interface. In this section, we need to configure the **Coordinate System Settings**, **Connection Settings**, **Acquisition Settings**, **Instrument Settings**, **Hull Settings**, and **Other Settings**.

First, set up the **Coordinate System** parameters according to the local coordinate system in use, like the Ellipsoid parameters, central meridian and so on.



6.2.3.3 Connection Settings

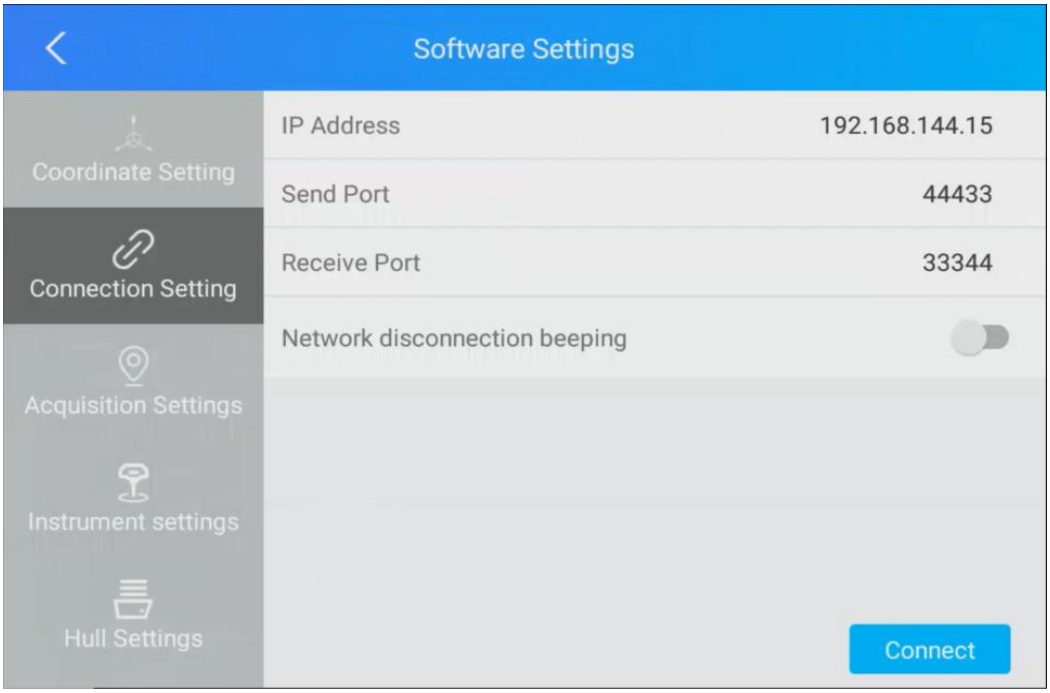
Next is the setup for connecting the remote controller and the USV. If it is the first time connecting to the USV, navigate to the **Connection Settings** page. If a default IP address and port are already available, simply click the **Connect** button to establish the connection.

If no IP address and port are configured, manually enter:

- **IP Address**: 192.168.144.15
- **Send Port**: 44433
- **Receive Port**: 33344

After entering these details, click the **Connect** button to establish communication between the remote controller and the USV.

Note: Normally, we conduct a pre-test of the USV, so the IP address and ports are usually pre-configured. In most cases, no additional setup is required here. Simply check whether the communication signal on the remote controller shows full bars to confirm a successful connection.



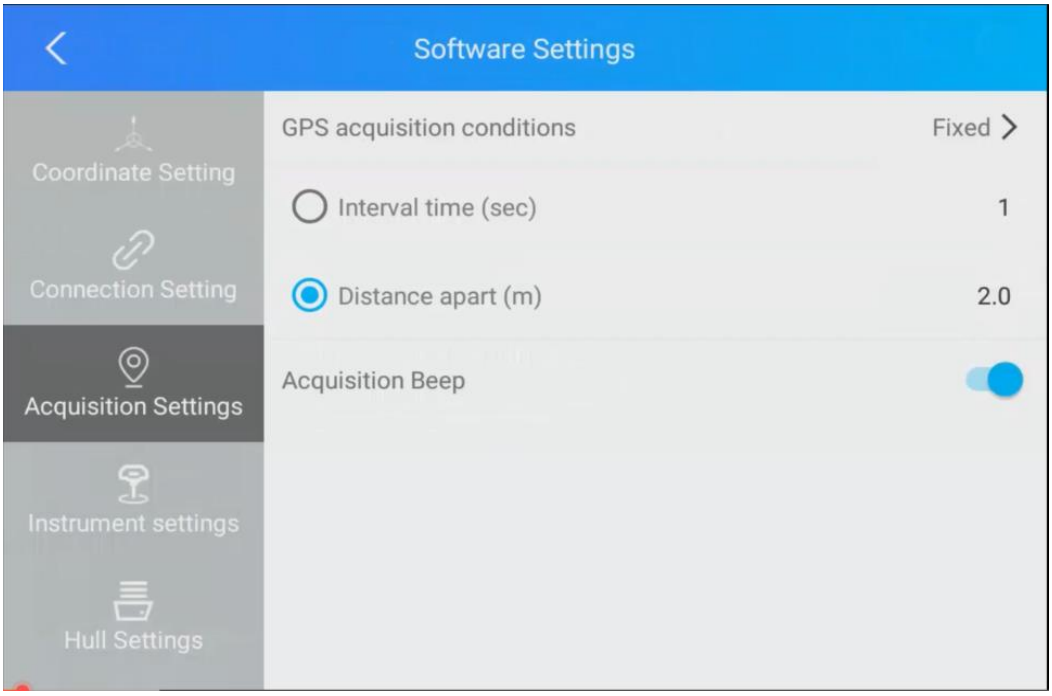
6.2.3.4 Acquisition Settings

Acquisition Settings refer to the configuration of data acquisition conditions. For example, GPS acquisition conditions settings—whether to use **Fixed Solution** or **Single Point Solution**.

Next is the **Collection Interval**, which offers two modes:

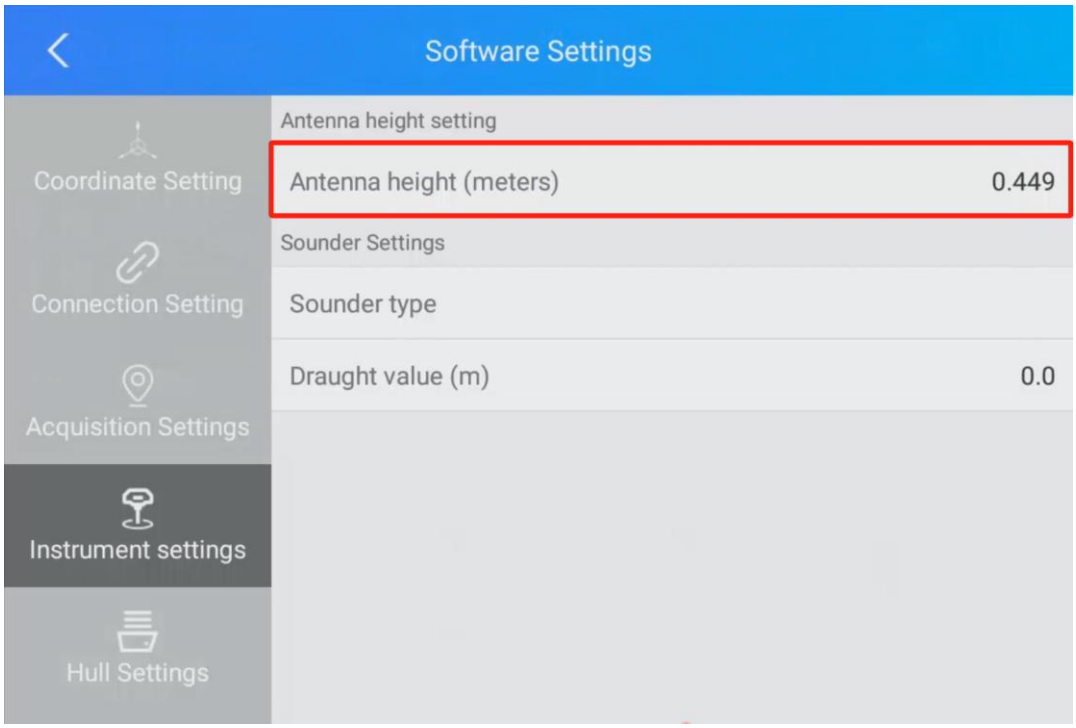
1. **Interval Time**: Collects data at fixed time intervals in seconds.
2. **Distance apart**: Collects data at predefined distance intervals.

We recommend using **distance interval collection** for optimal results.



6.2.3.5 Instrument Settings

Instrument Settings primarily involve configuring the **RTK antenna height**. Here we must use the value of **0.383+Phase center offset of RTK,** then the final value refers to the height from the **bottom of the echo sounder to the GNSS phase center**, so the antenna height value here is **0.383+0.066 (L300 for example)**. No setting here is required for the draft value.

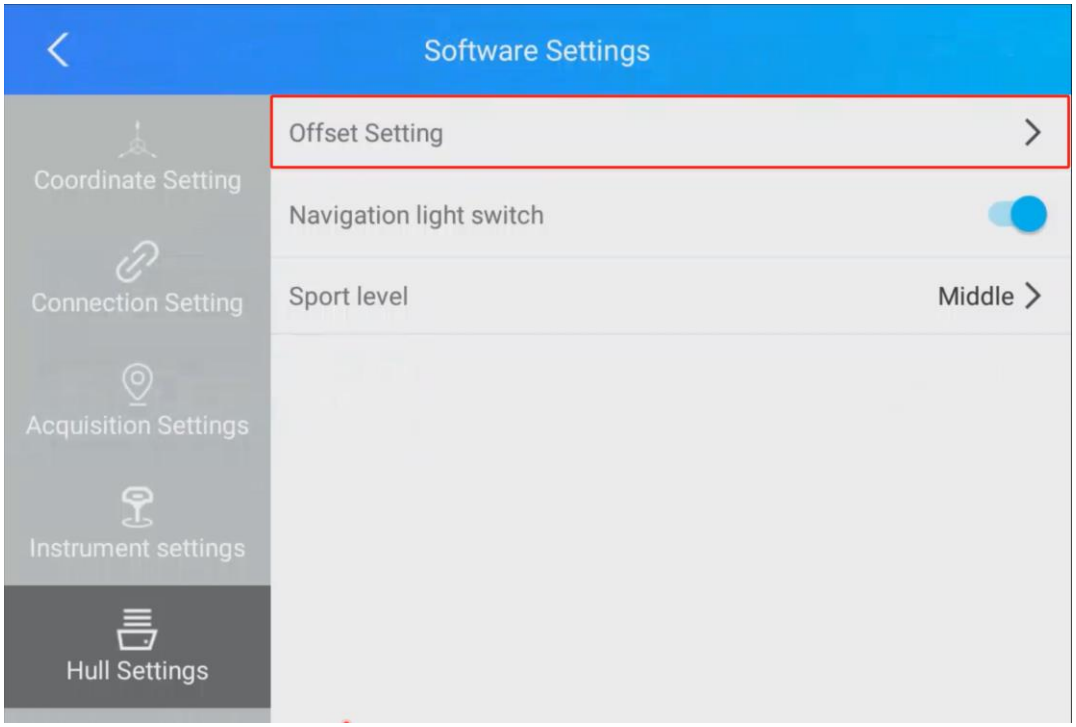


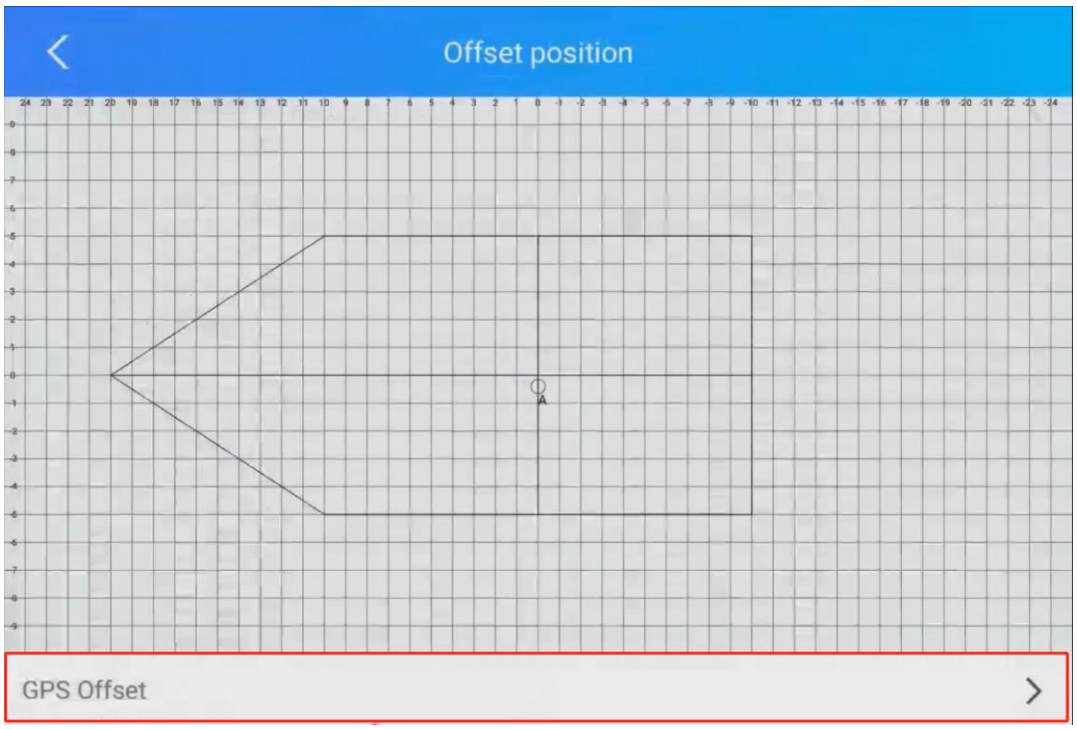
6.2.3.6 Hull Settings

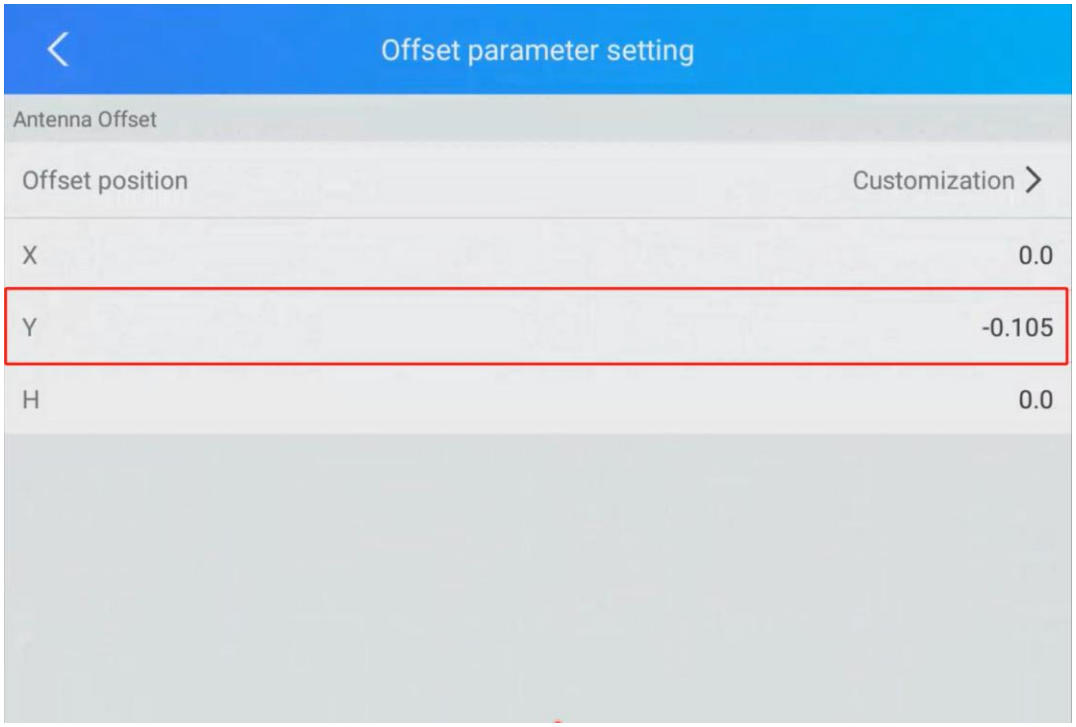
Hull Settings primarily involve adjusting the **RTK position offset** to align it directly above the echo sounder. Since the RTK is not installed precisely above the echo sounder, an offset value must be applied to correct its position. To configure this:

1. Click **"Offset Setting → GPS Offset → Y"**.
2. Set the **Y-value to -0.105** (no other values need adjustment).

This ensures the RTK data is referenced to the correct position above the echo sounder.

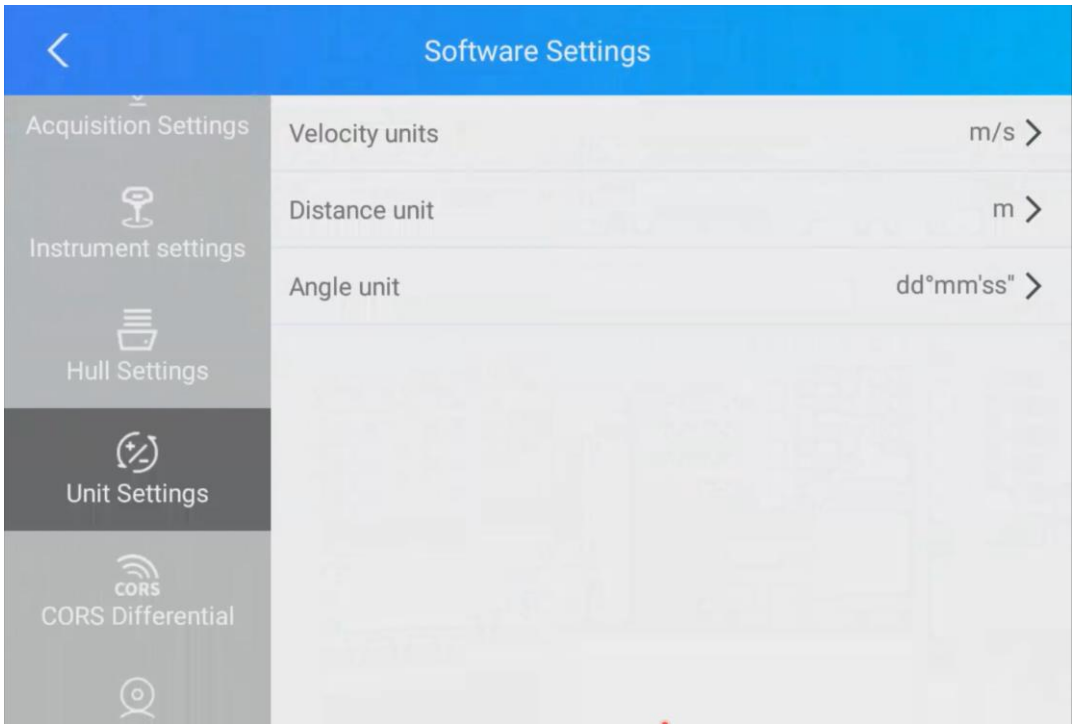

Software Settings
Coordinate Setting
Connection Setting
Acquisition Settings
Instrument settings
Hull Settings
Offset Setting
Navigation light switch
Sport level
Middle


Offset position
GPS Offset



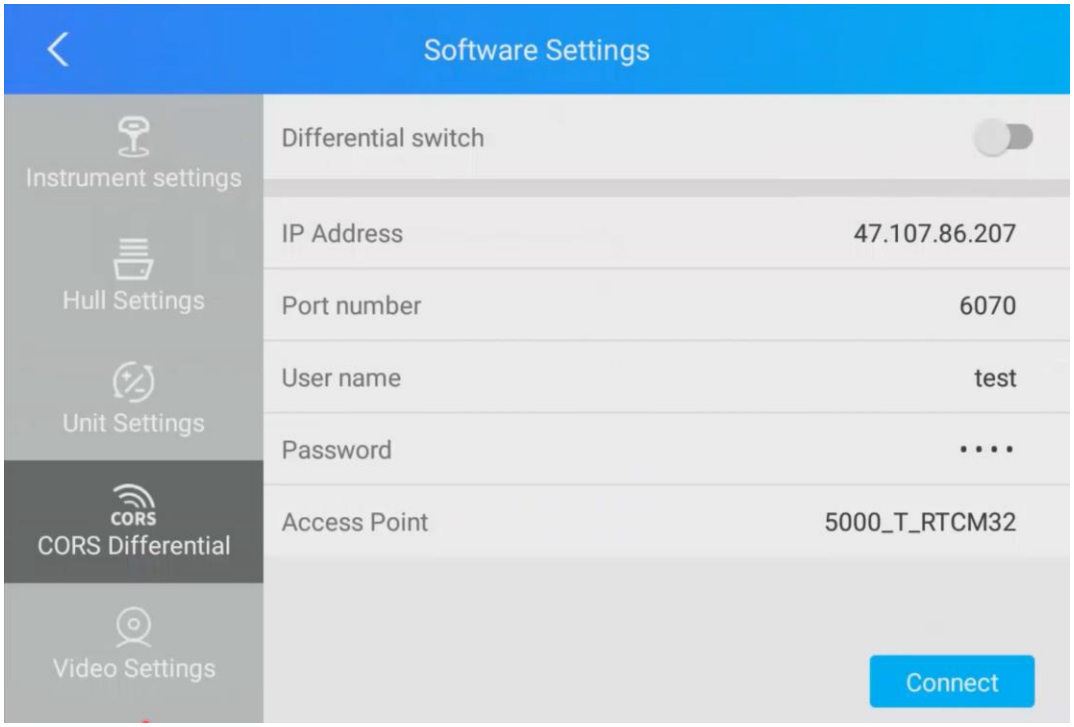
6.2.3.7 Unit Settings

Unit Settings: No configuration is required by default. However, you may customize the settings based on your preferences, such as the angle unit.



6.2.3.8 CORS Differential

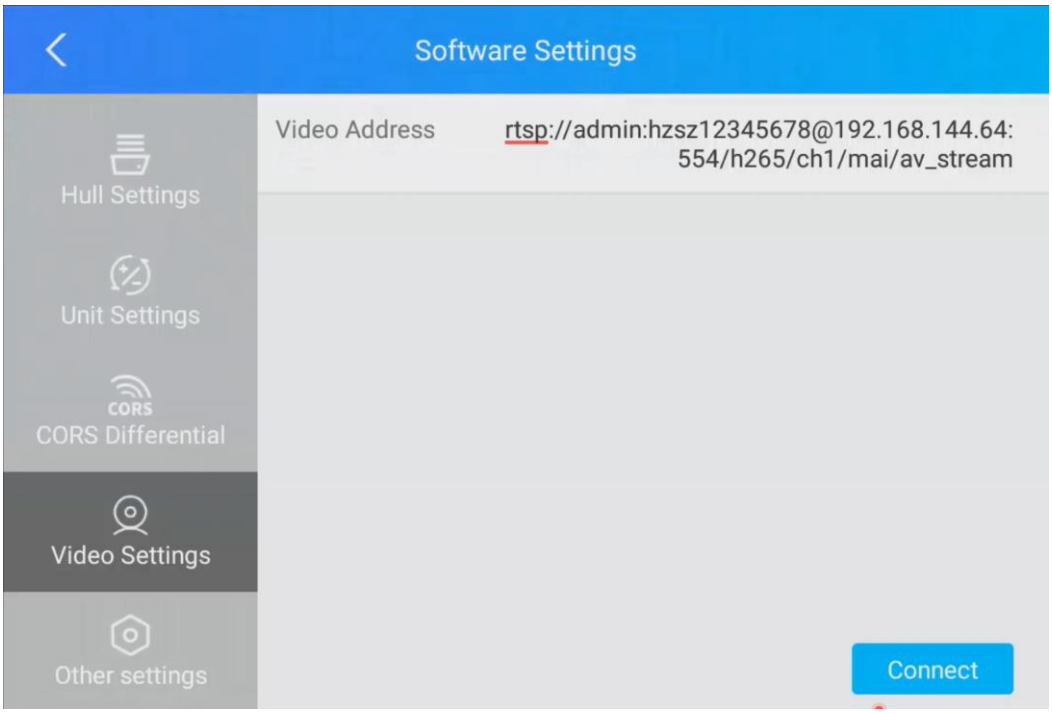
Since we are using an **external RTK receiver** which has already been configured via the RTK controller software, and it achieved a **fixed solution** already, **no differential data settings** are required in this interface. *The CORS differential configuration here is for the internal RTK module*.



6.2.3.9 Video Settings

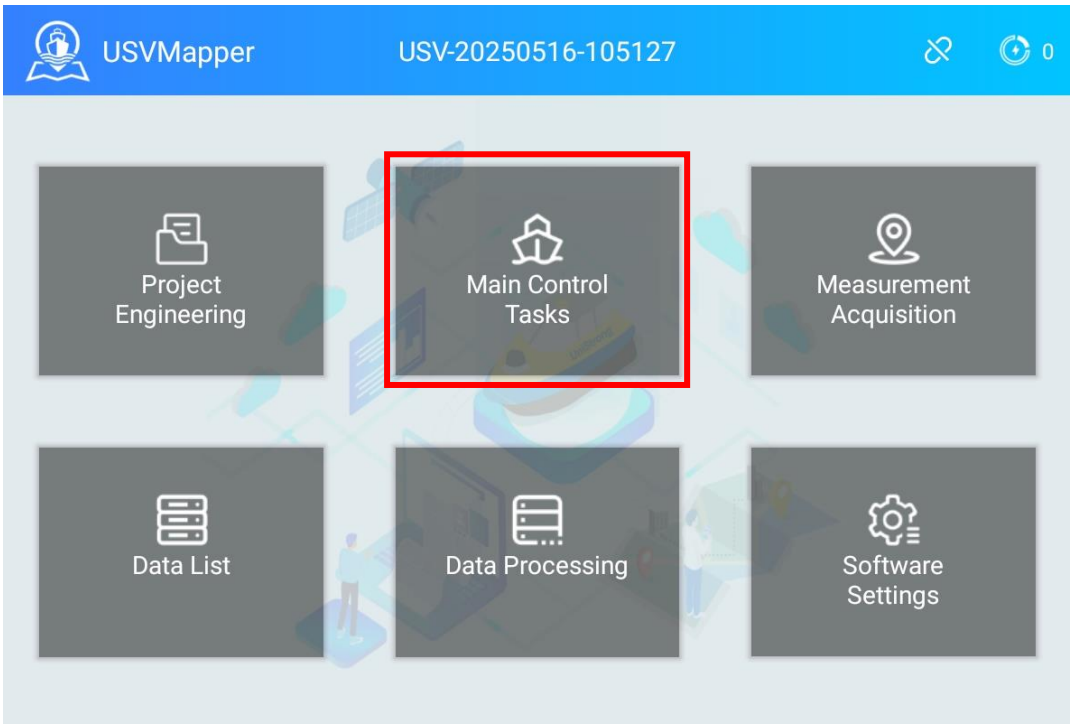
Video Settings: This section is primarily used to retrieve and display the live feed from the USV's camera on the remote controller's screen. Simply paste the camera's **IP address** into the designated field and click **"Connect"**.

Camera IP Address: rtsp://admin:hzsz12345678@192.168.144.64:554/h265/ch1/main/av_stream

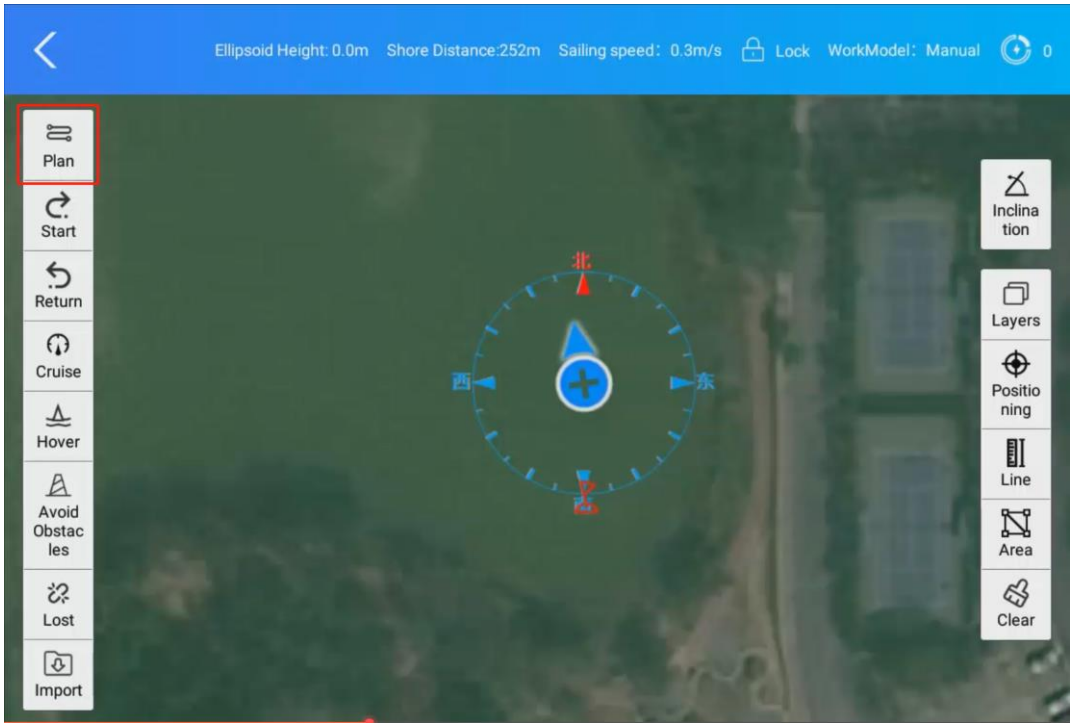


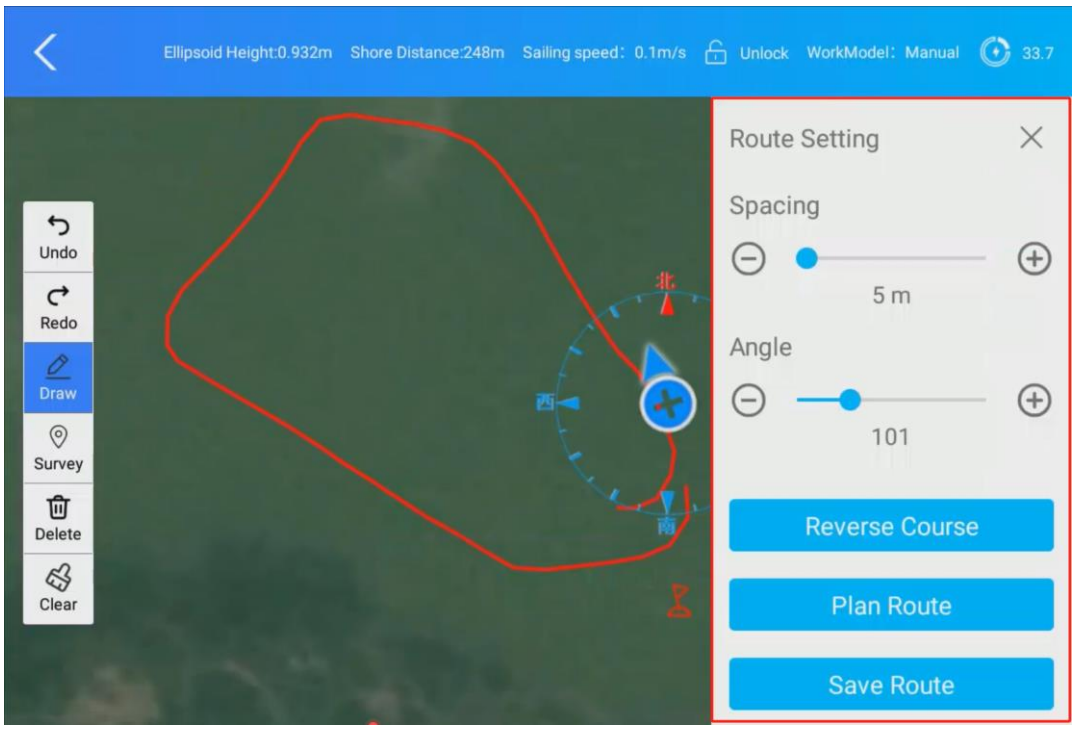
6.2.3.10 Route Planning

Return to the **main interface**, click the **Main Control Tasks** menu to enter the Main Control Tasks interface.



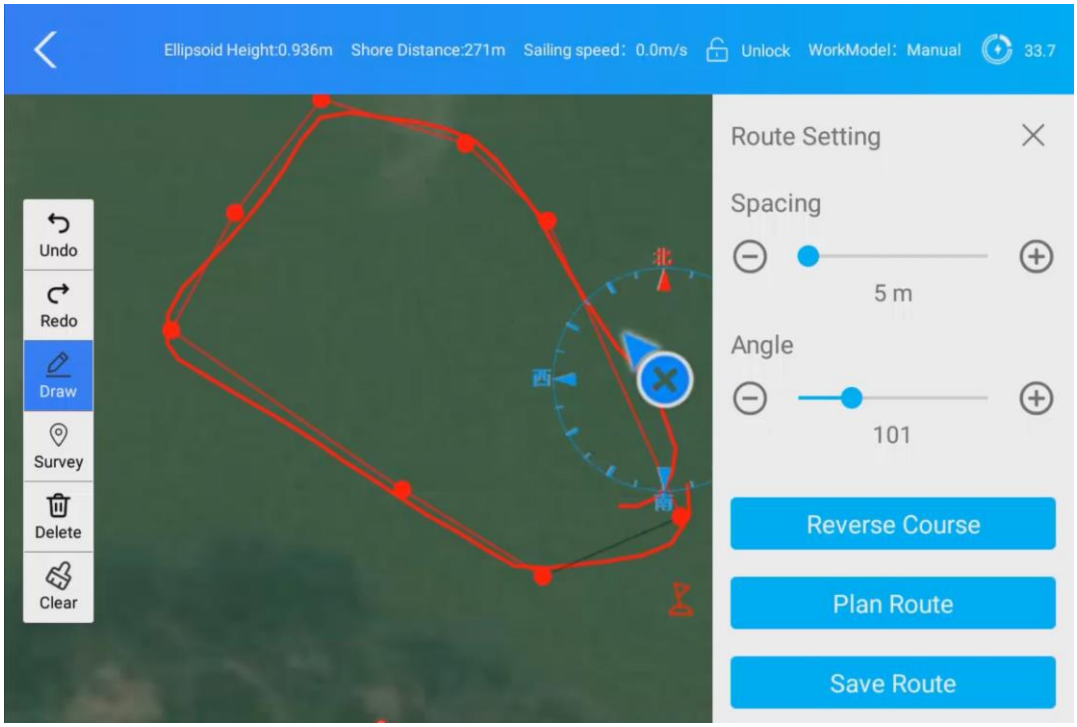
After entering Main Control Tasks interface, zoom in on the map to the target survey area. Click the **"Plan"** button, and a set of route settings (e.g., line spacing and angle) will appear on the right side of the interface.





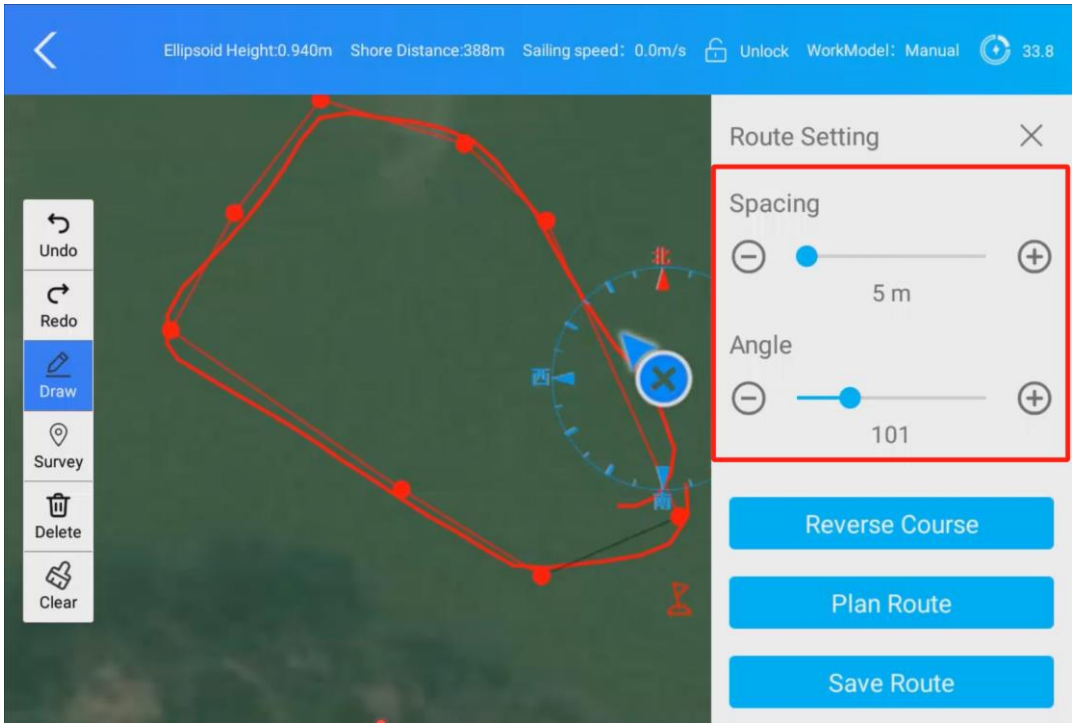
Click the **"Draw"** button, then outline the survey area on the map.

Note: *If the map is inaccurate, we recommend first using the USV to manually trace the shoreline and define the survey area.*



After defining the area, set the **line spacing** (default: 5m) and adjust the **angle** to optimize the survey line orientation.

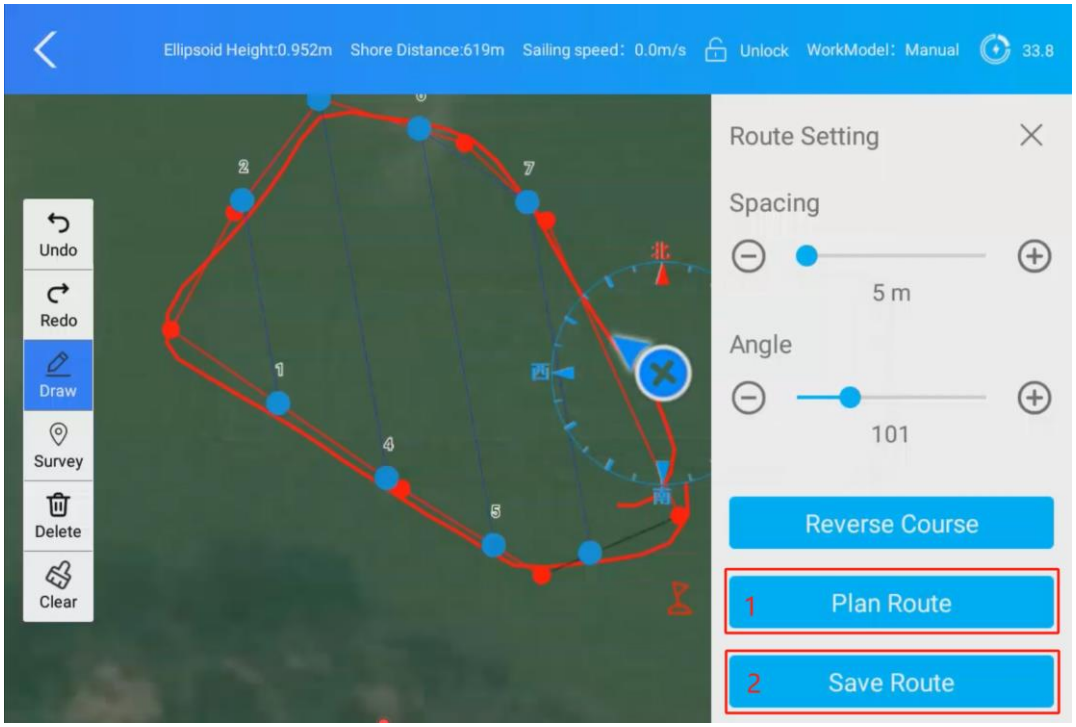
Note: *Avoid setting the spacing too small, as it must account for the USV's turning radius.*

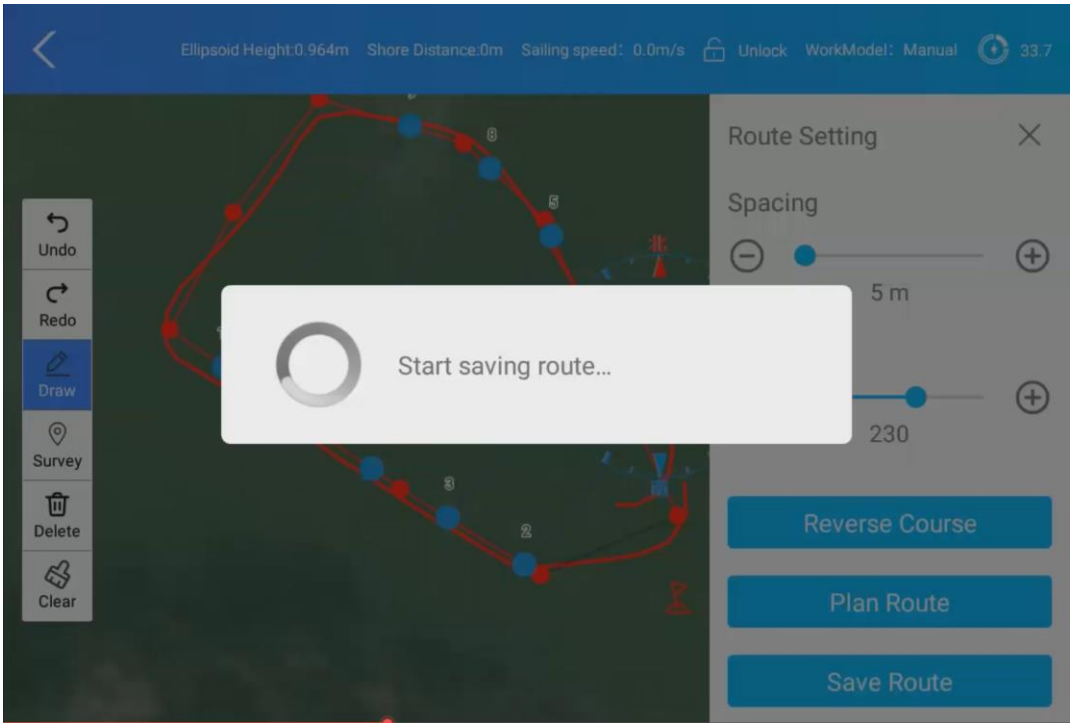


Click the **"Plan Route"** button to generate the route based on the configured parameters.

If the angle appears suboptimal, adjust it and click **"Plan Route"** *again to regenerate.*

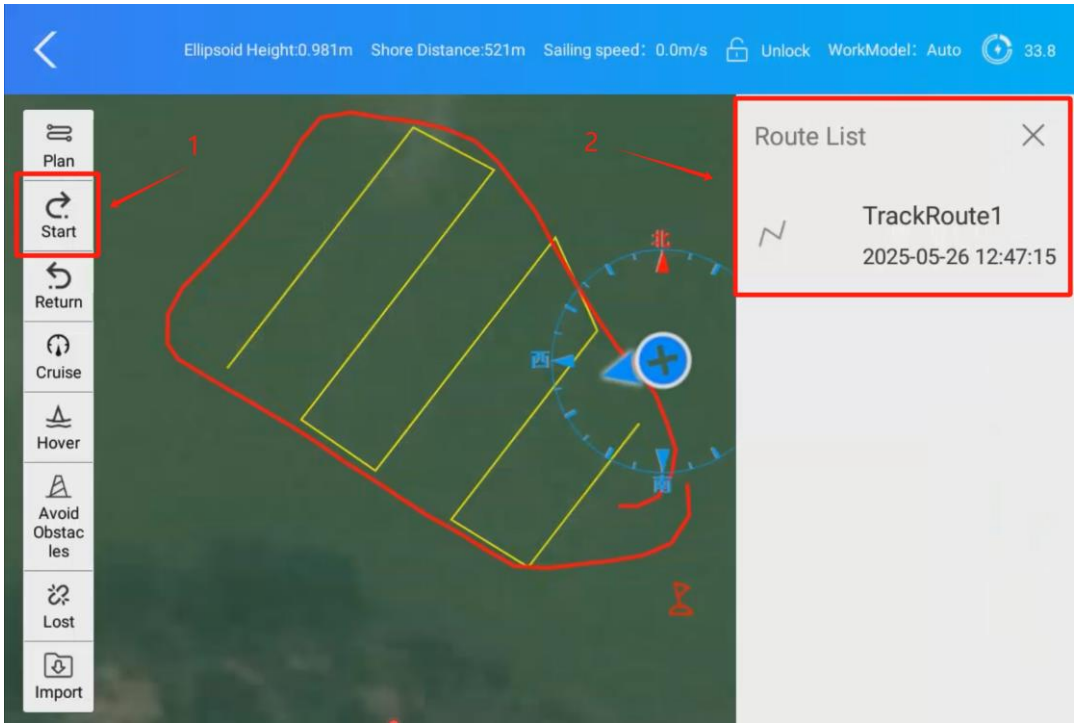
Once satisfied, click **"Save Route"** to store the planned route.





6.2.3.11 Mission Settings

Click the **"Start"** button to display the planned route on the right panel. Select the route file to load it on the survey area.



Start Node Number: Set the departure location for the USV to begin data collection, usually we set the number 1 as the starting waypoint.

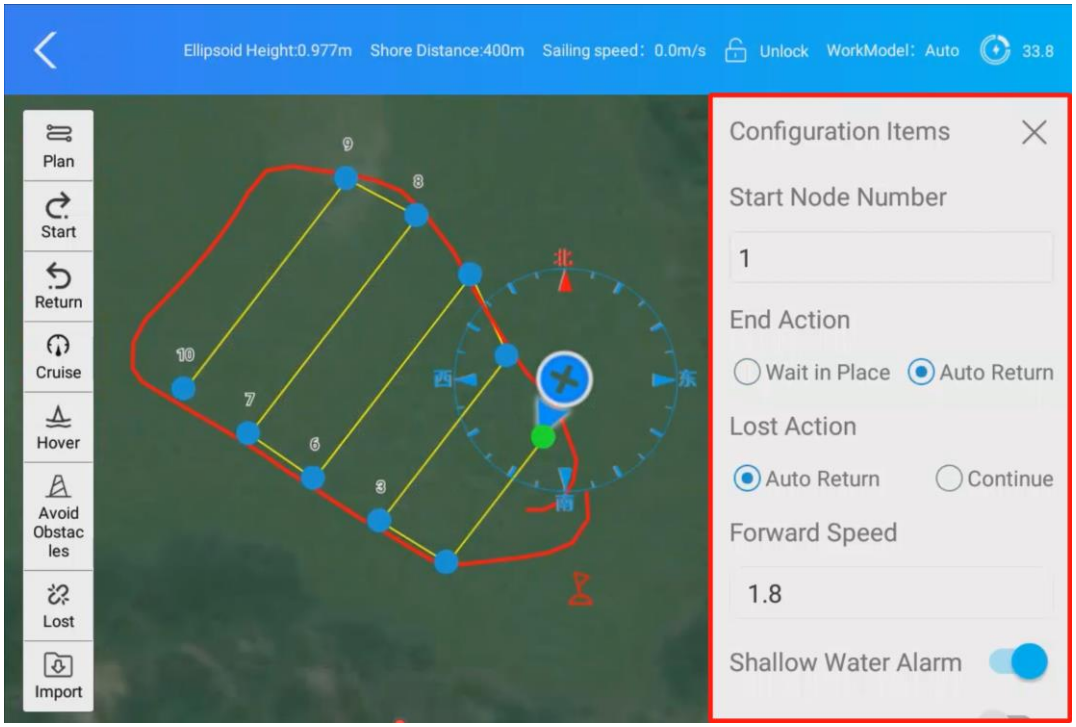
End Action: What action of USV after the mission finish, select **Auto Return** for the end action.

Lost Action: What action of USV if the communication signal lost, select **Auto Return** if communication is lost.

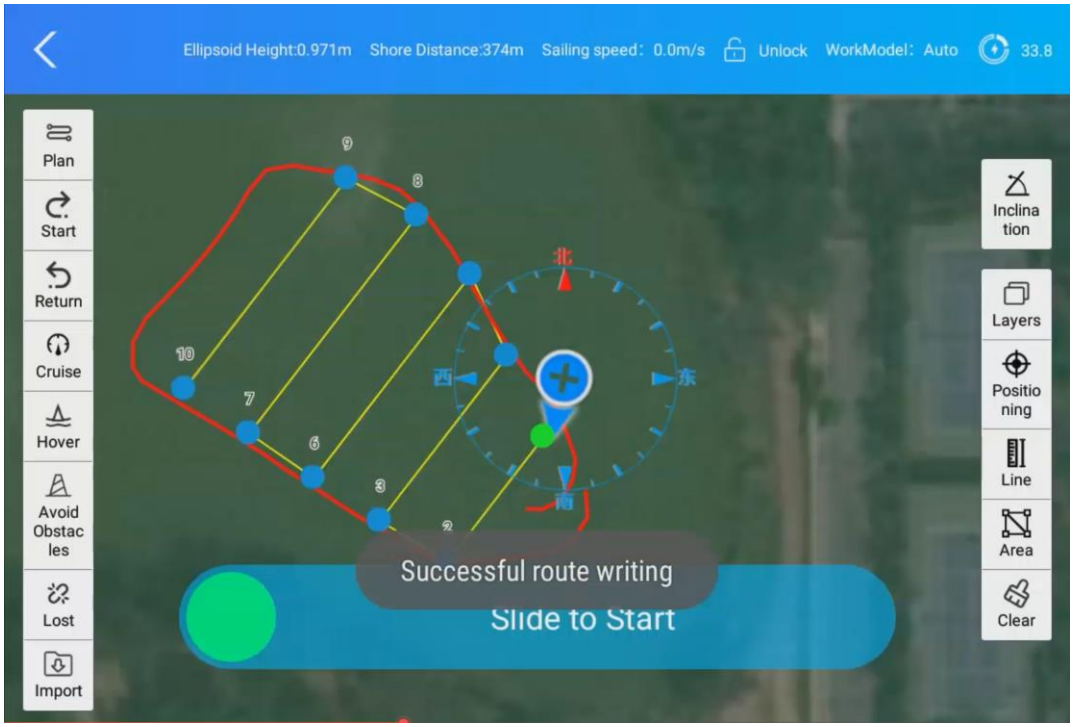
Forward Speed: This is the cruising speed of USV for the mission execution. Usually the cruising speed is set at the range **1.5m/s ~ 2.0m/s**, default is **1.8 m/s**.

Avoid excessive speed, as it may cause the USV's bow to lift, compromising depth sounder signal quality.

Click **"Confirmation"** to finalize settings.


Ellipsoid Height:0.977m
Shore Distance:400m
Sailing speed：0.0m/s
Unlock
WorkModel：Auto
33.8
Plan
Start
Return
Cruise
Hover
Avoid Obstacles
Lost
Import
Configuration Items
Start Node Number
1
End Action
Wait in Place
Auto Return
Lost Action
Auto Return
Continue
Forward Speed
1.8
Shallow Water Alarm

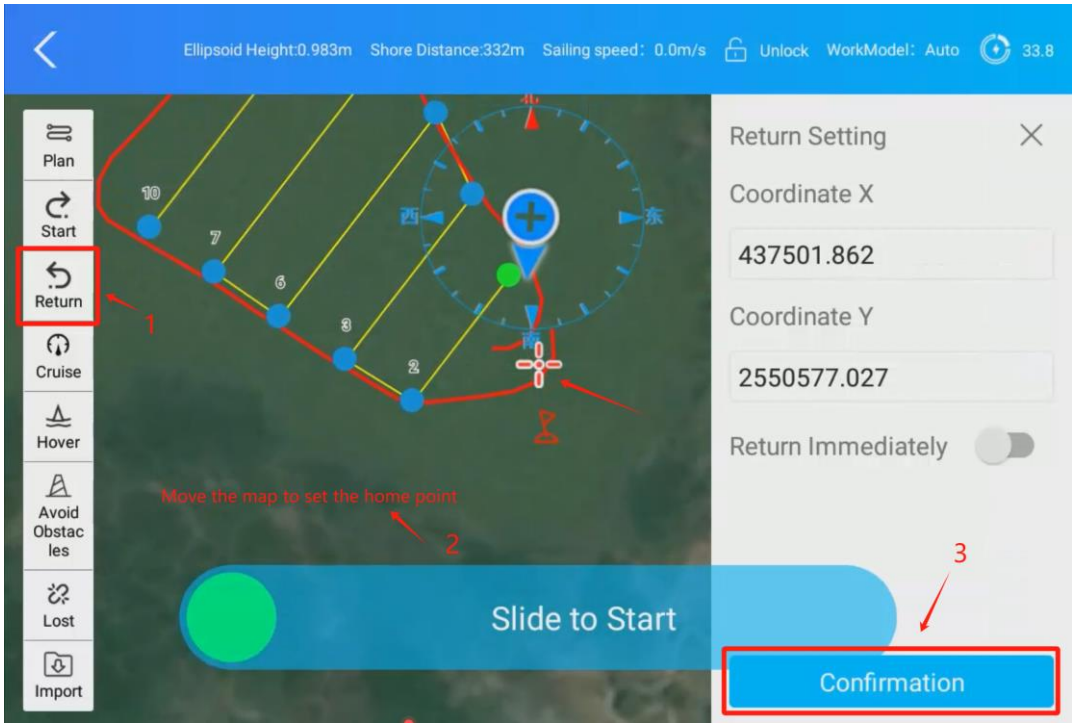

Ellipsoid Height:0.981m
Shore Distance:396m
Sailing speed：0.0m/s
Unlock
WorkModel：Auto
33.8
Plan
Start
Return
Cruise
Hover
Avoid Obstacles
Lost
Import
1
End Action
Wait in Place
Auto Return
Lost Action
Auto Return
Continue
Forward Speed
1.8
Shallow Water Alarm
Reverse Sail
Confirmation

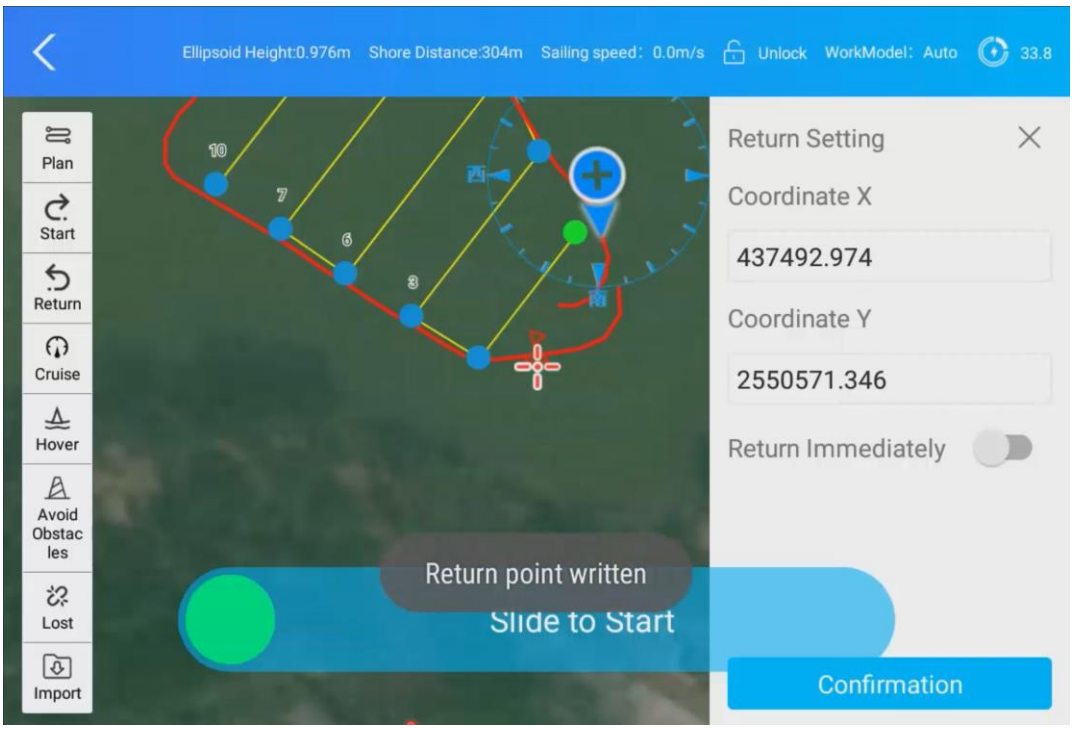


Manually control the USV to face the bow outward, avoiding pointing it toward the shore to prevent unnecessary damage. Then set the **SW2 toggle switch** on the remote controller to **Auto mode**.

6.2.3.12 Setting the Home Point

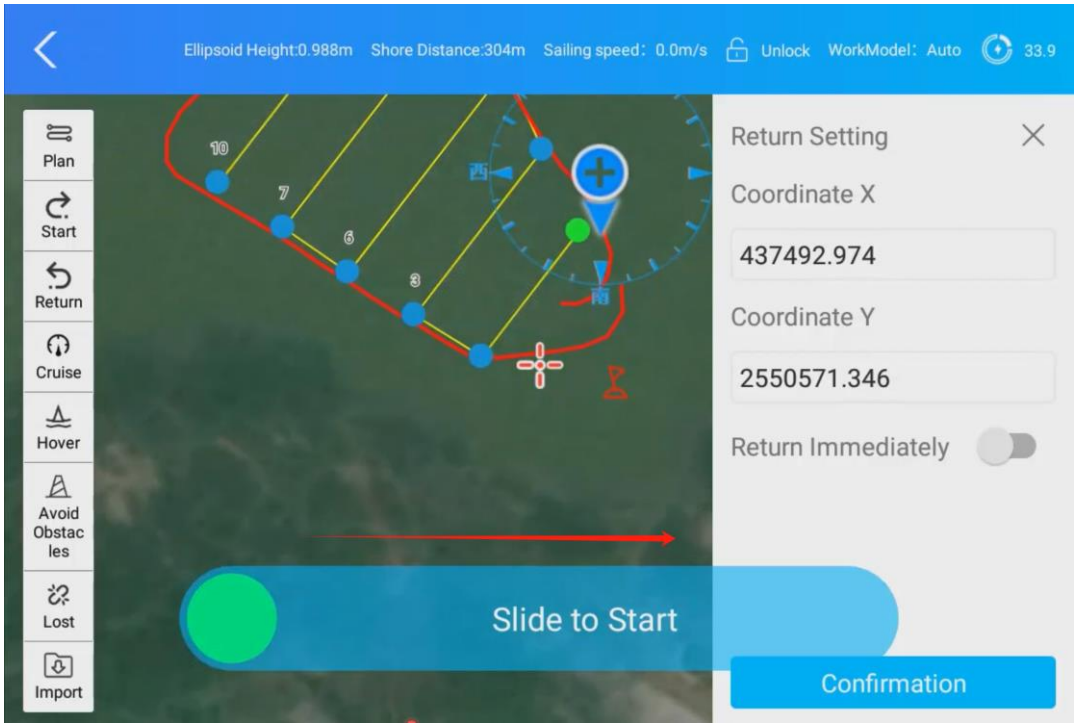
Click the **"Return"** button, then move the map to adapt the crosshair cursor (it always locates at the center of map) to select the desired return point. The right-side information panel will display the coordinate details. Once a suitable return point is confirmed, click the **"Confirmation"** button to finalize the selection.

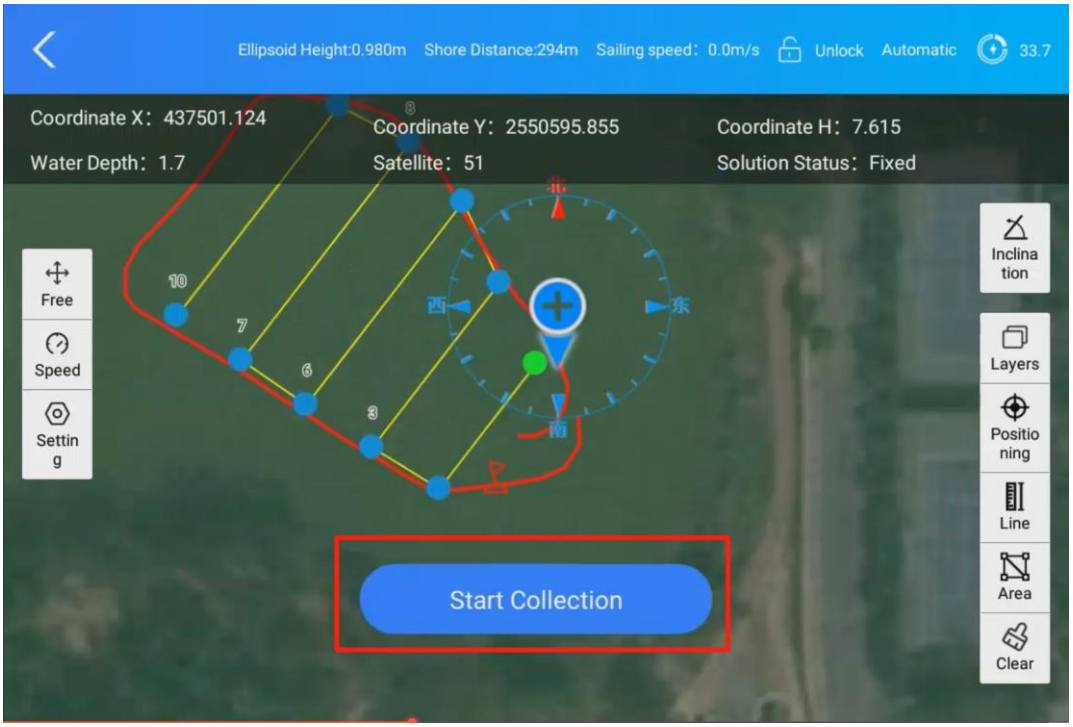




6.2.3.13 Mission Execution

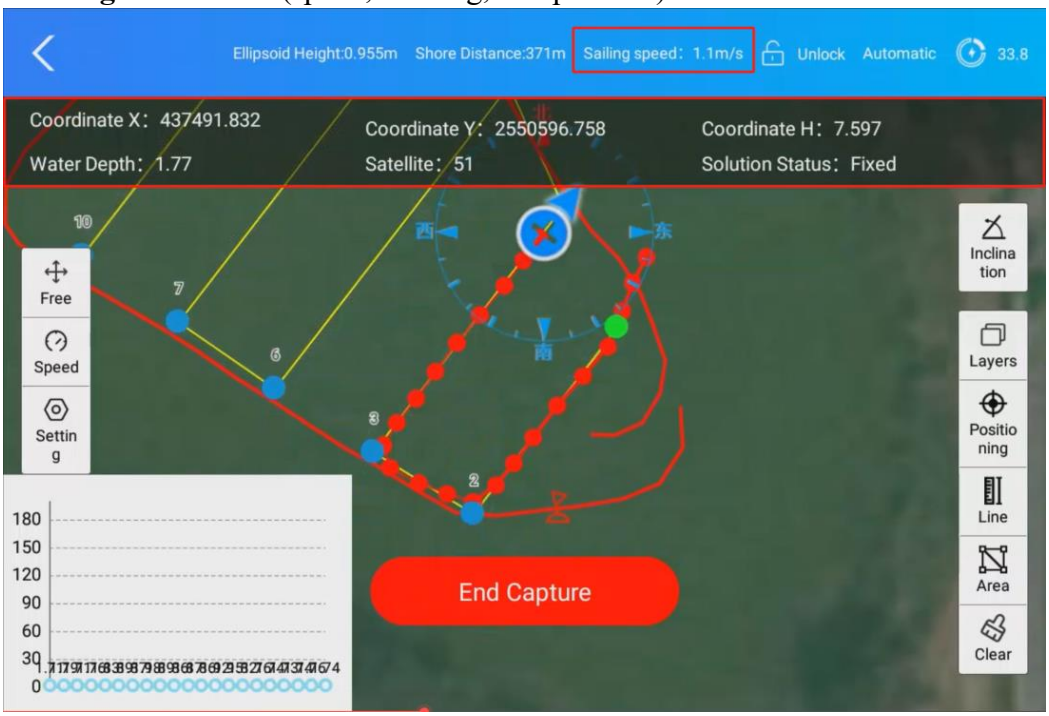
After the return point is confirmed, then slide the toggle button to start the mission. The USV will automatically navigate to the starting waypoint, and the software will simultaneously switch to the **Measurement Acquisition interface**. Click the **"Start Collection"** button to begin data acquisition.


Ellipsoid Height:0.988m
Shore Distance:304m
Sailing speed：0.0m/s
Unlock
WorkModel：Auto
33.9
Plan
Start
Return
Cruise
Hover
Avoid Obstacles
Lost
Import
Return Setting
Coordinate X
437492.974
Coordinate Y
2550571.346
Return Immediately
Slide to Start
Confirmation


Ellipsoid Height:0.980m
Shore Distance:294m
Sailing speed：0.0m/s
Unlock
Automatic
33.7
Coordinate X：437501.124
Coordinate Y：2550595.855
Coordinate H：7.615
Water Depth：1.7
Satellite：51
Solution Status：Fixed
Free
Speed
Setting
Inclination
Layers
Positioning
Line
Area
Clear
Start Collection

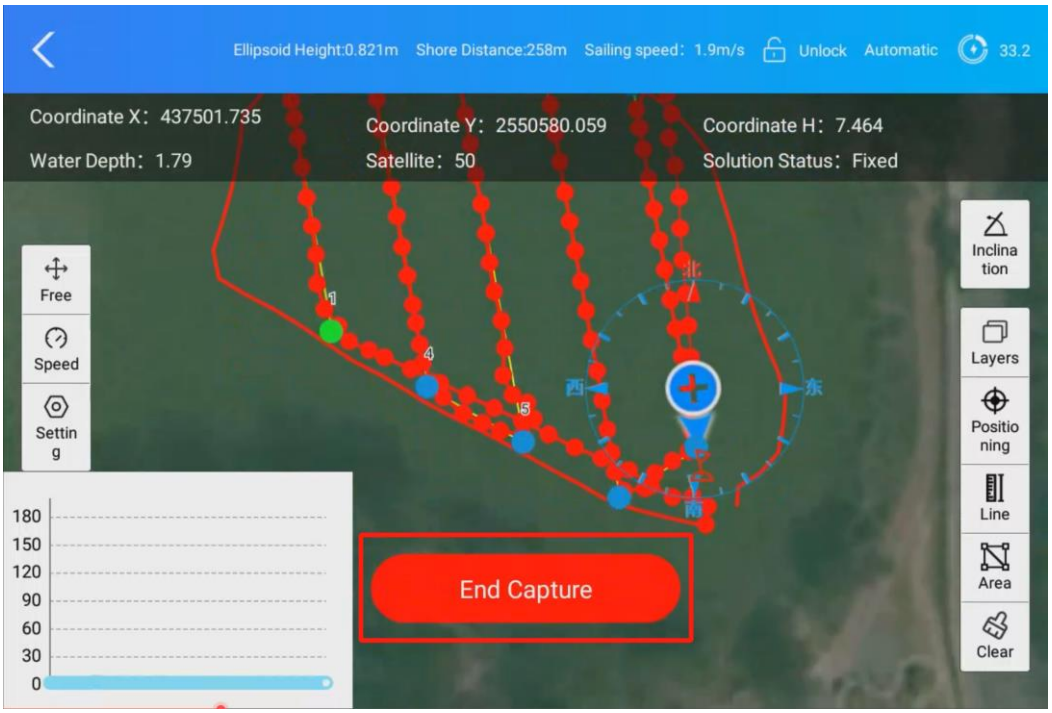
During the collection process, monitor the following parameters in real-time:

- **Water depth**
- **RTK solution status** (Fixed/Float/Single)
- **USV navigation status** (speed, heading, and position)



Upon mission completion, the USV will automatically navigate to the preset return point. Click the **"End Capture"** button to finish data collection.

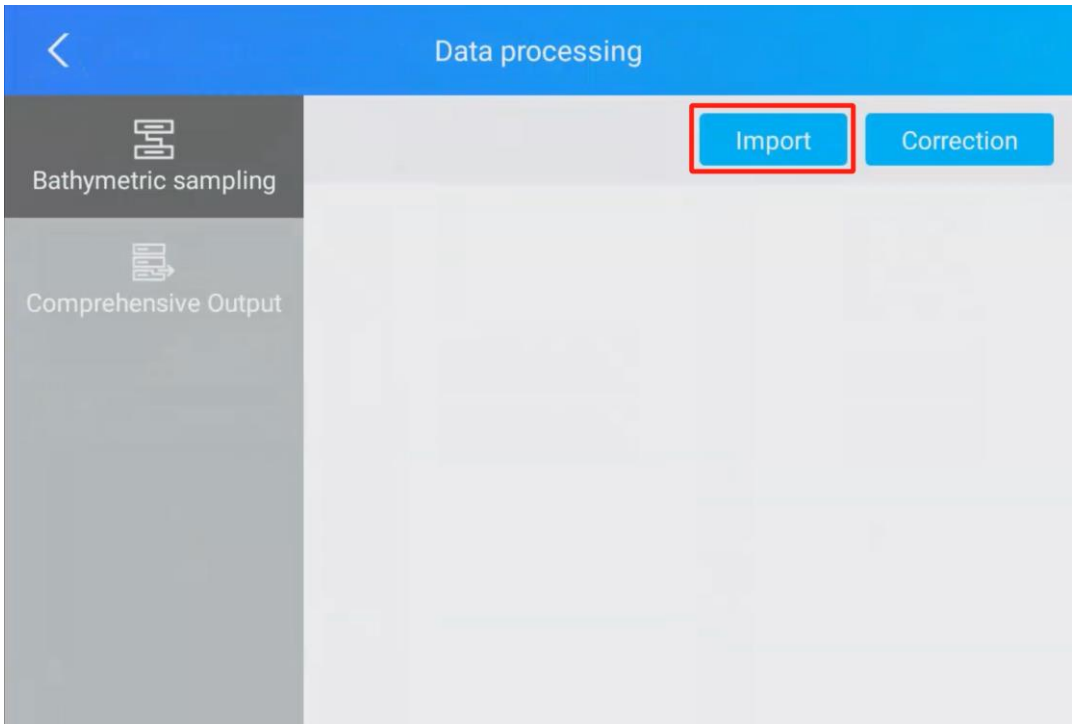
Once the USV reaches the return point, switch the remote controller to **Manual Mode**. Gently steer the USV toward the shore for safe retrieval.

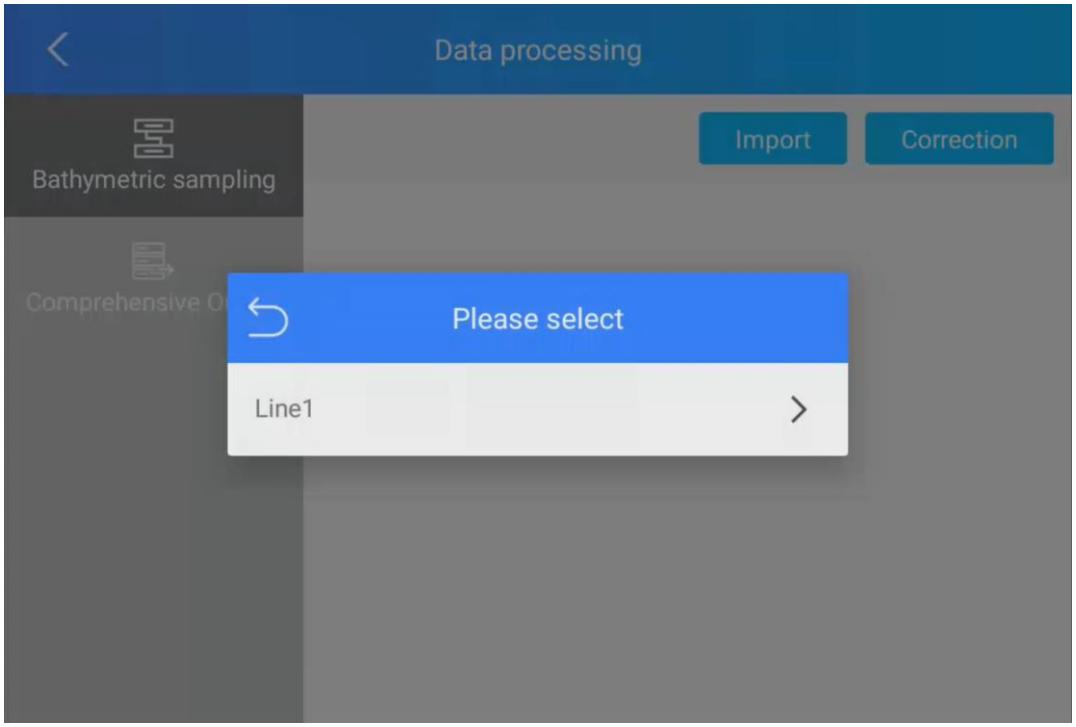


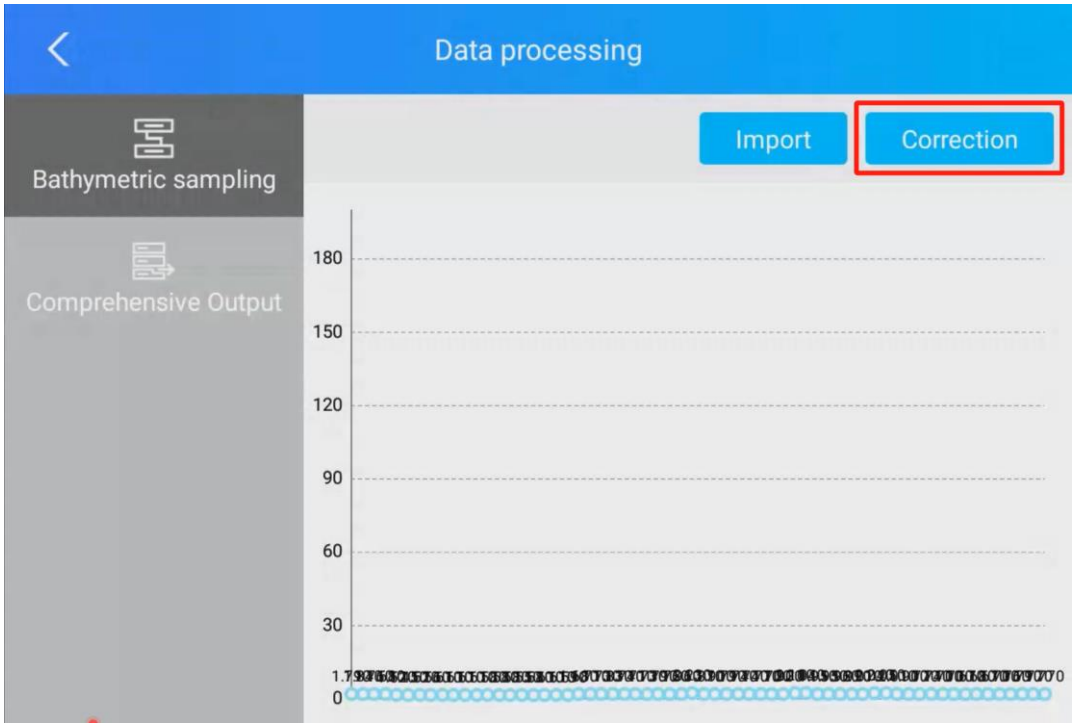
6.2.3.14 Data Processing

After completing data collection, click the **Data Processing** menu to enter the data processing interface.

Go to Bathymetric Sampling Interface and click the **"Import"** button to load depth data. If anomalous depth values (e.g., outliers) are detected, click the **"Correction"** button to automatically adjust anomalous depth measurements.

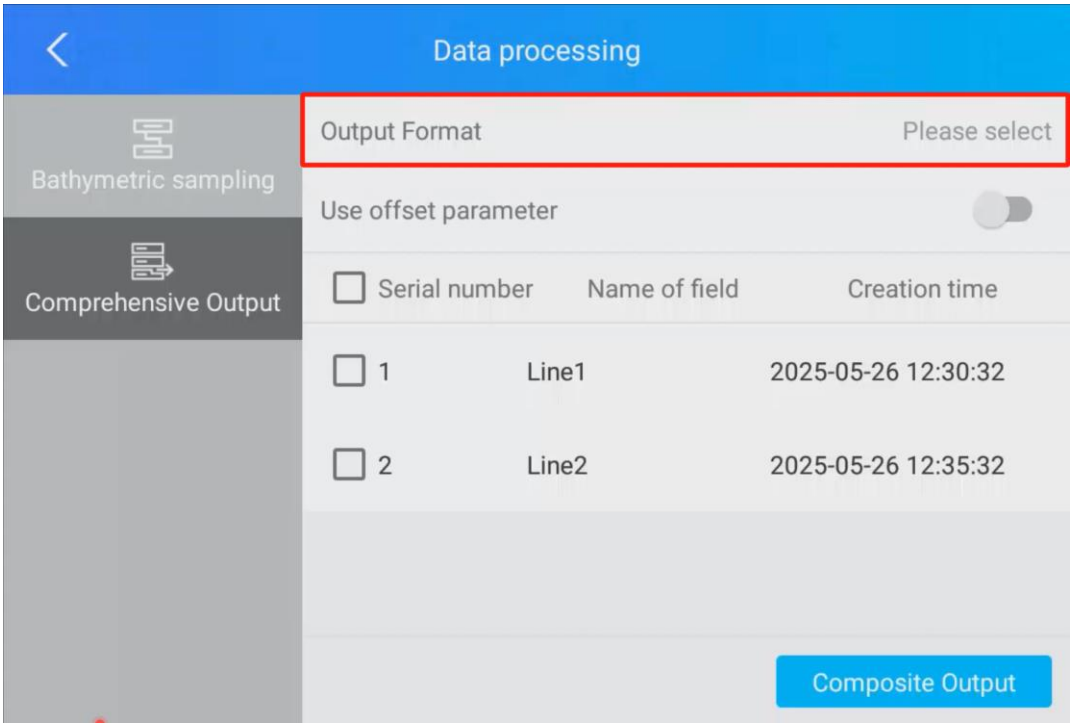


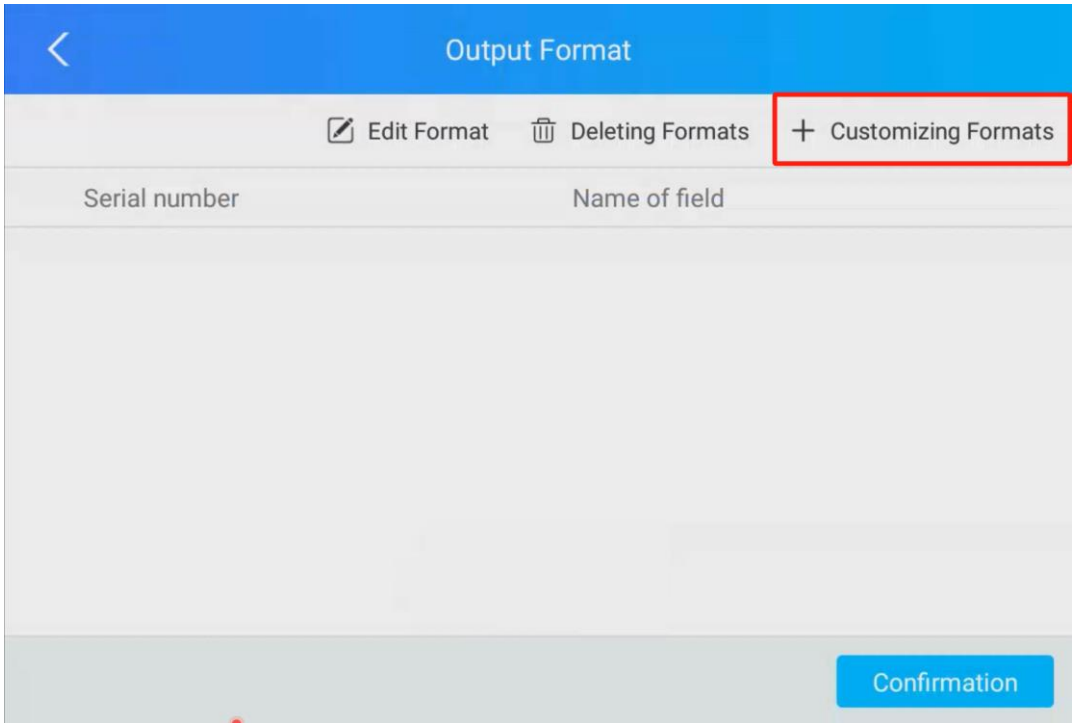

Data processing
Bathymetric sampling
Import
Correction
Please select
Line1


Data processing
Bathymetric sampling
Import
Correction
Comprehensive Output
180
150
120
90
60
30
0

6.2.3.15 Comprehensive Output

Go to the **Comprehensive Output** interface, click **"Output Format"** to enter the format definition menu, select **Customizing Formats**.





Set **Name of Field** to CSV, choose CSV as the **Extension**.

Check the following fields for inclusion:

Point Name

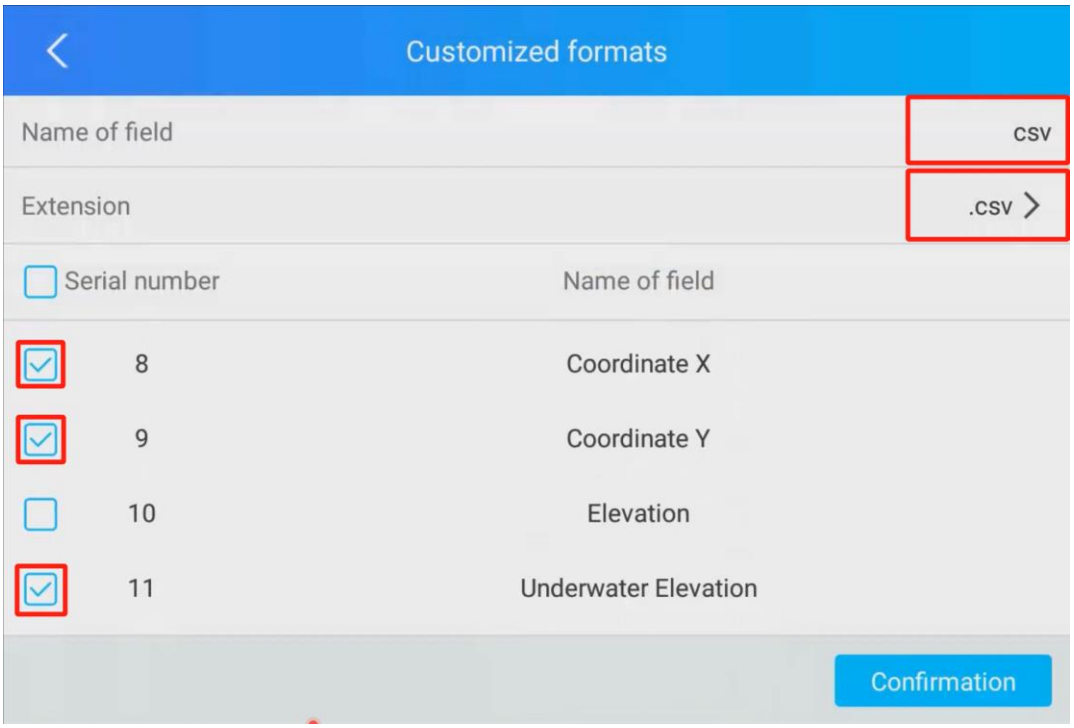
Coordinate Y (e.g., Latitude)

Coordinate X (e.g., Longitude)

Underwater Elevation

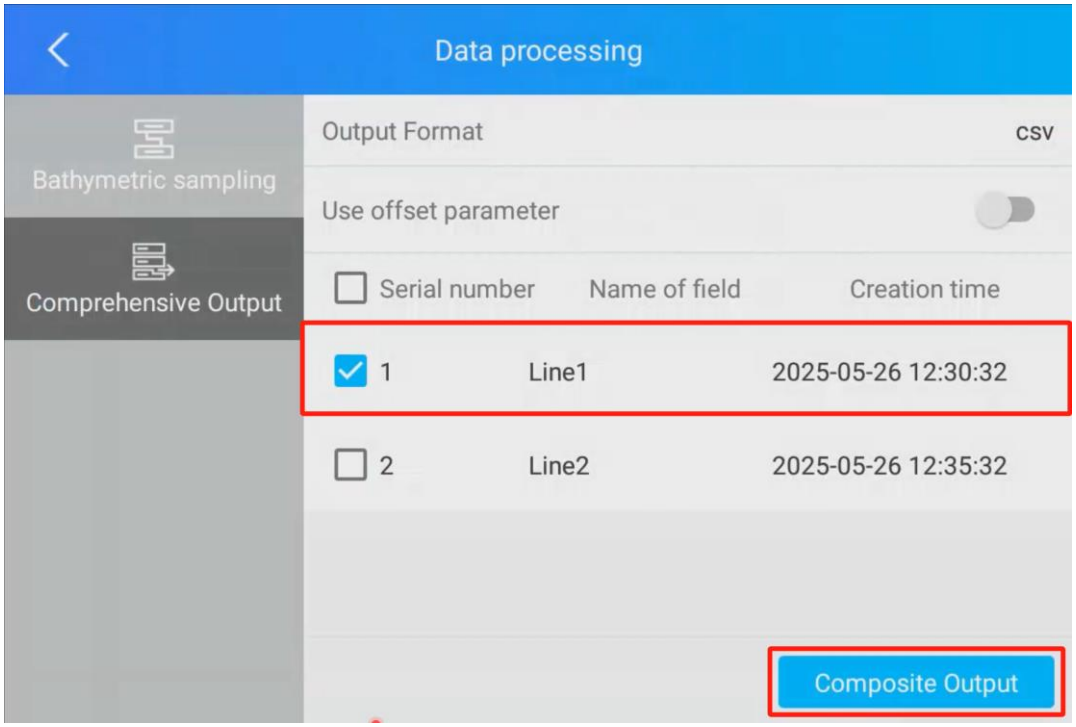
Raw Water Depth

Click "**Confirmation**" to save the format.

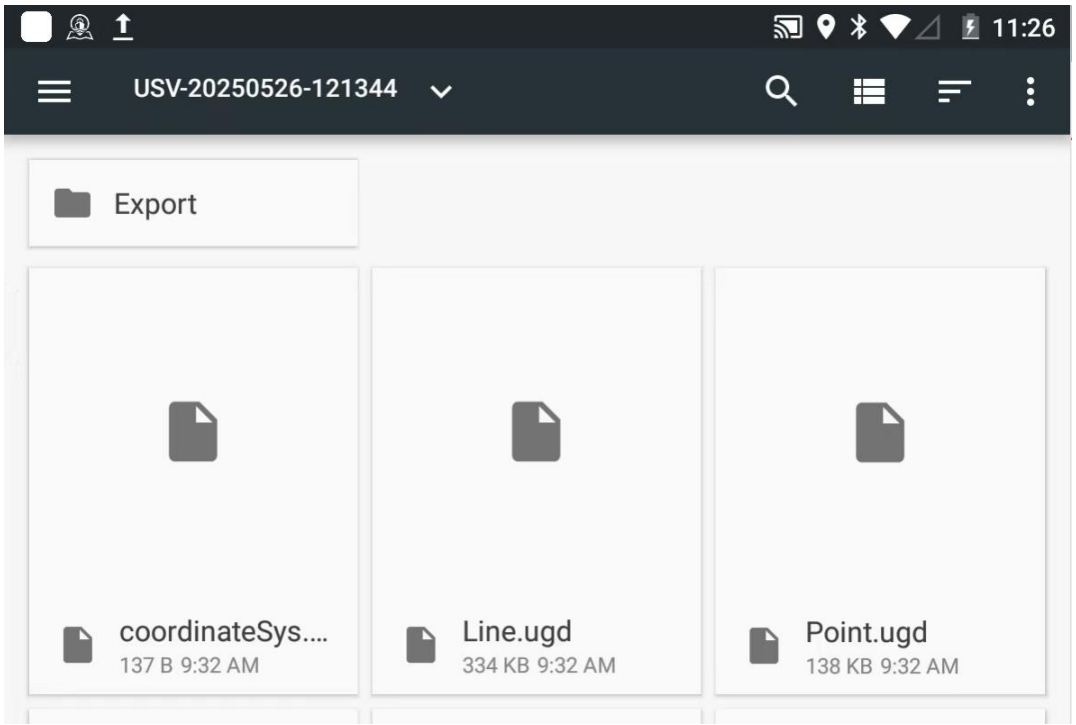


Back in the **Output Format** menu, select the newly defined CSV format and click "**Confirmation**" button.

Back in Comprehensive Output interface, choose the processed survey route, then click **Composite Output**.



The exported file you can find in the directory as Settings—Storage—Internal shared storage—Other—USVMapper—Task—Project(project name)—Export.



Chapter 7 Battery system

7.1 Charging

After connecting the charger to the battery, plug the charger into a 220V power socket, at this time, the charging indicator light will turn red and the cooling fan inside the charger will start to rotate. The charging process takes about 6 hours.

When the battery is fully charged, the charger indicator light will turn green, unplug the charger. Press the button on the battery and the 5 indicators of battery life will light up to show 100% power capacity.

7.2 Working environments

(1) The charging temperature for normal temperature lithium batteries is 0℃~45℃, and the discharging temperature is -20℃~60℃, the storage temperature is -40℃~65℃.

(2) The charging temperature for low temperature lithium batteries is -20℃~25℃, and the discharging temperature is -20℃~35℃, the storage temperature is -40℃~65℃.

(3) Do not place the battery output terminals close to metal objects to prevent metal objects from touching the positive and negative poles of the battery, causing a short circuit, damaging the battery or even causing danger.

(4) Do not knock, puncture, step on, modify or expose the battery to sunlight at will. Do not place the battery in a microwave, high voltage environment.

(5) Please use the lithium battery charger specified by the manufacturer to charge the battery. Using a non-original charger will cause the charging protection system to be mismatched, which is likely to damage the battery or even cause danger.

7.3 Storage environments

(1) If the lithium battery is not used for a long time, it should be fully charged and removed from the device and stored in a dry and cool environment. It should be charged every 2 months to prevent self-discharge and low power, which may cause irreversible capacity loss.

(2) The self-discharge of lithium batteries is affected by temperature and humidity of the environment. High temperature and humidity will accelerate the self-discharge of the battery. It is recommended to store the battery in a dry environment of 0℃~20℃.

(3) The battery should be placed in an explosion-proof cabinet or explosion-proof bag when charging and should also be placed in an explosion-proof cabinet or explosion-proof bag when storing.

7.4 Emergency

When a lithium battery catches fire, we need to analyze the cause of the fire and extinguish the fire in time. We recommend the following solutions:

(1) If a small fire occurs, use a carbon dioxide or ABC dry powder fire extinguisher to extinguish the fire.

(2) When thoroughly checking the fire, do not touch any high-voltage components and always use insulating tools for inspection.

(3) If the high-voltage battery is bent, twisted, damaged, or in a mess during the fire, or if there is a problem with the battery, use a large amount of water to extinguish the fire and continue to cool the battery.

(4) When the battery fire is extinguished, flush it with water for 10 minutes to ensure that the high-voltage battery is completely cooled before the accident ends. Monitor the battery to see if it will reignite and move it to a safe area. Smoke indicates that the battery is still hot and monitoring should be continued until the battery stops smoking.

Chapter 8 Maintenance

8.1 Battery

(1) New lithium battery will only store 30% of power when it is shipped, and it must be fully charged before use.

(2) Do not over-discharge the battery, as this will cause irreversible capacity loss.

(3) To avoid affecting the battery life, the battery must not be overcharged or over-discharged, the voltage should not be lower than 22.5V after each operation.

When charging, the battery must be removed from USV. If it is not used for a long time, the battery must be stored at the storage voltage.

8.2 Propeller

(1) Please clean the aquatic plants and debris on the propellers after each use and rinse with water.

(2) After the unmanned boat is operated in the seawater environment, it needs to be rinsed with fresh water.

(3) Before the propellers enter the water, check that all fasteners are properly tightened to ensure that they can work normally after entering the water.

(4) Regularly check whether there is foreign matter in the propellers and the degree of wear of parts, and replace them with new ones as appropriate.

(5) Regularly check the wear of the propellers and whether it has fallen off.

8.3 Boat hull

(1) If the product is not used for a long time, it should be sealed. After packing, it should be stored in a cool, dry environment without corrosive gases.

(2) If the product has any abnormal phenomenon or failure, please contact the manufacturer's technicians or local dealers in time, and the product must be repaired by a dedicated person, unauthorized repair is not allowed.

(3) After each use, the hull can be wiped dry with an absorbent towel.

(4) The unmanned boat should be stored in a cool, dry place and kept ventilated.