ROBSENSE

Humanise the Robotics

EASYSWARM PERSONAL USER MANUAL

V2.0

ROBSENSE TECHNOLOGIES

2018

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1.EasySwarm

1.1 Overview

EasySwarm helps developers to fast build ultra-reliable wireless local networks for communications between a swarm of unmanned systems. Benefitted from the SwarmLink DevKit gateway, EasySwarm offers an user-friendly software to interact with customized unmanned devices, e.g. drones, AGV, UGV, etc. The EasySwarm software is free and open-source.

1.2 Open-Source

EasySwarm offers an open-source ground control software, with which developers can

- ✓ deploy customized swarming strategies
- ✓ monitor operation status of all unmanned vehicles

EasySwarm application available at RobSense website:

http://www.robsense.com

EasySwarm source code available at GitHub：

https://github.com/RobSenseTech/SwarmLink.git

The supported open-source fly control firmware is as follows：

PX4：V1.6.5、V1.7.2

ArduPilot：ArduCopter V3.3.3 Quad、ArduCopter V3.5.7 Quad

1.3 Hardware

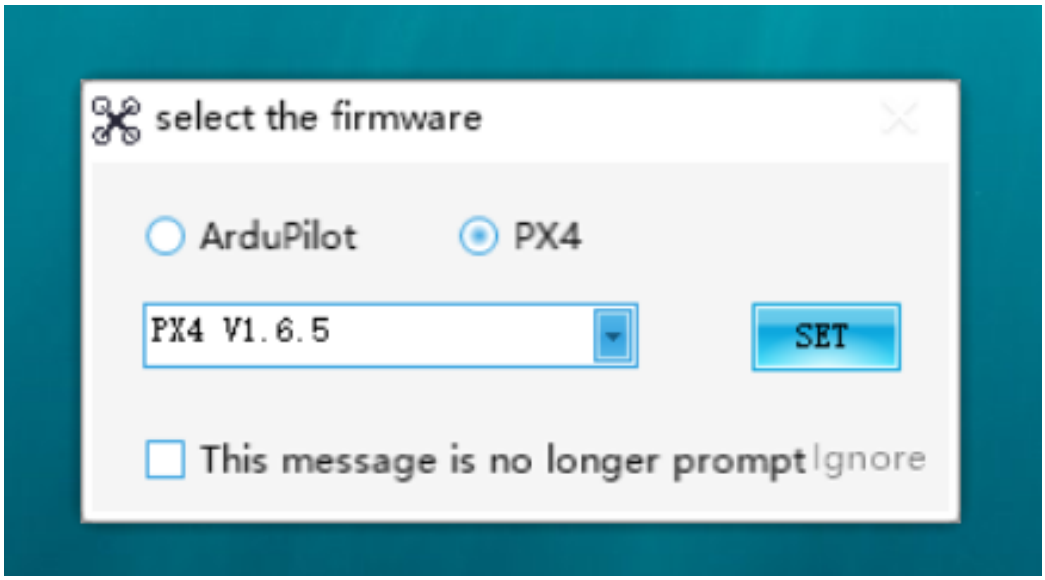
SwarmLink Gateway

SwarmLink Node

2.EasySwarm Introduction

2.1 Networking

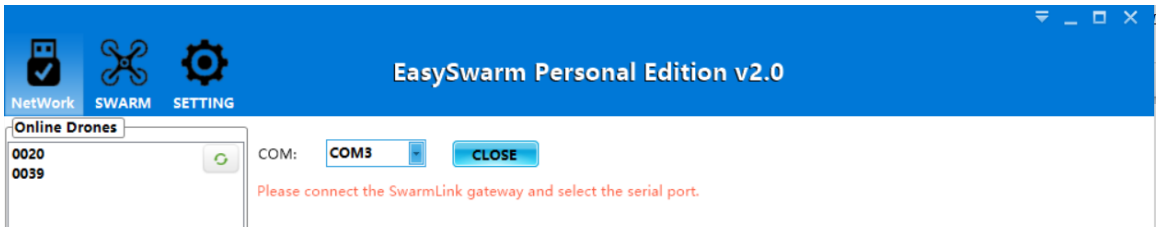
Select firmware version



After the software is started, the firmware selection popup window will pop up by default. Please select the flight control version of the current drone and click “Settings”.

If you have selected the firmware version, you can select "Ignore" and open the software directly. If you select "Do not display this prompt message next time", the software startup will no longer have a pop-up prompt. If necessary, you can modify it in the "System Settings" tab.

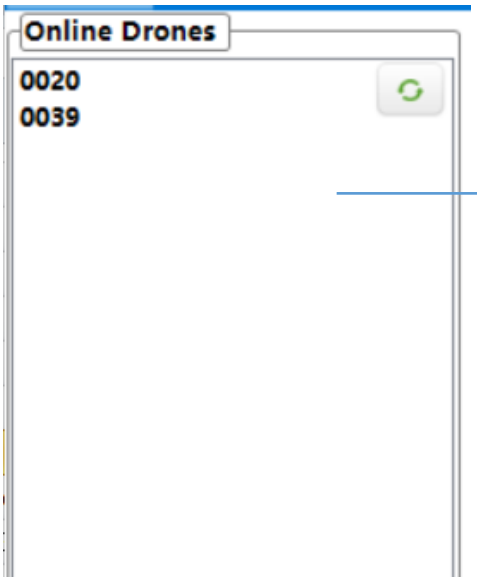
Open Serial Port



After connecting the SwarmLink gateway to the PC with the serial port tool, the software will automatically identify the serial port number of the serial device that has been connected.

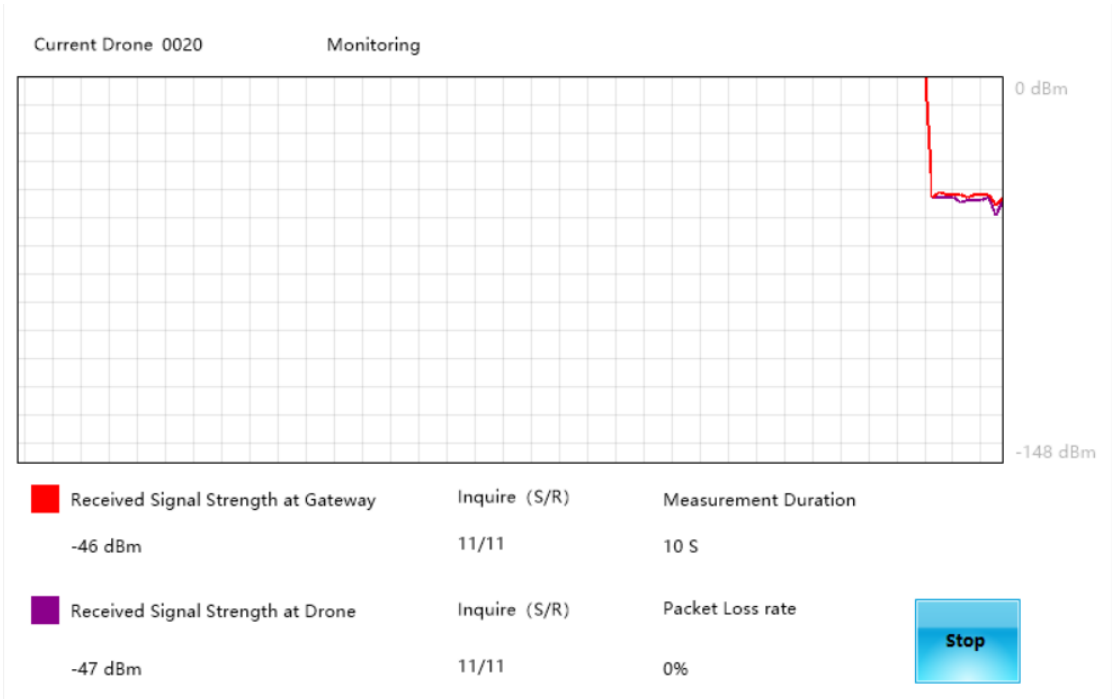
After selecting the serial port number, click “Open” and the progress bar in the lower right corner will light up, prompting “Open the serial port successfully”.

Online drone list



Click the Refresh button and all nodes that have already entered the network will be displayed here. To add an access node, refer to the operations in "System Settings" -> "Gateway Whitelist Management".

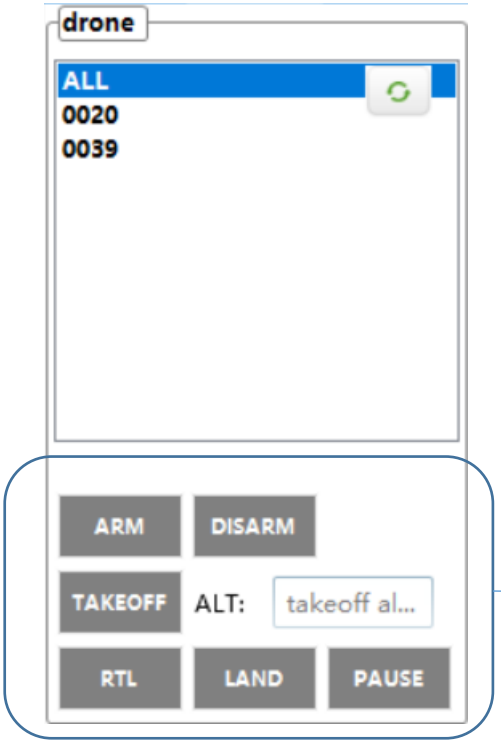
Signal quality monitoring



In the "Online drones" list, select a node and click the "Start Measurement" button to monitor the signal quality of the networking node.

2.2 SWARM

Single drone control



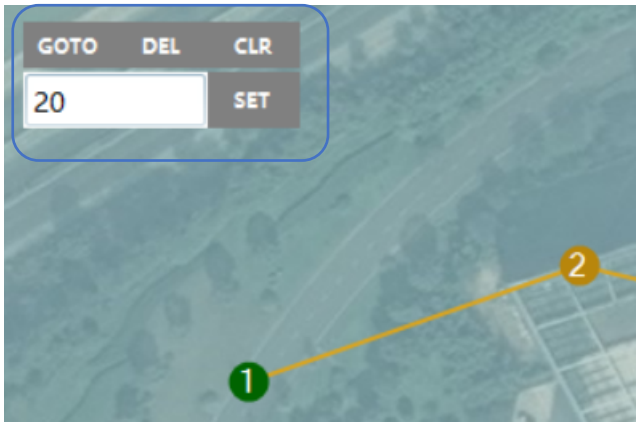
Select single or all online drones (ALL) to control the drone's simple operations such as unlocking, taking off, landing, and locking.

ARM: Unlock the drone.
DISARM: Lock the drone.
TAKEOFF: Let the drone that has been unlocked take off.
RTL: Return to land drone
LAND: The drone will land slowly at the current position
PAUSE: The drone will pause in the current air position until a new flight instruction is received

Operation process: ARM -> TAKEOFF -> GOTO (right map interface function) -> RTL -> DISARM。

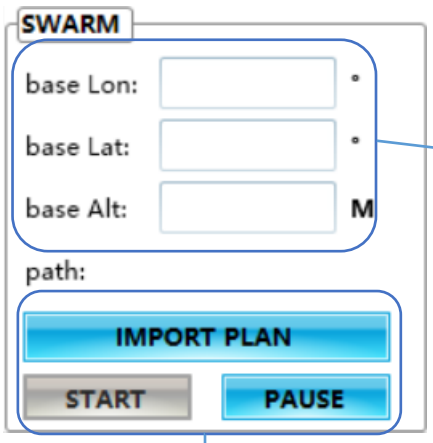
Path planning interface

The map on the right side of the "SWARM" tab is used to perform path planning flight for a single drone. For the list of nodes on the left side, please select a single drone.
Then in the map on the right, click the right mouse button to plan several flight points in advance. Take off the drone and click on "GOTO" to fly to the set target point.
The map uses Microsoft bing as the source. If you need to plan the flight, it is recommended to guarantee the Internet connection of EasySwarm.



SET: The height value can be set separately for each flight point. The default height value is 20 and the unit is meter. ;
GOTO: execute the currently selected point, and automatically select or manually select the nrxt target flight point;
DEL: the currently selected flight point can be deleted;
CLEA: All flight points can be cleared.

EasySwarm 2.0 supports importing drone swarm files and executing flight plans in sequence at regular intervals. The flight plan demo files are in the software root directory (SwarmPlan-3Drones.csv).
Note: Before performing a swarm flight, it is recommended to perform a single takeoff and landing test and ensure that the drone MAC in the flight plan file is consistent with the MAC in the online node list.

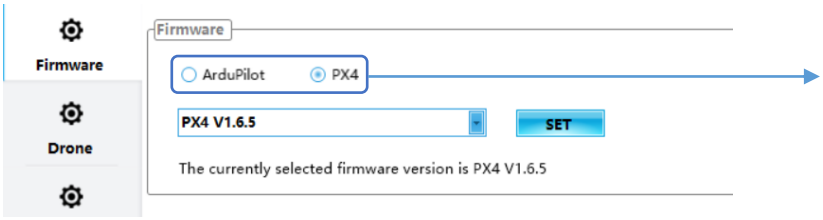


The base point will be used as the coordinate reference origin in the swarm flight plan file. Offset the base point, which will cause the overall offset of the swarm flight area, please fill in carefully and carefully.
Base Lon: The longitude value of the base point, please be accurate to 6 decimal places;
Base Lat: The latitude value of the base point, please be accurate to 6 decimal places;
Base Alt: The altitude value of the base point, filled in an integer value greater than or equal to 0.

IMPORT PLAN: Import flight plan files that conform to the specification. Please check the file format and the end of each line to avoid execution errors.
START: After clicking, the flight command will be executed sequentially until the execution is completed.
PAUSE: If an accident occurs during the execution, you can immediately suspend all drones and perform emergency operations such as returning and landing.

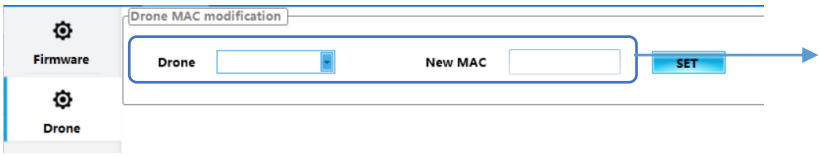
2.3 SETTING

Firmware selection



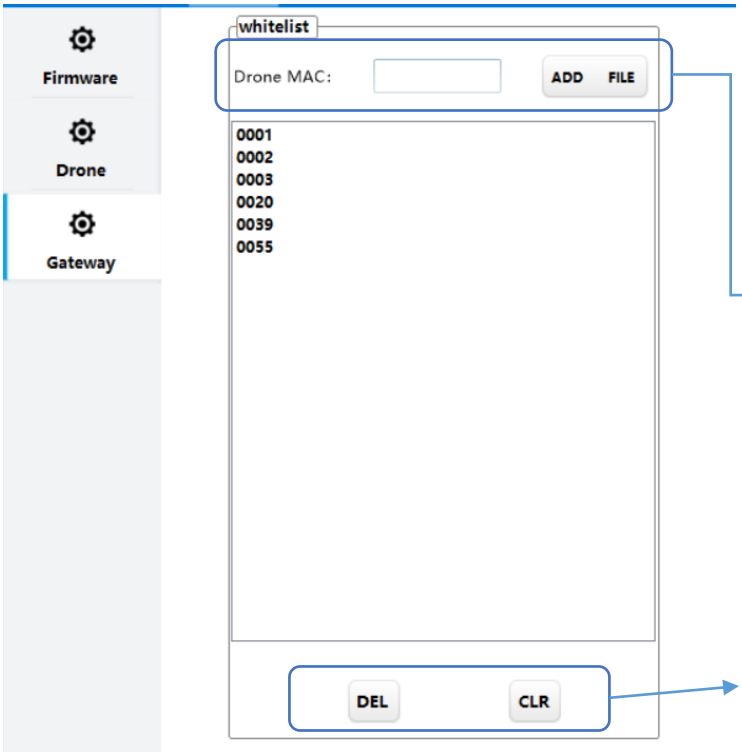
Firmware selection: Select the firmware type and version of the currently connected device.

Drone MAC modification



Drone setting: Select the connected online drone, and then fill in the new MAC address, the MAC address format is 4 digits (less than 4 digits, please add 0 to the front), click "Settings" and then power off and restart the node to complete the MAC. Address update.

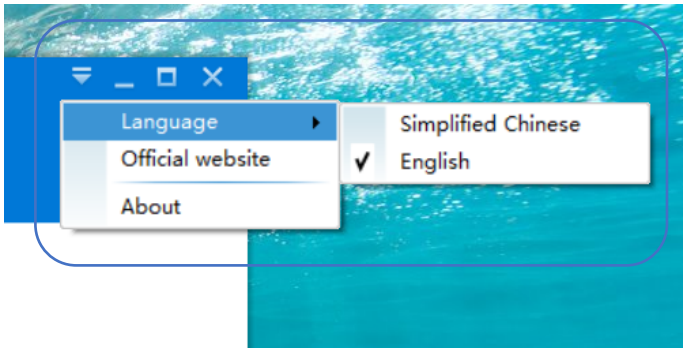
Gateway whitelist management



ADD: You can add drone manually, please fill in the 4-digit MAC address number;
FILE: You can import files in batches and add drones in batches. The file format is txt, and one line fills in a

DEL: Select a single MAC address, you can manually delete the drone;
CLR: Click to clear all MAC addresses, wait for the progress bar at the bottom

2.4 other



Language: Switch between Chinese and English software operating languages
Official website: Visit the official website of Robsense to get the latest firmware and software update information in time.
About: Get current software

3.Quick Connections

System settings in the function is still perfect, can only use the modified mac address

STEP 1 Connect RobSense Phenix Pro's Serial1 port with SwarmLink node UART port.

STEP 2 Connect SwarmLink Gateway micro USB with ground station.

STEP 3 Select the ground station serial number, baud rate, click open serial port.

3.1Hardware parameters

CPU：ARM Cortex-M3
Working frequency：433MHz
Channel bandwidth：500KHz
Modulation mode：LoRa spread spectrum
Transmit power：20dBm
Receiving sensitivity：-148dBm
Working voltage：5V

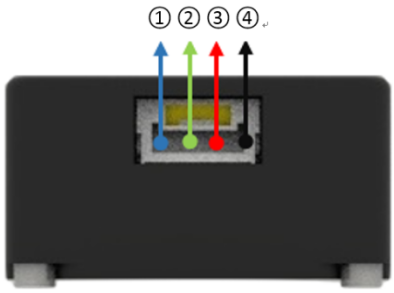
Working current：50mA

Working temperature：-40℃-+85℃

Interface：CAN，MicroUSB，LAN

Size：60mm*37mm*11mm

Weight：20g



SwarmLink Node/Gateway：1.TXD　　2.RXD　　3.VCC　　4.GND

3.2 Flight Controller Configuration (PX4 1.7.3)

If the developer is using px4-1.7.3 version, there is need to modify original firmware. The red boxes below show the code to be modified or added.

Mavlink update:

```
2034
2035    if (_mode != MAVLINK_MODE_IRIDIUM) {
2036
2037        /* HEARTBEAT is constant rate stream, rate never adjusted */
2038 //     configure_stream("HEARTBEAT", 1.0f);
2039
2040        /* STATUSTEXT stream is like normal stream but gets messages from logbuffer instead of u
2041 //     configure_stream("STATUSTEXT", 20.0f);
2042
2043        /* COMMAND_LONG stream: use unlimited rate to send all commands */
2044 //     configure_stream("COMMAND_LONG");
2045
```

1

```
2047
2048    switch (_mode) {
2049    case MAVLINK_MODE_NORMAL:
2050        configure_stream("HEARTBEAT", 1.0f);
2051        configure_stream("STATUSTEXT", 20.0f);
2052        configure_stream("COMMAND_LONG");
2053
```

2

```
2082
2083    case MAVLINK_MODE_ONBOARD:
2084        configure_stream("HEARTBEAT", 1.0f);
2085        configure_stream("STATUSTEXT", 20.0f);
2086        configure_stream("COMMAND_LONG");
2087
```

3

```
2122
2123    case MAVLINK_MODE_OSD:
2124        configure_stream("HEARTBEAT", 1.0f);
2125        configure_stream("STATUSTEXT", 20.0f);
2126        configure_stream("COMMAND_LONG");
```

4

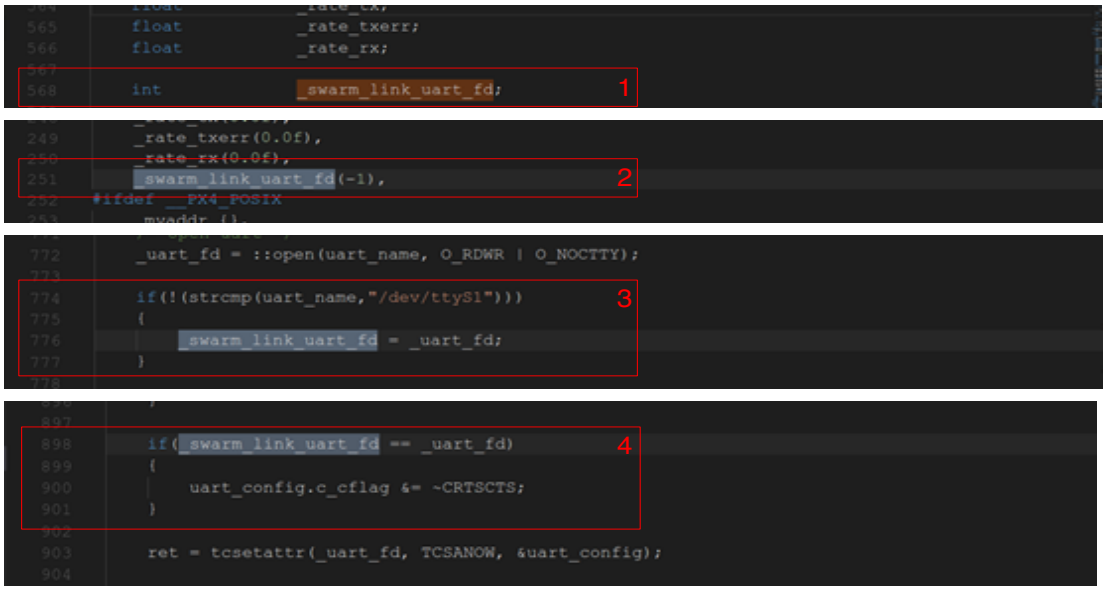
```
2147
2148    case MAVLINK_MODE_CONFIG:
2149        // Enable a number of interesting streams we want via USB
2150        configure_stream("HEARTBEAT", 1.0f);
2151        configure_stream("STATUSTEXT", 20.0f);
2152        configure_stream("COMMAND_LONG");
```

5

1.Find the firmware/SRC/module/mavlink/mavlink_main.cpp file.

2. Add code in the corresponding position, as shown in the 1, 2, 3, 4 and 5 steps shown above.

Turn off serial port flow control:



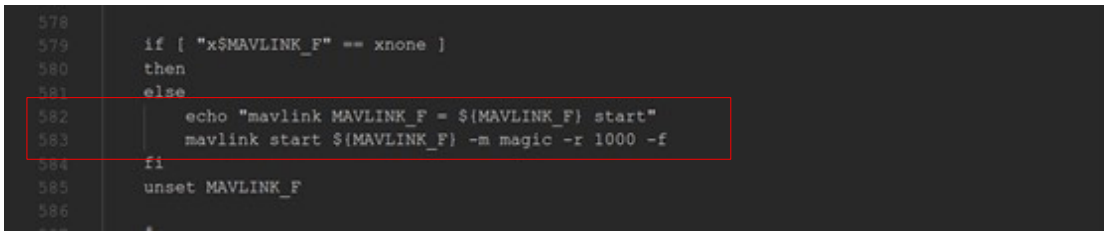
1.Find the firmware/SRC/module/mavlink/mavlink_main.h file.

2. Add code in the corresponding position, as shown in the 1 steps shown above.

3.Find the firmware/SRC/module/mavlink/mavlink_main.cpp file.

4. Add code in the corresponding position, as shown in the 2,3,4 steps shown above.

Modify boot file:



1.find firmware/ROMFS/px4fmu_common/init.d/rcS file。

2. add the code at the corresponding location, as shown in the red area above.

4.Use Cases

Case 1: MAC Address Management

The default MAC address of SwarmLink is FDFD0001, which can be customized changed for the purpose of networking.

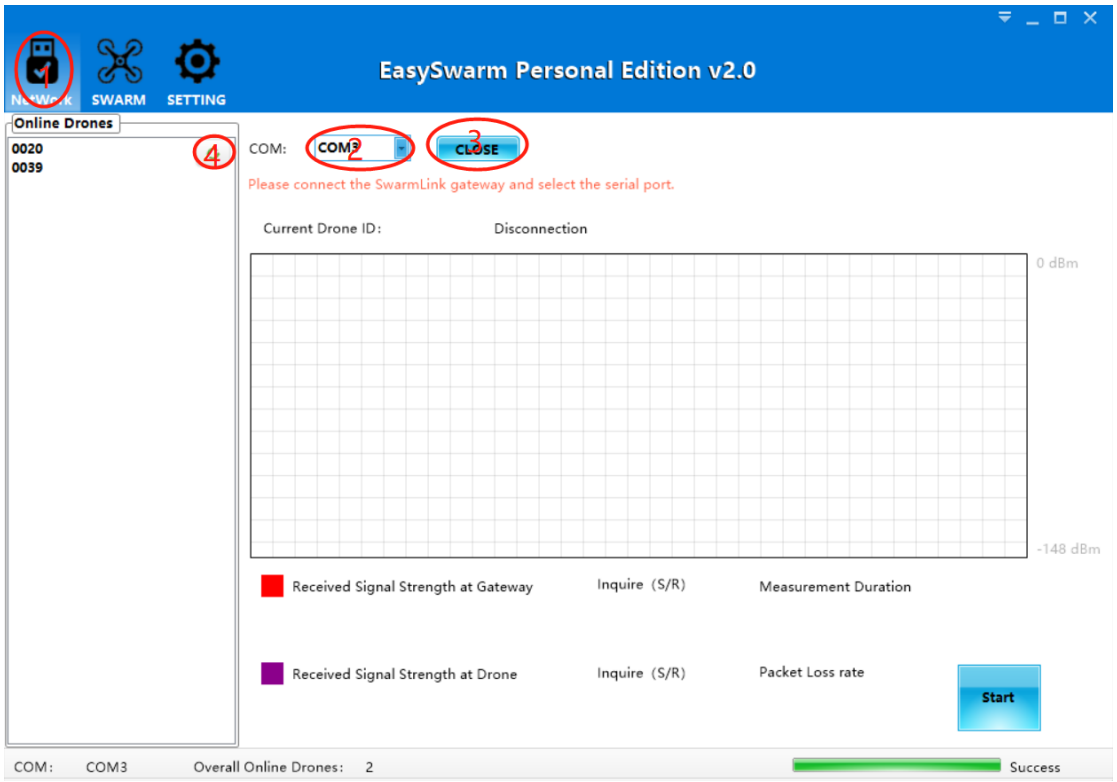
Hardware：SwarmLink Gateway、SwarmLink Node、PC.

Software：EasySwarm2.0。

Note: You can only modify one node at a time, multiple nodes, please modify them separately.

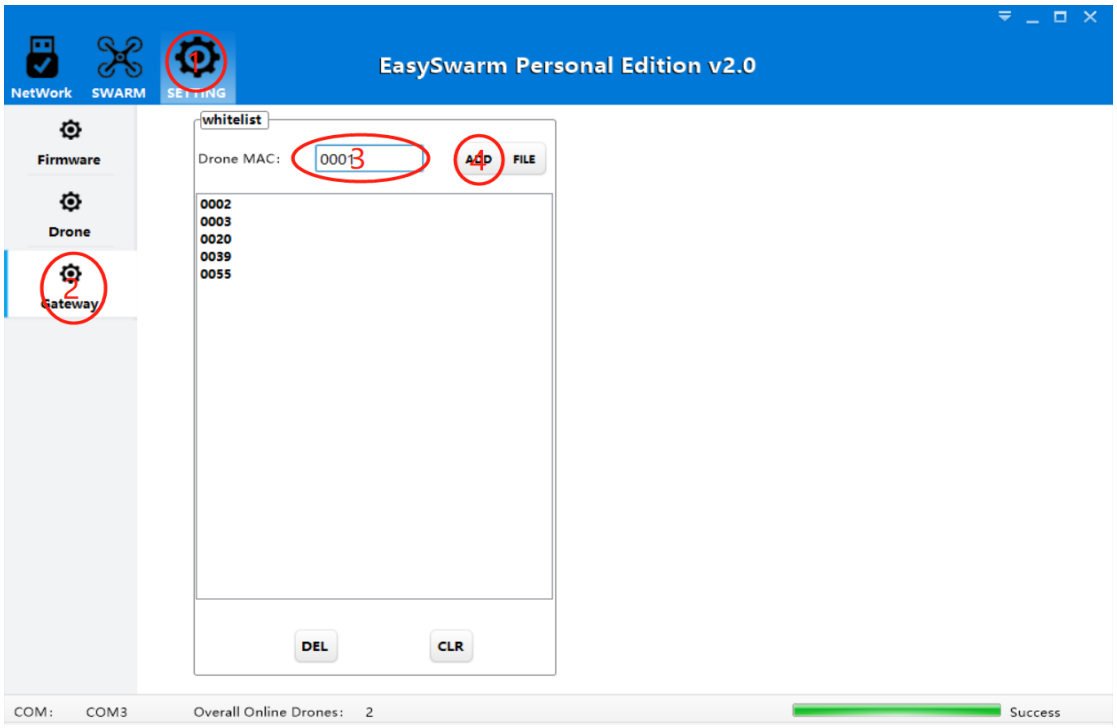
Modify the MAC address：

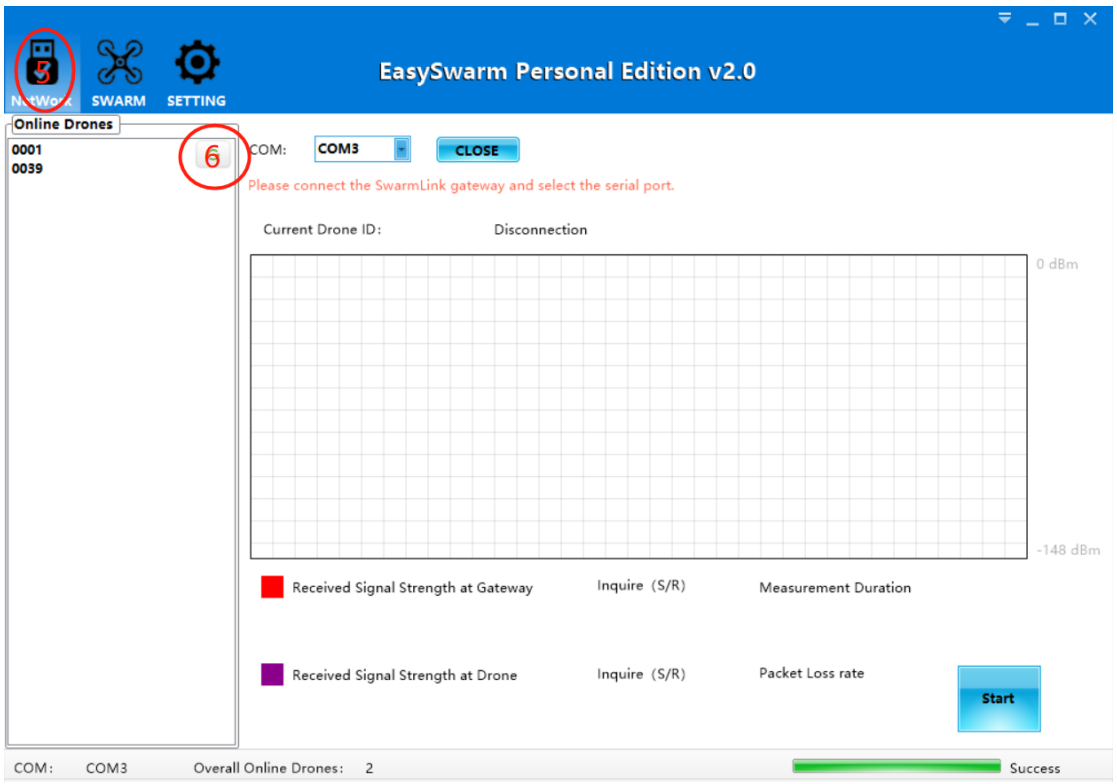
1. Open the gateway serial port



1. Click on the "NETWORK" tab
2. Select the serial port number of the gateway connection
3. Click “Open” and “Success” is displayed in the lower right corner, indicating that the gateway has successfully accessed. At this point, the factory node can also be powered on.
4. Click to refresh the list on the left. If the 0001 node appears, skip step 2.

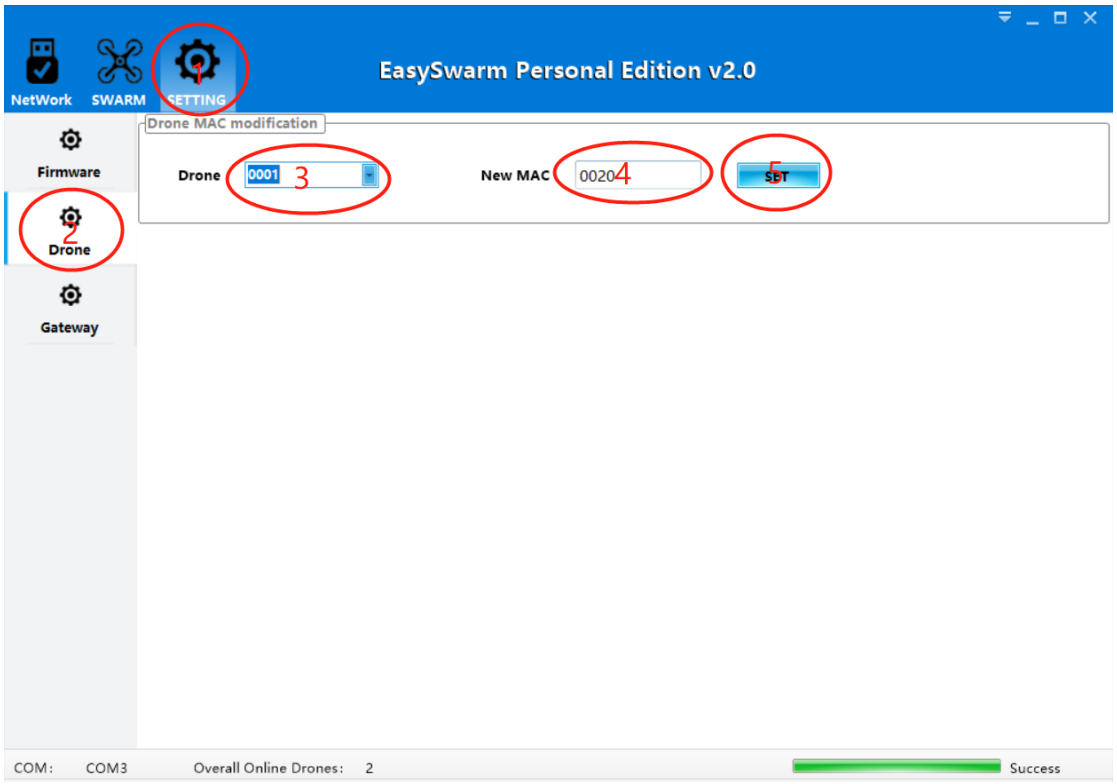
2. Add 0001 node to the gateway (you can skip this step if you have added)





1. Switch to the "SETTING" tab
2. Click on "Gateway"
3. Enter the node MAC address: 0001,
4. Click “ADD”. If you see the 0001 node in the white list below, the addition is successful. At this point, the factory node needs to be powered off and restarted.
5. Click on the "NETWORK" tab
6. Click Refresh to see if online node 0001 appears. If successful, go to step 3.

3. Modify the drone MAC address



1. Click on the "SETTING" tab
2. Click on "Drone"
3. Pull down and select the "0001" node
4. Fill in the new 4-digit MAC address
5. Click on “SET” and the prompt “Success” will pop up. Power off and restart the factory node, then refresh the online node list to view the modification.

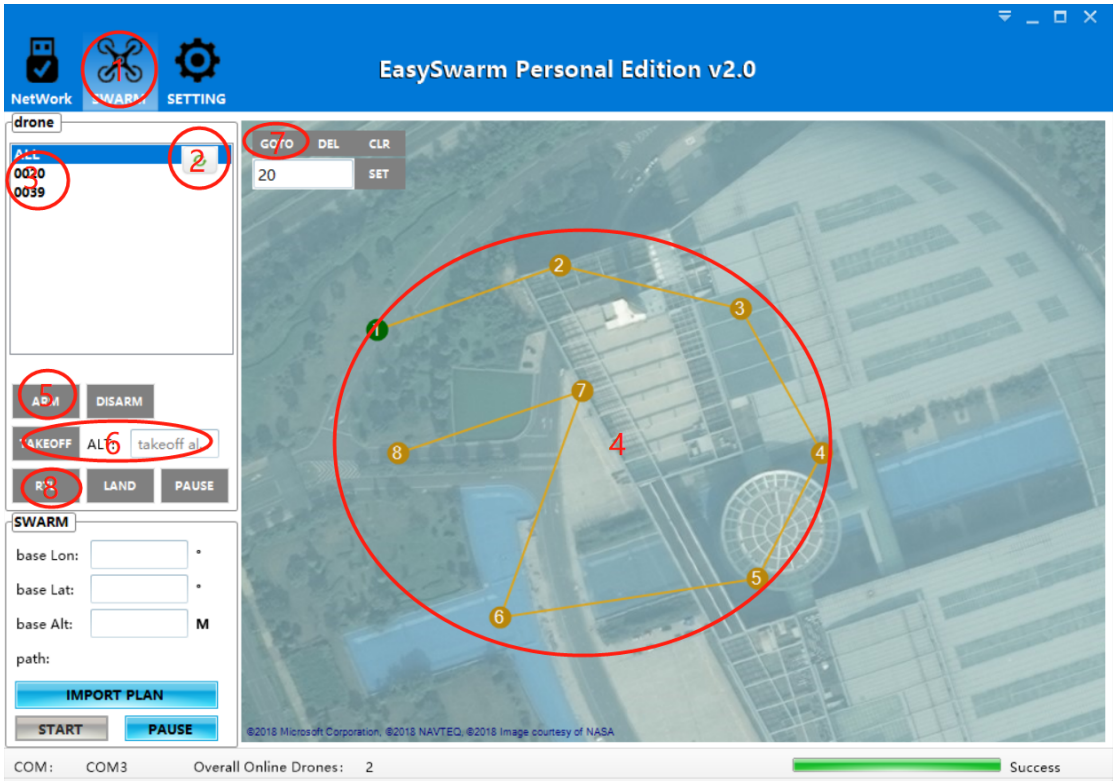
Note: If the new MAC address is not in the gateway whitelist, repeat the Add Gateway Whitelist operation in step 2 and refresh again.

Case 2: Single drone manual control

Hardware： Phenix Pro DevKit，RobSense RST330 research drone、SwarmLink gateway、SwarmLink node、PC

Software： EasySwarm2.0

Note: Before the drone is controlled by a single unit, you need to perform networking operations. Repeat steps 1 and 2 in Case 1 to complete the node addition. Once the drone node appears in the online list, you can proceed.



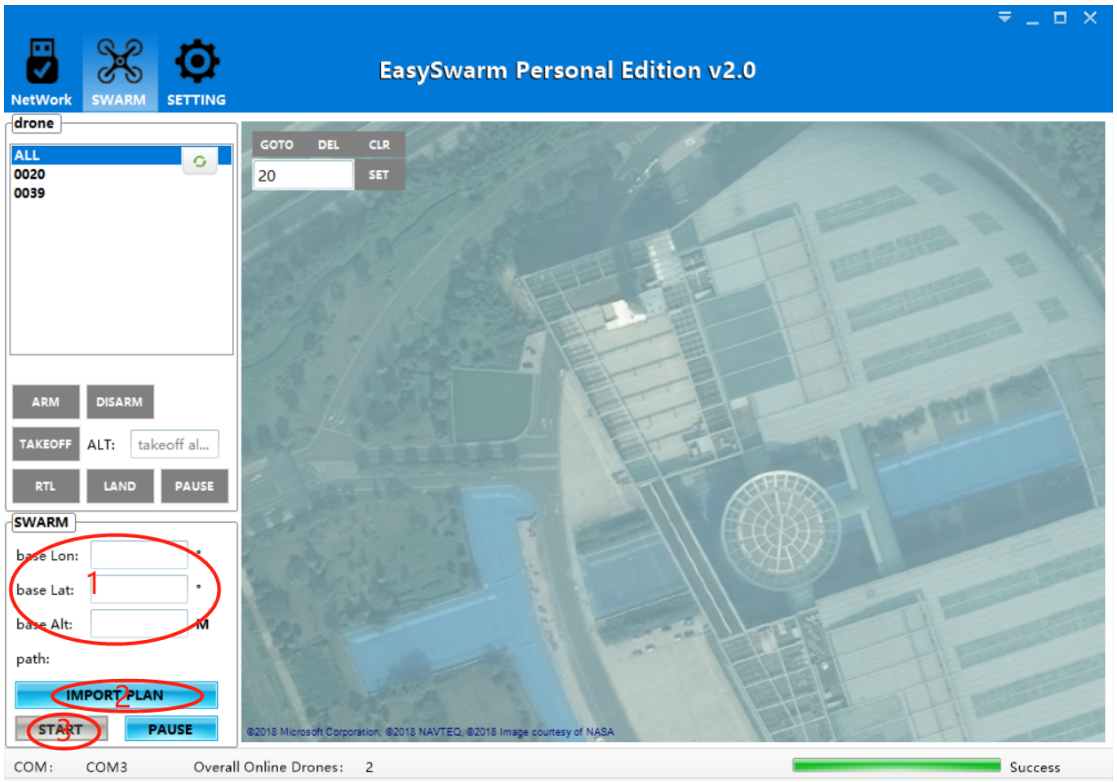
1. Switch to the "SWARM" tab
2. Click the refresh button
3. The drone node appears in the list, left click to select
4. In the map on the right, drag the map area with the left button, zoom in and out on the map, and right click on the map to plan the flight point. When finished, click the flight point No. 1.
5. Place the drone near the flight point No. 1, click "ARM", wait for the drone to unlock
6. Set the takeoff height (m), click "TAKEOFF", wait for the drone to take off to the specified height
7. Click on “GOTO” and the drone will fly to the currently selected flight point.
8. After completing the flight, click on “RTL” and the drone will return to the takeoff location and land automatically.

Case 3: Automatically Swarming

Hardware : RobSense RST330 research drone , RobSense Phenix Pro DevKit , SwarmLink Gateway,SwarmLink Node,PC （windows）.

Software : EasySwarm2.0

Note: Before swarm flight, you need to perform swarmLink networking and single-machine manual take-off and landing control test. For details, see Case 1 and Case 2.



1. Fill in the longitude, latitude, and altitude of the base point. The longitude and latitude need to be accurate to 6 digits after the decimal point, and the height is an integer greater than or equal to 0.
2. Import flight plan file, the format is csv, can be opened with execl, there is "SwarmPlan-3Drones.csv" under the software root directory, which can be used as a test file to directly import flight. You can also write your own flight files according to the flight plan file format specification.
3. Separate the drones on the ground, pay attention to the order of the drones (for example, the order of the demo files is from north to south, in the order of 1, 2, 3), click the "START" button. The drone will automatically execute the flight plan file at set intervals.
4.In the process of swarm flight, if there is an accident, please click the "PAUSE" button of the formation function for the first time, then return or land according to the actual situation, and do not support direct return.

Note: The drone's ARM, TAKEOFF, GOTO, RTL and other operations can be completed in the flight plan file.

Flight plan file preparation instructions:

The following are flight file format specifications:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	序号	提示	指令	间隔(秒)	节点MAC地址(无须加0补齐4位)	向东(米)	向北(米)	高度(米)	节点MAC地址	向东(米)	向北(米)	高度(米)	节点MAC地	向东(米)	向北(米)	高度(米)	结束符
2	1	解锁	ARM	0.5	1	0	0	0	2	0	0	0	3	0	0	0	ENDL
3	2	起飞	TAKEOFF	20	1	0	0	25	2	0	0	25	3	0	0	25	ENDL
4	3	1-3 GOTO 调整位置	GOTO	20	1	0	0	25	2	0	-5	25	3	0	-10	25	ENDL
5	4	1-3 东飞行 20米	GOTO	20	1	20	0	25	2	20	-5	25	3	20	-10	25	ENDL
6	5	2-3 东北飞行	GOTO	20	2	25	0	25	3	30	0	25	ENDL				
7	6	1-3 北飞行 20米	GOTO	20	1	20	20	25	2	25	20	25	3	30	20	25	ENDL
8	7	1-3 西北飞行	GOTO	20	2	20	25	25	3	20	30	25	ENDL				
9	8	1-3 西飞行 20米	GOTO	20	1	0	20	25	2	0	25	25	3	0	30	25	ENDL
10	9	1-3 西南飞行 20米	GOTO	20	2	-5	20	25	3	-10	20	25	ENDL				
11	10	1-3 南飞行 20米	GOTO	20	1	0	0	25	2	-5	0	25	3	-10	0	25	ENDL
12	11	1-3 东南飞行 20米	GOTO	20	2	0	-5	25	3	0	-10	25	ENDL				
13	12	3-1 返航	RTL	0	3	0	0	0	2	0	0	0	1	0	0	0	ENDL

Column A - Serial number: starting from 1 and filling in ascending order

Column B - Tip: Plain text content, only used to prompt the instruction of the line, improve readability

Column C - Instruction: Includes ARM, TAKEOFF, GOTO, RTL. Only one flight instruction is allowed in a row.

Column D - Interval (seconds): After the execution of the command is completed, wait for N seconds and execute the next line. If the flight distance is long, it is recommended to increase the time interval.

Column E - Node MAC address (no need to add 0 to fill 4 digits): Fill in the MAC address of the drone node that needs to be in formation flight.

Column F- east (meter): If it is a GOTO command, it represents the offset of the flight point relative to the base point, with a positive integer to the east and a negative integer to the west.

Column G - north(meter):: If it is a GOTO command, it represents the north-south offset of the flight point relative to the base point, with a positive integer to the north and a negative integer to the south.

Column H-height (meter): If it is a TAKEOFF command, it represents the takeoff altitude of the drone; if it is a GOTO command, it represents the up and down offset of the flight point relative to the base point, up to a positive integer, down to Negative integer.

Column Q- terminator: Each line must be filled with an ENDL at the end, indicating the end of the line instruction.

ROBSENSE

Humanise the Robotics

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