# CHC AP Commander

# User Manual

**Feb, 2017**

**Shanghai HuaCe Navigation Technology Ltd.**

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# 1. Overview

Ground station software CHC Commander is the command & control center of the entire UAV system. For the full-functional and highly integrated Flight Control & Navigation System of AP Series, CHC Commander performs all ground station instructions. Therefore, ground station software is in fact the human-machine interface of AP Series Flight Control & Navigation System, as shown in Figure 1.1 below.

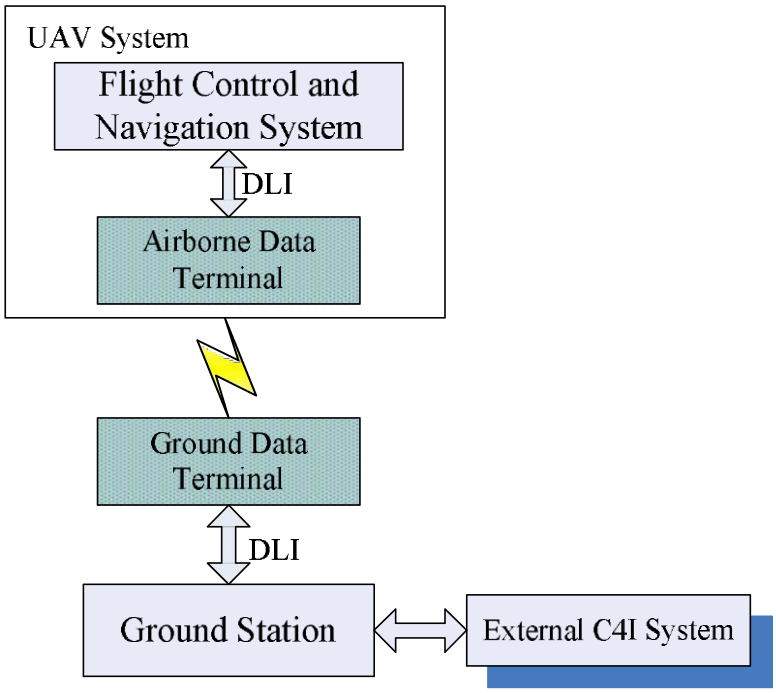



**Figure 1.1** Flight Control & Navigation System Interoperation Interface

# 2. Software Installation and Operation

## 2.1 System Requirements

### 2.1.1 Hardware Requirements

CPU: at least Intel Pentium 1.8 GHz, low-power consumption series processors are not recommended.

Memory: at least 2G

Monitor: at least 1024×768 (including) resolution, widescreen monitor can get better display results.

Port: at least one RS-232 serial port

### 2.1.2 Software Requirements

Operating System: Windows XP, Windows 7 or Linux Operating

Environment: Microsoft.NET Framework 4.0

Operation Authority: when operating in system that has authority management such as Windows 10, it must run as Administrator.

## 2.2 Installation and Operation

P310 CHC Commander is a set of Windows application programs installed via Windows installation file. Double click the installation file to start the installation process. The installation process is a step-by-step interface same as general Windows programs, such as agree the copyright agreement, select installation directory, etc. After installation, CHC Commander can be started via Windows Start Menu.

The Linux-version CHC Commander, which is not provided in the standard edition, is developed with QT platform. It is able to achieve coordinated operation with multi hosts, monitors, remote measurement and control multiple UAV flights.

## 2.3 Communication Mode

The first interface in P310 AP Commander after start is Communication Settings Dialog Box, as shown in Figure 2.1. It is utilized to set the communication mode between Windows system which operates CHC Commander and GCS-202 by WIFI hotspot.

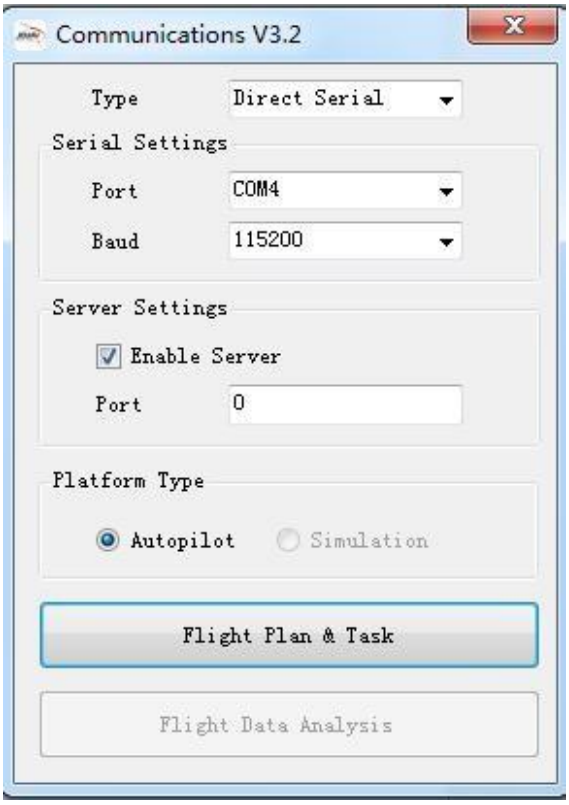



**Figure 2.1** Communication Settings Dialog Box

## 2.4 Operating Mode

From Figure 2.1 above, there are three Operating Modes in CHC Commander Ground station software: Autopilot Installation & Settings, Flight Plan & Task, and Flight Data Analysis. We can comprehend these three Operating Modes as followed:

- Autopilot Installation & Settings

  This mode is mainly used to set the installation methods along with the hardware installation of autopilot and each functional interface of autopilot, in order to achieve the normal operating status.

- Flight Plan &Task

  This mode is mainly used to plan and implement the flight task, and process the results of flight task.

- Flight Data Analysis

This mode is mainly used to playback the flight telemetry data file to help analyze the flight process.

These three Operating Modes are related to each operation of AP Series Autopilot System before, during and after task execution respectively. Each Operating Mode, interfaces and operations of its AP Commander ground station software are described below.

# 3. Magnetic Sensor Calibration

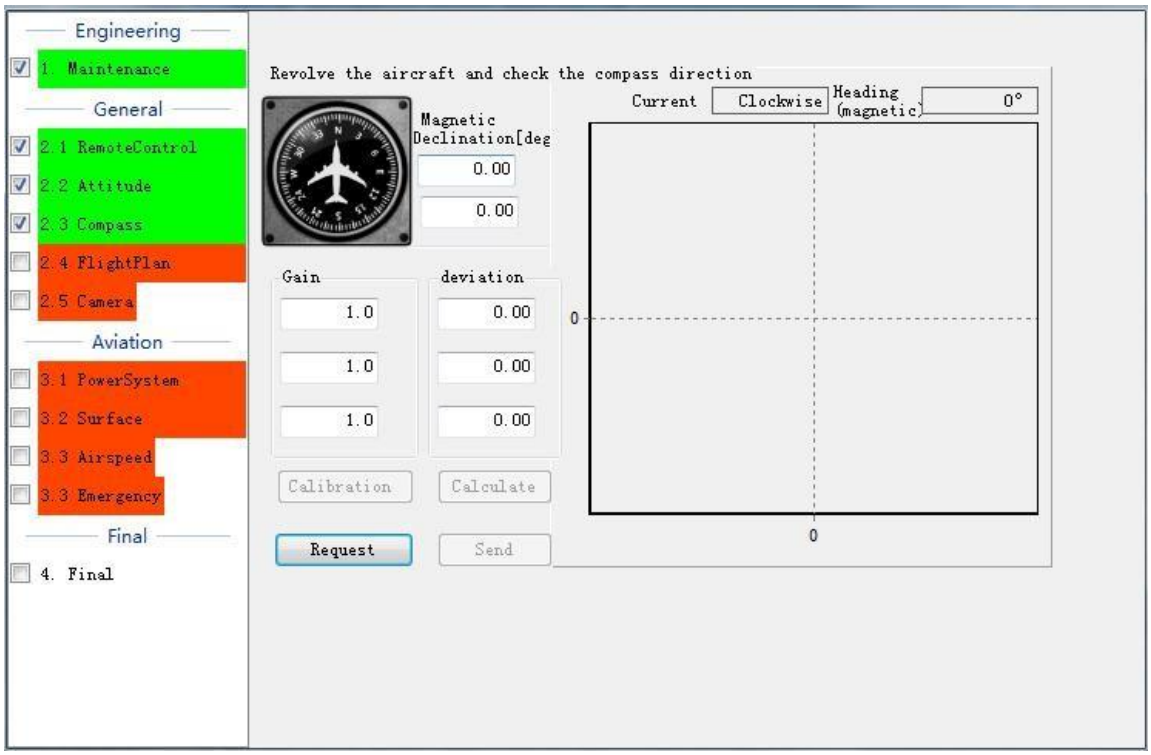



**Figure 3.1** Magnetic Sensor Calibration Panel

First, go to “Magnetic Sensor Calibration” Tab,
Next click **“Request”**, then click **“Start”** , a new window should pop out as in Figure 3.1.

**Click on Sample** to watch it.
Then two or more people lift the plane up, revolve it for two circles around the center of the flight control on the plane. While it is revolved, there should be red dots appear indicating the position of the head of the plane. The speed for the rotation should be slow, no less than 1 min per circle. After the rotation, click “OK” in Figure 8, then click “Send” to autopilot

**Notice**: Every time we fly the plane in a new place more than 50km, or haven’t calibrate the magnetic sensor in more than 2 weeks, we need to calibrate the magnetic sensor before we fly it.

# 4. Control Surface Calibration

The control surfaces are the UAV actuating device. AP Series Autopilot equipment supports various control surface types, PWM and SBus actuators. During the installation of autopilot equipment, the installation and configuration of autopilot equipment and actuators is an important step.

Configure in “Surface Calibration” interface, and then install the actuating control surface.

User needs to organize the actuating control surface conditions of UAV firstly, and determine the relationship between actuator channels of autopilot equipment and actuating control surfaces, then add the appropriate function channel at this interface to adjust the control surface.

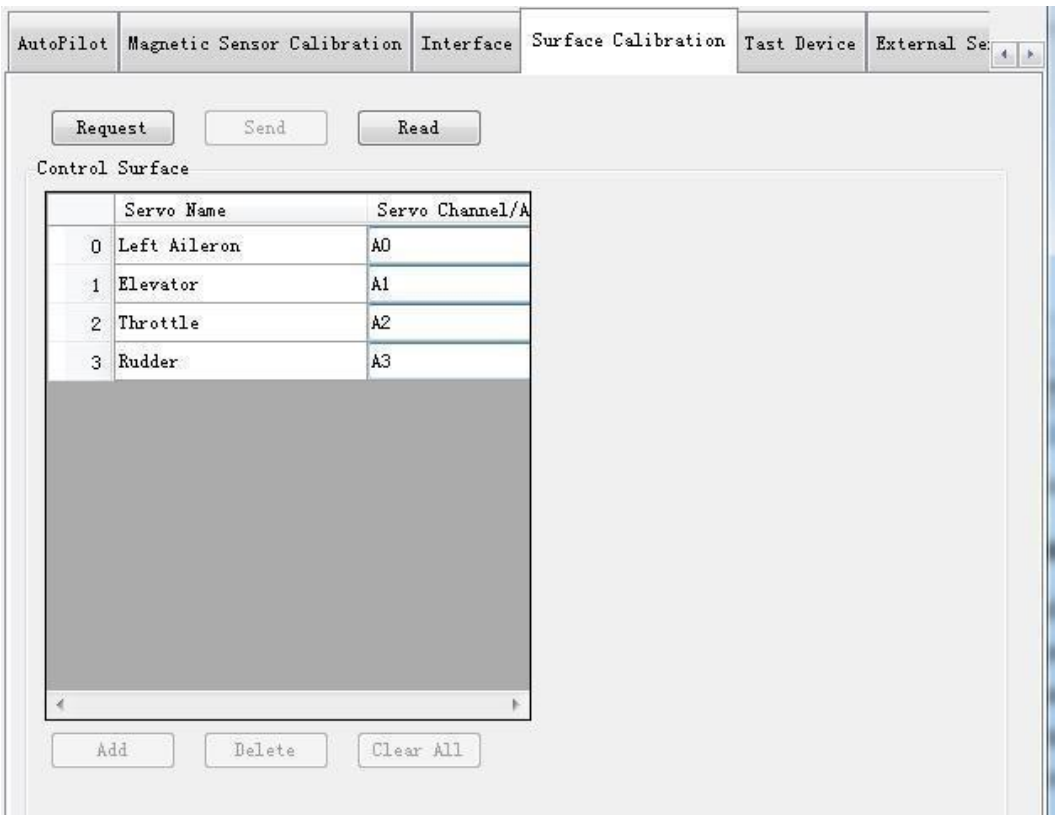



**Figure 4.1** Control Surface Calibration

Click “Add” button, a dialog box will pop up as follows:

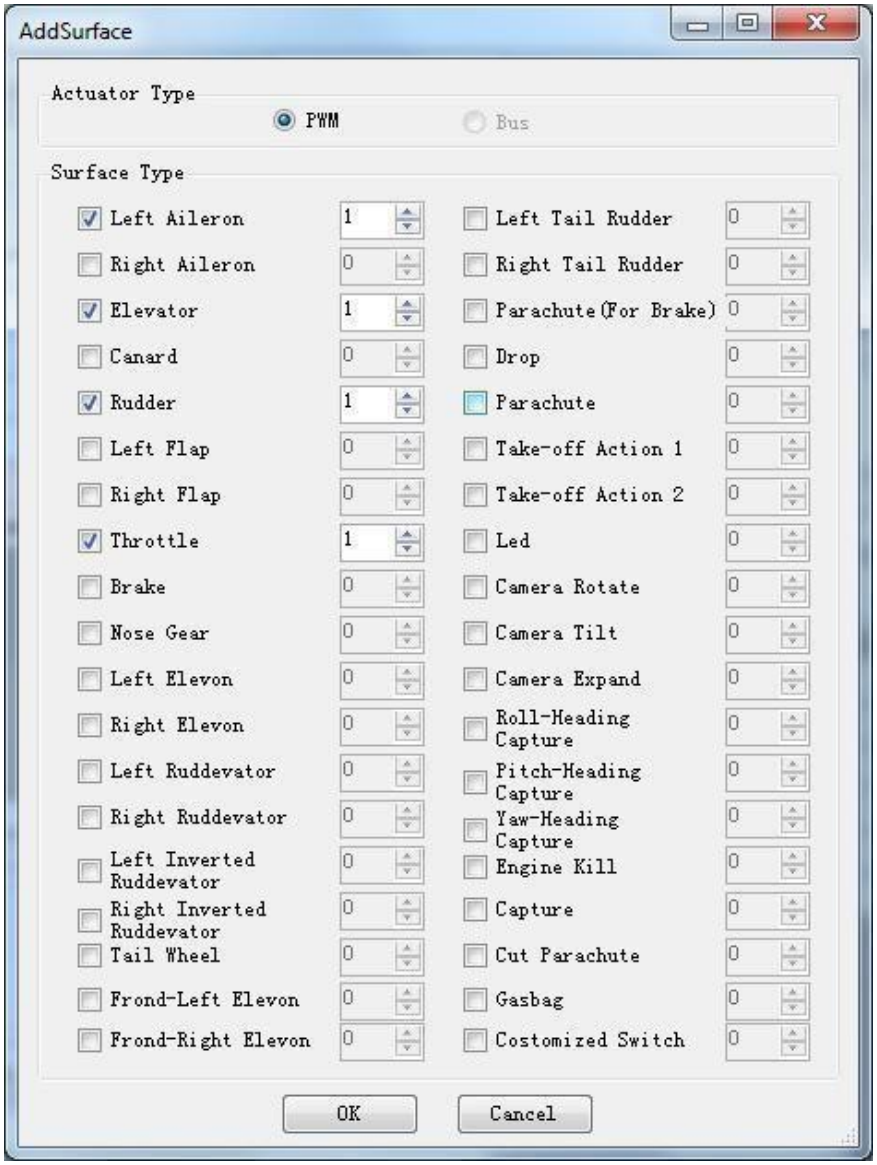



**Figure 4.2** Add Surface Dialog Box

After adding the Actuator channel, click “OK” button to return. As shown in the following figure 4.3, add two new function channels displayed in red background, which means it has not yet sent to autopilot. Use “Actuator Channel/Address” drop-down options to configure the appropriate channel number of each Actuator, click “Send” button. If configuration parameters are sent successfully, it will display in white background.

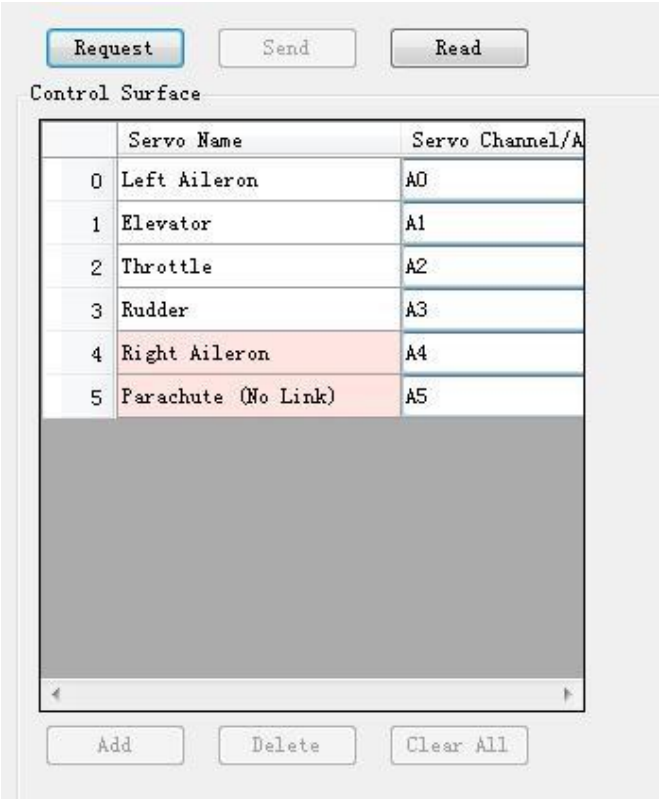



**Figure4.3** Actuator List

After finishing the Actuator channel configuration, we must also adjust the direction, neutral position and limit position of Actuator output. Select the Actuator that needs adjustment in the Actuator list, the right side will display the test panel. The initial test of Actuator can be performed at this moment, but it must switch to auto piloting mode.

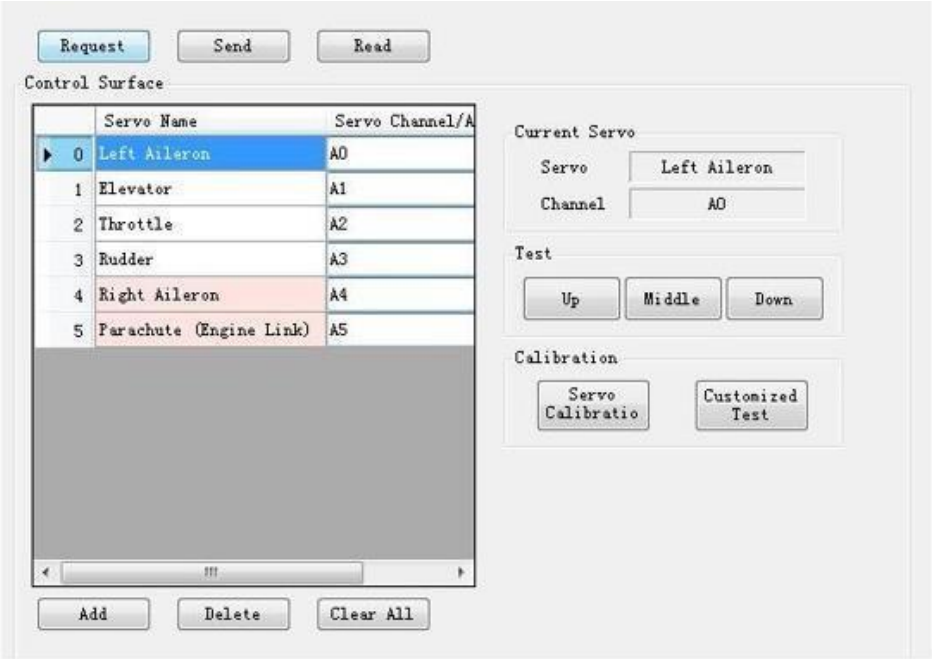



**Figure 4.4** Actuator Test Display

As shown in Figure4.4, the left aileron is being tested right now. Click "Up", "Middle" and "Down" buttons, the left aileron will act accordingly. If it's contrary to the command, enter the calibration interface to calibrate. Click "Servo Calibration" button, "Servo Calibration" interface will pop up as follows Figure 4.

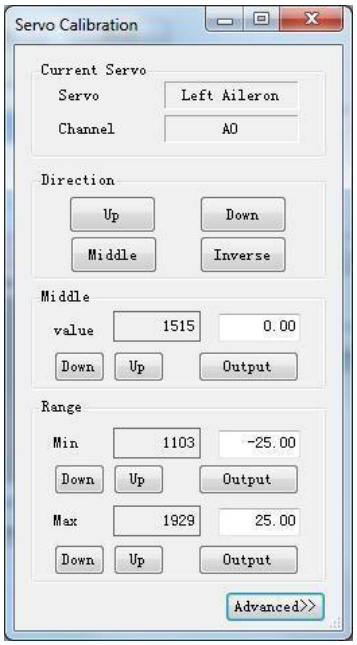



**Figure 4.5** Servo Calibration

Direction calibration is performed firstly in “Servo Calibration” interface. Click the appropriate action test buttons – “Up”, “Down” and “Middle” to perform direction calibration. If the control surface action does not conform to the instruction action, click “Inverse” button to solve this problem.

Middle position calibration can be started after finishing the direction calibration. For Actuator middle position, the control surface must be adjusted to the middle position at first by use of Actuator adjusting rocker arm and connecting rod. The adjustment of Actuator middle position in this interface is fine adjustment. Output the appropriate location command by “Output” button. Click “Down” or Up” button related to the middle position to adjust. Click “Output” button again to output the appropriate command. Observe the reaction of control surface, and adjust the control surface to an ideal middle position.

The range calibration is performed by the order of location output, adjusting and re-output, similar to the middle position calibration.

The PWM Actuator signal output of AP Series Autopilot equipment is based on the relation table between Actuator angle (or percentage value of 0-

1) and PWM signal. If user is familiar with the principle of Actuator configuration table, click “Advance” button to enter the detailed settings of Servo configuration table for more accurate setting

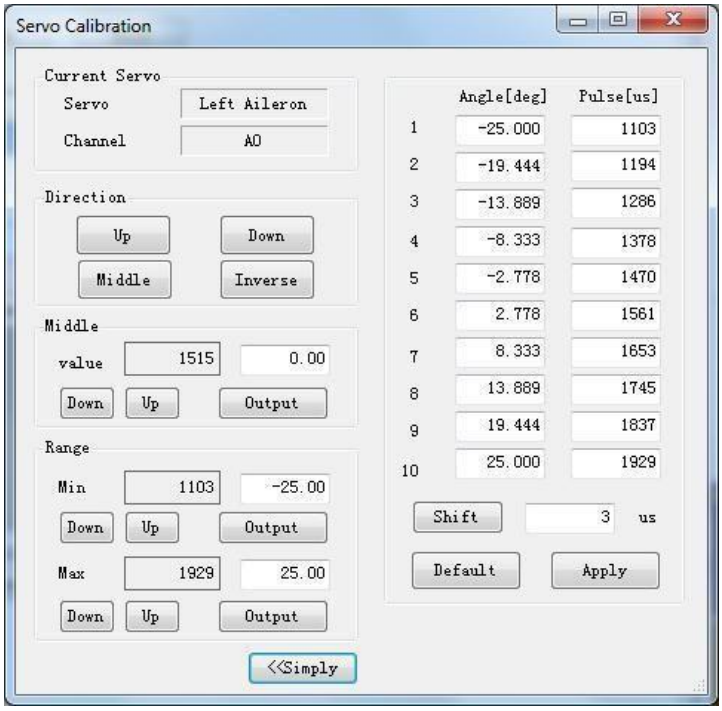



Figure4.6 Servo Configuration Advanced Interface

# 5. Controller Setting

User needs to make adjustments for some parameters of simple controller setting according to different situation, such as min. altitude, throttle percentage.


**Min. AGL**: Aircraft would switch to fixed wing mode if vertically lift up to the min altitude

**Climb coe.**: climb coef. × stall speed = transfer speed (from vertical mode to fixed wing mode) **Lateral deviation**: Max cross offset of check point for landing **Height deviation**: Max height offset of check point for landing **Deceleration Acc.**: Descending rate during vertically landing period

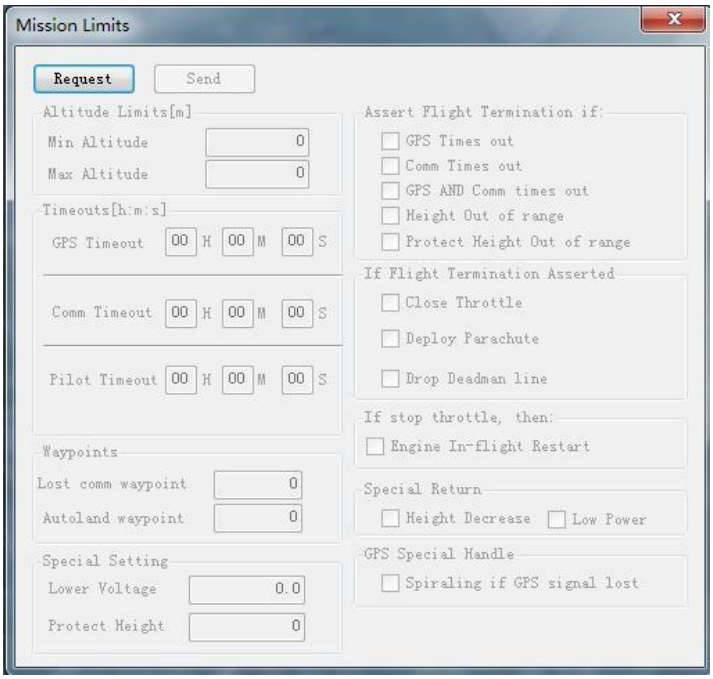
**Deceleration length**: Deceleration distance for fixed wing mode from waypoint 797 to 798

**Landing height:** vertical hovering height before landing

**Min. throttle:** Idle throttle

**Pre-launch throttle**: slightly higher than idle throttle **Auto Start throttle**: slightly higher than idle throttle **Cruise speed**: cruise speed for fixed wing mode **Climb speed**: climb speed for fixed wing mode

# 6. Emergency Handle




## 6.1 Altitude Limits

**Minimum altitude and maximum altitude** represent the flight altitude range for UAVs controlled by the autopilot. If the autopilot is in landing status, exceeding the minimum altitude is allowed. Otherwise, the navigation system instructions shall be limited by the altitude limits range.

The altitude limits setting uses height above sea level.

User has to select "Minimum altitude" setting and "Height Out of range" option. If the UAV exceeds minimum altitude for the first time, emergency handle would be triggered and UAV will be switch to quad -copter vertical mode.

## 6.2 Timeout

**6.2.1 GPS timeout:** represents the time span of UAV during continuous normal operation in case of GPS signal loss. If exceeded, GPS loss is confirmed.

After GPS loss, determine to terminate the flight or not based on the user-set conditions. If flight termination is not set, the UAV levels off for 10 seconds at the current pressure altitude after GPS loss is confirmed, waiting for GPS signals. If none yet, the UAV hovers with a 15 deg bank angle at the current pressure altitude, waiting for GPS signals.

**6.2.2 Data Timeout:** If the duration of data link signal complete loss Exceeds the time interval set by data link timeout, the autopilot shall launch the flight plan set by data link loss waypoint. After the data link loss time meets the setting, the autopilot checks the data link loss flight plan and choose the used waypoint.

**6.2.3 Pilot Timeout:** Manual command timeout sets the maximum duration of holding the manual control (or manual assistance) mode without receiving manual instructions under this mode. If the time of not receiving manual instructions exceeds the time interval, system will automatically switch to

autopilot mode. The time interval shall not be set to zero, otherwise the manual (or manual assistance) flight mode is not available.

## 6.3 Emergency Waypoint

**6.3.1 Data link loss**: defines the flight plan entry point after data link loss.

**6.3.2 Auto landing**: defines the landing flight plan entry point. Defining is available here, and the value shall be updated every time a new landing flight plan is created with map. When the autopilot starts landing, the navigator navigates the UAV to this waypoint, which is also true for the case where landing flight is canceled.

## 6.4 Special Return

**6.4.1 Height Decrease:** It is important to select the option

**6.4.2 Lower Power:** If it's in lower voltage condition, the aircraft would return back to waypoint 0

## 6.5 Engine In-flight Restart

It is important to select engine in-flight restart. If engine fails in flight, autopilot would command to restart engine.

## 6.6 Height Decrease Return Setting

If engine fails without power during auto mode, the aircraft would decrease to keep the airspeed. If the height decrease to setting value, the emergency handle would be triggered and aircraft would return back to waypoint 0

# 7. Flight Plan & Task

## 7.1 Main Menu

The screen-shot Figure 7.1 below displays an overview of what the CHC Commander looks like in a nominal configuration with urban area map information loaded.

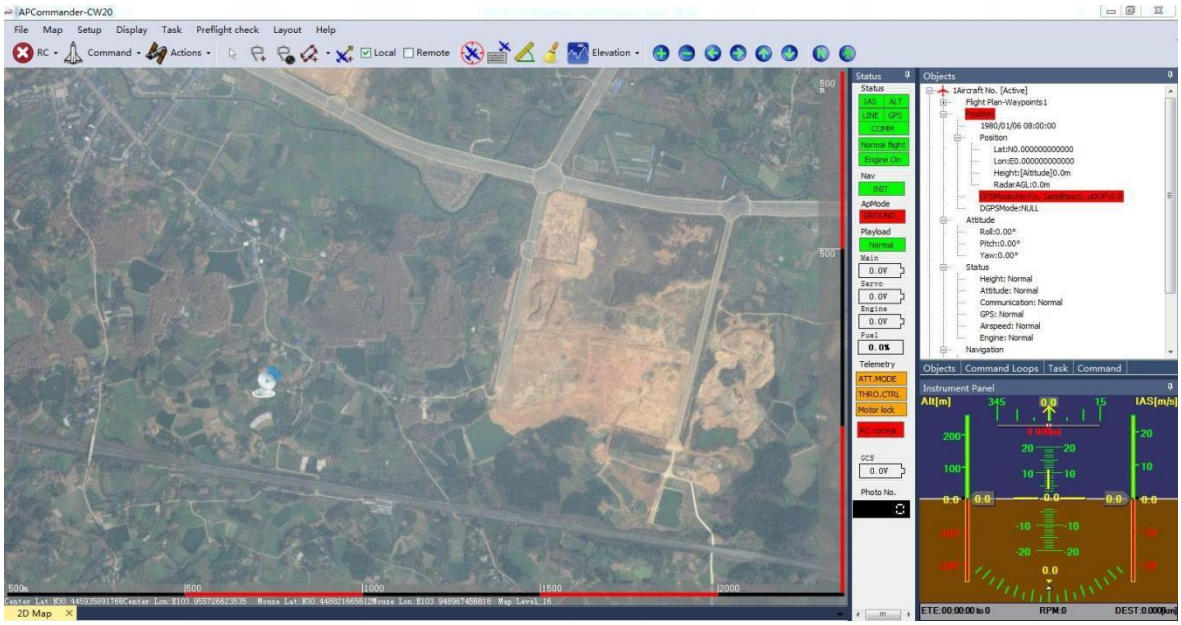



**Figure 7.1** CHC Commander Flight Plan & Task

## 7.1.1File Menu

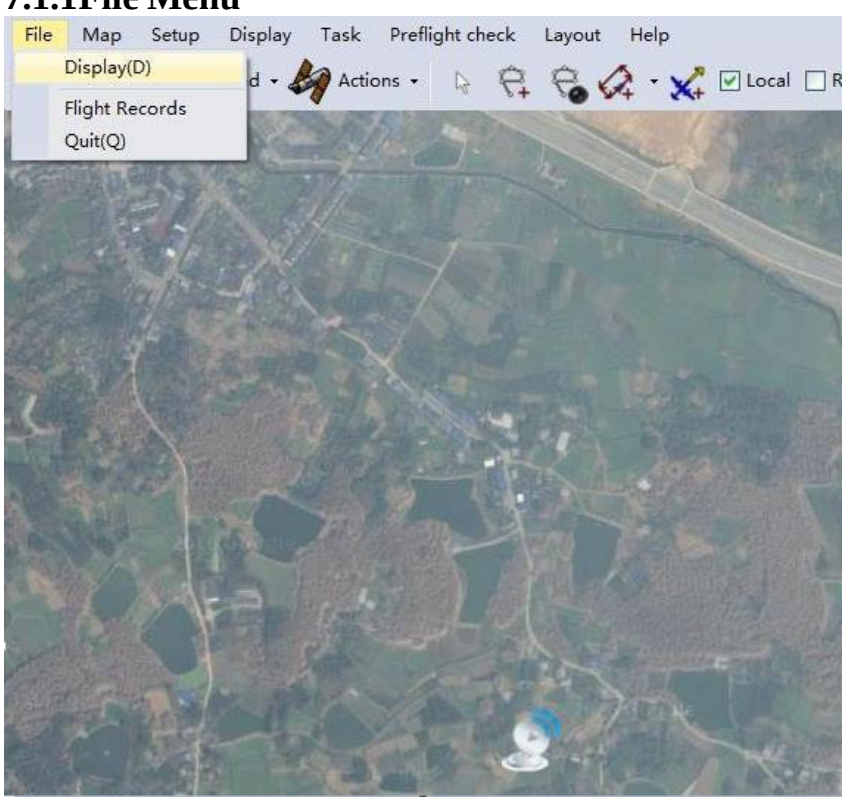



**Figure 7.2** File Menu

**Display:**Display includes unit, height, engine, alarm, wind direction and power and engine alarm setting as below figure:

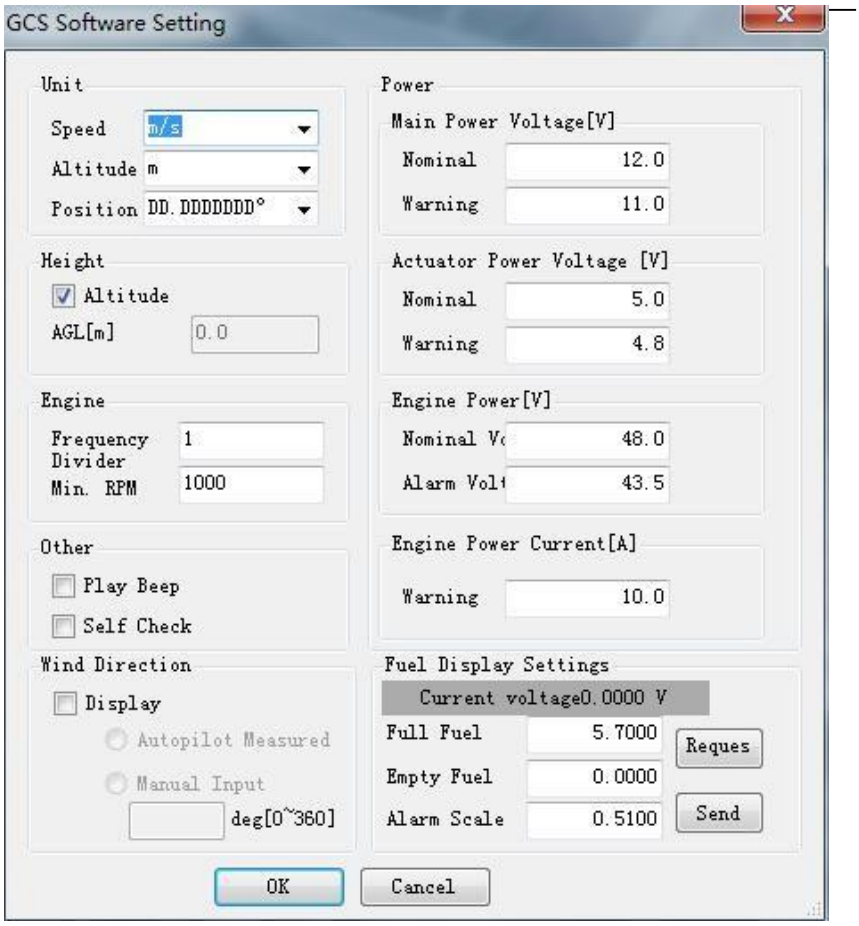



**Figure7.3：**Display

**Speed**: m/s or km/s

**Altitude**: m or km

**Position** :DD.DDDDDDD° or DD°.MM'SS.SSS'

**Height**: If you don't select "Altitude", it would display AGL height

**Frequency Divider:** If the hall sensors asymmetric installed, it would be 2

**Play Beep**: If selected. Play beep voice regularly in normal comunication

**Self-Check**: If selected, self-check of sensors data would be displayed on thescreenshot

**Power Display**: If the power is lower than the alarm setting, it would turn to redbackground for alarm.

**Fuel Display Setting:** Fuel measurement analogy to digital voltage display. If fuel is lower than alarm scale, it would turn to red background for alarm.

**Flight Record:** The black box in the aircraft would start to record till autopilot power off.

**Record module**: command to communicate with autopilot and download the data from black box.

## 7.1.2 Map Menu

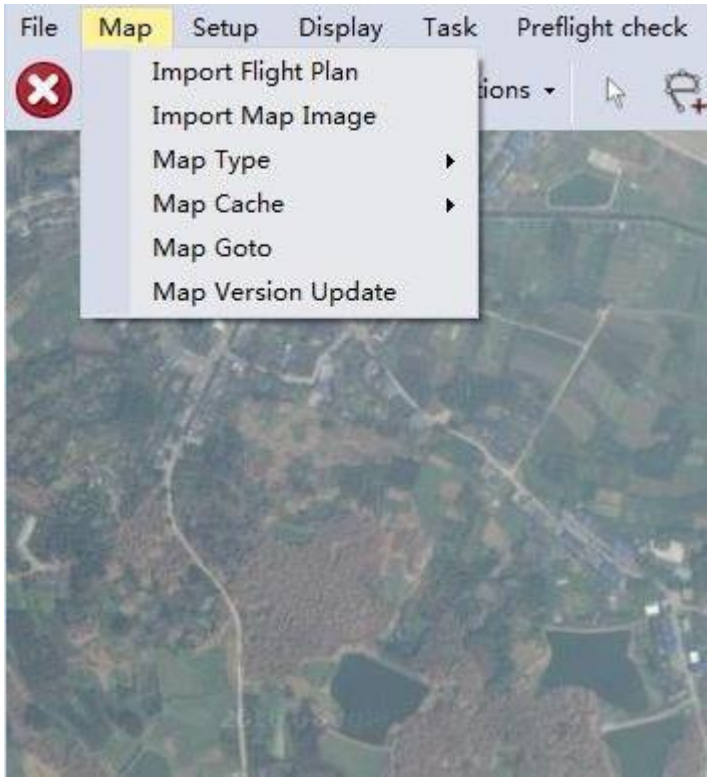



**Figure 7.4** : Map

**Import Flight Plan**: read the flight plan from the file, and display the flight plan as local flight plan in the map form.

**Import Map Image**: the sources of map display data are from online map data. The resolution of some areas' online data might not meet the usage requirements, if user has high precision map picture, overlay them in the appropriate areas.

**Map Type**: 2D map supports the following map types, which can be selected here as

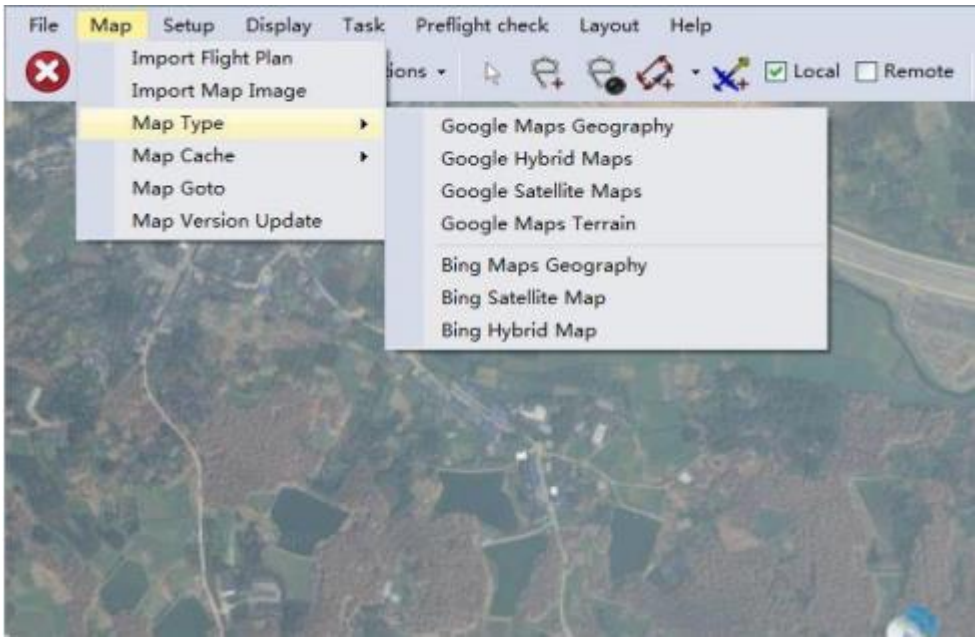



**Figure 7.5** Map Type

Google Geographical Map Google
Satellite Map Google Hybrid Map
Google Terrain Map
Bing Geographical Map Bing
Satellite Map Bing Hybrid Ma
Among which, the map type data of Google China might have some position offset due to the policies.

**Map Cache Management:** 2D map supports to download the map data online. Data cache can be used when offline and the cache files can be imported and exported.

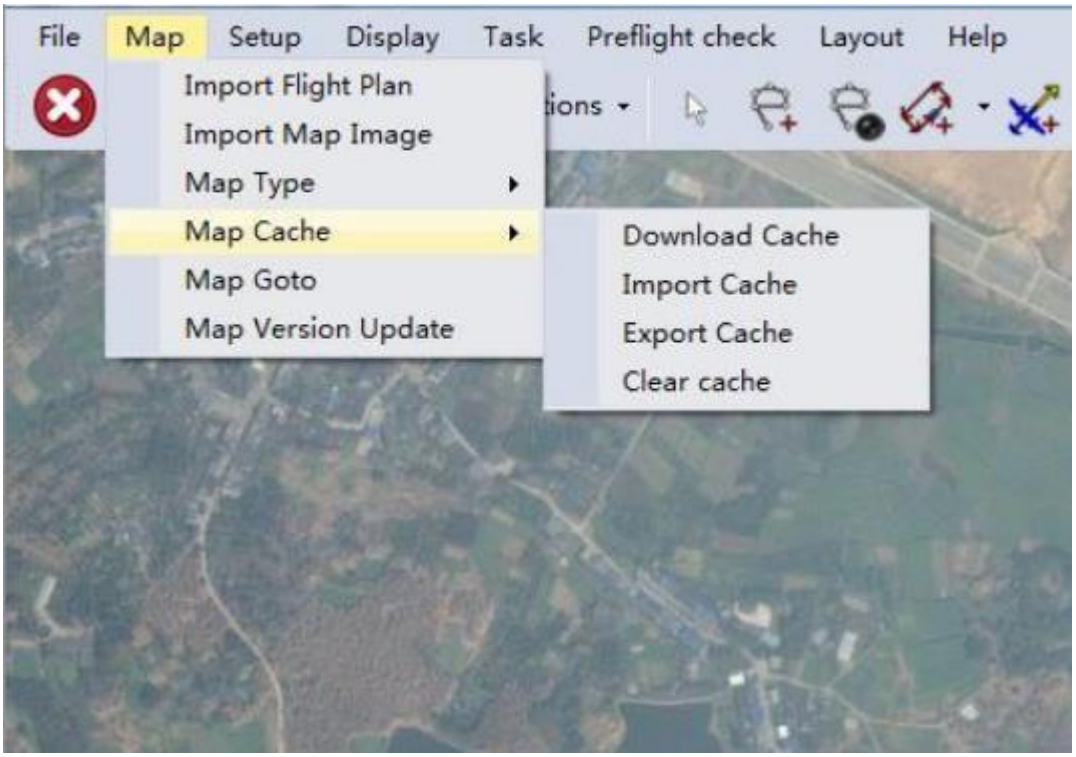



Figure 7.6 Map Cache

**Map Goto**: user can use this option to quickly jump to the given longitude and latitude position.

## 7.1.3 Setup Menu

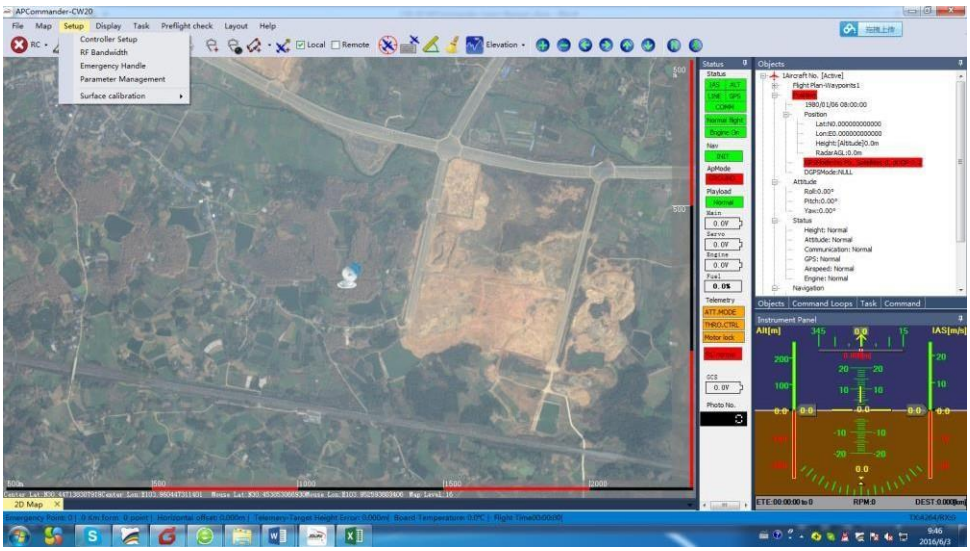



**Figure 7.6 Setup**

**Controller Setup**: set the controller parameters, including Lateral control parameters, longitudinal control parameters, trim parameters, limit parameters, UAV basic parameters, control surface hybrid control parameters and parameters related to the controller such as take-off and landing. The parameter details see the sections related to the controller parameter settings.

**RF Bandwidth**: set the receiving frequency of telemetering.

**Emergency Handle**: altitude limits settings, timeout settings of GPS, data link and manual instructions, and emergency waypoint and emergency processing procedure and action settings.

**Parameter Management**: manage the autopilot system parameters. If all settings are finished, please select "save to autopilot" and be sure autopilot power on during save to autopilot as Figure 7.7

GPS is default to select for altitude control resource.


**Figure 7.7** Data Management

### 7.1.4 Display Menu

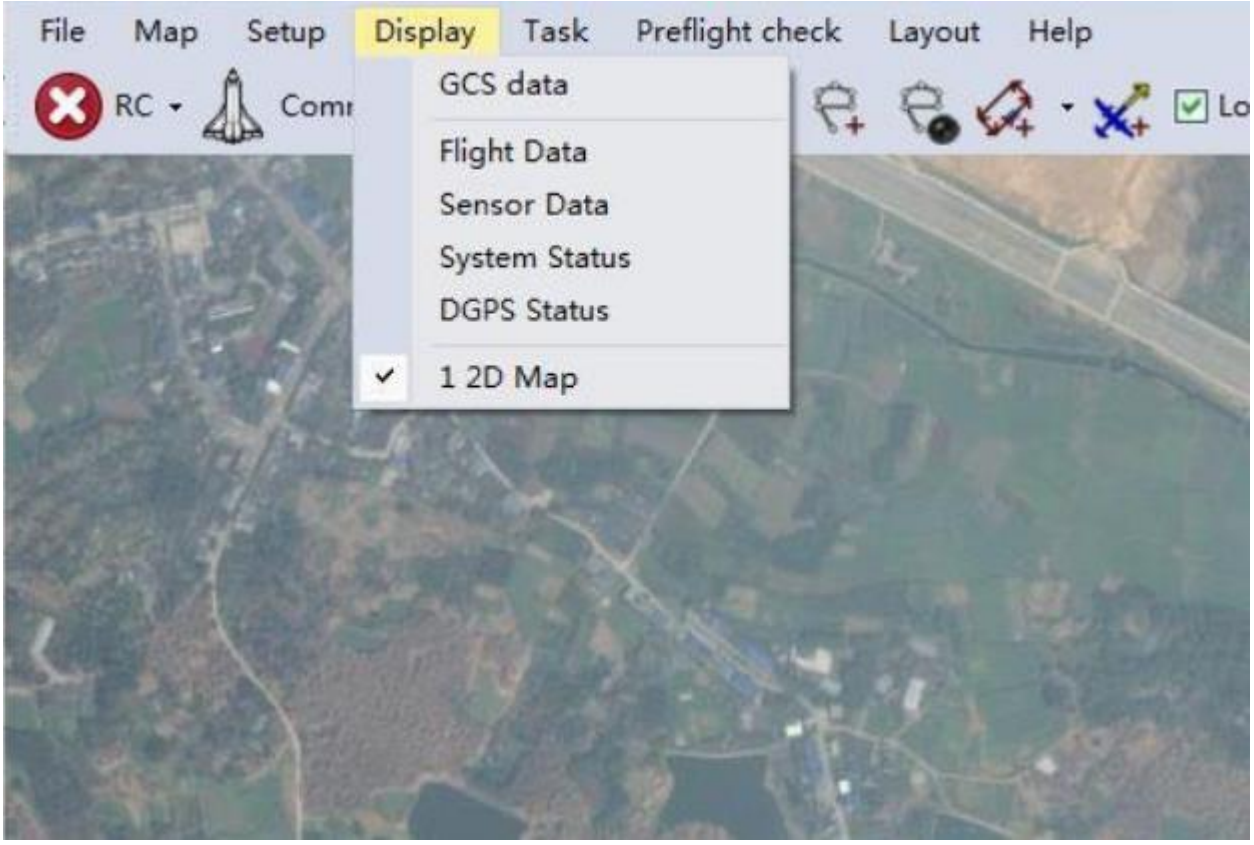



**Figure 7.8** Display

**DCS Data:** monitor GCS GPS position and voltage.

**Flight Data**: real-time display the system telemetry data, including GPS data, attitude data, air data, wind speed, engine speed, fuel, radar/ultrasound height, navigation offset distance, magnetic heading and navigation filtering;

**Sensor Data:** display temperature, static pressure, dynamic pressure, tri-axial gyroscope angular speed, tri-axial accelerated speed, angular deviation, accelerated speed deviation and magnetic sensor;

**System Status**: display system running time (s), time at pickup altitudes, system power supply status, data link status, system version, recording status of data recorder and parameter lock-out status;

**DGPS Status**: differential GPS status will be displayed here if there is Novatel difference input;

## 7.1.5 Task Setting Menu

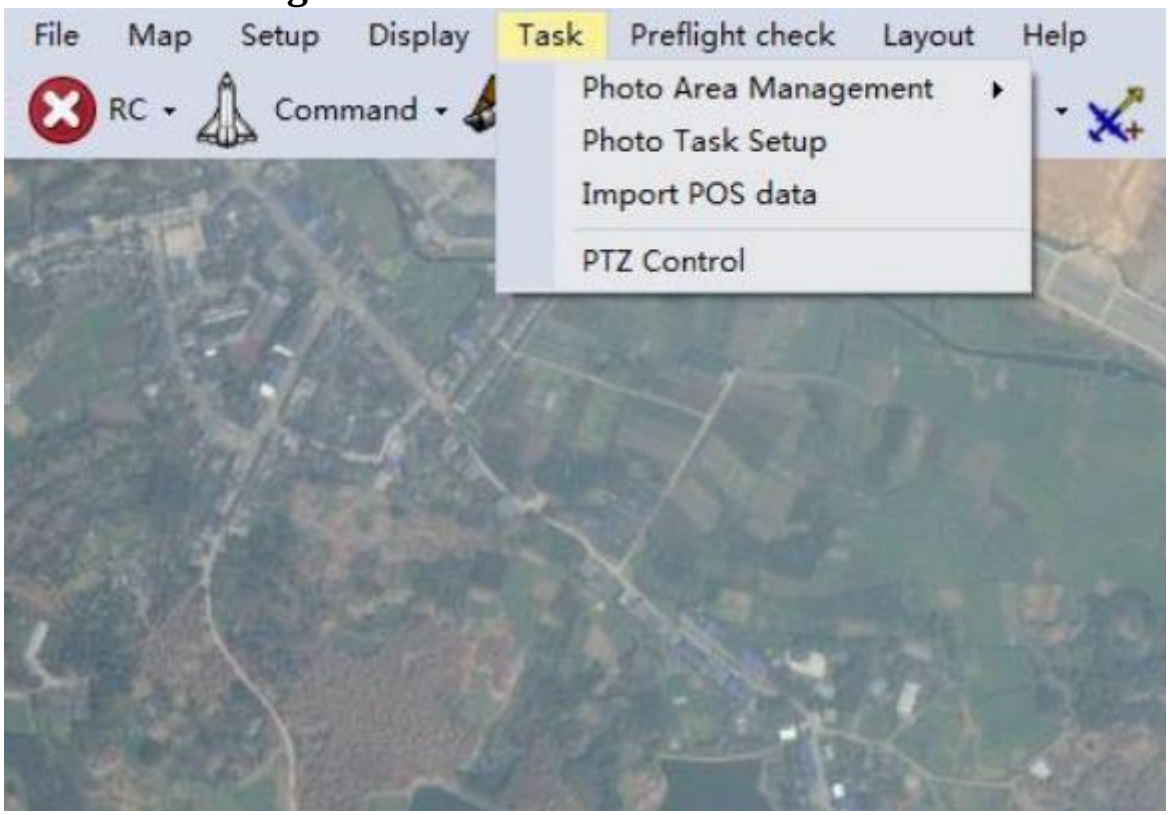



**Figure 7.9** Task

**Photo Area Management**: import and remove the Aerial Photography areas, import and export the planning areas

**Photo Task Setup**: set the camera parameters and Aerial Photography parameters involved in Aerial Photography task

**Import POS Data**: the achieved results will be obtained after finishing the Aerial Photography task, among which the picture POS data is an important result. Loading this data can quickly examine the location of aerial photography point, to see if there are any missing shots;

**PTZ Control**: Stabilized gimbal control for Pan/Tilt/Zoom

## 7.1.6 Preflight Check Menu

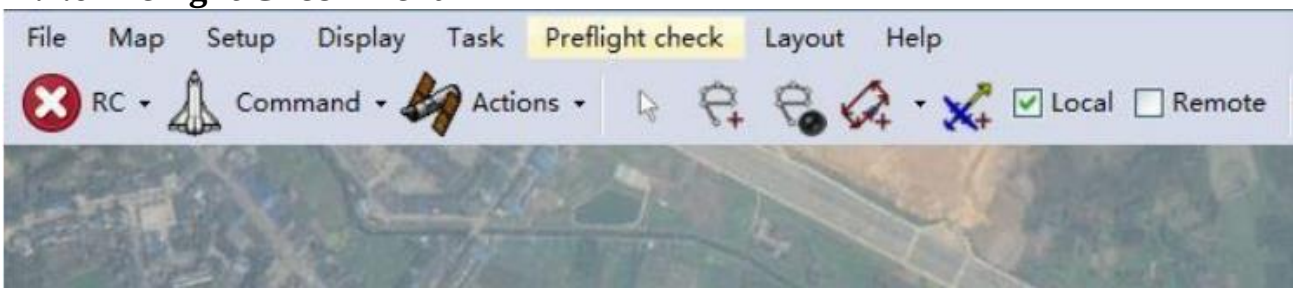



**Figure7.10:** Preflight Check

Pre-flight check: click this option to enter the Pre-flight check interface before fly.

## 7.1.7 Layout Menu

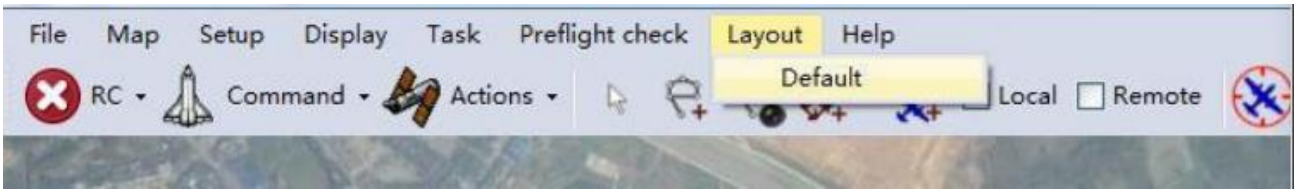



**Figure 7.11**

**Layout**: Restore the default layout of ground station software CHCAP Commander

## 7.1.8 Help Menu

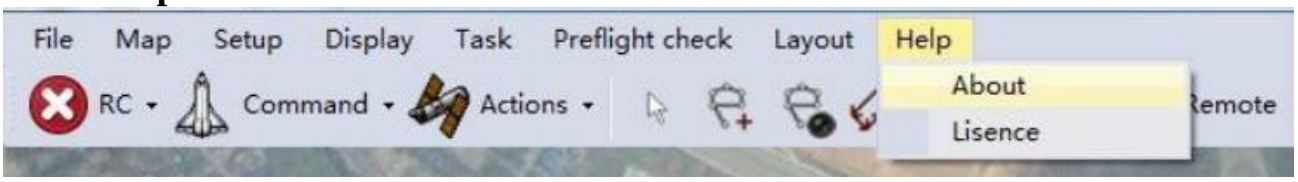



**Figure 7.12**

**About**: Some basic information of this software;

**License**: request the autopilot License information.

## 7.2 Toolbar

The system toolbar of ground station software AP Commander includes instruction toolbar, flight plan toolbar, common operational toolbar and map view toolbar, as shown in the following figure. Each toolbar can be floated at any location, and docked at the top, bottom and left side of the program interface.


**Figure 7.12** : Tool bar

### 7.2.1 Instruction Toolbar

Instruction toolbar consists of RC/Auto Switch, Command and Actions, as screenshot below:


**Figure 7.13** : Instruction toolbar

**RC** color would be switched to green or red if aircraft mode switch to RC or Auto mode as screenshot below , the 5th channel of RC switch to RC or Auto mode:

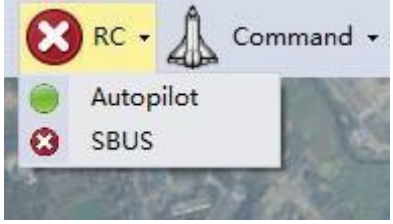



**Figure7.14**: RC Indicators

**Command** consists of pre-flight check, land and abort options. Please send command “Land now “within 30 min if pre-flight check finished.

**Abort** is used to finish the takeoff command and make aircraft vertically landing if any emergency happens during takeoff

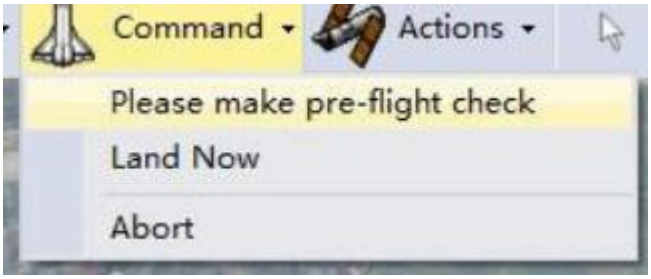



**Figure 7.15**: Command

**Actions** consists of open /close engine, open/close receiver during auto in-flight mode.

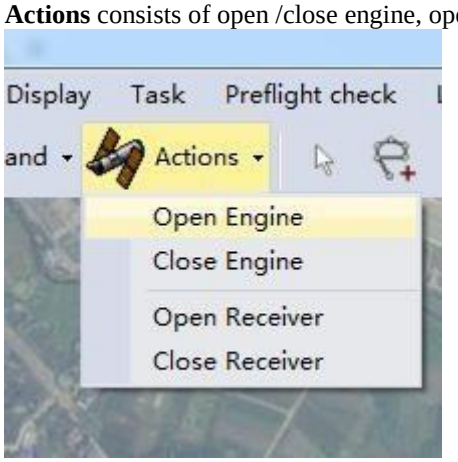



**Figure 7.16**: Actions

## 7.2.2 Flight Plan Toolbar

Flight plan toolbar contains various instructions of flight plan. The specifics refer to the relevant flight plan sections.


**Figure 7.17** : Flight plan tool bar

 Select 

 Create multi point flight plan

 Create mapping photo flight plan

Create auto landing flight plan


Create quick flight plan

Request local flight plan

Request remote flight plan

## 7.2.3 Common Toolbar

Common toolbar contains aircraft centering, display the small label of flight status, range rod, clear flight path and add map identification.


**Figure 7.18 :** Common toolbar


Zoom in the map to make aircraft centering


Label for the main data of aircraft flight status


Measurement rod for actual distance between waypoints


Clear the flight track


Profile elevation

## 7.2.4 Map View Toolbar

Map view toolbar contains Zoom, Pan, map north view mode and aircraftheading view modes.


**Figure 7.19**: Map view tool bar

## 7.3 System Status Bar

System status indicator is always at the right of map form. It's mainly used to display the key information of autopilot's current status. The red stands for abnormal status, the green stands for normal status.

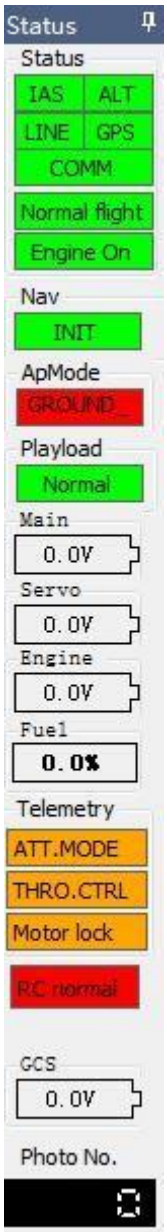



**Figure 7.20**: System status bar

**IAS**: if aircraft airspeed exceeds the max./min. airspeed range settings, it will display in red colour.
**ALT**: if flight altitude exceeds the allowable max./min. altitude ,it will display in red colour.

**Line**: if the aircraft attitude exceeds the attitude angle allowed by the controller, it will display in red.

**GPS**: if GPS receiver couldn't transmit correct position and speed, it will display in red.

**COMM**:telemetry data disconnection up to comm timeout setting in emergency handle, it will display in red.

**System**: if aircraft is in normal fly state, it will display "Normal" [green], or it will display prompt messages [red] such as "lateral deflection, go-around" and "decline return".

**Engine**: Engine on is green and Engine fail is red

**Nav**: It display INIT if GPS signal in normal situation, it display AHRS if GPS signal loss.

**AP Mode**:Display the flight modes of autopilot. Flight modes are described in the following table.

| | |
|---|---|
| **Ground Test** | 1. Enter this mode automatically after starting the programme. |

| | |
|---|---|
| | 2. The automatic recorder is not running;<br>3. The parameter adjustment can be set locked or not in this mode. Once locked, all modes can not be used to adjust control law and its parameters;<br>4. This mode only responds to the external instructions of remote-control device, does not perform any other operations. |
| **Ready-to-takeoff** | Ready-to-takeoff Mode:<br>1. If there are remote control commands, the throttle will act as the remote control commands; if not, the throttle will align with the minimum throttle (idle) position ;<br>2. Braking;<br>3. The control surface can be tested under this status. During aircraft swaying, the aircraft control surface will act to remain horizontal;<br>4. If taking off by throwing, rotate the aircraft to check if the control surface is correct. The action of all control surfaces is damping rotation. The airplane mode can be switched to take-off conversion mode by fast swaying forward and backward. |
| **Takeoff Conversion (Takeoff Run)** | 1. Catapult takeoff, takeoff from vehicle roof, hand-launch takeoff: waiting time, inspecting airspeed, and putting the throttle into ready-to-takeoff<br>2. Wheeled takeoff: roll out as per the takeoff flight plan;<br>3. Release the brake. |
| **Liftoff** | Lift the front wheel of the landing gear after reaching the liftoff speed, and wait for vertical rate to reach a positive value. Only in the takeoff from a vehicle roof and wheeled takeoff approaches will enter this mode. |
| **Climb** | 1. Keep climbing up with noseup;<br>2. Open the waypoint tracking when exiting this mode, and fly to waypoint 1. |
| **Flight** | Enable all functions in normal flight mode. |
| **Landing** | Fly according to the waypoints of landing plan after given the landing command by user. |
| **Approach** | Glides to the decision point along the last air route in the landing plan. |
| **Short Approach** | Enter the final gliding stage after passing the decision point conditions. |
| **Flareout** | Reach the flareout height to perform the balloon maneuvering. |
| **Landing Run** | Roll and start the brake system when detecting touchdown information. |

**Payload**: Task Devices (for example, parachute, Gasbag) will display green light and normal characters in normal state; if the parachute and Gasbag are opened, it will display yellow light and characters of relevant equipment status.

**Power**: This will display the main power, Actuator power and power voltage of autopilot. If power voltage is lower than the alarm voltage, itwill display in red.

**Fuel**: Display the fuel percentage, if less than 0.25 as setting , it indicates red alarm.

**GCS**: Display the GCS voltage

## 7.4 Flight Status Display

Display flight status information, such as emergency point, distance to waypoint 0 , horizontal offset , board temperature and flight time.


**Figure 7.21** Flight status display

## 7.5 2D Map Display

When 2D map form is connected to the map server, it will read and display the map data, and give the longitude and latitude coordinates of flight plan & flight path.2D map form also indicates the icon and flight path of aircraft. The location and flight path of aircraft are updated based on the telemetry data. The aircraft coordinate column below the map also gives the longitude and latitude of the current aircraft location. The mapping scale which shows the map size is at the bottom column in the map form.

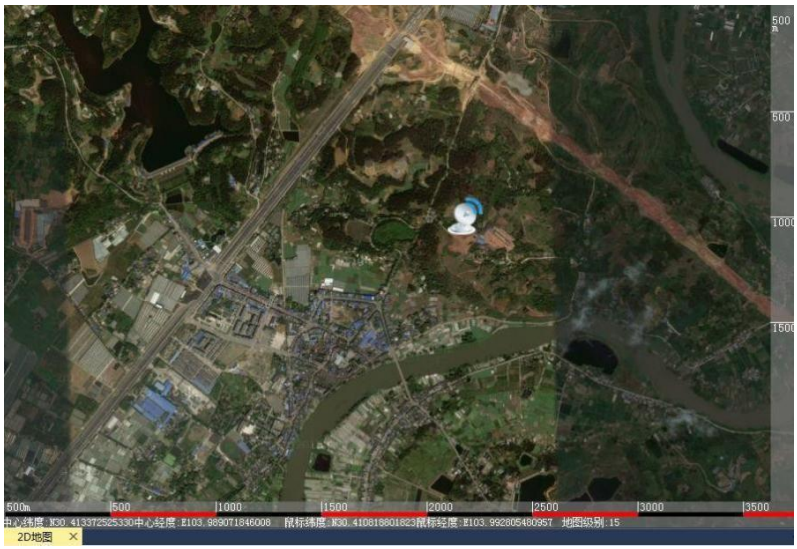



**Figure 7.21** 2D Map

## 7.6 Flight Status Display

### 7.6.1 Object List

The information relating to existing UAVs and ground stations, including position, attitude, status and navigation, will be shown in the Object List Form. If abnormal situation, the item will be displayed in red highlight

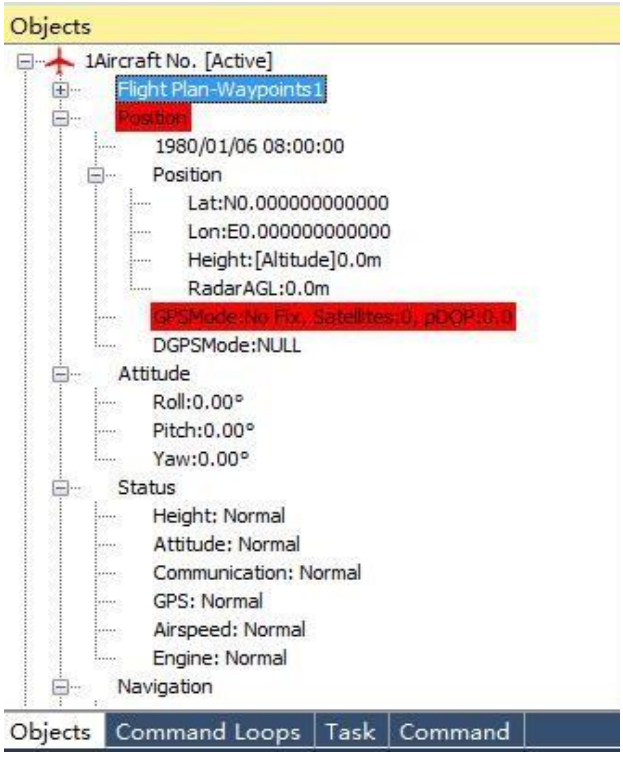



**Figure 7.22** Object list

## 7.6.2 Command Loops

The Command Loop consists of telemetry information, current status and current instructions of 7 control loops. Please refer to the Controller Instruction Sections for the primarily supported control loops and their function descriptions

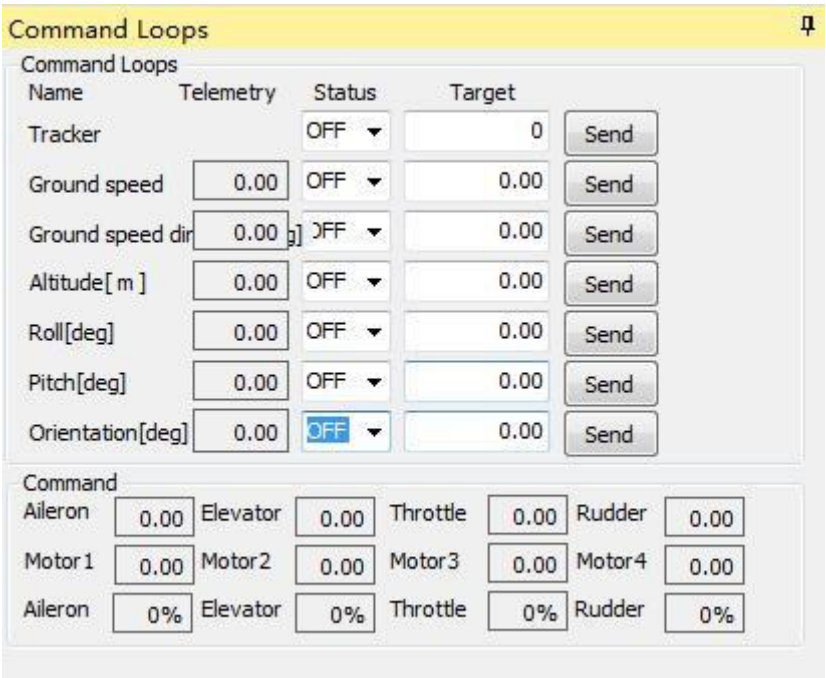



**Figure 7.23** Command Loops

## 7.6.3 Task Instruction

Task Instruction Form covers task instruction buttons of RC receiver, fixed wing propeller and camera actions.

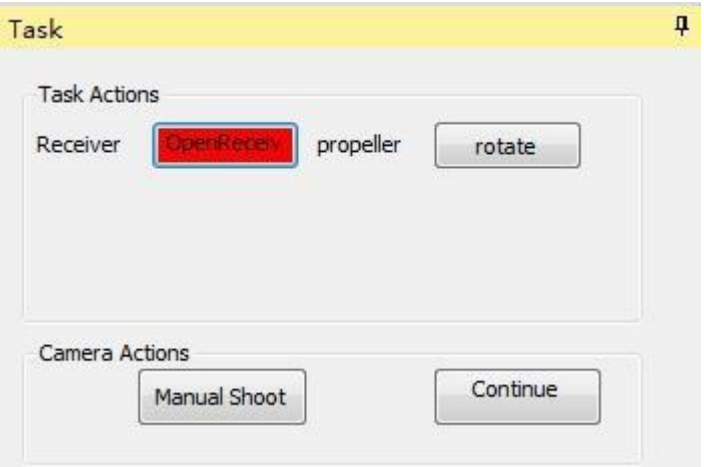


**Figure 7.24** Task

## 7.6.5 Command

Command consists three main commands of aircraft flying circle, change altitude and regain altitude.

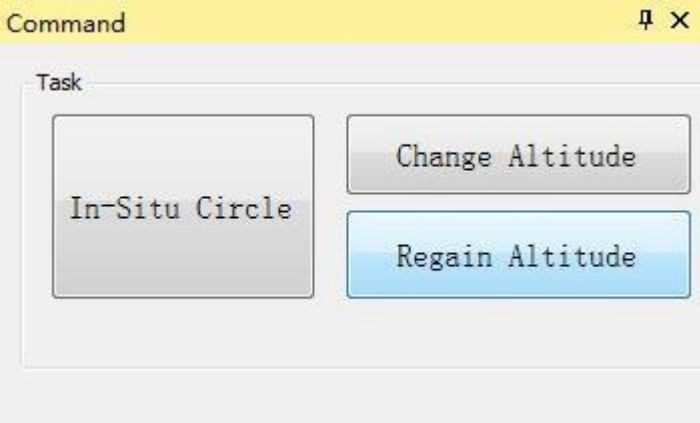



**Figure 7.25** Command

## 7.6.5 Instrument Panel

Instrument panel display the most important information of aircraft flight status.

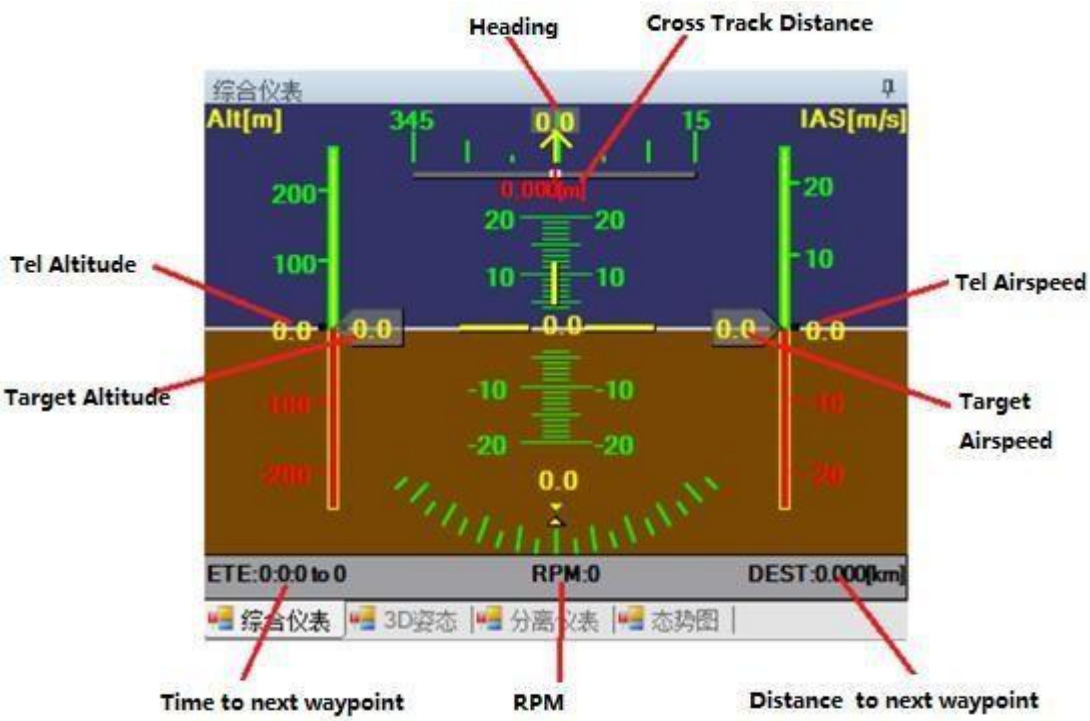



**Figure 7.26** Instruction Panel

# 8. Flight Plan

## 8.1 Check Flight Plan

A self-closed Flight Plan is created by flying from waypoint 0 to waypoint 1 followed by waypoint 2 and 3, and then back to the waypoint 0. The flight plan also includes the flight altitude. When the autopilot changes a waypoint, it will create a height directive based on the height of the target waypoint.

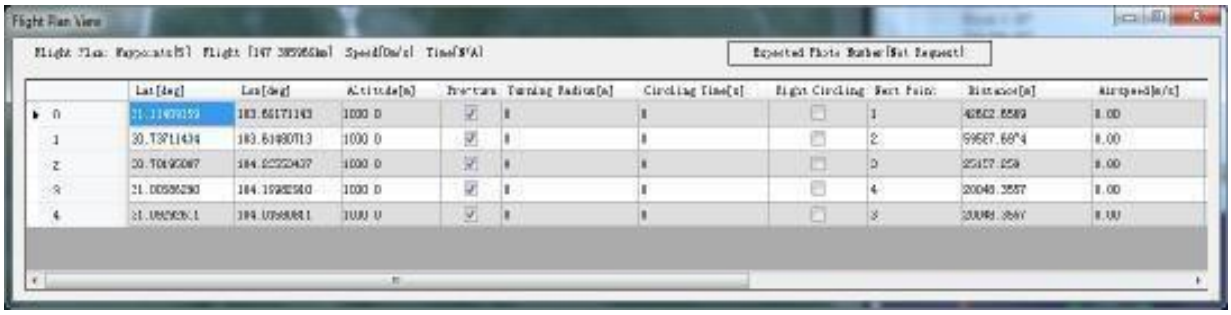



**Figure 8.1** Flight plan check

**Pre-turn**: The Pre-turn setting will turn the UAV prior to reach the target waypoint, to avoid overshooting in the next flight path. When creat a new Flight Plan, Enabling Pre-turn is set as default. The Pre-turn setting shall be disabled when it is required to ensure the UAV flying over the target waypoint.

**Circling**: The target waypoint can be designated as a circling waypoint, where the UAV will circle around that point instead of flying over it. The circling radius, time and direction (clockwise or counterclockwise) shall be set for circling. The UAV will first assess the circling radius. If the value of circling radius is zero, it means no circling on that point; if the value is greater than zero, it means the UAV shall circle around the point in designated direction for a certain time and then fly to the next waypoint. However, the actual circling radius is related to the performance of UAV and other restrictions. If the circling time is zero, the UAV shall circle around that point with no time limit.

The Over-High Circling or Over-Low Circling can be set but cannot be set in the same time. If the actual height is far below the target height when UAV reaches the waypoint at the Over-Low Circling setting, the UAV will circle up and will not change to the next waypoint until it reaches the target height. If the actual height is far above the target height at the Over-High Circling setting, the UAV will circle down to reach the target height. When the Over-High or Over-Low circling is set, the UAV will regard whether the target height shall be reached, not the circling time, as the prerequisite of stopping circling.

**Light, Parachute Opening and Drop**: The task actions from the target waypoint shall be indicated. Light is to turn on the lights as soon as UAV reaches the target waypoint; Parachute Opening means opening the parachute after reaching that point; Drop refers to action after UAV reaches that point.

**Slope**: if set to be flying by gradient, the UAV will fly from the former waypoint to the height of the target waypoint (ascending / descending) gradually by gradient, otherwise the UAV will change the height in its maximum capacity. This mode is applied to landing primarily and can also be used for other purposes.

**Landing:** Selecting this item, will set the target waypoint as the landing point. The waypoints in the end of the landing plan will be automatically generated by autopilot, without any necessity to change the settings.

**Photo**: If there is any photographing set at the waypoint, the air route from that point to the next waypoint will be photographed at a fixed distance or time.

**Hover**: Applied to helicopter, not to fixed wing aircraft.

**Airspeed**: The flight airspeed of UAV from that waypoint is set at the optimum cruising airspeed as default. (This function is supported in the versions after Autopilot program 3.2.p).

## 8.2 Local and Remote Flight Plan

**The Local Flight Plan** refers to the flight plan that was created with ground station software or stored in the ground stations, and have not been sent to the autopilot equipment. All the data in that plan can be edited by users without restrictions. The local plan is shown in white on map.

**The Remote Flight Plan** refers to the flight plan stored in the autopilot. The Remote Flight Plan received by ground station software through data link is shown in blue on map. The new Remote Flight Plan can be created by sending a Local Flight Plan to the autopilot. Users can operate the Remote Flight Plan through drag-and-drop operation, but which only change the latitude and longitude of the dragged point and become effective immediately. In case of uploading failure, the dragged point will return to the original state before dragging.

## 8.3 Create New Flight Plan

 Select the button in the Flight Plan toolbar to create flight plan, and then click on the map once with the left mouse button to form a waypoint. Clicking twice means the end of creating. The system will automatically
choose the waypoint nearest the double clicked point as the next waypoint of the last one, to create a self-closed flight plan. In the meanwhile, the system will pop up a flight altitude setting dialog box. The Local Flight Plan will be created after entering the right height data and will be displayed in white on the map.

**Only one Local Flight Plan can exist**. The existing flight plan will lost when creating a new flight plan.


**Figure 8.2**: Local Flight Plan

Various operations can be performed to the flight plan by moving the mouse to point at the flight plan, clicking the right mouse button and selecting the context menu. Edit the Flight Plan dialog box as shown in Figure 4.31 below, in which only the Local Flight Plan can be edited through that dialog box. In addition, the data of a single waypoint can be edited by selecting that waypoint.

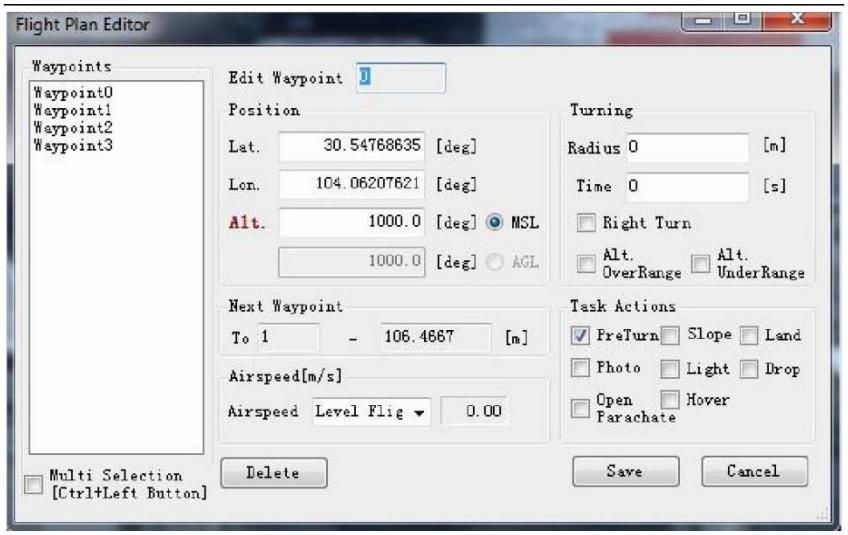
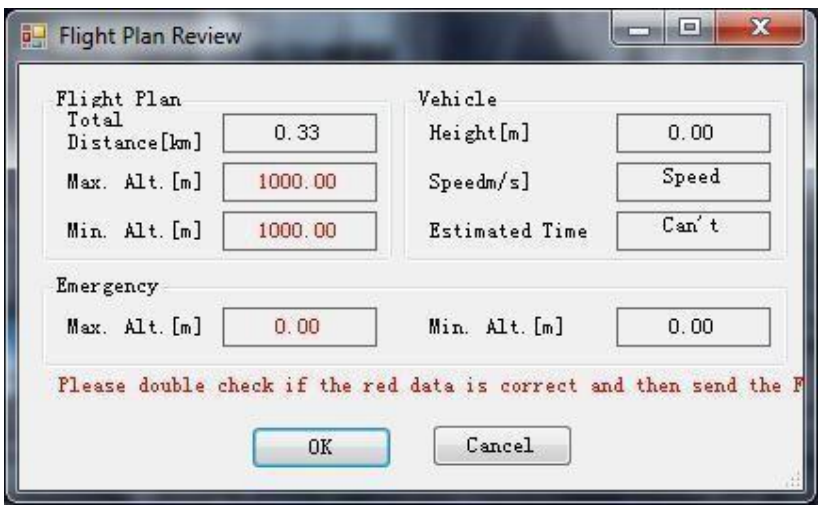



**Figure 8.3**: Flight Plan edit

## 8.4 Send Flight Plan

Newly created flight plans are all Local Flight Plans in the beginning, and they will turn into Remote Flight Plans after being sent to the autopilot by selecting the Send Flight Plan in the context menu.

Before sending flight plans, a Flight Plan Summary dialog box will pop up. Users can assess the overall air range, height of waypoint etc. of a flight plan, and can send the flight plan after the flight requirements are met. After clicking "OK", a dialog box will come out for index number. The index number means where the sending flight plan will be stored from when arriving at the autopilot, which depends on the existing flight plans in the autopilot and also whether the existing flight plan shall be replaced. As soon as the flight plan is successfully sent, the Local Flight Plan will be hidden to display the blue Remote Flight Plan; otherwise a prompt dialog box will turn up to indicate "sending failed"



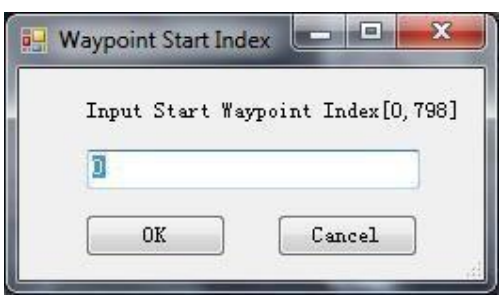




**Figure 8.4** : Flight Plan Review

## 8.5 Create Quick Flight Plan

 Quick Flight Plan is a simple flight plan consisting of one or two waypoints, the start waypoint of which is the current location of UAV, and the target waypoint is the location clicked with left mouse button. The Quick Flight Plan is a simple and fast instruction used mainly for circling terminating, and directing the UAV to a certain point. After selecting the button and clicking on the target point, the system will pop out a Quick Flight Plan dialog box for parameter setting.

The target location of Quick Flight Plan is in the latitude and longitude clicked by mouse, and the modifiable height is set at the current height of UAV as default. The "Circling at the Point" is checked, in which the circling radius default is 100 meters with no circling time limit. The serial number of that point is set at 799 as default. The instruction will be sent immediately after clicking "OK", and the UAV will be navigated to that point straightaway.

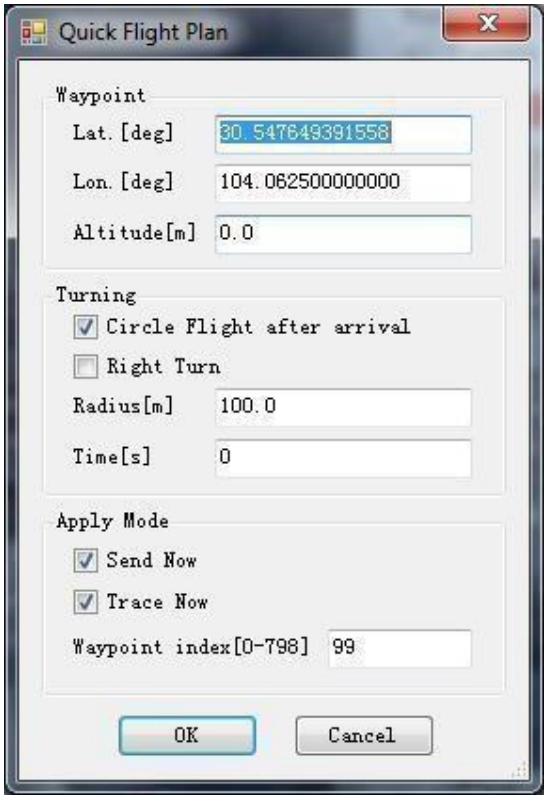



**Figure 8.5**:Quick flight plan

## 8.6 Create Landing Plan

is to create landing plan, the autopilot needs to know the landing location and landing direction. All those data can be generated by clicking on the map with the left mouse button. The first click indicates the landing location and the second indicates the designated landing direction. After the second click, a dialog box as shown in Figure 4.45 will turn up to facilitate the creation of landing plan.

The height of landing site and the start waypoint index number of landing plan shall be designated, while the right-turn or left-turn landing mode can be chosen. The location data displayed on the lower part of the dialog box can be adjusted precisely; furthermore, the known precise data of landing direction can be entered directly, or the collected at key points before flying.

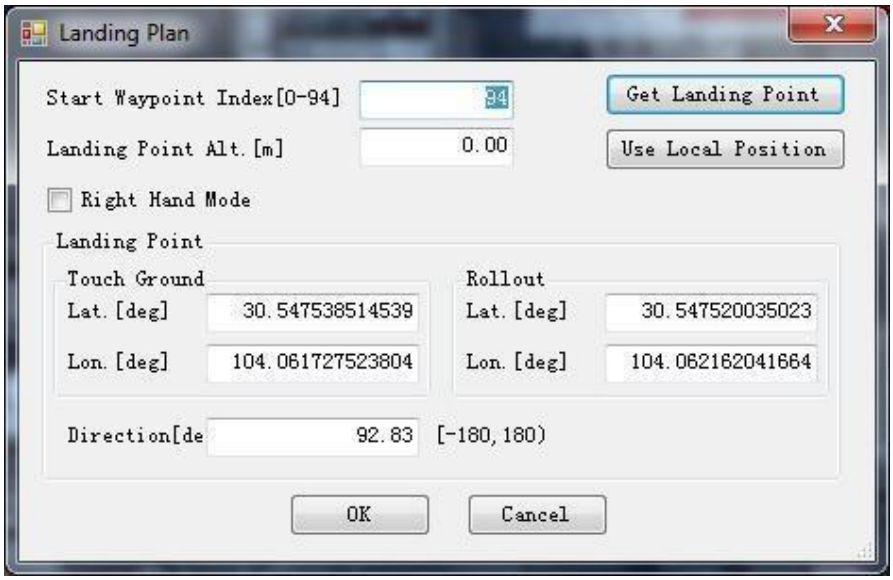



**Figure 8.6** : Landing Plan setting

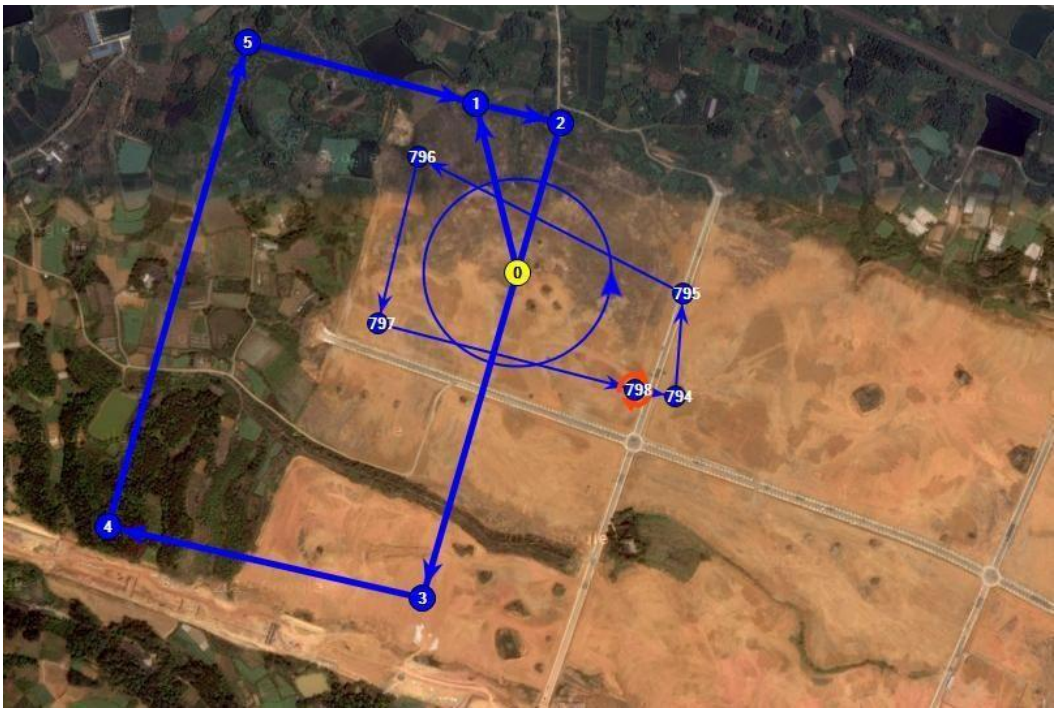



**Figure8.7** Landing Flight Plan

Clicking “OK”, the landing location and direction will be sent to autopilot, which will produce a landing plan automatically. The specific landing plan will be determined by the landing parameters of the controller of autopilot. The final landing plan will be sent back and displayed on the map.

The point 798 is the touch down point, 794 is the missed approach point and the air route from 797 to 798 is the approaching route.

\

## 8.7 Photo Flight Plan

The Photo Flight Plan is a flight plan generating mode designed specifically for aerial photography tasks. In order to enable the system to automatically generate an aerial photography flight plan, users only need to choose the area for aerial photography tasks on the map and simply set a few parameters.

Step 1: Import plan area as below screenshot, the import plan area would be TXT or XML (format)


**Figure 8.8**: Import plan are setting

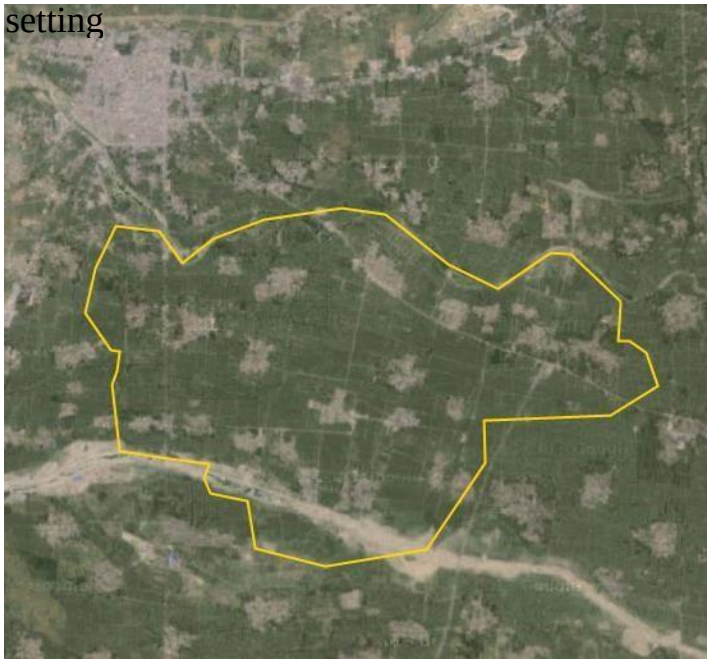


**Figure 8.9**: Imported Area

At first, click the “New Photo Flight Plan” in the menu bar to get into the Aerial Photography area design mode, and then hold down the left mouse button and drag. As a result, that area on the map will present as a semi-transparent planned Aerial Photography area.

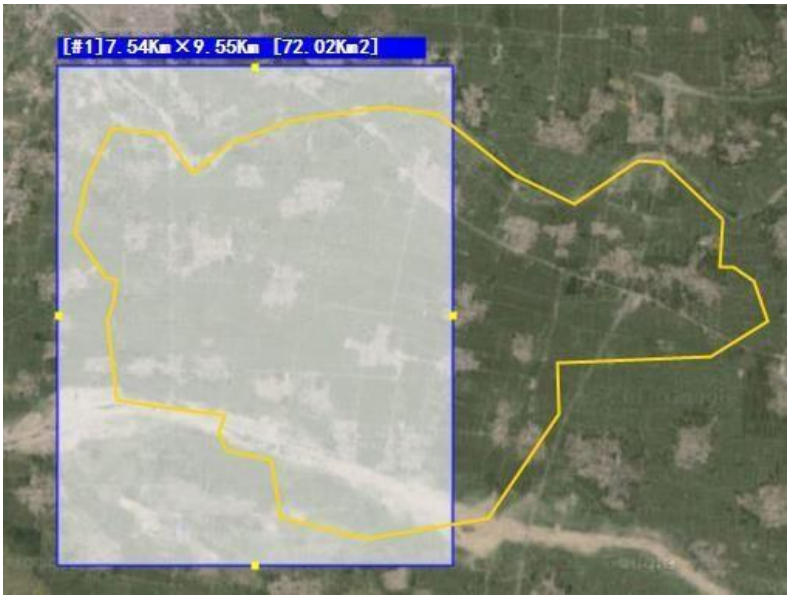



**Figure 8.10**: Select plan area

Under the mode of aerial photography design, the task area can be divided into one or more aerial photography areas according to conditions of that area. In the end of planning, users can exit the design mode of aerial photography after clicking twice with the left mouse button. The above aerial photography task area was divided into 2 areas as shown


**Figure8.10**:Select plan area

After the aerial photography area planning, users need to adjust each area and set aerial photography parameters. Clicking on the map with right mouse button will pop up a context menu.


**Figure 8.11**: Adjust flight area

Then, choose different menu items will get different functions, i.e., translation, stretching, spinning, and aerial photography area settings, which can be used to determine the planned aerial photography area.


**Figure 8.12** : Adjust flight area

Parameters of Photo Flight Plan can be set by selecting “Photo Settings” after the Aerial Photography Area was determined. In order to create an aerial photography air route.

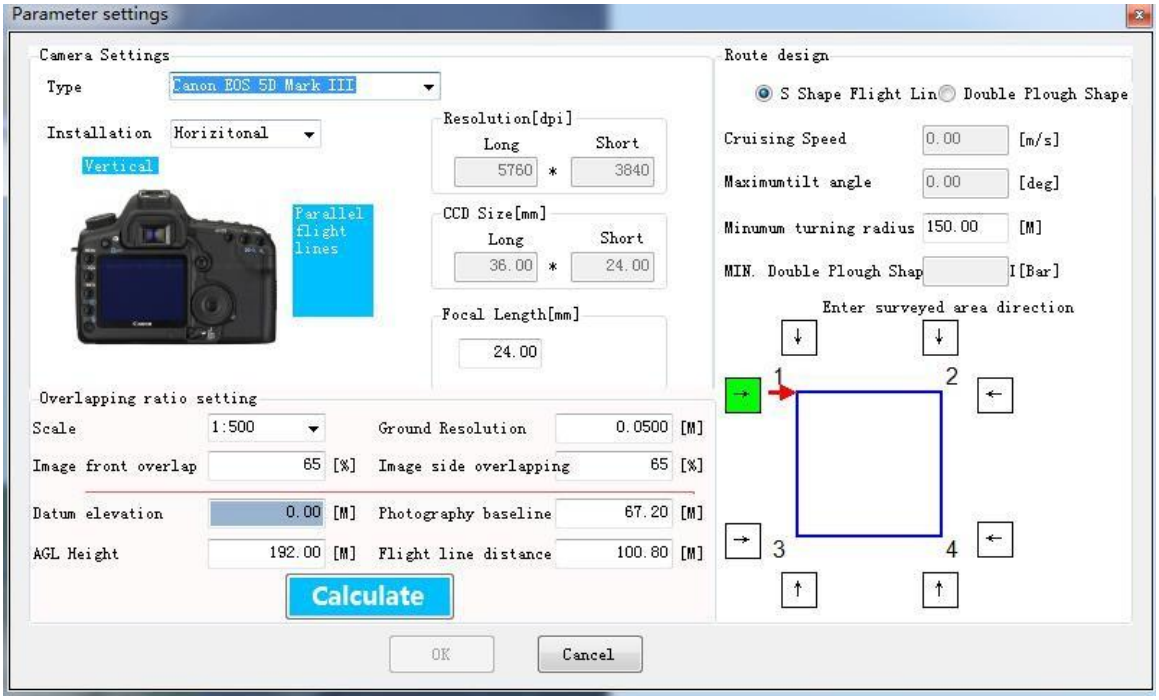



**Figure 8.13**: Photo setting

The parameters of several common aerial photography cameras specified in *Specifications for Field Work of Low-Altitude Digital Aerial Photography* were built in the “Cam Param” page and available for use. The correspondent relative flight altitude, the photographic baseline length, span width between air routes can be calculated by clicking the “Calc Button” after editing through “Customized” item.

The minimum turning radius of UAV is determined by the theoretical turning radius calculated based on set maximum bank angle and cruise speed, but can be modified against the actuality. The minimum turning radius has a great deal with the turning path when switching from one air route to another

In the “Photo” page, the aerial photography mode and shooting parameters shall be set and sent. The interval parameter is the photographic baseline length calculated according to the parameters in “Camera”page.

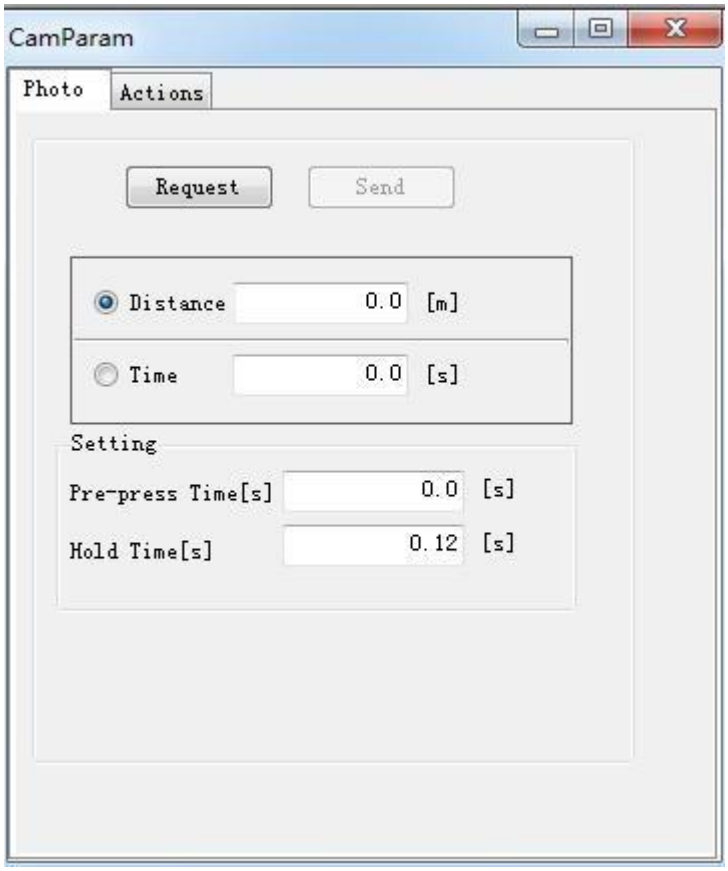



**Figure 8.14**: Photo task setup

After the parameter setting is done, the program will generate a preview of aerial photography working sections based on the aerial photography parameter settings when return to the map interface

After the modification of aerial photography working sections is done, users can select "Generate Air Route in This Area" option in the context menu of this area to create an aerial photography flight plan for this area, as shown in the figure below:

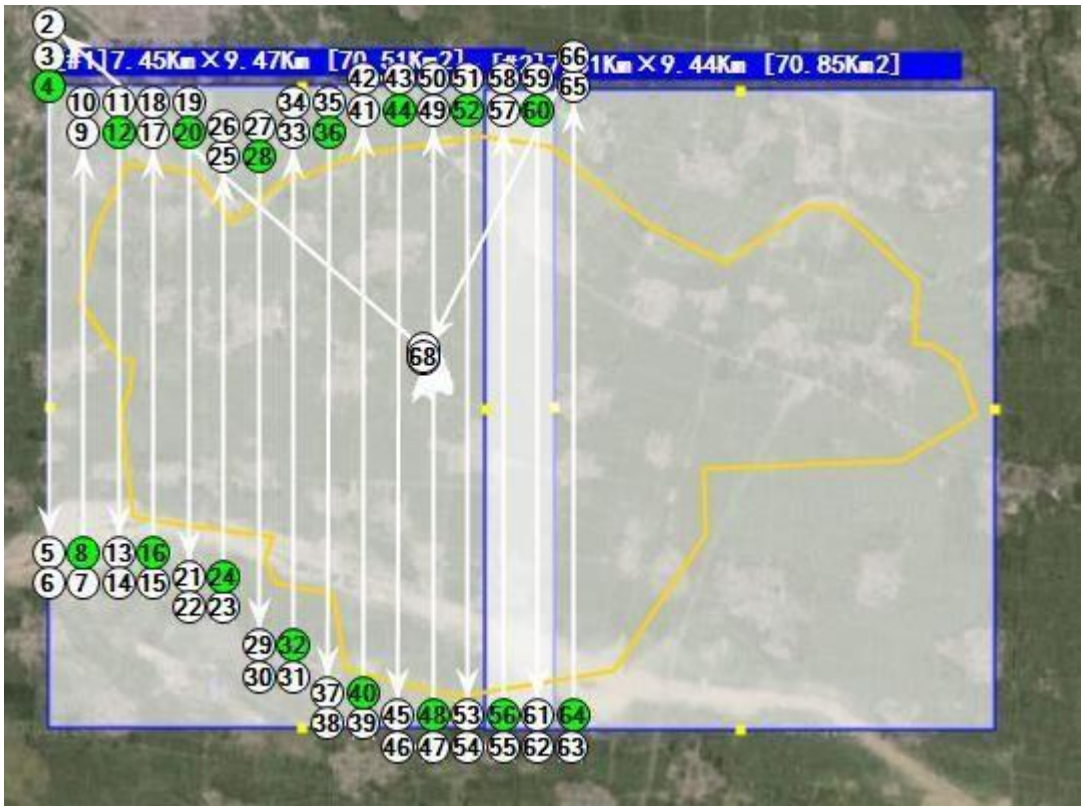



**Figure 8.15**: Local flight plan generation

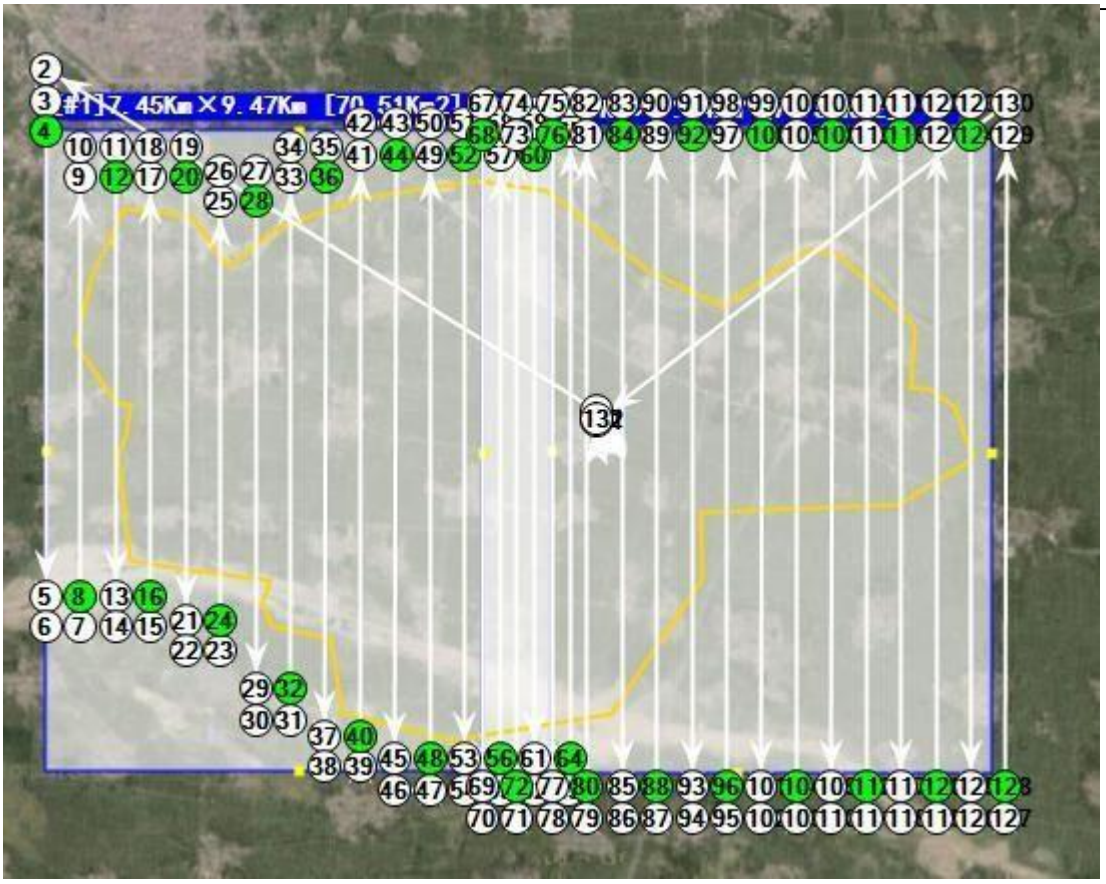


**Figure 8.16**: Local flight plan generation

In the generated Aerial Photography Flight Plan, the UAV will start shooting in the start point of each working section and stop shooting in the end point, for instance: start shooting at point 4 and stop shooting at point 5, and start shooting at 8 and stop at 9, etc. The extension points outside the planned aerial photographing point are the set turning guide points, the location of which is generated by the set minimum turning radius and span between air routes, with the purpose of switching over working routes more smoothly.

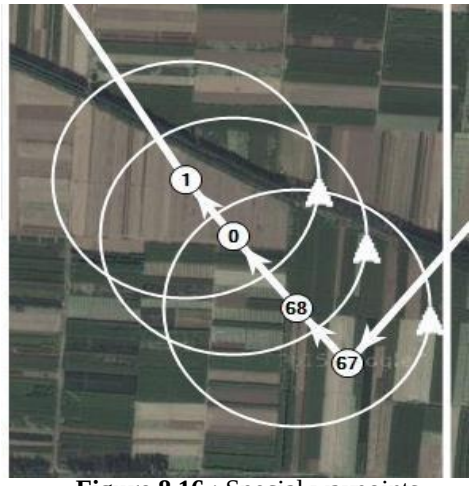



**Figure 8.16** : Special waypoints

In the generated Aerial Photography Flight Plan, there are four points with special significance. They are generated in the center of the visible area on the map. Point 0, with the same altitude of aerial photography working plane, is set as an emergency point, and has the setting of Infinite Circling. Point 1, with the same altitude of aerial photography working plane, is a take-off altitude correction point for aerial photography tasks, and has the setting of Over-Low Circling. The UAV will first be navigated to point 1 after taking off and switching to autopilot mode. If UAV's altitude is far below point 1, the UAV will not be navigated to point 2 until it finishes the altitude correction by circling up. Point 67 and 68 are the last two waypoints generated. Point 67, with the same altitude of aerial photography working plane, is the pre-recover point for return, i.e., the return point after finishing aerial photography tasks. Point 68, with the default altitude the same as that of aerial photography working plane, is the adjusting point for recovering, and is set with Over-High Circling. However, that point can be adjusted to a height good for recovering according to the actual conditions, so that the UAV can circling down around that point to the recovering altitude, for example, 100 meters from the ground, the height that operator can manually recover the UAV,and get ready for recovering.

## 8.8 POS Data of Aerial Photography

After aerial photography tasks are done, the program will first request the sum of photos, and download the POS data in the Aerial Photography Action page in the Aerial Photography Tasks Menu. As soon as the download is finished, the photo data will be stored into a text file and opened automatically. Users can save the photos to another file to process later after checking.

The format of photo data is shown as Table 4.2.

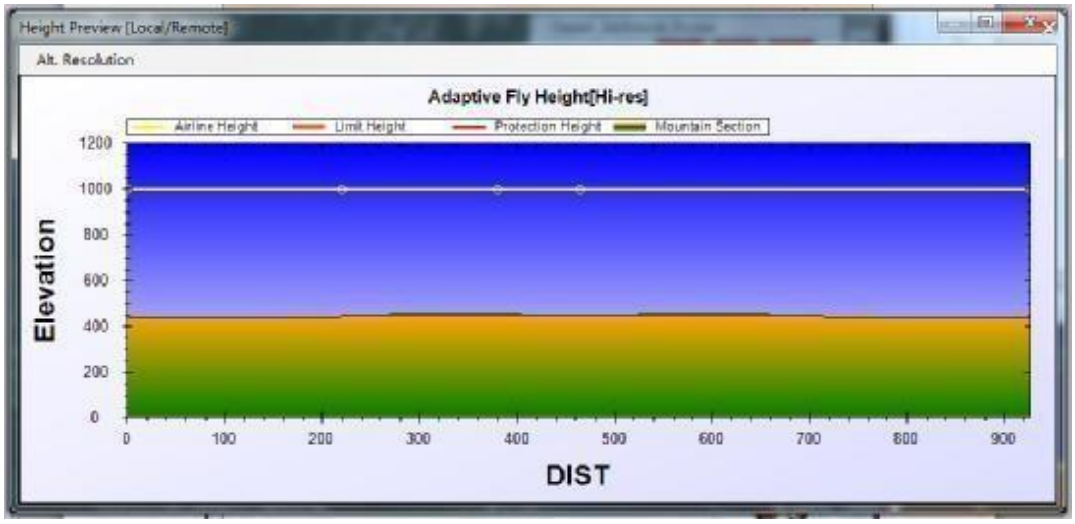
Table 4.2 Photo Data Format

| S/N | Time Stamp | Latitude | Longitude | Altitude | Roll Angle | Pitch Angle | Course | GPS Direction | Ground Speed |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

## 8.9 Preview of Altitudes in a Flight Plan

In the planning period of a flight plan, users need to consider the overall flight environment, among which the terrain (altitude) along the flight plan is especially important for safe flight of UAV. Therefore, the flight plan has to avoid possibly existing landform of mountain peak.

AP Commander can provide basic comparison of altitude information, by supporting online request for preview of altitude information, from the open interface of Google Maps, corresponding to planned flight path. As shown in Figure 4.60, the red curve in the figure is the altitude curve formed by each waypoint in the flight plan and can be compared to the altitude curve



# 9. Pre-flight Check

## 9.1 Mechanical Check

a. Check cables and connection fixed well

b. Check the engine propeller fixed tightly

c. Check the pitot without damage

d. Power on autopilot, GCS, engine start, motor to check by AP Commander

## 9.2 Engine Check

a. Check the engine propeller mounting correctly

b. Check the motors propeller mounting correctly

Engine propeller would be anticlockwise rotation (from nose to tail view)

Motors propellers would be Front-Right /Left-Back motors with clockwise rotation, and Front-Left/Right-Back motors with anti-clock wise rotation (from nose to tail view)

## 9.3 Gravity Center Check


Figure 9.2: P310 Gravity Center

P310 gravity center is as shown as figure 9.2. User would recheck the gravity center before each flight and any payload change.

## 9.4 AP Commander Check

**Notice**: Users do not power on the motors and engine start for AP Commander check for safety.

### 9.4.1 Remote Control Check

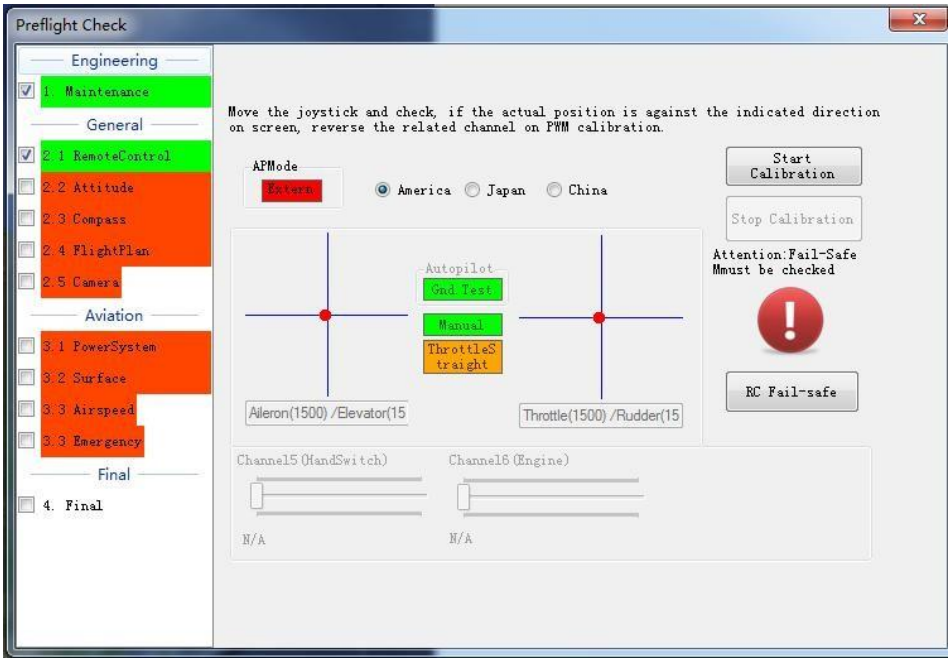


Figure 9.1: Preflight Check

Users move the remote control joystick and check the AP Commander Movement direction coordinate with actual joystick movement. Otherwise, pilot would inverse on remote control.

### 9.4.2 Attitude Check

Change the aircraft attitude mechanically and check instruction panel the attitude status correctly.

### 9.4.3 Magnetic Sensors Check

Users need to magnetic sensor check before each flight.
Step1: Rotate aircraft mechanically 90 degree and read the magnetic heading value,
Step2: Make 4 times rotation like step 1.
Step3: Check the difference value between two magnetic heading values would be about 90.
If the difference value has more deviation of 90, users need to make magnetic sensor calibration.

## 9.4.4 Flight Plan Check

User request the remote flight plan and landing plan and check the flight plan setting reasonable

***Note: If previous 4 steps check finished, users would power on the motors and engine start.***

## 9.4.5 Power and RTK Status Check

User check the power of motors, engine start and autopilot correctly and RTK status correctly

## 9.4.6 Control Surface Check

Pilot switch aircraft to auto mode to check the control surface of aileron , elevator, rudder and rotors direction by AP Commander,.

## 9.5.7 Dynamic Pressure Check

***Note: Dynamic pressure is very important to airspeed. Users need to make dynamic pressure check before each flight.***

a. Cover the pitot to keep out of wind

b. Send command “Zero Airspeed”， the dynamic pressure would be fluctuate at 0Pa

c. Press the pitot with finger to check the dynamic pressure value, which would increase immediately to certain value and keep the value.

Preflight check would be very important to ensure the UAV flight in safe situation.