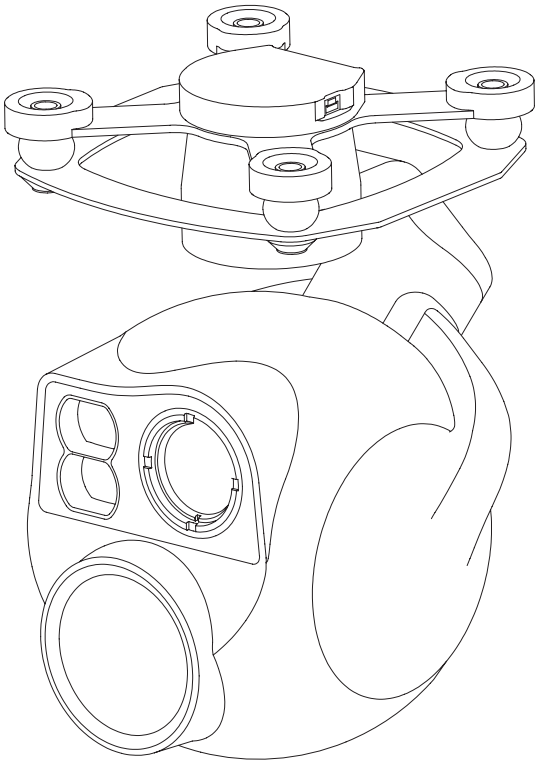
V4.0

2024.07

D-125AI

User Manual



Using this Manual – Legend

 Important

 Tips

 Explanation

Revision History

Date	Document Version
2024.06.13	V1.0

Caution

1. When not in use, store the D-125AI in the package box. The recommended storage environment is a relative humidity less than 40% at a temperature of 20±5° C. If the lenses fog up. The water vapor will usually dissipate after turning on the device for a while.
2. Do not expose the thermal camera lens to a strong energy source such as sun, lava or laser beam. The temperature of the observation target should not exceed 800°C , otherwise it will cause permanent damage.
3. Do not place the product under direct sunlight, in areas with poor ventilation, or near a heat source such as a heater.
4. Do not frequently power on/off the product. After it is turned off, wait at least 30 seconds before turning back on, otherwise the product life will be affected.
5. Make sure the pod port and pod surface are free from any liquid before installation.
6. Make sure the pod is securely installed onto the aircraft, the microSD card slot cover is clean and firmly in place.
7. Make sure the pod surface is dry before opening the microSD card slot cover.
8. Do not plug or unplug the microSD card during use.
9. Do not touch the surface of the camera lenses and keep it away from hard objects. As doing so may lead to blurred images and affect the imaging quality.
10. Clean the surface of the camera lenses with a soft, dry, clean cloth. Do not use alkaline detergents.
11. When not receiving valid carrier INS data, the yaw shaft of the pod will drift about 15 degrees per hour because of the earth rotation. To make sure the pod attitude corrects, it is necessary to transmit valid carrier INS data, usually the GNSS should be positioning.

Catalog

Introduction

Synopsis

The D-125AI equips with a high accuracy 3-axis nonorthogonal pod, an 120x hybrid zoom camera and a long-wave thermal camera, which can provide visual and infrared images simultaneously. Thanks to the laser range finder, the D-125AI can provide the location of a target and the distance to it that improves working efficiency.

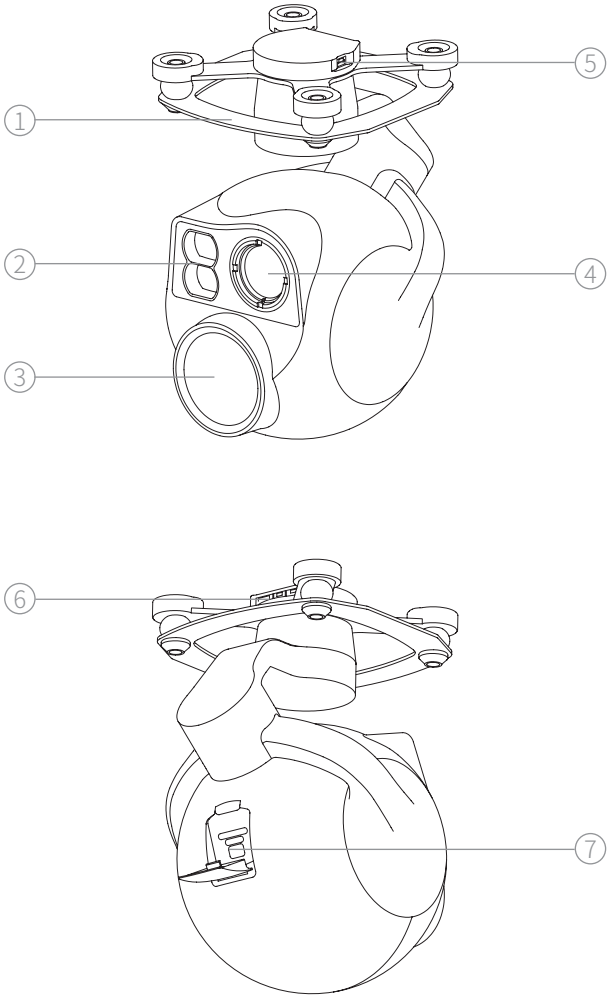
The D-125AI have AI multi-object detection and tracking function. The gimble camera can intelligently identify the persons and vehicles in the image, and constantly track one of them.

The D-125AI can be mounted tool-lessly onto multiple carriers, whether downward or upward. With the GCU and the Dragonfly software, user can watch the image from the camera and control the pod real-timely on a computer.

Characteristics

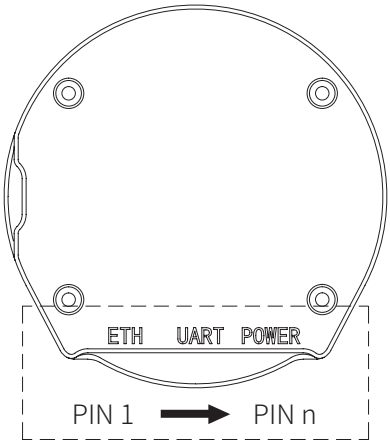
- Features AI multi-object detection and tracking, which can constantly track one of the persons and vehicles intelligently identified in the image.
- Carries an 120x hybrid zoom camera, a thermal camera and a laser range finder.
- Laser lighting module ensures the cameras getting a clear image even in complete darkness.
- 3-axis orthogonal mechanical stabilized structure, is able to spin continually around its yaw axis
- Built-in GCU module makes the product more integrated.
- Supports network, UART and S.BUS control. Supports both private protocol and MAVlink protocol.
- Thanks to the Dual-IMU complementary algorithms with IMU temperature control and carrier AHRS fusion, the D-125AI provides a stabilization accuracy at $\pm 0.01°$.
- Can be mounted onto multiple carriers, whether downward or upward.
- With the Dragonfly software, user can watch the image and control the gimba without protocol ducking.
- Screen supports overlaying OSD information such as latitude, longitude and altitude. Image supports shooting point coordinate EXIF save. Video stream upports SEI stacking.
- 20~53 VDC wide voltage input.

Overview



1. Damping Platform
2. Laser Range Finder
3. Zoom Camera
4. Thermal Camera
5. Update Port
6. Control Ports
7. MicroSD Card Slot

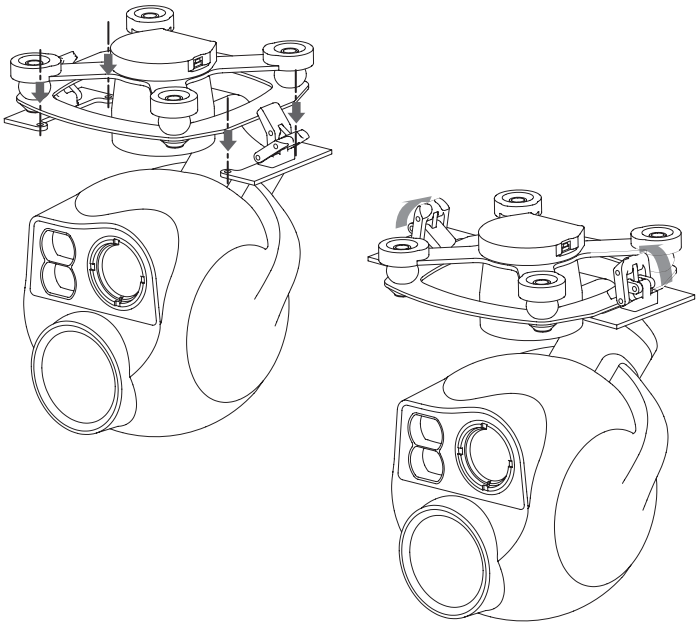
Ports Definition



Port	Description	Header	Pin	Definition
ETH	Network port. For camera configuration, camera updating, GCU configuration, private protocol control and video output	SM06B-GHS-TB	1	NC
			2	NC
			3	ETH_Tx+
			4	ETH_Tx-
			5	ETH_Rx+
			6	ETH_Rx-
UART	TTL serial port. For GCU configuration, GCU updating, private protocol control and MAVLink protocol control	SM03B-GHS-TB	1	GND
	S.BUS in port. Compatible with S.BUS1 standard such as FASST and SFHSS, and S.BUS2 such as FASSTest		2	UART_Rx (0~3.3V)
			3	UART_Tx (0~3.3V) / S.BUS In
POWER	Power in. Operating Voltage: 20~53VDC	SM05B-GHS-TB	1	GND
			2	
			3	NC
			4	Power In
			5	

Installation

Align and insert the 4 pins into the locating holes of the mount platform. Press down the lock catch to fix the pod. The pod can be also fixed with screws through the holes on the damping platform.



⚠ While upward mounted or mounted at carriers with large vibration or impact, the pod should be fixed with screws nor the quick-release locks.

⚠ Gently plug or unplug the cable. Avoid hardly pull the cable.

⚠ Ensure the microSD card slot cover is firmly in place to prevent dust or moisture entering during usage or storage.

⚠ The pod heats while operating. Please ensure the device good cooling.

The MicroSD card should be configured as HDD-FAT32 mode.

Configuration & Updating

⚠ Ensure the gimbal and the GCU have both been updated to the latest firmware before use. Otherwise, usage may be affected.

⚠ Ensure the diver of the config module is installed on the computer before configuration or updating.

⚠ Before configuration, the computer should be set to a static IP address, which is in the same network segment with the GCU and the camera (without IP address conflicts). The default IP address of the GCU and the camera are 192.168.144.121 and 192.168.144.108, and an interior reserved IP address is 192.168.144.199.

⚠ Do not power off the device while updating. Restart the device once the updating is complete.

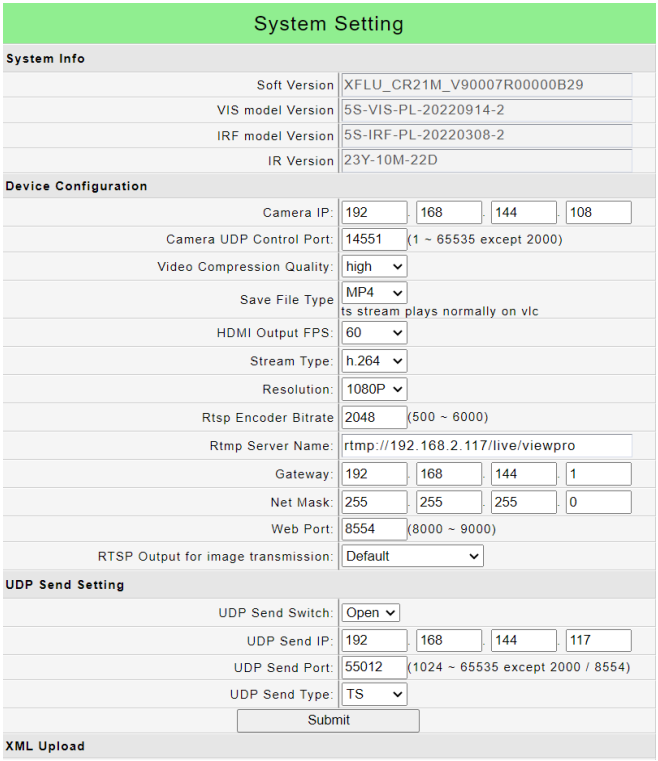
⚠ For Windows10 or higher version operating system, network authority needs to be conferred while first running the GCU_Config software.

Camera Configuration & Updating

Camera Configuration

1. Connect the computer and ETH port with the Network Conversion Module. Power on the devices.
2. Visit http://192.168.144.108:8554 on the computer (if the IP address of the camera has been changed, the IP address in the URL should be replaced with the current camera IP address). It is recommended to use Microsoft Edge.
3. Configure the camera in the web page, and click"Submit"to save the configuration.
4. Restart the pod to enable the configurations to take effect.

⚠ If the configuration page cannot fully read the current camera configuration, it should change another browser. DO NOT configure the camera by force, or the camera will be damaged.



- Camera IP
  The default value is 192.168.144.108.
- Camera UDP Control Port
  The default value is 14551.
- Video Compression Quality
  The higher compression quality, the better image quality. The default value is high.
- Save File Type
  The default value is MP4.
- Stream Type
  The default value is h.264.
- Resolution
  The default value is 1080P.

- Rtsp Encode Bitrate
  The unit is bps. The larger the bitrate, the better RTSP video, but the higher bandwidth requirement of the image transmission system. The default value is 2048.
- Rtmp Server Name
  The default value is rtmp://192.168.2.117/live/viewpro.
- Gateway
  The default value is 192.168.144.1.
- Net Mask
  The default value is 255.255.255.0.
- Web Port
  The default value is 8554.
- RTSP Output for image transmission
  RTSP video streaming optimization for image transmission systems. The Real-time Priority option will reduce the bandwidth requirement of the image transmission system, but will suppress image quality. The Low-fps and Real-time Priority option will further reduce the bandwidth requirement of the image transmission system, but will suppress image quality and reduce frame rate. The default value is Default.
- UDP Send Switch
  The default value is Open.
- UDP Send IP
  The default value is 192.168.144.117.
- UDP Send Port
  The default value is 55012.
- UDP Send Type
  The default value is TS.

Camera Updating

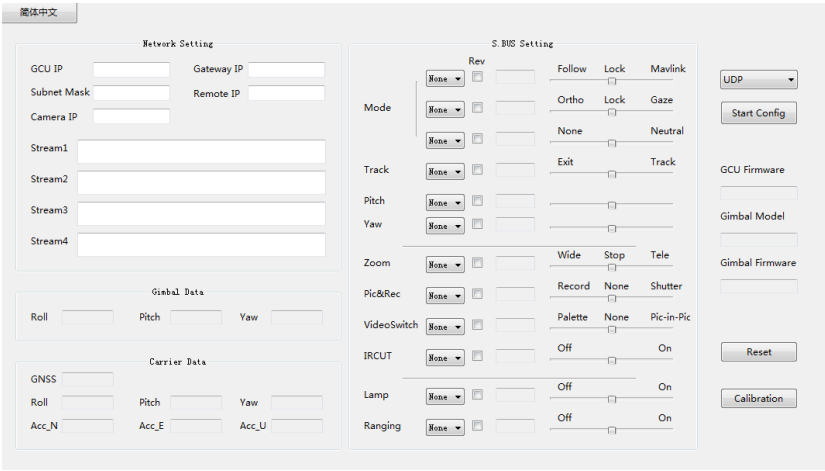
1. Connect the computer and ETH port with the Network Conversion Module. Power on the device.
2. Run netConfig software. Input current camera IP address and click "Connect".
3. Drag the firmware file. Click "Firmware Download" and wait for the download completing.
4. Restart the pod to enable the updating to take effect.

GCU Configuration & Updating

GCU Configuration

1. Connect the computer and ETH port with the Network Conversion Module, or connect the computer and UART port with the J1.25 Config Module.
2. Power on the device. Run the GCU_Config software and choose UDP port or the COM port corresponding to the config module. Click"Start Config", the, software will display current configuration of the GCU.
3. Configure the GCU in the software.

The new parameter filled in textbox will not be saved until clicking "Enter"on the keyboard. It is unnecessary to click "Enter" after editing other settings.



1.Network setting

- GCU IP / Gateway IP / Subnet mask / Remote IP
  Configure the network parameters of the GCU. Ensure the parameters will not cause network linkage abnormal.
- Camera IP
  Fill in the IP address of current camera, Video stream addresses will be generated automatically by the GCU. It will not change the IP address of the camera.

2.Gimbal Data

Display the attitude data of the pod.

3.Carrier Data

Display the INS positing statue, altitude angle and northward / eastward / upward accuracy of the carrier.

4.S.BUS Setting

Set S.BUS channels corresponding to pod functions and their renversements. The pitch and yaw are liner channel, and others are switch channels.

For switch channels, pulse width entering [1000μs , 1300μs] triggers lower function once; entering [1300μs , 1700μs] triggers middle function once; entering [1700μs , 2000μs] triggers higher function once. Pulse width varying in the same interval does not repeat the trigger.

- Mode

  Follow: Head follow mode. Yaw angle and pitch angle are controllable. Heading of the pod rotates with the carrier and pitch of the pod keeps current attitude while no rotating command is received.

  Lock: Head lock mode. Yaw angle and pitch angle of the pod are controllable and keep current angle while no rotating command is received.

  MAVlink: The pod can be controlled by MAVlink protocol. Other S.BUS channels controlling is unavailable in the mode.

  Ortho: Orthoview mode. In this mode, the pod rotates to vertical downward. The yaw angle follows the carrier and is uncontrollable. Otherwise the yaw angle remains unchanged and is controllable.

  Gaze: Gaze mode. Pod constantly aims current position in the center of the view. To pods equipped with laser ranger finder, turning on ranging before entering gaze mode will improve the accuracy of locking. The gaze mode is available only when the pod receiving valid GNSS data.

  Neutral: Pod returns its neutral position
- Track

  The pod will automatically keep tracking the target in the center of the screen.
- Pitch / Yaw

  Control value corresponds the angular velocity of pitch / yaw of the pod.
- Zoom

  The zoom rate constantly varies while the channel value is in Tele / Wide interval, until the channel value enters stop interval or the camera is at max / min zoom rate.
- Pic & Rec

  The Pic command triggers camera shoot one photo. The Rec command starts or stops recording. It is able to shoot photos while recording without ending record. The pictures and the video are saved in the MicroSD card of the pod.

- Video Switch
  Palette: To pods equipped with thermal camera, this command switches options of palette.
  Pic-in-pic: To pods equipped with multiple cameras, this command switches different view of the cameras.
- IRCUT
  Turn on IRCUT, the camera will switch to night scene to achieve a better image quality in low-light environment.
- Lamp
  To pods equipped with laser lighting module, choose this function to turn on laser lighting and IRCUT at the same time.

⚠ Several models of pod equipped with laser lighting module, which is a Class 3B invisible laser. DO NOT exposure eyes to the beam within 12 meters or observe the beam by any optical instrument. DO NOT place any inflammable within 20 centimeters in front of the lighting module.

- Ranging
  To pods equipped with laser range finder, this command turns on / off ranging. The pod is able to calculate out the longitude, latitude and elevation of the target while receiving valid carrier INS data.

5.Reset

Click to reset all the parameters of the GCU.

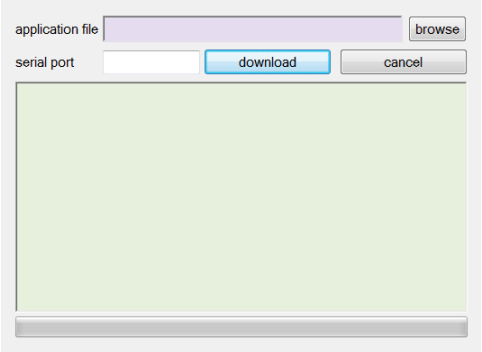
6.Calibration

Click to calibrate the gimbal. Please keep the pod static while calibrating.

After calibration, it is normal that the yaw shaft of the pod drifts about 15 degrees per hour when not receiving valid carrier INS data. To make sure the pod attitude corrects, it is necessary to transmit valid carrier INS data, usually the GNSS should be positioning.

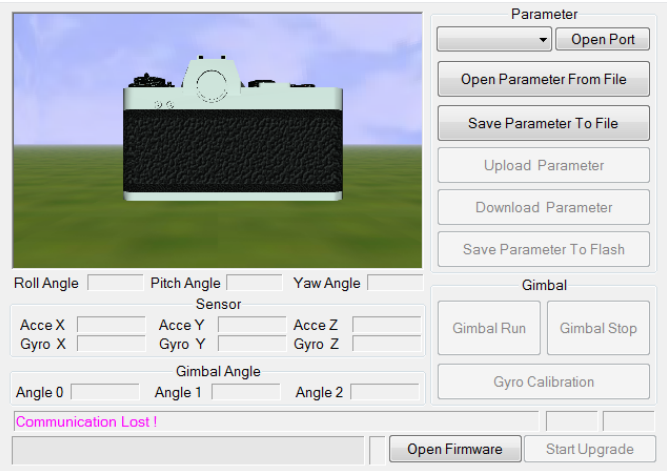
GCU Updating

1. Connect the computer and UART port with the J1.25 Config Module.
2. Run FreeFlightIAP software. Choose the COM port corresponding to the config module.
3. Click "browse", choose the firmware file, click "download" and wait for the updating complete.



Gimbal Updating

1. Connect the computer and the pod update port with the J1.25 Config Module. Power on the device.
2. Run GimbalConfig software. Choose the COM port corresponding to the config module. Click "Open Firmware" , choose the firmware file, click "Start Upgrade" and wait for the updating complete.



Real-time Video Playing

Example as camera IP address 192.168.144.108:
Stream address: rtsp://192.168.144.108

Appendix 1 Specifications

General			
Product Name	D-125AI		
Dimensions	142 x 125 x 187mm		
Weight	1055g		
Operating Voltage	20 ~ 53 VDC		
Power	10.7W (Static, ranging off) / 40.0W (Peak, ranging on)		
Mounting	Downward / Upward		
Target Positioning Accuracy[1]	Horizonal Error: 1.8m Vertical Error: 0.7m	@	Horizonal Distance: 105m Relative Height: 75m
	Horizonal Error: 17.4m Vertical Error: 6.7m	@	Horizonal Distance: 513m Relative Height: 119m
	Horizonal Error: 33.8m Vertical Error: 13.7m	@	Horizonal Distance: 1003m Relative Height: 246m
Gimbal			
Gimbal Type	3-axis Nonorthogonal Mechanical Stabilization		
Angular Accuracy	±0.01°		
Controllable Range	Pitch: -120°～ 40° , Roll: ±40° , Yaw: ±360° constantly		
Max Controllable Speed	±200° /s		
Zoom Camera			
Image Sensor	1/2.8-inch CMOS, Effective Pixels: 4.09M		
Lens	Actual Focal Length: 4.7~141mm (Equivalent focal length: 27.9~837mm) Aperture: f/1.5~f/4.0 HFOV: 59.5°～ 2.2° VFOV: 35.8°～ 1.2° DFOV: 66.6°～ 2.5°		
Resolution	2688(H) x 1520(V)		
Pixel Size	2.0μm(H) x 2.0μm(V)		
Optical Zoom Rate	30x		
Equivalent Digital Zoom Rate	4x		

Object Detection Distance	EN62676-4:2015	Person[2]: 3283m Light vehicle[3]: 4315m Large vehicle[4]: 9192m
	Johnson Criteria	Person: 37500m Light vehicle: 115000m Large vehicle: 245000m
Object Identification Distance	EN62676-4:2015	Person: 657m Light vehicle: 863m Large vehicle: 1838m
	Johnson Criteria	Person: 9375m Light vehicle: 28750m Large vehicle: 61250m
Object Verification Distance	EN62676-4:2015	Person: 328m Light vehicle: 432m Large vehicle: 919m
	Johnson Criteria	Person: 4688m Light vehicle: 14375m Large vehicle: 30625m
Thermal Camera		
Thermal Sensor	Uncooled VOx Microbolometer	
Lens	Focal Length: 25mm (Equivalent focal length: 93.2mm) Aperture: f/1.0 HFOV: 17.5° VFOV: 14.0° DFOV: 22.3°	
Resolution	640(H) x 512(V)	
Pixel Size	12μm(H) x 12μm(V)	
Spectral Band	8~14μm	
Sensitivity (NETD)	<50mk@F1.0@25°C	
Object Detection Distance	Johnson Criteria	Person: 1042m Light vehicle: 3194m Large vehicle:6806m
Object Identification Distance		Person: 260m Light vehicle: 799m Large vehicle: 1701m
Object Verification Distance		Person: 130m Light vehicle: 399m Large vehicle: 851m

Laser Range Finder	
Wavelength	905nm
Max Laser Power	1mW
Beam Angle	2.5mrad
Beam Diameter	0.25m@100m
Laser Safety	Class 1M（IEC 60825-1:2014）
Measurement Accuracy	±0.3m（⩽ 300m）/ ±1.0m（>300m）
Measurement Range	5-1800m (ϕ12m vertical surface with 20% reflectivity)
AI Multi-object Detection & Tracking	
Object Identification Size	⩾ 30x20 px
Object Identification Rate	⩾ 85%
Object Identification Quantity	⩽ 50
Target Tracking Size	16x16~256x256 px
Tracking Deviation Refresh Rate	30Hz
Tracking Deviation Output Delay	⩽ 60ms
Target Pixel Error	⩽ ±1 px
Tracking Speed	>24 px / frame
Target Memory Time	>5s

Image & Video	
Image Format	JPEG
Maximum Image Resolution	1920 x 1080
EXIF	Shooting point coordinate
Video Format	MP4
Maximum Video Resolution	Stream: 1920 x 1080 @25fps Recording: 1920 x 1080 @30fps
Stream Encode Format	H.264, H.265
Stream Network Protoco	RTSP
Storage	
Supported SD Cards	Supports a Speed Class 10 MicroSD card with a capacity of up to 256GB
Environment	
Operating Temperature	-20°C～ 50°C
Storage Temperature	-40°C～ 60°C
Operating Humidity	⩽ 85%RH (Non-condensing)

[1] Measured by pod mounted on a dual antenna RTK positioned multicopter drone to a known coordinate point. The target positioning accuracy is influenced by carrier's positioning and orientation accuracy, angle between the direction of pod mounted and the heading of carrier, slant range, gradient of measurement line and air quality. The data is for reference only.

[2] Reference dimension of person: 1.8x0.5m. Critical dimension under Johnson criteria is 0.75m

[3] Reference dimension of light vehicle: 4.2x1.8m. Critical dimension under Johnson criteria is 2.3m

[4] Reference dimension of large vehicle: 6.0x4.0m. Critical dimension under Johnson criteria is 4.9m

Appendix 2 SEI Data Structure

```
typedef struct // 64 bytes. Little-endian byte order. Byte alignment
{
    uint8_t head[2]; // Header [0xEE, 0x16]
    struct
    {
        uint8_t rng_trig:1; // Ranging trigger flag
        uint8_t_pip_state:3; // Pic-in-Pic Statue
                        0-Zoom camera (main)+Thermal camera (sub);
                            1-Thermal camera;
                        2-Thermal camera (main)+ Zoom camera (sub);
                            3-Zoom camera
        uint8_t data_valid:1; //Validity flag of carrier's coordinate, carrier's attitude
                        and pod's attitude
        uint8_t tgt_valid:1; //Validity flag of target's coordinate
        uint8_t reserved:2; // Reserved flag
    } flag;
    int32_t uav_lon; // Longitude of carrier. [-180° , 180° ). Resolution 1e-7deg
    int32_t uav_lat; // Latitude of carrier. [-90° , 90° ]. Resolution1e-7deg
    int32_t uav_alt; // Altitude of carrier. Resolution 1mm
    int32_t uav_hgt; // Relative height of carrier. Resolution 1mm
    int16_t uav_phi; // Roll angle of carrier. [-180° , 180° ). Resolution 0.01deg
    int16_t uav_the; // Pitch angle of carrier. [-90° , 90° ]. Resolution 0.01deg
    uint16_t uav_psi; // Yaw angle of carrier. [0° , 360° ). Resolution 0.01deg
    int16_t cam_phi; // Roll angle of pod. [-90° , 90° ]. Resolution 0.01deg
    int16_t cam_the; // Pitch angle of pod. [-180° , 180° ). Resolution 0.01deg
    uint16_t cam_psi; // Yaw angle of pod. [0° , 360° ). Resolution 0.01deg
    uint16_t cam1_zoom; // Zoom rate of zoom camera. Resolution 0.01x
    uint16_t cam2_zoom; // Zoom rate of thermal camera. Resolution 0.01x
    uint16_t rng_dist; // Distance from target. Resolution 0.1m (Invalid, 0)
    uint16_t gnss_week; //GNSS week
    uint32_t gnss_itow; //GNSS microsecond. Resolution 1ms
    int32_t tgt_lon; // Longitude of target. [-180° , 180° ). Resolution 1e-7deg  (Invalid, 0)
    int32_t tgt_lat; // Latitude of target. [-90° , 90° ]. Resolution 1e-7deg (Invalid, 0)
    int32_t tgt_alt; // Altitude of target. Resolution 1mm (Invalid, 0)
    uint16_t cam1_fl1x; // Focal length of zoom camera at 1x. Resolution 0.01mm
    uint16_t cam2_f1x; // Focal length of thermal camera at 1x. Resolution 0.01mm
    uint8_t reserved[4]; // Reserved
    uint8_t check_sum; // Checksum
} SdSei_t;
```

Appendix 3 MAVLink Configuration

ArduPilot

SERIAL1	
SERIAL1_BAUD	115
SERIAL1_OPTIONS	1024
SERIAL1_PROTOCOL	2
SR1	
SR1_ADSB	0 Hz
SR1_EXIT_STAT	0 Hz
SR1_EXTRA1	0 Hz
SR1_EXTRA2	0 Hz
SR1_EXTRA3	0 Hz
SR1_PARAMS	0 Hz
SR1_POSITION	0 Hz
SR1_RAW_CTRL	0 Hz
SR1_RAW_SENS	0 Hz
SR1_RC_CHAN	0 Hz
MNT1	
MNT1_TYPE	4 (Gremsy) / 6 (SToRM32 Mavlink)
RC1	
RC1_OPTOPN	213 (MOUNT1_PITCH)
RC2	
RC2_OPTOPN	214 (MOUNT1_YAW)
RC3	
RC3_OPTOPN	163 (MOUNT1_LOCK)
CAM	
CAM_TRIGG_TYPE	3 (Mount)

The MNT1_TYPE is recommended as 6. The MNT1_ROLL_MAX, MNT1_ROLL_MIN, MNT1_PITCH_MAX, MNT1_PITCH_MIN, MNT1_YAW_MAX and MNT1_YAW_MIN will be configured automatically depend on data from the GCU. The angle limit should be set manual while the MNT1_TYPE is 4.

The RC1~RC3 are just examples, which can be defined according to actual situation.

PX4

MAVLink	
MAV_1_CONFIG	TELEM2
MAV_1_MODE	Custom / Gimbal
MAV_1_RATE	115200 B/s
Serial	
SER_TEL2_BAUD	115200 8N1
Mount	
MNT_MAIN_PITCH	AUX1
MNT_MAIN_YAW	AUX2
MNT_MODE_IN	Auto (RC and Mavlink Gimbal)
MNT_MODE_OUT	MAVLink gimbal protocol v2
Camera Setup	
Trigger mode	Distance based, on command (Survey mode)
Trigger interface	MAVLink (forward via MAV_CMD_IMAGE_START_CAPTURE)

The MAV_1_MODE is recommended as Custom.

The AUX1 and AUX2 are just examples, which can be defined according to actual situation. It should be configured in RC Map for further application.

The trigger mode is just an example, which can be modified according to actual situation.

Appendix 4 MAVlink Communication Process

After receiving HeartBeat from the flight controller, and identifying SYSID and COMPID of the flight controller, GCU will operate as below:

1. GCU actively sends package *MAVLINK_MSG_ID_HEARTBEAT 0* at a frequency of 2Hz.
2. GCU requests following packages in turn at a frequency of 1Hz. The flight controller fills these parameters into package *MAVLINK_MSG_ID_COMMAND_LONG 76* until the request completing.:
   MAVLINK_MSG_ID_EKF_STATUS_REPORT 193 (No this package for PX4);
   MAVLINK_MSG_ID_GLOBAL_POSITION_INT 33;
   MAVLINK_MSG_ID_SCALED_IMU 26;
   MAVLINK_MSG_ID_SYSTEM_TIME 2;
   MAVLINK_MSG_ID_RC_CHANNELS 65;
   MAVLINK_MSG_ID_CAMERA_TRIGGER 112 (No this package for APM);
   MAVLINK_MSG_ID_AUTOPILOT_STATE_FOR_GIMBAL_DEVICE 286;
   MAVLINK_MSG_ID_GIMBAL_DEVICE_SET_ATTITUDE 284 (No this package for APM);
3. GCU actively sends package *MAVLINK_MSG_ID_GIMBAL_DEVICE_ATTITUDE_STATUS 285* at a frequency of 100 Hz while the packages above being received and the pod being operational.
4. Generally, the flight controller will request package *MAVLINK_MSG_ID_GIMBAL_DEVICE_INFORMATION 283*, which GCU does not send actively.

Appendix 5 Wiring Diagram of Connecting to Open Source Autopilot