

Falcon K1 LiDAR

User Manual



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Preface

Product

Falcon K1 LiDAR

Manufacturer

SEYOND

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Overview

This manual provides instructions for the installation, usage, maintenance, and diagnostic evaluation of Falcon K1 LiDAR (hereinafter referred to as "Falcon" or "LiDAR"). The contents of the manual are based on the different phases of the LiDAR life cycle, including the installation, configuration, and maintenance of the LiDAR.

The intended users of this manual include project developers (R&D personnel and designers), installers, electrical professionals, safety professionals, and service personnel.

Original document

This document is the original document owned by Seyond.

Manual description

Although this document covers instructions to handle frequent problems, it is still not guaranteed to fully resolve all problems. If you encounter other issues not covered in the manual, please contact Seyond staff in time. This manual will be updated when new information becomes available.

Tel : (650)963-9573 E-mail: info@ seyond.com

Precautions

This user manual provides descriptions of Falcon K1 LiDAR introduction, installation, transferring, usage, maintenance, diagnostic evaluation, disposal, etc., and software instructions.

Considering this is a laser product (1550 nm), please thoroughly read and comprehend all information within this manual before the operation and consider the precautions to avoid danger. Please strictly follow the instructions and steps described in the manual during operation.

Safety notices

Before using the product, please read this manual carefully and strictly follow the relevant instructions.

Please contact Seyond staff to obtain detailed specifications.

To reduce the risk of electric shock and avoid violating the warranty, please do not disassemble or modify the LiDAR without permission. This product does not contain the user's serviceable parts. Please consult Seyond's certified service personnel for maintenance and repair.

Service procedures where the laser is energized, is only intended to be performed by Seyond service personnel or persons trained by Seyond to perform such service.



CLASS 1

LASER PRODUCT



Use of controls, adjustments, or performance of procedures other than those specified for this product may result in hazardous radiation leakage.



Class 1 laser product.

➤ Failure to use, control, adjust or operate LiDAR as specified herein may result in serious radiation hazards.

➤ The product incorporates a Class 4 fiber laser system which, by itself, may be hazardous. This device incorporates a protective housing and a scan failure safeguard in the machine design such that there is no exposure or human access to laser radiation generated by the fiber laser during operation or maintenance.

➤ UNDER NO CIRCUMSTANCE shall attempts be made to operate the laser with protective housing removed or the scan failure safeguards overridden.

➤When the laser is powered up, service procedures are only intended to be operated by Seyond service personnel or persons trained and certified by Seyond.



21 CFR 1040.10 and 1040.11, except for the deviation of Laser Notice No.50 issued on June 24, 2007.

Device maintenance

This product is made of metal, glass, plastic, and contains sensitive electronic components.

- > Do not misuse the product by dropping, burning, piercing, bumping, squeezing, etc.
- Shut off the product immediately once it is hit or dropped. Please contact Seyond staff for technical support.
- If there is any possibility that the product may have been damaged, please stop using it immediately to prevent personnel injury.
- > Do not touch the LiDAR window with your hands in case of performance degradation.
- If the LiDAR window is stained, please clean the product as described in the <u>Cleaning</u> section of this manual.
- It is strictly forbidden for users to disassemble or convert the device without permission. Dismantling this product may result in product damage, loss of waterproof performance, or personal injury.

Electrical safety

- > Always use the connecting cable and power adapter provided or specified by Seyond.
- Using damaged cables or adapters in a humid environment may lead to fire, electric shock, personal injury, product damage, or other property losses.
- Voltage surges due to lightning may lead to the degeneration of electrical systems over an extended period.

Heat dissipation

- Long-time contact with the hot surface of the product may cause personal discomfort or injury.
- > To avoid heat accumulation, please ensure the device is in well-ventilated environment.
- LiDAR may generate a high amount of heat after prolonged operations. It is recommended to shut off the power for a few minutes before touching it.

Operating environment

- > Do not subject the product to intense vibration.
- Do not look directly at the transmitting laser through a magnifying device (such as a microscope and magnifying glass).
- > Do not look directly at the transmitting laser through an electronic device.
- > Do not place this product near flammable and explosive materials.
- Do not expose this product to areas with explosive air, such as areas with a high concentration of flammable chemicals or saturated vapor.
- Do not expose this product to an environment with high-density industrial chemicals, such as easily vaporized liquefied gas (e.g., helium), to avoid performance degradation.

Radio frequency interference

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Before the operation, please read the product label's certification and safety information. Although the product's design, testing, and manufacturing comply with the relevant provisions of RF energy radiation, the radiation from the product may still lead to the failure of other electronic equipment.

Medical device interference

Some components and radio devices contained in this product will emit electromagnetic fields that may interfere with medical equipment, such as cochlear implants, pacemakers, and defibrillators. Consult your doctor and medical equipment manufacturer for specific information, e.g., whether you need to keep a safe distance from this product. If there's any possibility that this product is interfering with your medical equipment, please stop using it immediately.

1 Product description

1.1 Product introduction

Product Overview

Falcon K1 (hereinafter referred to as "Falcon" or "LiDAR") is an industry-leading automotive-grade LiDAR developed by Seyond through forward engineering. It can detect objects as far as 500 meters, and dark objects with 10% reflectivity up to 250 meters. Falcon can maximize point density in region of interest (ROI) which is adjustable to focus where it matters most to better track objects on the road. High performance LiDAR with strong environmental adaptability like Falcon is key to safe autonomy and smart transportation.

Product features

- > 500m ultra-long detection range, image-grade ultra-high resolution
- Flexible and adjustable ROI
- > 1550nm laser wavelength enables better eye-safety
- > Greater environmental adaptability and longer product life
- Mass production of automotive-grade robust products is ready

1.2 Time of flight

LiDAR performs based on the time-of-flight (ToF) methodology.

- 1. The LiDAR emits a light pulse of short duration and narrow divergence.
- 2. Upon hitting an object, the emitted light will undergo scattered reflection.
- 3. Some of the reflected light will return to the unit and be detected by the LiDAR's optical sensor.
- 4. The object's distance is calculated by measuring the time between the emission of the light pulse and the detection of the reflected light. The object's location is known since the angular direction of the emitted light pulse is known.
- 5. The LiDAR emits light pulses in multiple directions sequentially, thereby constructing a 3dimensional map of the system's surroundings.

The distance is expressed as:

$$d = \frac{ct}{2}$$
d: distance c: speed of flight t: flight time of the laser pulse

1.3 LiDAR laser and coordinate system

Falcon is a semi-solid-state LiDAR with a laser light source wavelength of 1550nm.

The three-dimensional coordinate system is defined as follows.

> X-axis is perpendicular to the ground, pointing up.

- > Y-axis is parallel to the ground, pointing right.
- > Z-axis is parallel to the ground, pointing forward.
- > The origin in this coordinate is the optical origin and can be used for calibration reference.



1.4 Scanning pattern

Falcon is designed with a dual-dimensional scanning pattern.

The Field of View (FOV) is the angle through which the LiDAR is sensitive to the electromagnetic radiation. FOV ($H \times V$): 120°×25°. Angular resolution ($H \times V$): 0.18°×0.24°.

The Region of Interest (ROI) is the angle with high point cloud density, which is about six times higher than the non-ROI in LiDAR. FOV in ROI ($H \times V$): 40°×4.8°. Angular resolution in ROI ($H \times V$): 0.09°×0.08°.

The position of ROI center can be adjusted in real-time within the entire FOV through the computer commands sent to LiDAR.



1.5 Specifications

Table	1	Specifications	
-------	---	----------------	--

OPTICAL PERFORMANCE	
Range (Maximum)	500 m
Range (Minimum)	1.5 m
Detection Range (10% Lambertian	250 m@100 klx sunlight, POD>90%
reflectivity @ 10 Hz)	
Detection Range Accuracy	± 5 cm for Lambertian targets

	± 10 cm for retroreflectors	
Detection Range Precision (10%	2 cm (50 m@1sigma)	
Lambertian reflectivity)		
Detection Range Resolution	0.5 cm	
Vertical Scanning Lines	1520 lines/sec	
FOV in non-ROI (H×V)	120°×25°	
FOV in ROI (H×V)	40°×4.8°	
Angular Resolution in non-ROI (H×V)	0.18°×0.24°	
Angular Resolution in ROI (H×V)	0.09°×0.08°	
Angular Accuracy	± 0.1°	
Frame Rate	10 FPS (configurable: 5 to 20 FPS)	
False Positive Rate	<0.01% @ 100 klx sunlight	
# of Returns	Up to 2 returns	
LASER		
Laser Safety Class	Class 1 (IEC 60825-1)	
Laser Wavelength	1550 nm	
Beam Divergence (Full Angle)	0.1°	
LIDAR OUTPUT		
Data transmission	1000Base-T1 Ethernet (UDP, TCP)	
Points Per Second	900,000 Points/sec	
Data Rate (Megabits Per Second)	7.385MB/S@1 return	
	10.965MB/S@2 return	
CONTROL INTERFACE		
Interface	TCP and HTTP APIs	
Time Synchronization	• IEEE1588 (PTP)	
	IEEE 802.1as(gPTP)	
	4.21/2014	
Power	12V/30W	
Operating Voltage	9 to 34V DC	
Connector	Proprietary pluggable connector (Power + Automotive Ethernet	
	+ CAN)	
Dimensions (H×W×D)	58.9mm×228mm×149.6mm	
Weight	1.75 kg	
Mounting	4×M4×18 screws, located in bushings	
OPERATIONAL		
Operating Temperature	-40 °C to +85 °C	
Storage Temperature	-40 °C to +105 °C	
Ingress Protection	IP67(body)	
	IP69K(window)	
Shock	IEC 60068-2-27	

Vibration	IEC 60068-2-64
Compliance	IEC60825-1 Class 1 eye-safe, RoHS, CE
	CE ROHS
ACCESSORIES	
Optional Wire Harness	5m cable (power & Ethernet)
Optional Converter	Metadaptor
Optional Mount	Metal bracket
SOFTWARE	
Available Drivers	ROS/ROS2

Note

Specifications are subject to change without notice.

2 Getting started

This chapter provides the procedure to test and verify that your LiDAR is operating properly.

2.1 Delivery list

It is highly recommended to check if there are any loss or damage of the components according to the delivery list before installation.

	Table 2 Star	ndard delivery	list
No.	Name	No.	Name
1	Lidar	2	Standard cable

You can select the optional components to customize your delivery list on demand. The list of the optional components is shown below. For more information, please contact Seyond staff for support.

Table 3 Optional delivery list				
No.	Name	No.	Name	
3	LiDAR connector	4	Metadaptor	
5	Metadaptor charger			

Note

The delivery list is subject to your individual order, this section is for reference only.

2.2 Verification

Note

It is recommended to check out a new LiDAR's functionality and start processing the LiDAR before

mounting.

- 1. Unpack the LiDAR and the accessories on a workbench or desk. About the component list, see <u>2.1 Delivery list.</u>
- 2. Connect the LiDAR to the power supply and startup the LiDAR. About the connection method, see <u>2.2.1 LiDAR connection</u>. About the LiDAR startup, see <u>2.2.2 Start the LiDAR</u>.
- 3. Connect the LiDAR to a test computer. Change the computer IP address to the same subnet with the LiDAR. About the connection method, see <u>2.2.1 LiDAR connection</u>.

About how to change the computer IP address on Windows, see <u>2.2.3.1 Change the computer IP</u> <u>address on Linux</u>. About how to change the computer IP address on Windows, see <u>2.2.3.2</u> <u>Change the computer IP address on Windows</u>.

4. View the point cloud status to verify the connection and the function. You could choose one of the following methods according to your actual situation.

About how to view the point cloud via ILA, see 2.2.4 View the point cloud status on ILA.

About how to view the point cloud in ROS, see <u>2.2.5 (Optional) View the point cloud status in</u> <u>ROS</u>.

5. About how to view the point cloud via MetaView, see <u>2.2.6 (Optional) View the point cloud</u> <u>status via MetaView.</u>

2.2.1 LiDAR connection



2.2.2 Start the LiDAR

- 1. Connect the power supply to start the LiDAR.
- 2. The LiDAR completes initialization and generates data after powering on for 11 to 18 seconds.

Note

The LiDAR does not have a power switch. It will become operational when power is applied.

2.2.3 Change the computer IP address

You need to change the computer IP address to the same subnet with the LiDAR before viewing the point cloud status. The method of changing the IP address may vary with the operating system.

2.2.3.1 Change the computer IP address on Linux

- 1. Connect the computer to LiDAR and ensure the Ethernet connection.
- 2. Select Settings > Network.
- 3. Select IPv4. Click Manual to change the computer IP to the same subnet with the LiDAR.
- 4. Click Apply.

2.2.3.2 Change the computer IP address on Windows

1. Connect the computer to LiDAR and ensure the Ethernet connection.

- 2. Select Settings > Network & internet > Ethernet.
- 3. Click **Edit** on the **IP assignment** bar.

← Settings		- 🗆 X
di Milana	Network & internet > Ethernet	
Find a setting Q	Not connected	^
System	Authentication settings	Edit
8 Bluetooth & devices	Metered connection Some apps might work differently to reduce data usage when you're connected to this network	Off
Network & internet Personalization	Set a data limit to help control data usage on this networ	'k
Apps	IP assignment:	
e Accounts	Automatic (DHCP)	Edit
 Time & language Gaming 	DNS server assignment: Automatic (DHCP)	Edit
🗙 Accessibility	Primary DNS suffix:	Сору
Privacy & security	Manufacturer:	
Windows Update	ASIX Description:	
	ASIX AX88179A USB 3.2 Gen1 to Gigabit Ethernet Adapter	

4. Select Manual in the Edit IP settings dialog box.

Automatic (DHCP)	
Manual	

5. Toggle on **IPv4**. Enter the **IP address**, **Subnet mask** and **Gateway** to make the computer with the same subnet to the LiDAR. See below for example of the settings for a default factory LiDAR. Click **Save** to save the settings.

Manual	~
IPv4	
On	
IP address	
172.168.1.15	
Subnet mask	
255.255.255.0	
255.255.255.0 Gateway	
255.255.255.0 Gateway 172.168.1.1	×
255.255.255.0 Gateway 172.168.1.1 Preferred DNS	×
255.255.255.0 Gateway 172.168.1.1 Preferred DNS DNS over HTTPS	×
255.255.255.0 Gateway 172.168.1.1 Preferred DNS DNS over HTTPS Off	×
255.255.255.0 Gateway 172.168.1.1 Preferred DNS DNS over HTTPS Off	×

6. (Optional) Verify the connection.

It is recommended to check the access to the LiDAR IP address by using the ping command. The return value is shown in the figure below. The default factory LiDAR will usually have an IP address of 172.168.1.10.

demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$ ping 172.168.1.10
PING 172.168.1.10 (172.168.1.10) 56(84) bytes of data.
64 bytes from 172.168.1.10: icmp_seq=70 ttl=64 time=0.448 ms
64 bytes from 172.168.1.10: icmp_seq=71 ttl=64 time=0.222 ms
64 bytes from 172.168.1.10: icmp_seq=72 ttl=64 time=0.200 ms
64 bytes from 172.168.1.10: icmp_seq=73 ttl=64 time=0.208 ms
64 bytes from 172.168.1.10: icmp_seq=74 ttl=64 time=0.200 ms
64 bytes from 172.168.1.10: icmp_seq=75 ttl=64 time=0.219 ms
64 bytes from 172.168.1.10: icmp_seq=76 ttl=64 time=0.255 ms
64 bytes from 172.168.1.10: icmp_seq=77 ttl=64 time=0.212 ms
64 bytes from 172.168.1.10: icmp_seq=78 ttl=64 time=0.206 ms
64 bytes from 172.168.1.10: icmp_seq=79 ttl=64 time=0.170 ms
64 bytes from 172.168.1.10: icmp_seq=80 ttl=64 time=0.207 ms
64 bytes from 172.168.1.10: icmp_seq=81 ttl=64 time=0.207 ms
64 bytes from 172.168.1.10: icmp_seq=82 ttl=64 time=0.145 ms
64 bytes from 172.168.1.10: icmp_seq=83 ttl=64 time=0.168 ms
64 bytes from 172.168.1.10: icmp_seq=84 ttl=64 time=0.316 ms
64 bytes from 172.168.1.10: icmp_seq=85 ttl=64 time=0.192 ms
64 bytes from 172.168.1.10: icmp_seq=86 ttl=64 time=0.309 ms
64 bytes from 172.168.1.10: icmp_seq=87 ttl=64 time=0.295 ms
^C
172.168.1.10 ping statistics
87 packets transmitted, 18 received, 79% packet loss, time 88040ms
rtt min/avg/max/mdev = 0.145/0.232/0.448/0.069 ms
demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$

2.2.4 View the point cloud status on ILA

1. Open the browser. Enter the LiDAR IP address and port number in the address bar <IP Address>: <PORT> to access the ILA.

Note

The default LiDAR IP address is 172.168.1.10. By default, the ILA port number is 8675. The default ILA

login address is 172.168.1.10:8675.

It is recommended to use the Google Chrome browser to log in to the ILA.

- 2. You can directly view the status of the LiDAR point cloud in real-time on the **View Stream**.
- 3. (Optional) Change the point of view and distance in which the point cloud data is displayed using the keyboard shortcuts and mouse.

The available keyboard shortcuts are listed on the View Stream.

4. (Optional) Click **Viewer Only** to launch the point cloud viewer and view the live point cloud in a new tab.

From the new tab, it is possible to maximize the display into full-screen mode.

Inno?usionLidar Appliance - for falcon (ILA-f)			۵ 👁 ک
₩ View stream 🖌 Sensor config 🖺 Log files 🕕 Help			
L Copy viewer URL ⊗ Viewer only	China server e	frame(s) recording format select format +	Region of Interest (ROI) ROI-horz ROI-vert 0.000000
	© T	Viewer keyboard controls Inter pause / unpause random scene paceokae same as guitor freeze frame / resume live G to pan left / right G to pan left / right G to pan up / down	e motion
	21	 a cycle color scheme → → + a 0 *bookmark* viewpoint b 0 fast *fly* to viewpoi c 0 fast *fly* to viewpoi c 0 restore viewpoint (from bookm a or tioze reset view to default 	nt nt ark #)
		Increase frame decay 100ms + 12: shitcl Falcon ROI on/off 2 ROI color ← →	decrease frame decay 100ms

2.2.5 (Optional) View the point cloud status in ROS

2.2.5.1 View the point cloud status in ROS1

1. View the system details and obtain the corresponding driver. Copy the driver to the root directory of the system. Execute the following command to install the driver.

sudo dpkg -i <package.deb>

Note

package.deb is the driver's name of the LiDAR. Obtain the latest driver version based on the actual conditions.

2. Start ROS. The return value is shown in the figure below.

roscore

<pre>demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$ roscore logging to /home/demo/.ros/log/a09b36de-9f71-11ec-874a-c85acfaa1d16/roslaunch-demo-OMEN-by-HP-Laptop-16-b0xxx-9812.log thereing log directory for dire used. This may take a while</pre>
These for a interrupt
Done checking log file disk usage. Usage is <1GB.
started roslaunch server http://demo-OMEN-by-HP-Laptop-16-b0xxx:42677/ ros_comm version 1.14.12
SUMMARY
PARAMETERS * /rosdistro: melodic * /rosversion: 1.14.12
NODES
auto-starting new master process[master]: started with pid [9822] ROS_MASTER_URI=http://demo-OMEN-by-HP-Laptop-16-b0xxx:11311/
setting /run_id to a09b36de-9f71-11ec-874a-c85acfaa1d16 process[rosout-1]: started with pid [9833] started core service [/rosout]

- 3. Obtain the point cloud data of the LiDAR. The return value is shown in the figure below.
 - Obtain the point cloud data via the TCP port.

source /opt/ros/melodic/setup.bash

roslaunch innovusion_pointcloud innovusion_points.launch device_ip:= <device_ip> port:=< TCP_port > processed:= <Processed_number>

• Obtain the point cloud data via the UDP port.

source /opt/ros/melodic/setup.bash

roslaunch innovusion_pointcloud innovusion_points.launch device_ip:= <device_ip> udp_port:=
<UDP_port> processed:= <Processed_number>

Note

The default value of device_ip is 172.168.1.10. By default, the UDP port number is 8010.

The value of processed_number can be 0 or 1. When the process_number is set to 1, the point cloud data is obtained from ROS client. When the process_number is set to 0, the point cloud data is obtained from external PCS.



4. Start the graphical tool rviz. The return value and rviz interface are shown below.

iz	
	demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$ rviz rviz
	[INF0] [1646808931.535449917]: rviz version 1.13.21
	[INF0] [1646808931.535492615]: compiled against Qt version 5.9.5
	[INFO] [1646808931.535502544]: compiled against OGRE version 1.9.0 (Ghadamon)
	[INFO] [1646808931.539157206]: Forcing OpenGl version 0.
	[INFO] [1646808932.122437501]: Stereo is NOT SUPPORTED
	[INFO] [1646808932.122552411]: OpenGL device: NVIDIA GeForce RTX 3060 Laptop GP
	U/PCIe/SSE2
	[INF0] [1646808932.122633840]: OpenGl version: 4.6 (GLSL 4.6).
	QObject::connect: Cannot queue arguments of type 'QVector <int>'</int>
	(Make sure 'QVector <int>' is registered using qRegisterMetaType().)</int>
	QObject::connect: Cannot queue arguments of type 'QVector <int>'</int>
	(Make sure 'QVector <int>' is registered using qRegisterMetaType().)</int>

rv

					default.rv	viz* - RViz				● 🗉 😣
<u>F</u> ile <u>P</u> anels <u>I</u>	<u>H</u> elp									
🗄 Interact 🥳	🖗 Move Camer	Select	🚸 Focus Camera	m Measure	🗡 2D Pose Estimate	💉 2D Nav Goal	💡 Publish Point	+ - ·		
🛄 Displays			×						M Views	×
 Global Op Fixed Fran 	otions	D							Type: Orbit (rviz)	▼ Zero
Backgrour Frame Rat Default Li Global Str Fixed F * Grid	nd Color ∎ te 30 ght v stus: No °rame v	48; 48; 48	al err					,	 Current View Near Clip Invert Z Axi Target Fra Distance Focal Shap Focal Shap Yaw Pitch Focal Point 	orbit (rviz) 0.01 0.1 < . 19.7382 . 0.05 . .0.0 . 0.733398 0.620398 0; 0; 0 .
Add	uplicate F	emove Re	ename						Save Re	move Rename
🕒 Time										×
ROS Time: 164	46965299.12	ROS Ela	psed: 15.17	Wa	all Time: 164696529	9.15 Wall E	lapsed: 15.10			Experimental
Reset										31 fps

5. Select Global Options > Fixed Frames. Set the Fixed Frames value to innovusion.



- i. Add PointCloud2 to Displays.
 - a. Click Add.
 - b. Select By topic > iv_points > PointCloud2.
 - c. Click **OK**.

default.rviz* - RViz	000
<u>File Panels</u> <u>H</u> elp	
🗁 Interact 🕸 Move Camera 🛄 Select 🚸 Focus Camera 📼 Measure 🖌 2D Pose Estimate 🖌 2D Nav Goal 💡 Publish Point 💠 📼 🔍	
🖵 Displays 🗶 rviz 😢	► Views ×
Fixed Frame innovusion Create visualization	Type: Orbit (rviz) 👻 Zero
Background Color ■ 44; 48; 48 Frame Rate Default Light ♥ Colobal Status: ♥ fixed Frame > ♥ Grid By display type By topic ♥ /call_points ♥ /call_points ♥ /call_points ♥ /call_points ♥ /call_points ♥ pointStamped ♥ /initialpose ♥ /ose ♥ /visualization_marker ♥ /ose ♥ /visualization_marker ♥ Marker Displays a point cloud from a sensor_msgs:PointCloud2 message as points in the world, drawn as points, billboards, or cubes. More Information.	 Current View Orbit (rviz) Near Clip001 Invert Z Axis Invert Z Axis Invert Z Axis Invert Z Axis Invert Z Axis Fixed Frame> Distance 19.7382 Focal Shap vi Yaw 0.735398 Pictol Oc20398 Focal Point 0; 0; 0
Fixed Frame Display Name Frame into which all data is transformed before being displayed. PointCloud2	
Add Duplicate Remove Rename	Save Remove Rename
	×
ROS Time: 1646965355.28 ROS Elapsed: 71.33 Wall Time: 1646965355.31 Wall Elapsed: 71.26	Experimental
Reset	31 fps

ii. Select **PointCloud2** > **Topic**. Set the Topic value to **/iv_points**.



iii. Select PointCloud2 > Style. Set the Style value to Points.



2.2.5.2 View the point cloud status in ROS2

1. View the system details and obtain the corresponding driver. Copy the driver to the root directory of the system. Execute the following command to install the driver.

sudo dpkg -i <package.deb>

Note

package.deb is the driver's name of the LiDAR. Obtain the latest driver version based on the actual conditions.

ROS2 version	System Version	CPU			
Form Calactic	Ubuptu 20.04	ARM			
TOXY, Galactic	Obuntu 20.04	X86			
Humblo	Ubuntu 22.04	ARM			
пипріе	0001110 22.04	X86			

Table 4 Available system

2. You could obtain the point cloud data of the LiDAR via TCP or UDP.

Note

Execute the following command and re-run the obtain command and if the point cloud data was

obtained correctly.

source /opt/ros/foxy/setup.bash

- Obtain the point cloud data via TCP.
 - Method 1

```
ros2 launch innovusion ivu_pc2.py device_ip:=<device_ip> lidar_port:=<TCP_port>
 immovusion ivu_pc2.py device_lp:=<device_lp> lidar_port::
immovusion ivu_pc2.py device_lp:=172.168.1.10 lidar_port:=8010
[INF0] [launch]: All log files can be found below /home/demo/.ros/log/2023-08-07-14-19-28-785946-sza0682-8254
[INF0] [publisher-1]: process started with pid [8256]
[publisher-1] [INF0] [1691389168.844260321] [lvu_pub]:
[publisher-1] lidar_iname: falcon, frame id: innovusion
[publisher-1] lidar_iname: falcon, frame id: innovusion
[publisher-1] process: nultiple_return: 1
[publisher-1] packet_rate: 20
[publisher-1] packet_rate: 20
[publisher-1] file_rewind: -1
[publisher-1] file_rewind: -1
                                       lidar_udp_port: -1
name_value_pairs:
continue_live: 1
coordinate_mode: 0
     ublisher-1
                                                                                                   max_range: 2000.000000, min_range: 0.400000
                 sher
       ublisher
             isher
      ublisher-1
    vublisher 1] [INFO] [1691389168.845036003] [ivu_pub]: 8256 mem_pool_manager.cpp:32 MemPoolManager [AsyncJob_memory_pool] 0x56246836ba70 created
pol=0x7f65944e6010, unit_size=4096, unit_count=90, allocator=DefaultMemAllocator
publisher-1] [INFO] [1691389168.845204190] [ivu_pub]: 8268 consumer_producer.cpp:191 thread AsyncLogThread_Manager starts. pid=8268 target_prior
                                                                                                                                            8256 async_log.cpp:69 LIDAR Log Async Thread work : True
8256 api_common.cpp:59 LIDAR SDK version is DEV-internal
8256 api_common.cpp:60 LIDAR SDK build tag is LOCAL-BUILD
8256 api_common.cpp:61 LIDAR SDK build time is 03:49:44 Jun 30 2023
8256 api_common.cpp:69 log level change from 6 to 6
8256 driver_lidar.cc:101 Lidar name is falcon
8256 mem_allocator.cpp:313 DefaultMemAllocator calloc start
8256 mem_pool_manager.cpp:32 MemPoolManager [packet_pool] 0x562468374d40 created pool=0x7f
      ublisher-1]
                                   [INF0]
                                                   [1691389168.855174368] [ivu pub]:
       blisher-1]
                                   [INFO]
[INFO]
                                                     [1691389168.855262757]
[1691389168.855278958]
                                                                                                                [ivu_pub]:
[ivu_pub]:
      ublisher-1]
                                   [INFO]
[INFO]
                                                     [1691389168.855282835]
[1691389168.855286138]
                                                                                                              [ivu_pub]:
[ivu_pub]:
      ublisher-
      ublisher
       ublisher
                                     [INFO]
                                                      [1691389168.855291512]
                                                                                                                 [ivu_pub]:
                                      INFO
                                                         1691389168.
```

Method 2

ros2 run innovusion publisher --ros-args -p device_ip:=<device_ip> -p lidar_port:=<TCP_port>

```
demo@sza0662:-$ ros2 run innovusion publisher --ros-args -p device_ip:=172.168.1.10 -p lidar_port:_E010
[INF0] [169138938.648625138] [ivu_pub]:
    lidar_nps: falcon, frame_id: innovusion
    lidar_upt prot: St. 10, lidar_port: 8010
    reflectance: 1, multiple_return: 1
    pcap_file:
    packt_rate: 20
    file_rewind: 0
    lidar_upd port: -1 max_range: 2000.000000, min_range: 0.400000
    name_value_patrs:
    continue_live: 1
    coordinate_mode: 0
2023-08-07 14:23:08.649 [ INF0] 8578 driver_lidar.cc:97 INNOVUSION LIDAR SDK version=DEV-internal build_time=03:49:44 Jun 30 202
3
2023-08-07 14:23:08.649 [ INF0] 8578 log.cpp:655 setup_sig_handler ready
[INF0] [1691389388.649087016] [ivu_pub]: 8578 mem_pool_manager.cpp:32 MemPoolManager [AsyncJob_memory_pool] 0x55ff7e337a30 crea
ted pool=8x7fa328efc010, unit_size=4096, unit_count=90, allocator=DefaultMemAllocator
[INF0] [1691389388.6591074] [ivu_pub]: 8578 async_log.cpp:69 LIDAR SDK version is DEV-internal
[INF0] [1691389388.6591074] [ivu_pub]: 8578 async_log.cpp:69 LIDAR SDK version is DEV-internal
[INF0] [1691389388.6594127104] [ivu_pub]: 8578 async_log.cpp:69 LIDAR SDK version is DEV-internal
[INF0] [1691389388.659412716] [ivu_pub]: 8578 async_log.cpp:69 LIDAR SDK version is DEV-internal
[INF0] [1691389388.659412716] [ivu_pub]: 8578 async_log.cpp:69 LIDAR SDK version is DEV-internal
[INF0] [1691389388.659412716] [ivu_pub]: 8578 async_common.cpp:59 LIDAR SDK version is DEV-internal
[INF0] [1691389388.659412716] [ivu_pub]: 8578 async_common.cpp:59 LIDAR SDK build time is 03:49:44 Jun 30 2023
[INF0] [1691389388.659412716] [ivu_pub]: 8578 mem_allocator.cp151 LIDAR SDK build time is 03:49:44 Jun 30 2023
[INF0] [1691389388.659412716] [ivu_pub]: 8578 mem_allocator.cp1533 DefaultMemAllocator calloc start
[INF0] [1691389388.659439841 [ivu_pub]: 8578 mem_allocator.cp1533 MemPoolManager [packt_pool] 0x55ff7e340d000 created pool=
0x7ra315427010, unit_size=655340, unit_count=700, allocator-DefaultMemAllocator
[INF0] [1691389388.659431741] [ivu_pub]: 8578 mem_pool_ma
```

Note

The default value of device_ip is 172.168.1.10. By default, the TCP port number is 8010. You can run the ros2 launch innovusion ivu_pc2.py or ros2 run innovusion publisher directly to obtain the point cloud data with the default settings.

- Obtain the point cloud data via UDP.
 - Method 1

ros2 launch innovusion ivu_pc2.py device_ip:=<device_ip> udp_port:=<UDP_port>

Method 2

ros2 run innovusion publisher --ros-args -p device_ip:=<device_ip> -p udp_port:=<UDP_port>

Note

The default value of device_ip is 172.168.1.10. Please notice that the LiDAR transmits the data via TCP by default.

3. Open a new terminal and execute the command to source the setup file.

source /opt/ros/foxy/setup.bash

4. Start the graphical tool rviz. The return value and rviz interface are shown below.

ros2 run rviz2 rviz2

Copyright©Seyond, Inc.

demo@sza0682:~\$ ros2 run rviz2 rviz2 [INFO] [1691389803.621535541] [rviz2]: Stereo is NOT SUPPORTED [INFO] [1691389803.621596887] [rviz2]: OpenGl version: 4.6. (GLSL 4.6)		
default.rviz* - RViz		⊜ 🛛 😣
Eile Panels Help		
👚 Interact 🕆 Move Camera 🛄 Select 🚸 Focus Camera 📼 Measure 🖌 2D Pose Estimate 🖌 2D Nav Goal 💡 Publish Point 🕀 🚽 🔍		
Displays K Global Options	M Views	×
 Cuoda Options Fixed Frame Background Color Para Rate Default Light Clobal Status: Fixed Frame Fixed Frame Fixed Frame No tf data. Actual err Grid 	Type: Orbit (rviz) Current View Near Clip Distance Torcal Shap Yaw Pitch Focal Shap	 Zero Orbit (rviz) 0.01 Fixed Frame> 9.7382 0.05 Vi 0.620398 0; 0; 0
Add Duplicate Remove Rename	Save	Rename
O Time		×
ROS Time: 1646965299.12 ROS Elapsed: 15.17 Wall Time: 1646965299.15 Wall Elapsed: 15.10		Experimental
Reset		31 fps

5. Select **Global Options** > **Fixed Frames**. Set the Fixed Frames value to **innovusion**.

default.rviz* - RViz	●
Eile Panels Help	
🗁 Interact 🕆 Move Camera 🛄 Select 🗄 Focus Camera 📼 Measure 🗡 2D Pose Estimate 🗡 2D Nav Goal 💡 Publish Point 🔮 😑 🔍	
Displays ×	► Views ×
Fixed Frame innovusion	Type: Orbit (rviz) - Zero
Background Color 48; 48; 48 Frame Rate 30 DeFault Light √ ♥ Global Status ♥ Fixed Frame ▶ ♥ Grid ♥ ↓	 Current View Orbit (rviz) Near Clip 0.01 Invert Z Axis Target Fra <fixed frame=""> Distance 19.7382 Focal Shap 0.05 Focal Shap 0/ Yaw 0.735398 Pitch 0.620398</fixed> Focal Point 0; 0; 0
Fixed Frame Frame into which all data is transformed before being displayed.	
Add Duplicate Remove Rename	Save Remove Rename
O Time	×
ROS Time: 1646965328.24 ROS Elapsed: 44.29 Wall Time: 1646965328.27 Wall Elapsed: 44.26	Experimental
Reset	31 fps

- i. Add PointCloud2 to Displays.
 - a. Click Add.
 - b. Select By topic > iv_points > PointCloud2.
 - c. Click OK.

default.rviz* - RViz		000
<u>File Panels</u> Help		
💾 Interact 👘 Move Camera 🛄 Select 🚸 Focus Camera 📼 Measure 🖌 2D Pose Estimate 🖌 2D Nav Goal 💡 Publish Point 💠 😑 👁		
🖳 Displays 🕷 🔹	No Views	×
✓ Ø Global Options	Type: Orbit (rviz)	▼ Zero
Background Color H3;48;48 Default Light ✓ Grid Global Status: Fixed Frame No tf data. Actual err Fixed Frame No tf data. Actual err // Fixed Frame No tf data. Actual err // rowe base Simple ✓/initialpose // more base Simple ✓/initialpose // roye base Simple ✓/initialpose // roye base Simple ✓/initialpose // roye base Simple ✓/initialpose // souldization_marker // solutization_marker // solutization_marker Show unvisualizable topics Displays a point cloud from a sensor_msgs:PointCloud2 message as points in the world, drawn as points, billboards, or cubes. More	 Current View Near Clip Invert Z Axis Target Fra Distance Focal Shap Focal Shap Yaw Pitch Focal Point 	Orbit (rviz) 0.01 <fixed frame=""> 19.7382 0.05 ☑ 0.735398 0.620398 0; 0; 0</fixed>
Frame into which all data is transformed before being displayed. Display Name PointCloud2		
Add Duplicate Remove Rename Cancel	Save Rem	nove Rename
ROS Time: 1646965355.28 ROS Elapsed: 71.33 Wall Time: 1646965355.31 Wall Elapsed: 71.26		Experimental
Reset		31 fps

ii. Select **PointCloud2** > **Topic**. Set the Topic value to **/iv_points**.



Reset



iii. Select PointCloud2 > Style. Set the Style value to Points.

2.2.6 (Optional) View the point cloud status via MetaView

1. Double-click to open MetaView.exe.

Note

You can download the latest MetaView at the Seyond Resource Hub at https://hub.seyond.com/.

2. Go to Data Source > Live Source. Click Add New Data Source.

Inno , usio	n		🗏 Data Sou	irce 🚳 Se	etting	s 🕛 Exit
& Live Source	Local Source					
44	LIVE DATA IP	LIVE DATA PORT	NOTE			DELETE C
Inno r usion	172.168.1.10	8010/stream	Defalut	al		×
Inno=usion	10.42.0.93	8010/stream	Empty Note			×
Inno=usion	10.42.0.119	8003/stream	laptop			×
Inno [®] usion	127.0.0.1	8010/stream	Empty Note	al		×
Inno ^s usion	172.16.115.139	8003/stream	Empty Note	al		×
Inno=usion	114.114.114.114	8010/stream	Empty Note	.11		×
		Add New Data Source				
Preset Gradient Reflectance Mode	Low	High		E ADD S	OURCE	ESC BACK

3. Enter LiDAR IP address and port number. Click to connect the LiDAR. The default LiDAR IP address is 172.168.1.10 and the default port number is 8010.

Inno r usio	n		🗏 Data Sou	rce 🕸 S	etting	s © Exit
ஃ Live Source	🕽 © Local Source					
44	LIVE DATA IP	LIVE DATA PORT	NOTE	STABILITY		DELETE C
Inno [®] usion	172.168.1.10	8010/stream	Defalut	al	D_2	×
Inno=usion	10.42.0.93	8010/stream	Empty Note			×
Inno=usion	10.42.0.119	8003/stream	laptop			×
Inno [®] usion	127.0.0.1	8010/stream	Empty Note	al		×
Inno=usion	172.16.115.139	8003/stream	Empty Note	al		×
Inno=usion	114.114.114.114	8010/stream	Empty Note	.11		×
		🔶 Add New Data Source				
Preset Gradient Reflectance Mode	Low	High		E ADD S	OURCE	ESC BACK

4. You could check the point cloud status after adding the LiDAR.



3 Installation

3.1 Precautions

Falcon is generally intended to be mounted on vehicles. Please follow the instructions during the installation process.

Personnel Requirements

The device is only intended to be installed by Seyond service personnel or persons trained by Seyond.

Installation

- > If components are damaged or lost before installation, please contact Seyond staff for support.
- It is recommended to connect the ground to the vehicle chassis to improve the Falcon's immunity to emissions.
- > It is recommended to install the device on the center of the vehicle top.
- Make sure the LiDAR installation is flat and the tilt angle should be less than 3.5°. If there are specific tilt angle requirements, please contact Seyond staff for support.
- It is recommended that the mounting surface should be made of aluminum alloy to facilitate the heat dissipation of the LiDAR.
- > Make sure that the LiDAR cable keeps a certain degree of slackness.
- > A space of 8 cm should be reserved at the outlet of the LiDAR to facilitate cabling.
- Before installation, please ensure there is no obstruction in the FOV (field of view) of the LiDAR. The vertical FOV of the LiDAR is between -13 ° to +12°, and the horizontal FOV of the LiDAR is between 60 ° to +60°. The specific FOV is shown in the figures below. It is recommended to keep a vertical FOV of -16 degrees to 15 degrees free of obstructions to allow for variations in mounting angle tolerance.

Storage

- The storage environment should be dry and well-ventilated. The recommended storage temperature is between -40°C and +85°C. The recommended storage humidity is lower than 85%.
- > Without the official consent of Seyond, do not continuously immerse the product in water.
- > Avoid exposing the product to an environment exceeding the ingress protection rating.

Transportation

- The equipment should be packed in a packing box filled with cushioning materials to avoid product damage during transportation.
- Please handle the device with care. Impact to the device can damage or decrease performance of optical components in the device.
- > Consider the space and location during transportation to minimize the handling distance. Utilize

auxiliary tools or assistants if needed.

Please do not place the device in an unstable position or handle it in an incorrect posture in case of device damage and personal injury.

Disposal of packaging materials



- ▶ Packaging materials are recyclable. Please dispose of them correctly when discarding.
- ➤ Packaging bags, cartons, or plastic films should be kept out of reach of infants and children to avoid injury or suffocation.

3.2 LiDAR installation

3.2.1 Power description

The operating voltage range of Falcon is 9 to 34 VDC. It is recommended to use standard 12 VDC for the power supply. The power consumption of LiDAR is about 30W during regular operating. The peak power when the LiDAR is activated is about 50W and lasts less than 1 second. The peak power should be considered when choosing the power supply.

3.2.2 Dimensions





.

3.3 Cable description

Please notice that if the Falcon must connect to industrial Ethernet with an RJ45 connector, it is necessary to adopt a media converter for the switch from the 1000Base-T1 interface to an RJ45 interface.



Table 5 Interface description

NO.	Name	Description
1	LiDAR interface	8-pin interface. Pins are defined as follows.

		A
		7~8 5 4
		[1]: Grounding
		[2]: Empty pin
		[3]: Shield grounding
		[4]: Power supply
		[5]: CAN high
		[6]: CAN low
		[7] and [8]: Gigabit Ethernet
2	Power supply	 4-pin interface. Pins are defined as follows. 3 4 1 2 1 2 1 2 1 2 2 2 2 2 2 2 2 3 2 2 2 4 4 2 4 4<!--</td-->
3	1000Base-T1 automotive Ethernet	1000Base-T1 automotive Ethernet. Pins are defined as follows. 1 2 [1]: Ethernet D+ [2]: Ethernet D-
4	Grounding	Shield grounding

3.4 LiDAR connection



3.5 Cleaning

For optimal performance of LiDAR, please keep the front window of the sensor clean and free of dirt, bugs, and other debris. The steps to clean the optical window are as follows.

- 1. Prepare a lint-free cloth, soak it in the alcohol, and wring it out.
- 2. Loose the debris from the LiDAR window with the lint-free cloth for 1 minute. Do not wipe dirt directly off the LiDAR window glass without loosening it sufficiently.



- 3. Please wait 1 minute, gently wipe the window with the clean microfiber cloth and dry it.
- 4. Wipe the window with a new, dry lint-free cloth. Do not apply excessive force to avoid damaging the optical coating.

Note

Please wash your hands or wear PVC powder-free clean gloves before touching the product.

Do not use solvents since they may damage the window coating.

Please use a new dust-free wiper to wipe the LiDAR window.

The LiDAR window is made of special plastic material. Please pay attention to the following items when cleaning: Avoid direct skin contact with the optical window. Do not use corrosive cleaners and solvents. Do not use paper towels or similar materials to clean the window to avoid scratches.

4 Software operation

You can operate the LiDAR on the following platforms. For how to operate LiDAR using SDK tools, please refer to <u>5 SDK configuration</u>. If you want to get more information, please contact Seyond staff to obtain related manuals.

NO.	Software Interface	Description	
1	ILA	ILA is the quickest way to view live point clouds and record data. The	
		ILA GUI can be accessed through a web browser (preferably Chrome)	
		and does not require any SW installation. Running on Linux, Windows,	
		or Mac OS, and does not require any SW installation. ILA does not	
		support the replaying of recorded data.	
2	ROS	ROS (ROS1) drivers are available for Kinetic, Melodic and Noetic.	
		Please notice that drivers for ROS Kinetic will be discontinued soon.	
		ROS2 drivers are also available for Foxy Fitzroy, Galactic Geochelone,	
		and Humble Hawksbill.	
3	MetaView	The MetaView can be run from any Linux or Windows OS computer.	
		It allows viewing of the live point cloud, data recording, and replaying	
		recorded data. For the operations on MetaView, please see the user	
		manuals related to MetaView.	
4	Docker	Docker drivers are available for users to view and replay data. It also	
		provides a convenient way for calibration and troubleshooting.	

Table 6 platform instructions

4.1 Operate on ILA

The ILA operations in this chapter are based on the 4385 version of the firmware.

4.1.1 Start the LiDAR

- 1. Connect the power supply to start the LiDAR.
- 2. The LiDAR completes initialization and generates data after powering on for 11 to 18 seconds.

Note

The LiDAR does not have a power switch. It will become operational when power is applied.

4.1.2 Login

- 1. Connect the computer to LiDAR and ensure the Ethernet connection.
- 2. Change the computer IP address to the same subnet with the LiDAR.
- 3. Open the web browser. Enter the LiDAR IP address and port number in the address bar <IP Address>: <PORT> to access the ILA.

Note
The default LiDAR IP address is 172.168.1.10. By default, the ILA port number is 8675. The default ILA

login address is 172.168.1.10:8675.

It is recommended to check the access to the LiDAR IP address by using the ping command. The return value is shown in the figure below.

It is recommended to use the Google Chrome browser to log in to the ILA.

demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$ ping 172.168.1.10	
PING 172.168.1.10 (172.168.1.10) 56(84) bytes of data.	
64 bytes from 172.168.1.10: icmp_seq=70 ttl=64 time=0.448 ms	
64 bytes from 172.168.1.10: icmp_seq=71 ttl=64 time=0.222 ms	
64 bytes from 172.168.1.10: icmp_seq=72 ttl=64 time=0.200 ms	
64 bytes from 172.168.1.10: icmp_seq=73 ttl=64 time=0.208 ms	
64 bytes from 172.168.1.10: icmp_seq=74 ttl=64 time=0.200 ms	
64 bytes from 172.168.1.10: icmp_seq=75 ttl=64 time=0.219 ms	
64 bytes from 172.168.1.10: icmp_seq=76 ttl=64 time=0.255 ms	
64 bytes from 172.168.1.10: icmp_seq=77 ttl=64 time=0.212 ms	
64 bytes from 172.168.1.10: icmp_seq=78 ttl=64 time=0.206 ms	
64 bytes from 172.168.1.10: icmp_seq=79 ttl=64 time=0.170 ms	
64 bytes from 172.168.1.10: icmp_seq=80 ttl=64 time=0.207 ms	
64 bytes from 172.168.1.10: icmp_seq=81 ttl=64 time=0.207 ms	
64 bytes from 172.168.1.10: icmp_seq=82 ttl=64 time=0.145 ms	
64 bytes from 172.168.1.10: icmp_seq=83 ttl=64 time=0.168 ms	
64 bytes from 172.168.1.10: icmp_seq=84 ttl=64 time=0.316 ms	
64 bytes from 172.168.1.10: icmp_seq=85 ttl=64 time=0.192 ms	
64 bytes from 172.168.1.10: icmp_seq=86 ttl=64 time=0.309 ms	
64 bytes from 172.168.1.10: icmp_seq=87 ttl=64 time=0.295 ms	
^C	
172.168.1.10 ping statistics	
87 packets transmitted, 18 received, 79% packet loss, time 88040ms	
rtt min/avg/max/mdev = 0.145/0.232/0.448/0.069 ms	
demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$	

4.1.3 View the point cloud status of the LiDAR

Note

Ensure the internal point cloud service (PCS) runs on the **Sensor config**. If PCS is running, the green Run button should be greyed out.

Before viewing the point cloud status, please ensure the computer can access to the Internet. While the latest ILA has a built-in WebGL viewer, a more feature-rich viewer is available with an Internet

connection.

- 1. You can directly view the status of the LiDAR point cloud in real-time on the View Stream.
- 2. (Optional) Change the point of view and distance in which the point cloud data is displayed using the keyboard shortcuts and mouse.

You could click 🔲 to check the available keyboard shortcuts.

Inno	View Stream	Sensor Config	Log File	Help	e Fir	mware 🛑 SDK 🔵 UDS	😑 ртр
CP							
@							
8							
Ø							
	184		10				
		11 200					
Ē							
Ð							
		Sensor values					
		Serial Number: 37	1922210720 Firmv	vare Version: falcor	nk-k24-2.12.0-4385.2023-08-01-05-21-48		
			0.9.246-nio SDK	Version: 2.12.0-fk-	rc5-arm-public		
		Model: k		Address: 04:c3:e6	145335103		B

4.1.4 Record LiDAR point cloud data

You can record LiDAR point cloud data in different formats.

- 1. Go to View stream > Record data stream.
- 2. Select the way to record the point cloud file.

If you select **Auto**, you need to specify the size of file before recording. If you select **Manual**, you need to click **Stop** to stop recording the file.

Inno	Fusion	View Stream	Sensor Config Log File	Help	Firmware <mark>SDK O</mark> UDS OPTI
	Record Data Stream (2)				
۲	Record Stream: Auto Manual				
8≣	Format: Please Select V				
0					
	Frame(s):				
	Start				
ů.					
			Sensor values		
			Serial Number: 371922210720	Firmware Version: falconk-k24-2.12.0-4385.2023-08-01-05-21	-48 Hardware Version : C2
			ILA/UDS Version: 0.9.246-nio	SDK Version: 2.12.0-fk-rc5-arm-public	
				MAC Address: 04:c3:e6:43:33:03	

- 3. Select the file format and size of the data to be recorded.
 - Record a file in pcd format.

Select **Pointcloud snapshot (.pcd)** in **Format**. Enter the number of frames to be recorded in **frame (s)**. The range is from 0 to 20.

• Record a file in inno_pc format.

Select Inno-pointcloud (.inno_pc) in Format. Enter the number of frames to be recorded in frame (s).

inno_pc is a proprietary format of Seyond point cloud files and cannot be read by 3rd party software. The points in inno_pc files are in spherical coordinates. inno_pc is in the optimum compression.

• Record a file in inno_pc_xyz format.

Select Cartesian **coordinates Pointcloud (.inno_pc_xyz)** in **Format**. Enter the number of frames to be recorded in **frame(s)**. The range is from 0 to 10.

inno_pc_xyz is a proprietary format of Seyond point cloud files and cannot be read by 3rd party software. The points in inno_pc_xyz files are in Cartesian coordinates. inno_pc_xyz is in the less optimum compression compared to inno_pc.

• Record a file in png format.

Select Portable Network Graphic (.png) in Format.

• Record a file in csv format.

Select **Comma-separated value (.csv)** in **Format**. Enter the number of frames to be recorded in **frame (s)**. The range is from 0 to 20.

4. Click **Start** to record the file. If you select **Manual**, you need to click **Stop** to stop recording the file.

Note

Point cloud data recording starts immediately by default.

The recorded data file is in the **Download** folder on the computer.

The limitation of the file size is subject to change according to the file format.

4.1.5 View/download logs

You can view and download logs related to different components to confirm operations and alarm information.

- 1. Go to Log File.
- 2. Select the log type. You can select four types of logs: **ILA-f (related to the webpage)**, **Firmware**, **Pointcloud server**, and **UDS**.

InnoFusion	View Stream Sensor C	onfig Log File	Help	Firmware SDK UDS PTP
ILA-f Firmware Pointcloud server	UDS			Download All
20211220 19:58:02.390 DEBUG ila fw.get_current_value(error_code) 20211220 19:58:03:483 DEBUG ila log is in frmp/fial/ogs/filalog (21 20211220 19:58:03:580 INFO corror_log_size: [99998, 1669, 19] 20211220 19:58:03:589 DEBUG ila fw.get_current_value(error_code)	i >> response: Error Code: 0x0 47421 bytes)			Log Operation
20211220 19:58:03.591 DEBUG _get(reg rd 0x140, True) 20211220 19:58:03.694 DEBUG ila fwget current value(error_code) 20211220 19:58:04.780 DEBUG ila log is in /tmp/ila/logs/ila.log (21- 20211220 19:58:04.864 INFO error log size: (99998, 1669, 19] 20211220 19:58:04.887 DEBUG i fa /uget current value(error_code)	ı >> response: Error Code: 0x0 47786 bytes)			Boot cycle: This boot Prev boot Content: Full log Issues only
20211220 19:58:04.889 DEBUG _get(reg_rd 0xtf0, True) 20211220 19:58:04.993 DEBUG ila fw.get current value(error_code) 20211220 19:58:06.078 DEBUG ila log is in /tmp/ila/logs/ila.log (21 20211220 19:58:06.172 INFO error_log_size; [99998, 1669, 19]	, ı >> response: Error Code: 0x0 48151 bytes)			Log level: debug ~
20211220 19:58:06.197 DEBUG ila fw.get.current value(error_code) 20211220 19:58:06.198 DEBUG _get(reg_rd 0x16), True) 20211220 19:58:06.301 DEBUG ila fw.get.current value(error_code) 20211220 19:58:07.393 DEBUG ila log is in /tmp/ila/logs/ila.log (21 20211220 19:58:07.393 DEBUG ila log is in /tmp/ila/logs/ila.log (21	i i >> response: Error Code: 0x0 48516 bytes)			Live update: C
20211220 19580/34/61WPU effor_log_stz8(9998, 1009, 19) 20211220 19580/500 DEBUG lia Kwget current value(error_code) 20211220 195807.502 DEBUG lia Kwget current value(error_code) 20211220 195807.666 DEBUG lia Kwget current value(error_code) 20211220 195807.667 DEBUG lia Kwget current value(error_code)	>> response: Error Code: 0x0			
20211220 19:58:08.694 DEBUG ila log is in /tmp/la/logs/ila.log (214 20211220 19:58:08.794 INFO error log size: [9998, 1669, 19] 20211220 19:58:08.805 DEBUG ila fw.get current value(error_code) 20211220 19:58:08.807 DEBUG qetfrea rd Okr106 True)	48969 bytes)			
20211220 19:58:08.910 DEBUG ila fw.get_current_value(error_code) 20211220 19:58:09.997 DEBUG ila log is in /tmp/ila/ogs/nla.log (21 20211220 19:58:10.080 INFO error_log_size: [99998, 1669, 19] 20211220 19:58:10.099 DEBUG ila fw.get_current_value(error_code)	i >> response: Error Code: 0x0 49334 bytes)			
20211220 19:58:10.101 DEBUG _get(reg _rd 0x140, True) 20211220 19:58:10.203 DEBUG ila fw.get_current_value(error_code) 20211220 19:58:11.293 DEBUG ila log is in /tmp/ila/logs/ila.log (214	i >> response: Error Code: 0x0 49699 bytes)			

- 3. (Optional) Set the filtering criteria of the logs.
 - Time range: Select **Prev boot** or **This boot** to choose whether to display the last 100 log messages generated before this boot or those generated after this boot.
 - Type of log: Select **Issues only** or **Full log** to choose whether to display only the problem or all logs.
 - Log level: Click **Log level** and select the log level to be displayed. The log level is described in the following table.
- 4. You can view logs on the left panel. You can also click **Download** to download the corresponding logs.

4.1.6 View version information

You can check the device serial number, hardware version, and SDK version information in the **View Stream** > **Sensor values**.

Sensor values		
Serial Number: 371922210720	Firmware Version: falconk-k24-2.12.0-4385.2023-08-01-05-21-48	Hardware Version: C2
ILA/UDS Version: 0.9.246-nio	SDK Version: 2.12.0-fk-rc5-arm-public	TCP Client Count: 0
Model: k	MAC Address: 04:c3:e6:43:33:03	

4.1.7 Shut down the LiDAR

Disconnect the power supply to shut down the LiDAR.

4.2 Operate in ROS

4.2.1 Operate in ROS1 environment

The operations in this chapter are based on the Ubuntu 18.04. The version of ROS is melodic.

4.2.1.1 Start the LiDAR

- 1. Connect the power supply to start the LiDAR.
- 2. The LiDAR completes initialization and generates data after powering on for 11 to 18 seconds.

Note

The LiDAR does not have a power switch. It will become operational when power is applied.

4.2.1.2 Obtain point cloud data

Note

- The ROS driver needs to be restarted after the LiDAR is shut down or the software is restarted.
- For the installation method of ROS, please refer to http://wiki.ros.org/.
- 1. Connect the computer to the LiDAR.
- 2. Change the computer IP address to the same subnet with the LiDAR.

Note

The default LiDAR IP address is 172.168.1.10.

It is recommended to check the access to the LiDAR IP address via the ping command. The return value is shown in the figure below.

demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$ ping 172.168.1.10
PING 172.168.1.10 (172.168.1.10) 56(84) bytes of data.
64 bytes from 172.168.1.10: icmp_seq=1 ttl=64 time=0.100 ms
64 bytes from 172.168.1.10: icmp_seq=2 ttl=64 time=0.155 ms
64 bytes from 172.168.1.10: icmp_seq=3 ttl=64 time=0.159 ms
^C
172.168.1.10 ping statistics
3 packets transmitted, 3 received, 0% packet loss, time 2052ms
rtt min/avg/max/mdev = 0.100/0.138/0.159 <u>/</u> 0.026 ms
demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$

3. View the system details and obtain the corresponding driver. Copy the driver to the root directory of the system. Execute the following command to install the driver.

sudo dpkg -i <package.deb>

Note

package.deb is the driver's name of the LiDAR. Obtain the latest driver version based on the actual conditions.

Table 7 Available system				
System Version	CPU			
Ubuptu 16.0.4	ARM			
05untu 10.0.4	X86			

System Version	СРИ
Libuatu 18.0.4	ARM
	X86
Libuatu 20.0.4	ARM
	X86

4. Start ROS. The return value is shown in the figure below.

• Obtain the point cloud data via the TCP port.

source /opt/ros/melodic/setup.bash

```
roslaunch innovusion_pointcloud innovusion_points.launch device_ip:= <device_ip> port:=<
TCP_port > processed:= <Processed_number>
```

• Obtain the point cloud data via the UDP port.

source /opt/ros/melodic/setup.bash

```
roslaunch innovusion_pointcloud innovusion_points.launch device_ip:= <device_ip> udp_port:=
<UDP_port> processed:= <Processed_number>
```

Note

The default value of device_ip is 172.168.1.10. By default, the UDP port number is 8010.

The value of processed_number can be 0 or 1. When the process_number is set to 1, the point cloud data is obtained from ROS client. When the process_number is set to 0, the point cloud data is obtained from external PCS.

[INFO] [1679565063.399176909]: 8959 net manager.cpp:93 Reguesting /command/?get lidar id from 172.168.1.10:8010
[INFO] [1679565063.399817013]: 8959 lidar client.cpp:894 innovusion nodelet manager remote lidar id: 0
[INFO] [1679565063.399824240]: 8959 net_manager.cpp:93 Requesting /command/?get_debug_from 172.168.1.10:8010
[INFO] [1679565063.400252594]: 8959 lidar client.cpp:894 innovusion nodelet manager remote debug: 6
[INF0] [1679565063.400259688]: 8959 net manager.cpp:93 Requesting /command/?get udp ports ip from 172.168.1.10:8010
[INFO] [1679565063.400691698]: 8959 lidar client.cpp:894 innovusion nodelet manager remote udp ports ip: 8010.8010.8010.eth0.172.168.1.255
[INFO] [1679565063.4007080942]: 8959 net manager.cpp:93 Requesting /command/?get status interval ms from 172.168.1.10:8010
[INFO] [1679565063.401117911]: 8959 lidar client.cpp:894 innovusion nodelet manager remote status interval ms: 50
[INFO] [1679565063.401126444]: 8959 net manager.cop:93 Requesting /command/?get sn from 172.168.1.10:8010
[INFO] [1679565063.402341843]: 8959 lidar client.cpp:906 innovusion nodelet manager serial number: 371922210720
[INFO] [1679565063.402366560]: 8959 net manager.cpp:93 Requesting /command/?get frame rate from 172.168.1.10:8010
[INFO] [1679565063.409042175]: 8959 lidar client.cpp:915 innovusion nodelet manager frame rate: 10.000000
[INFO] [1679565063.409081497]: 8959 net_manager.cpp:93 Requesting /command/?get_udp_ports_ip from 172.168.1.10:8010
[INFO] [1679565063.410094869]: 8959 stage client read.cpp:355 read udps: data:8010 nessage:8010 status:8010 ip=eth0,172.168.1.255 my_ip=
[INFO] [1679565063.410111857]: 8959 stage_client_read.cpp:369 set_server_udp_ports_ip(8010)
[INFO] [1679565063.410133210]: 8959 net_manager.cpp:93 Requesting /command/?set_udp_ports_ip=8010,8010,8010 from 172.168.1.10:8010
[INFO] [1679565063.410636763]: 8959 net_manager.cpp:93 Requesting /command/?get_udp_ports_ip from 172.168.1.10:8010
[INFO] [1679565063.411191583]: 8959 stage_client_read.cpp:355 read udps: data:8010 message:8010 status:8010 ip=eth0,172.168.1.255 my_ip=
[INFO] [1679565063.411256491]: 8959 stage_client_read.cpp:242 innovusion_nodelet_manager wait for state 1
[INFO] [1679565063.411424818]: 8960 stage_client_read.cpp:255 recvfrom UDP 8010
[INFO] [1679565063.457292022]: frame #1: points=1275 (391 365 291 228) blocks=412
[INFO] [1679565064.353766300]: 8958 stage_client_deliver.cpp:264 StageClientDeliever: convert_xyz mean/std/max/total=0.00ms/0.00/0 callback mean/std/max/total=0.03ms/0.03/0.30/244 total=273 total_d
ropped=0 data=244 message=10 status=19 points=21735 frames=10 points_2nd_return=0
[INFO] [1679565064.353901492]: 8958 consumer_producer.cpp:495 deliver queue#0 added=273 finished=272 dropped=0 blocked=0 wait=68us process=31us drop=0us pid=8958 elapsed_time=957/957ms active_time=8/8ms
ratio=0.90%/0.90%
[INFO] [1679565064.432722366]: REMOTE-[INFO] level=6, code=0, message=[INFO] CODE=0 [FROM_FW] 2021-12-28 23:41:35.646 [INFO] delay set config done
[THEN] [1670555964 DE4001151], from #15, polat-3370 (552 403 601 634 634) black-032
[100] [107303000.394004131]. Home #10. points#2270 (33) #2 001 024) DUCK5#220 [100] 024) D
[20/33 Joind Jistad ala
(2)/2) circle-10-15, both circle-10-16 (2) circle-10-16 (
[WARN] [167956565, 987684989]: 8968 resource stats con:158 «READ» handwidth too low: 8.33846 counter: 1
[TNFO] [1679555665 982723231]: 8968 resource stats consiste innovusion nodelet manager hidu826 untime=2.58s. #RESOURCE STATS# «READ» packets=723/723 hytes=887K/887K handwidth=8.33M/s: «DATA» packets=
645/645, bytes=772K/772K, bandwidth=0.32M/s: <point> frames=25/25, points=55K/55K, point-rate=0.02M/s, ref intensity sum = 0, ref count total = 0: <message> packets=27/27, bytes=4K/4K, bandwidth=0.00M/s;</message></point>
<status> packets=50/50, bytes=29K/29K, bandwidth=0.01M/s;</status>
[INF0] [1679565065.902996838]; REMOTE-[INF0] level=6, code=0, message=[INF0] CODE=0 2021-12-28 23:41:37.116 26973 server ws.cpp:104 Server: Connect connection 0x7f78010cd0. path: //command/?.*\$ query:
get_mode_status. From 172.168.1.111
[INF0] [1679565065.903080731]: REMOTE-[INF0] level=6, code=0, message=[INF0] CODE=0 2021-12-28 23:41:37.116 26973 pcs.cpp:896 command get_mode_status ret=0 result= 3,2,2,0
[INFO] [1679565065.903128779]: REMOTE-[INFO] level=6, code=0, message=[INFO] CODE=0 2021-12-28 23:41:37.116 26973 server_ws.cpp:51 Server: Event in connection 0x7f78010cd0. message: End of file
[INFO] [1679565066.466663089]: frame #31: points=2285 (552 494 608 631) blocks=931
[INF0] [1679565066.694277172]: REMOTE-[INF0] level=6, code=0, message=[INF0] CODE=0 2021-12-28 23:41:37.908 24501 status_report.cpp:372 counters: point_data_packet_sent=45809543 point_sent=2040759418
message_packet_sent=1790840 raw_data_read=653265338368 total_frame=3581679 total_polygon_rotation=14326721 total_polygon_facet=71633602 power_up_time_in_second=791689 process_up_time_in_second=791684 lose
_ptp_sync=0 bad_data[4]=0/0/0/0 data_drop[8]=0/0/0/0/0/0/0/0/0/0 signals[8]=28959065/2617744848/0/2768625976/0/2579918756/2696291965/3372156756 latency_10us_average[6]=0/261/69/1048/0/16 latency_10us_variatio
n[6]=0/0/62/16/0/1 latency_10us_max[6]=0/3153/1326/3401/0/230 blg_latency_frame=0 bad_frame=0 small_gap_frame=0 cpu_percentage=100 mem_percentage=4 netstat_rx speed/drop/err=0kBps/0/0 nets
tat_tx speed/drop/err=338kBps/0/0 sys_cpu_percentage=28/20/27/25 motor[5]=35582/0872/12210/39784/9085 galvo[5]=36134/28976/62880/41784/28125 in_faults=0x137438953496;sensor_readings: t_fpga=520 t_laser=51
0 t_adc=580 t_board=0 t_det=550/550/560/560 t_other=0/0/0 heater_ma=0 m_rpm=4801000 g_fpm=100000 m_total=0 g_total=281 moisture=0/0 window_blockage=0/0 motor=220/0/0/0/0/0/0 galvo=22/0/0/0/0/0 laser=2700/0/0
/0/0/0 galvo_client=0x0/0

4.2.1.3 View LiDAR point cloud data

Note

Before viewing the point cloud data, please confirm that the point cloud data has been obtained.

1. Start the graphical tool **rviz**. The return value and **rviz** interface are shown below.

rviz	
	demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$ rviz rviz
	[INFO] [1646808931.535449917]: rviz version 1.13.21
	[INFO] [1646808931.535492615]: compiled against Qt version 5.9.5
	[INFO] [1646808931.535502544]: compiled against OGRE version 1.9.0 (Ghadamon)
	[INFO] [1646808931.539157206]: Forcing OpenGl version 0.
	[INFO] [1646808932.122437501]: Stereo is NOT SUPPORTED
	[INFO] [1646808932.122552411]: OpenGL device: NVIDIA GeForce RTX 3060 Laptop GP
	U/PCIe/SSE2
	[INF0] [1646808932.122633840]: OpenGl version: 4.6 (GLSL 4.6).
	QObject::connect: Cannot queue arguments of type 'QVector <int>'</int>
	(Make sure 'QVector <int>' is registered using qRegisterMetaType().)</int>
	QObject::connect: Cannot queue arguments of type 'QVector <int>'</int>
	(Make sure 'QVector <int>' is registered using qRegisterMetaType().)</int>

		default.rviz* - RViz		⊜ 8 ⊗
<u>F</u> ile <u>P</u> anels <u>H</u> elp				
🗁 Interact 🛛 🕆 Move Camera 🛄 Select	🔶 Focus Camera 🛛 📟 Measure	🗡 2D Pose Estimate 🛛 🗡 2D Nav Goa	l 💡 Publish Point 🛛 🖶 🚽 🔍	
🖵 Displays	×			► Views ×
Global Options Fixed Frame man				Type: Orbit (rviz) - Zero
Background Color ■ 48; 48; 48 Frame Rate 30 Default Light ♥ ④ Global Status: ● Fixed Frame No tf data. Actu	ual err			▼ Current View Orbit (rviz) Near Clip 0.01 Invert Z Axis Fixed Frame> Distance 19.7382 Focal Shap Q' Yaw 0.735398 Pitch 0.620398 > Focal Point 0; 0; 0
Add Duelieste Decrus				
	ename			Save Remove Rename
() Time				×
ROS Time: 1646965299.12 ROS El	apsed: 15.17 W	Vall Time: 1646965299.15 Wal	l Elapsed: 15.10	Experimental
Reset				31 fps

2. Select Global Options > Fixed Frames. Set the Fixed Frames value to innovusion.



- i. Add PointCloud2 to Displays.
 - a. Click Add.
 - b. Select By topic > iv_points > PointCloud2.
 - c. Click **OK**.

default.rviz* - RViz	• • •
<u>Eile Panels</u> Help	
🗁 Interact 🕸 Move Camera 🛄 Select 🚸 Focus Camera 🥅 Measure 🖌 2D Pose Estimate 🖌 2D Nav Goal 💡 Publish Point 💠 📼 👁	
Displays × rviz Ø	Views ×
Fixed Frame innovusion Create visualization	Type: Orbit (rviz) 👻 Zero
Background Color Frame Rate Default Light ♥ Colobal Status: ● Fixed Frame * © Circled ata. Actual err ♥ Keiner Could ♥ / Call point ♥ / Call point ♥ / Call point ♥ PointStamped ♥ / Initialpose ♥ PoseWithCovariance ♥ / Pose ♥ / Yisualization marker ♥ / Yisualization marker ♥ Marker Displays a point cloud from a sensor_msgs::PointCloud2 message as points in the world, drawn as points, billboards, or cubes. More Information.	 Current View Orbit (rviz) Near Clip 0.01 Invert Z Axis Target Fra <fixed frame=""> Distance 19.7382 Focal Shap 0.05 Focal Shap 0/ Yaw 0.735388 Pitch 0.620398</fixed> Focal Point 0; 0; 0
Fixed Frame Display Name Frame into which all data is transformed before being displayed. PointCloud2	
Add Duplicate Remove Rename Concernation Con	Save Remove Rename
ROS Time: 1646965355.28 ROS Elapsed: 71.33 Wall Time: 1646965355.31 Wall Elapsed: 71.26	Experimental
	31 fps
Reser	51163

ii. Select **PointCloud2** > **Topic**. Set the Topic value to **/iv_points**.



iii. Select PointCloud2 > Style. Set the Style value to Points.



- 3. (Optional) You can change the angle and distance of the real-time point cloud status and get more information as needed.
 - You can select **Axes** to add the coordinate system to the diagram as a reference.
 - a. Select Add > By display type > Axes.
 - b. Click OK.

				•••
<u>F</u> ile <u>P</u> anels <u>H</u> elp				
💾 Interact 🧐 Move Ca	amera 🛄 Select 🔶 Foo	us Camera 🛛 📟 Mea	sure 🖌 2D Pose Estimate 🗡 2D Nav Goal 💡 Publish Point 🕀 😑 🔹	
👤 Displays	×		rviz 😣	► Views 🗶
	meraSelect	us Camera 📼 Mea	sure 2D Pose Estimate 2D Nav Goal Publish Point 4 =	Views Image: Construction of the state
Autocompute I Min Intensity Max Intensity Topic sensor_msgs/PointClour Add Duplicate O Time	254 d2 topic to subscribe to. Remove Rename 218 POS Flansert	778.23	Display Name Axes ¥Cancel Vall Time: 1646965562.21 Wall Time: 1646965562.21	Save Remove Rename
KUS TIME: 104096556	2.16 ROS Elapsed: 4	210.23	wait time: 1040905502.21 Wall Elapsed: 278.17	Experimental
Reset				31 fps

• Select **Grid** to add the grid to the diagram as a reference. Grid is enabled by default when rviz is started.



Set the **plane** value to view the point cloud status under different coordinate systems. There are three options: **XY**, **XZ**, and **YZ**.



4.2.1.4 Record LiDAR point cloud data

You can record the point cloud data of the LiDAR in bag format in ROS.

Note

Before recording the point cloud data of the LiDAR, please confirm that the point cloud data has been obtained correctly in ROS. For information on how to get the point cloud data, see <u>4.2.1.2 Obtain point</u> cloud data.

1. Record point cloud data in bag format. Recording starts at the execution time.

rosbag record /iv_points -o inno //Start to record the point cloud data in bag format. The file is saved in the current path and the file name is "inno-Year-Mon-Day-Hr-Min.bag"

demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$ rosbag record /iv_points -o inno [INFO] [1646810706.460522054]: Subscribing to /iv_points [INFO] [1646810706.463553818]: Recording to 'inno_2022-03-09-15-25-06.bag'.

- 2. Press **Ctrl+C** to stop recording point cloud data.
- 3. (Optional) Execute Is a command to check the directory of recorded point cloud data.



4.2.1.5 Replay LiDAR point cloud data

You can replay the point cloud data in bag format in ROS environment.

Note

Before replaying LiDAR point cloud data, please confirm that the recorded point cloud data file has been obtained.

1. Run ROS. The return value is shown in the figure.

roscore

demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$ roscore
logging to /home/demo/.ros/log/a09b36de-9f71-11ec-874a-c85acfaa1d16/roslaunch-demo-OMEN-by-HP-Laptop-16-b0xxx-9812.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.
started roslaunch server http://demo-OMEN-by-HP-Laptop-16-b0xxx:42677/
ros_comm version 1.14.12
-
SUMMARY
======
PARAME LEKS
//rosalstro: meloalc
* /rosversion: 1.14.12
NODEC
nues
auto-starting new master
process[master] + started with pid [9822]
POS MASTER URISHTS///demo.OMF.Ny.HP.1 anton.16.h0vvv:11311/
setting /run id to a09b36de-9f71-11ec-874a-c85acfaa1d16
process[rosout-1]: started with pid [9833]
started core service [/rosout]

2. Start the graphical tool rviz. The return value and rviz interface are shown below.

rviz
demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$ rviz rviz
[INF0] [1646808931.535449917]: rviz version 1.13.21
[INF0] [1646808931.535492615]: compiled against Qt version 5.9.5
[INF0] [1646808931.535502544]: compiled against OGRE version 1.9.0 (Ghadamon)
[INF0] [1646808931.539157206]: Forcing OpenGl version 0.
[INF0] [1646808932.122437501]: Stereo is NOT SUPPORTED
[INF0] [1646808932.122552411]: OpenGL device: NVIDIA GeForce RTX 3060 Laptop GP
U/PCIe/SSE2
[INF0] [1646808932.122633840]: OpenGl version: 4.6 (GLSL 4.6).
QObject::connect: Cannot queue arguments of type 'QVector<int>'
(Make sure 'QVector<int>' is registered using qRegisterMetaType().)
QObject::connect: Cannot queue arguments of type 'QVector<int>'
(Make sure 'QVector<int>' is registered using qRegisterMetaType().)

3. Replay LiDAR point cloud data in rviz.

rosbag play <filename.bag>

4. Select Global Options > Fixed Frames. Set the Fixed Frames value to innovusion.

default.rviz* - RViz	● 🛙 😣
<u>File Panels H</u> elp	
🗄 Interact 🕸 Move Camera 🛄 Select 🚸 Focus Camera 📼 Measure 🖌 2D Pose Estimate 🖌 2D Nav Goal 💡 Publish Point 🔮 🚽 🔍	
Uisplays X	► Views ×
Clobal Options	Type: Orbit (rviz) - Zero
Background Color ■48;48;48 Frame Rate 30 Default Light V ♥ Colobil Status: ♥ Fixed Frame > * Crid V ↓	 Current View Near Clip 0.01 Invert Z Axis Target Fra <fixed frame=""></fixed> Distance 19.7382 Focal Shap 0.05 Focal Shap 0.05 Focal Shap 0.05 Pocal Point 0.05 Pocal P
Fixed Frame Frame into which all data is transformed before being displayed.	
Add Duplicate Remove Rename	Save Remove Rename
O Time	×
ROS Time: 1646965328.24 ROS Elapsed: 44.29 Wall Time: 1646965328.27 Wall Elapsed: 44.26	Experimental
Reset	31 fps

- 5. Add and configure **PointCloud2**.
 - i. Add **PointCloud2** to the Displays.
 - a. Click Add.
 - b. Select By topic > display type > PointCloud2.
 - c. Click **OK**.

	default.rviz* - RViz	000
<u>F</u> ile <u>P</u> anels <u>H</u> elp		
💾 Interact 🕸 Move Camera 🛄 Select 🔶 For	ıs Camera 🔲 Measure 🖌 2D Pose Estimate 🖌 2D Nav Goal 💡 Publish Point 🛛 💠 💻 👁	-
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🔻 🏶 Global Options		Type: Orbit (ryiz) - Zero
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ii. Select **PointCloud2** > **Topic**. Set the Topic value to **/iv_points**.



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iii. Select **PointCloud2** > **Style**. Set the Style value to **Points**.

- 6. (Optional) You can change the angle and distance of the real-time point cloud status and get more information as needed.
 - You can select **Axes** to add the coordinate system to the diagram as a reference.
 - a. Select Add > By display type > Axes.
 - b. Click OK.

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• Select **Grid** to add the grid to the diagram as a reference. Grid is enabled by default when **rviz** is started.



• Set the **plane** value to view the point cloud status under different coordinate systems. There are three options: **XY**, **XZ**, and **YZ**.



7. Press **Space** to pause playback of the point cloud data file.

4.2.1.6 Shut down the LiDAR

Disconnect the power supply to shut down the LiDAR.

4.2.2 Operate in ROS2 environment

The operations in this chapter are based on the Ubuntu 20.04. The version of ROS is foxy.

4.2.2.1 Start the LiDAR

- 1. Connect the power supply to start the LiDAR.
- 2. The LiDAR completes initialization and generates data after powering on for 11 to 18 seconds.

Note

The LiDAR does not have a power switch. It will become operational when power is applied.

4.2.2.2 Obtain point cloud data

Note

The ROS driver needs to be restarted after the LiDAR is shut down or the software is restarted.

For the installation method of ROS2, please refer to <u>https://docs.ros.org</u>.

1. Connect the computer to the LiDAR.

Verify the protocol mode of the lidar for sending data. When the lidar sends data using UDP, it should be ensured that the host and LiDAR are on the same network segment. For how to change the computer IP on Windows, see <u>2.2.3 Change the computer IP address</u>.

Note

The default LiDAR IP address is 172.168.1.10.

It is recommended to check the access to the LiDAR IP address via the ping command. The return value is shown in the figure below.

demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~\$ ping 172.168.1.10	
PING 172.168.1.10 (172.168.1.10) 56(84) bytes of data.	
64 bytes from 172.168.1.10: icmp_seq=70 ttl=64 time=0.448 ms	
64 bytes from 172.168.1.10: icmp_seq=71 ttl=64 time=0.222 ms	
64 bytes from 172.168.1.10: icmp_seq=72 ttl=64 time=0.200 ms	
64 bytes from 172.168.1.10: icmp_seq=73 ttl=64 time=0.208 ms	
64 bytes from 172.168.1.10: icmp_seq=74 ttl=64 time=0.200 ms	
64 bytes from 172.168.1.10: icmp_seq=75 ttl=64 time=0.219 ms	
64 bytes from 172.168.1.10: icmp_seq=76 ttl=64 time=0.255 ms	
64 bytes from 172.168.1.10: icmp_seq=77 ttl=64 time=0.212 ms	
64 bytes from 172.168.1.10: icmp_seq=78 ttl=64 time=0.206 ms	
64 bytes from 172.168.1.10: icmp_seq=79 ttl=64 time=0.170 ms	
64 bytes from 172.168.1.10: icmp_seq=80 ttl=64 time=0.207 ms	
64 bytes from 172.168.1.10: icmp_seq=81 ttl=64 time=0.207 ms	
64 bytes from 172.168.1.10: icmp_seq=82 ttl=64 time=0.145 ms	
64 bytes from 172.168.1.10: icmp_seq=83 ttl=64 time=0.168 ms	
64 bytes from 172.168.1.10: icmp_seq=84 ttl=64 time=0.316 ms	
64 bytes from 172.168.1.10: icmp_seq=85 ttl=64 time=0.192 ms	
64 bytes from 172.168.1.10: icmp_seq=86 ttl=64 time=0.309 ms	
64 bytes from 172.168.1.10: icmp_seq=87 ttl=64 time=0.295 ms	
^C	
172.168.1.10 ping statistics	
87 packets transmitted, 18 received, 79% packet loss, time 88046	Ims
rtt min/avg/max/mdev = 0.145/0.232/0.448/0.069 ms	

2. View the system details and obtain the corresponding driver. Copy the driver to the root directory of the system. Execute the following command to install the driver.

sudo dpkg -i <package.deb>

Note

package.deb is the driver's name of the LiDAR. Obtain the latest driver version based on the actual conditions.

ROS2 version	System Version	CPU	
Foxy Galactic	Ubuntu 20.04	ARM	
Toxy, Galactic	054110 20.04	X86	
Humblo	Ubuntu 22.04	ARM	
Humble	0001110 22.04	X86	

3. You could obtain the point cloud data of the LiDAR via TCP or UDP.

Note

Execute the following command and re-run the obtain command and if the point cloud data was

obtained correctly.

source /opt/ros/foxy/setup.bash

- Obtain the point cloud data via TCP. •
 - Method 1

ros2 launch innovusion ivu pc2.py device ip:=<device ip> lidar port:=<TCP port>



Method 2

ros2 run innovusion publisher --ros-args -p device_ip:=<device_ip> -p lidar_port:=<TCP_port>

```
$ ros2 run innovusion publisher --ros-args -p device_ip:=172.168.1.10 -p lidar_port:=8010
demodizad082:-5 r652 run innovusion publisher --
[INF0] [1691389388.648625138] [ivu_pub]:
    lidar_name: falcon, frame_ld: innovusion
    lidar_ip: 172.168.1.10, lidar_port: 8010
    reflectance: 1, multiple_return: 1
    pcap_file:
    packet_rate: 20
    file rewind: 0

                        file_rewind: 0
                      lidar_udp_port: -1
name_value_pairs:
                                                                                      max_range: 2000.000000, min_range: 0.400000
                       continue_live: 1
                       coordinate_mode: 0
2023-08-07 14:23:08.649 [ INFO] 8578 driver lidar.cc:97 INNOVUSION LIDAR SDK version=DEV-internal build time=03:49:44 Jun 30 202
2023-08-07 14:23:08.649 [ INFO] 8578 log.cpp:655 setup_sig_handler ready
[INFO] [1691389388.649087016] [ivu_pub]: 8578 mem_pool_manager.cpp:32 MemPoolManager [AsyncJob_memory_pool] 0x55ff7e337a30 crea
ted pool=0x7fa328efc010, unit_size=4096, unit_count=90, allocator=DefaultMemAllocator
[INFO] [1691389388.649167594] [ivu_pub]: 8589 consumer_producer.cpp:191 thread AsyncLogThread_Manager starts. pid=8589 target_p
 riority=0
riority=0
[INF0] [1691389388.659227094] [ivu_pub]: 8578 async_log.cpp:69 LIDAR Log Async Thread work : True
[INF0] [1691389388.659431712] [ivu_pub]: 8578 api_common.cpp:59 LIDAR SDK version is DEV-internal
[INF0] [1691389388.659412613] [ivu_pub]: 8578 api_common.cpp:60 LIDAR SDK build tag is LOCAL-BUILD
[INF0] [1691389388.65941877] [ivu_pub]: 8578 api_common.cpp:60 LIDAR SDK build time is 03:49:44 Jun 30 2023
[INF0] [1691389388.65941877] [ivu_pub]: 8578 api_common.cpp:69 log level change from 6 to 6
[INF0] [1691389388.659431174] [ivu_pub]: 8578 dpi_common.cpp:31 DefaultMemAllocator calloc start
[INF0] [1691389388.65943884] [ivu_pub]: 8578 mem_pool_manager.cpp:32 MemPoolManager [packet_pool] 0x55ff7e340d00 created pool=
0x7fa31542f010, unit_size=65536, unit_count=700, allocator=DefaultMemAllocator
```

Note

The default value of device_ip is 172.168.1.10. By default, the TCP port number is 8010. You can run the ros2 launch innovusion ivu_pc2.py or ros2 run innovusion publisher directly to obtain the point cloud data with the default settings.

- Obtain the point cloud data via UDP.
 - Method 1

ros2 launch innovusion ivu_pc2.py device_ip:=<device_ip> udp_port:=<UDP_port>

Method 2

ros2 run innovusion publisher --ros-args -p device_ip:=<device_ip> -p udp_port:=<UDP_port>

Note

The default value of device_ip is 172.168.1.10. Please notice that the LiDAR transmits the data via TCP by default.

4.2.2.3 View LiDAR point cloud data

Note

Before viewing the point cloud data, please confirm that the point cloud data has been obtained.

1. Open a new terminal and execute the command to source the setup file.

source /opt/ros/foxy/setup.bash

2. Start the graphical tool rviz. The return value and rviz interface are shown below.

ros2 run rviz2 rviz2

```
demo@sza0682:-$ ros2 run rviz2 rviz2
[INFO] [1691389803.621535541] [rviz2]: Stereo is NOT SUPPORTED
[INFO] [1691389803.621596887] [rviz2]: OpenGl version: 4.6 (GLSL 4.6)
[INFO] [1691389803.637049672] [rviz2]: Stereo is NOT SUPPORTED
```

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3. Select Global Options > Fixed Frames. Set the Fixed Frames value to innovusion.



- i. Add PointCloud2 to Displays.
 - a. Click Add.
 - b. Select **By topic > iv_points > PointCloud2**.
 - c. Click **OK**.

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ii. Select **PointCloud2** > **Topic**. Set the Topic value to **/iv_points**.



iii. Select PointCloud2 > Style. Set the Style value to Points.



- 4. (Optional) You can change the angle and distance of the real-time point cloud status and get more information as needed.
 - You can select **Axes** to add the coordinate system to the diagram as a reference.
 - a. Select Add > By display type > Axes.
 - b. Click OK.

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• Select **Grid** to add the grid to the diagram as a reference. Grid is enabled by default when rviz is started.



Set the **plane** value to view the point cloud status under different coordinate systems. There are three options: **XY**, **XZ**, and **YZ**.



4.2.2.4 Replay LiDAR point cloud data

You can replay the point cloud data in pcap format in ROS environment.

Note

Before replaying LiDAR point cloud data, please confirm that the recorded point cloud data file has been obtained.

You could capture the pcap data with Wireshark.

Only data captured in UDP can be replayed in ROS.

1. Start the graphical tool **rviz**. The return value and **rviz** interface are shown below.



2. Select Global Options > Fixed Frames. Set the Fixed Frames value to innovusion.

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- 3. Add and configure **PointCloud2**.
 - i. Add **PointCloud2** to the Displays.
 - a. Click Add.

- b. Select By topic > display type > PointCloud2.
- c. Click OK.

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Displays a grid along the ground plane, centered at the origin of the target frame of reference.			
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ii. Select **PointCloud2** > **Topic**. Set the Topic value to **/iv_points**.

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iii. Select **PointCloud2** > **Style**. Set the Style value to **Points**.

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- 4. (Optional) You can change the angle and distance of the real-time point cloud status and get more information as needed.
 - You can select **Axes** to add the coordinate system to the diagram as a reference.
 - a. Select Add > By display type > Axes.
 - b. Click OK.

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• Select **Grid** to add the grid to the diagram as a reference. Grid is enabled by default when **rviz** is started.

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→ ✓ Status: Ok													Focal Shap	1 6554	
Topic	/iv_points												Pitch	0.28479	8
Selectable	V												Focal Point	0; 0; 0	
Size (Pixels)	Boints														
Alpha	1														
Decay Time	0														
Position Transformer	XYZ														
Channel Name	intensity														
Use rainbow	V														
Invert Rainbow															
Autocompute Intensity Bounds	V V							1/							
			•								ľ l				
Displays a grid along the ground plane	centered at the ori	igin of the targ	et												
frame of reference.		,													
Add Duplicate	Remove	Renam	ne									9	Save Re	move	Rename
Reset Left-Click: Rotate. Middle-Cl	ick: Move X/Y. Right	t-Click/Mouse	Wheel:: Zoom. Shi	ft: More options.											31 fps

- Set the **plane** value to view the point cloud status under different coordinate systems. There are three options: **XY**, **XZ**, and **YZ**.
- 5. Replay LiDAR point cloud data in **rviz**.

ros2 run innovusion publisher	<pre>ros-args -p device_ip:=<data_ip> -p pcap_file:=<pcap_file></pcap_file></data_ip></pre>
<pre>-p udp_port:=<data_port> [-p p</data_port></pre>	acket_rate=: <playback_rate>] [-p file_rewind=<file_rewind>]</file_rewind></playback_rate>

<pre>demo@sza0682:-/Desktop/ros2 installation\$ ros2 run innovusion publisherros-args -p device_ip:=172.168.1.10 -p pcap_file:=test_for_ros.pcap -p udp_port:=8010 -p file_rewind:=-1 [INF0] [1691390060.940374577] [ivu_pub]: lidar_name: falcon, frame_id: innovusion lidar_ip: 172.168.1.10, lidar_port: 8010 reflectance: 1, multiple_return: 1 pcap_file: test_for_ros.pcap packet_rate: 20 file_rewind: -1 lidar_udp_port: 8010 max_range: 2000.000000, min_range: 0.400000 name_value_pairs: continue_live: 1 roordinate mode: 0</pre>
2023-08-07 14:34:20.940 [INFO] 9124 driver_lidar.cc:97 INNOVUSION LIDAR SDK version=DEV-internal build_time=03:49:44 Jun 30 2023
2023-08-07 14:34:20.941 [INFO] 9124 [03.CPD:055 SETUP_SIG_ nanolef Feady [INFO] [1601200660 014054311 [ivu nub]. 0114 mm nonl manager [Actual]Manager [Actual]A managu nonl] 04555555555
[INFO] [109139000.341020431] [100_p00]. 3124 Mem_p00_Maiger.cpp.32 MemP00LManager [ASyNCJOD_MemOry_p001] 0.35013033030 Created p001=0.77 B3C838040 unit size_4006 unit count=00 allocator=DofaultMemBlocator
[INFO] [169139066.941093389] [ivu pub]: 9135 consumer producer.cpp:191 thread AsyncLogThread Manager starts, pid=9135 target priority=0
[INFO] [1691390060.951170615] [ivu pub]: 9124 async log.cpp:69 LIDAR Log Async Thread work : True
[INFO] [1691390060.951279656] [ivu_pub]: 9124 api_common.cpp:59 LIDAR SDK version is DEV-internal
[INFO] [1691390060.951316848] [ivu_pub]: 9124 api_common.cpp:60 LIDAR SDK build tag is LOCAL-BUILD
[INFO] [1691390060.951324099] [ivu_pub]: 9124 api_common.cpp:61 LIDAR SDK build time is 03:49:44 Jun 30 2023
[INFO] [1691390060.951330346] [ivu_pub]: 9124 api_common.cpp:69 log level change from 6 to 6
[INFO] [1691390060.951341801] [ivu_pub]: 9124 driver_lidar.cc:101 Lidar name is falcon
[INFO] [1691390060.951347649] [ivu_pub]: 9124 driver_lidar.cc:206 ## pcap_file is test_for_ros.pcap, device_ip_ is 172.168.1.10, play_rate i
20, rewind id -1, 8010/8010/8010 ##
[INFO] [1691390060.951353721] [ivu_pub]: 9124 mem_allocator.cpp:313 DefaultMemAllocator calloc start
[INFO] [1691390060.951359799] [ivu_pub]: 9124 mem_pool_manager.cpp:32 MemPoolManager [packet_pool] 0x55bf56566960 created pool=0x7fae1d42f01
, unit_size=5536, unit_count=700, allocator=DefaultMemAllocator
[INFO] [1091390000.951371500] [VVU_pub]: 9124 Ltdar_base.h:o22 Setting play rate to 20
[INFO] [10913900000.9513/8886] [Vu_pub]: 9124 (tdar_base.n:630 setting play rate to 20 MB/S
[INFO] [1991390000.951386293] [tvu_pub]: 9124 stage_citent_read.n:108 filename: test_ror_ros.pcap, play_round: 0
[INFO] [1991390000.952706825] [tvu_pub]: 9124 stage_client_read_pcad.ni42 retendme: test_foi_ros.pcap, ptag_ound: 0
$[1Mr0]$ [1951390000.535000053] [tvu_pub]. 5124 510g_ctten_ted_ptd_ptn+5 ptdp_ttten_ststc nost nz.105.1.10 and dup [TNR0] [1661300460 052007031] [tvu_pub]. 0124 and common concess and lider 1 (total=t total=trive=1)
[Into] [1991990000795000095] [red_bdb]. 5124 dpt_common:pp:05 ddo redai 1 (redater content content)
[TNFO] [1691390060.953026072] [ivu_pos]. 712 lidar_client.cps:243 file renlav fake set return mode
[INFO] [1691390060.953031237] [ivu pub]: 9124 driver lidar.cc:220 Use name value pairs
[INFO] [1691390060.953037633] [ivu pub]: 9124 driver lidar.cc:56 ## first call for ros2 driver ##



[Parameter description]

- > device_ip: The IP address of the LiDAR from which the data was captured.
- > pcap_file: The file name to be replayed.
- > UDP port: The UDP port of the LiDAR from which the data was captured.

- > packet_rate(Optional): The replay speed of the file. The default value is 20.
 - When the play_rate=0, the play speed is as fast as possible.
 - When the play_rate≤100, the unit of play speed is MB/s. e.g., When play_rate=50. the play speed is at 50 MB/s.
 - When the play_rate>100, the play speed=play_rate/10000.0. e.g., When play_rate=15000. the play speed is at 1.5 times.
- file_rewind(Optional): The number of times file is replayed.
 - A default value of 0 means no repeat.
 - A negative value means the file will be repeated indefinitely until the program is manually stopped.

4.2.2.5 Shut down the LiDAR

Disconnect the power supply to shut down the LiDAR.

4.3 Operate in Docker

4.3.1 Start the LiDAR

- 1. Connect the power supply to start the LiDAR.
- 1. The LiDAR completes initialization and generates data after powering on for 11 to 18 seconds.

Note

The LiDAR does not have a power switch. It will become operational when power is applied.

4.3.2 View the LiDAR point cloud data

Note

For more information about Docker installation, please contact the seyond staff.

1. Change the computer IP address to the same subnet with the LiDAR.

Note

The default LiDAR IP address is 172.168.1.10.

You can check the access to the LiDAR IP address via the ping command.

- 2. Enter the Docker path.
- 3. View the status of the LiDAR point cloud.

```
./launch-docker.py --deb-file < package.deb>--lidar-ip <INPUT_LIDAR_IP> --ros-version <ros
version>
```

<pre>demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~/install_docker/catkin_ws/src/rosprocessor/build/docker\$./launch-docker.p</pre>
ydeb-file ros-kinetic-innovusion-driver-release-2.4.0-rc237-public.deblidar-ip 172.168.1.10ros-version
kinetic
Script is starting 2022May11-191440
docker launch command: xhost +local:root; nvidia-docker run -itrmlabel rosdockerenv="DISPLAY"env="Q
T_X11_NO_MITSHM=1"env="IV_CWD=/home/demo/install_docker/catkin_ws/src/rosprocessor/build/docker" -v=/home/de
mo/install_docker/catkin_ws/src/rosprocessor/build/docker/ros-kinetic-innovusion-driver-release-2.4.0-rc237-publ
ic.deb:/root/ros-kinetic-innovusion-driver-release-2.4.0-rc237-public.deb -v=/home/demo/install_docker/catkin_w
s/src/rosprocessor/build/docker:/root/docker -v=/home/demo/install_docker/catkin_ws/src/rosprocessor/build/dock
er:/home/demo/install_docker/catkin_ws/src/rosprocessor/build/docker -v="/home/demo/.rviz_kinetic:/root/.rviz" -
v="/home/demo/.ros_kinetic:/root/.ros" -v=/home/demo/.innovusion:/root/.innovusion -v=/home/demo/install_docke
r/catkin_ws/src/rosprocessor/build/docker/output:/root/outputvolume="/tmp/.X11-unix:/tmp/.X11-unix:rw" ivusw
/ros-driver-test-public:ubuntu1604-kinetic-jsk-ceres bash -c "(echo start roscore; rm -fr /root/.ros/log/; rosco
re; echo roscore done) & (echo start rviz; until rostopic list 2>/dev/null; do sleep 0.2; done; rosrun rviz rviz
-f innovusion; echo rviz done) & dpkg -i "/root/ros-kinetic-innovusion-driver-release-2.4.0-rc237-public.deb" &
& echo dpkg install done && until rostopic list 2>/dev/null; do sleep 0.2; done; find /root/docker/cali_manager
-user root -exec chmod guo+rw {} \; && roslaunch innovusion_pointcloud innovusion_points.launch device_ip:=172.
168.1.10 lidarhome:=//root/.innovusion "
inside docker command: (echo start roscore; rm -fr /root/.ros/log/; roscore; echo roscore done) & (echo start rv
iz; until rostopic list 2>/dev/null; do sleep 0.2; done; rosrun rviz rviz -f innovusion; echo rviz done) & dpkg
-i "/root/ros-kinetic-innovusion-driver-release-2.4.0-rc237-public.deb" && echo dpkg install done && until rosto
pic list 2>/dev/null; do sleep 0.2; done; find /root/docker/cali_manager -user root -exec chmod guo+rw {} \; &&
roslaunch innovusion_pointcloud innovusion_points.launch device_ip:=172.168.1.10 lidarhome:=//root/.innovusion
'main' command: roslaunch innovusion_pointcloud innovusion_points.launch device_ip:=172.168.1.10 lidarhome:=//

Note

<package.deb> is the driver's name. Please get the latest driver based on the actual conditions of the computer. If the existing driver does not match the computer's version, please contact Seyond staff. The default LiDAR IP address is 172.168.1.10.

<ros version> is the version of the ROS environment.

4. **rviz** is started to show the current point cloud status. For a better display effect in rviz, refer to <u>4.2.1.3 View LiDAR point cloud data</u>.



4.3.3 Replay LiDAR point cloud data

The point cloud data in inno_raw format can be replayed by Docker.

1. Enter the Docker path. View the status of the LiDAR point cloud.

./launch-docker.py	deb-file <	package.deb>	yaml	<file< th=""><th>name.yaml></th><th>pcap</th></file<>	name.yaml>	pcap
<filename.inno_raw></filename.inno_raw>	ros-version <	<pre> version></pre>				

-release-2.4.0-rc237-public.debyaml FI0999 download.yamlpcap 1 13 sn363222100999 01 20 2022 06 43 12.inno rawros-version kinetic
Script is starting 2022May11-191631
use public yaml file FI0999_download.yaml
docker launch command: xhost +local:root; nvidia-docker run -itrmlabel rosdockerenv="DISPLAY"env="QT_X11_N0_MITSHM=1"env="IV_CWD=/home/dem
o/install_docker/catkin_ws/src/rosprocessor/build/docker" -v=/home/demo/install_docker/catkin_ws/src/rosprocessor/build/docker/ros-kinetic-innovusion-dri
ver-release-2.4.0-rc237-public.deb:/root/ros-kinetic-innovusion-driver-release-2.4.0-rc237-public.deb -v=/home/demo/install_docker/catkin_ws/src/rosproce
ssor/build/docker:/root/docker -v=/home/demo/install_docker/catkin_ws/src/rosprocessor/build/docker:/home/demo/install_docker/catkin_ws/src/rosprocessor/
Dulld/docker -v=/nome/demo/lnstall_docker/catkin_ws/src/rosprocessor/bulld/docker/F10999_download.yaml:/root/F10999_download.yaml -v=/nome/demo/.rvtz_ki
nett://oot/.rvt2 -v= /nome/demo/.ros_ktnett://oot/.ros -v=/nome/demo/.tnnovuston:/root/.tnnovuston -v=/nome/demo/instatt_docker/catkin_ws/src/rospro
Cessor/outud/aocker/output:/root/output -v=/nowe/demo/instat_aocker/catkin_ws/sic/rosprocessor/butud/aocker/i_15_Sho522210999/90_2022/00/43_12.timo
[aw, (bu)]
2' dona' roscin cui z viz ef inocursion e echa ruiz done) & doka et "/rost/roscinationinouvision driver relates 2.4 A src237 oublic debi & echa ruiz in a doka inst
all done && until rostopic list 2>/dev/null: do sleep 0.2: done: find /root/docker/cali manager -user root -exec chmod guo+rw {} \: && roslaunch innovusio
n pointcloud innovusion points.launch calibration:=/root/FI0999 download.vaml device ip:=172.168.1.10 lidarhome:=//root/.innovusion pcap:=/root/1 13 s
n363222100999 01 20 2022 06 43 12.inno raw read once:=0 "
inside docker command: (echo start roscore; rm -fr /root/.ros/log/; roscore; echo roscore done) & (echo start rviz; until rostopic list 2>/dev/null; do sl
eep 0.2; done; rosrun rviz rviz -f innovusion; echo rviz done) & dpkg -i "/root/ros-kinetic-innovusion-driver-release-2.4.0-rc237-public.deb" && echo dpkg
install done && until rostopic list 2>/dev/null; do sleep 0.2; done; find /root/docker/cali_manager -user root -exec chmod guo+rw {} \; && roslaunch inno
vusion_pointcloud innovusion_points.launch calibration:=/root/FI0999_download.yaml device_ip:=172.168.1.10 lidarhome:=//root/.innovusion pcap:=/root/1
1SN303222100999_01_20_2022_00_43_12.thno_raw read_once:=0
$r_{\rm eff}$ companies restaurch introduction_points table of a constraint of the state of the s
non-network local connections being added to access control list
start roscore
start rviz
Selecting previously unselected package ros-kinetic-innovusion-driver-public.
(Reading database 88654 files and directories currently installed.)
Preparing to unpack/ros-kinetic-innovusion-driver-release-2.4.0-rc237-public.deb
Unpacking ros-kinetic-innovusion-driver-public (2.4.0-rc237-public)
logging to /root/.ros/log/ctab6116-d11b-11ec-8360-0242ac110003/roslaunch-aa2c9dc92a1f-36.log
Lnecking log directory for disk usage. Inis may take awnile.
Press Critic to Interrupt
Setting up ros-kinetic-innovusion-driver-public (2.4.0-rc237-public)
started roslaunch server http://aa2c9dc92a1f:37743/

Note

<package.deb> is the driver's name. Please get the latest driver based on the actual situation of the

computer. If the existing driver does not match the computer's version, please contact Seyond staff.

<filename.yaml> is the configuration file. You can download this file using ILA.

<file name.inno_raw> is LiDAR point cloud data in .inno_raw.

<ros version> is the version of the ROS environment.

2. **rviz** is started to show the current point cloud status. For a better display effect in rviz, refer to <u>4.2.1.3 View LiDAR point cloud data</u>.


4.3.4 Shut down the LiDAR

Disconnect the power supply to shut down the LiDAR.

5 SDK configuration

You can operate the LiDAR using the following executable files. For more information, please contact Seyond staff to obtain related manuals.

NO.	Software Interface	Description
1	get_pcd	This lightweight executable file allows the user to record data files
		and convert data between different formats. It is very useful for
		scripted/automated data collection.
2	Innovusion_lidar_util	The command line utility enables you to obtain and change the
		configuration of the LiDAR. You can use the commands to get the
		status of LiDAR and check the firmware logs.
3	SDK	The SDK offers the most flexibility for customization regarding data
		streaming and lidar control.
4	cURL commands	cURL commands provide a convenient way to adjust ROI location,
		download system logs, and start/stop the pointcloud server (PCS).

Table 9 executable file	instructions
-------------------------	--------------

5.1 SDK download

You can access the resource Hub or contact the seyond staff to obtain the SDK package you need. You can log into ILA and select **Sensor Config** > **Falcon values** to check the SDK version information.

Falcon values				
Serial number	360282201471		model: i	
Firmware version	falconi-916.2022	falconi-916.2022-01-14-11-48-13		
SDK version	2.0.0-new-yaml-	2.0.0-new-yaml-rc13-arm-public		
UDP				
Ports		Client IP address		
data 0		0		
status 0				
message 0				

5.2 SDK Installation

Table 10 Installation environment requirements

Installation environment requirements	Architecture
Ubuntu 16.04 + GCC 5.4.0 and higher	x86/ARM
Ubuntu 18.04 + GCC 7.4.0 and higher	x86/ARM

6 Communication protocol

You can obtain the point cloud data via TCP or UDP.

6.1 Data transmission via TCP

TCP (Transmission Control Protocol) is a connection-oriented unicast transmission protocol. The LiDAR serves as the server, and the client serves as the client in TCP. The client initiates a connection request to the server. After a reliable connection is established, the server will actively send data to the client.



6.2 Data transmission via UDP

The LiDAR serves as the client, and the customer serves as the server in UDP (User Datagram Protocol). The client actively sends data to one or more servers.

Since UDP may lead to packet loss when transmitting mass data, it is only recommended to transmit a small amount of data. The connection diagram is shown in the figure below.



7 Time synchronization

The point cloud data has associated timestamp information due to the measurement feature of LiDAR. Time information management is essential to facilitate device debugging, multi-sensor fusion, operation, maintenance, and other functions during the use of LiDAR in the network environment. The mainstream time synchronization methods include GPS, NTP, and PTP (including gPTP). Currently, Falcon supports PTP, gPTP and NTP as their time synchronization method.

Note

If you want to adopt NTP, please contact Seyond staff for technical support.

7.1 PTP time synchronization

Precision Time Protocol (PTP) is divided into Hardware timestamp synchronization (precision at submicrosecond), Software timestamp synchronization (precision at tens of microseconds).

Synchronization method		Synchronization principle		Synchronization precision
DTD	Hardware	Hardware synchronization	timestamp	Sub microsecond
PIP	Software	Software synchronization	timestamp	Tens of microseconds

Table 11 Time Synchronization Method Instructions

Note

Before sync time in PTP mode, you need to ensure the following conditions.

- The network between the computer and the Falcon is connected.
- You have obtained the innovusion_lidar_util tool.

7.2 gPTP time synchronization

You need to confirm that all network nodes support PTP time synchronization before adopting gPTP as the time synchronization mode.

Note

Before sync time in gPTP mode, you need to ensure the following conditions.

- The network between the computer and the Falcon is connected.
- You have obtained the innovusion_lidar_util tool.

Appendix A. Computer configuration reference

The following table provides the reference for configuring the computer. Users can select suitable computers according to the table.

Note

The computer configuration recommended in this table only enables you to view point cloud data. If you have other requirements, please consult Seyond staff.

This table is only for reference to the minimum configuration requirements of the server. Users can upgrade the computer's configuration based on this table's requirements.

Attribute	Configuration
	Dual-core CPU
CPU	Intel I7-9 th generation or other types of processors with
	equivalent performance or above
RAM	1 GB
Free hard drive space	≥ 1000 MB
Ethernet connection	1 G/s

Table 12 Configuration reference for the computer

Appendix B. Command line instructions

Format	Description
<>	The content in "< >" needs to be replaced by the actual value.
	e.g., ./innovusion_lidar_util 172.168.1.10 get_version
[]	The contents in "[]" is optional.
[x y]	Only one option can be selected.
//	The content after "//" is a comment.

Appendix C. Abbreviations and terms

Abbreviations	Full name
AC	Alternating Current
DC	Direct Current
ETH	Ethernet
FAQ	Frequently Asked Questions
FOV	Field of View
GEN	Generation
GND	Ground
GPS	Global Positioning System
H × W × D	Height × Width × Depth
IP	Internet Protocol
Lidar	Light Detection and Ranging
MAC	Media Access Control
MEC	Multi-Access Edge Computing
NTP	Network Time Protocol
PPS	Pulse Per Second
РТР	Precision Time Protocol
PWR	Power
ROI	Region of Interest
ROS	Robot Operating System
SDK	Software Development Kit
SN	Serial Number
SW	Software
ТСР	Transmission Control Protocol
TOF	Time of Flight
UDP	User Datagram Protocol

Table 14 Abbreviations

Table 15 Technical Terms

Terms	Definition	
	Within the corresponding wavelength and emission duration, the exposure	
Class 1 laser products	of personnel to laser radiation is not allowed to exceed Class 1 laser	
	products that can reach the emission limit.	
	Network Time Protocol (NTP) is a protocol used to synchronize computer	
NTP	time. It is widely used to synchronize computers to Internet time servers,	
	such as radio or satellite receivers or telephone modem services.	
РТР	Precision Time Protocol (PTP) is a high-precision time synchronization	

	protocol. It is used for high-precision time synchronization between devices
	but can also be used for frequency synchronization between devices.
	Installers refer to those who have received professional training and have
Installer	rich experience in the relevant field, fully understand the application of
	protective devices on the machine, and can assess its working safety state.
Commissioning	Commissioning personnel have received professional training and have rich
Commissioning	experience in the relevant field, fully understand the application of
personner	protective devices on the machine, and can assess its working safety state.
	The time-of-flight (TOF) realizes distance measurement by determining the
Time of flight (TOF)	time-of-flight interval between transmitting and receiving signals. For the
	formula, see the Principles of operation section.
	Combination of any products or components used to construct or prepare
Laser product	for use to construct a laser or a laser system. An electronic component sold
	as a component to another manufacturer is not a laser product.
	An electromagnetic radiation device that mainly generates or amplifies the
Laser	wavelength in the range of 180nm \sim 1mm through a controlled laser
	emission process.
Laser equipment	A combination of laser products or laser products containing lasers.
Laser equipment	A combination of laser products or laser products containing lasers. A computer that can directly issue operation and control commands. The
Laser equipment	A combination of laser products or laser products containing lasers. A computer that can directly issue operation and control commands. The server sends commands first to the slave computer, and then the slave
Laser equipment	A combination of laser products or laser products containing lasers. A computer that can directly issue operation and control commands. The server sends commands first to the slave computer, and then the slave computer controls the device according to this command. The slave
Laser equipment	A combination of laser products or laser products containing lasers. A computer that can directly issue operation and control commands. The server sends commands first to the slave computer, and then the slave computer controls the device according to this command. The slave computer reads the device status data from time to time, converts it into a
Laser equipment	A combination of laser products or laser products containing lasers. A computer that can directly issue operation and control commands. The server sends commands first to the slave computer, and then the slave computer controls the device according to this command. The slave computer reads the device status data from time to time, converts it into a digital signal, and feeds it back to the server.
Laser equipment Server	A combination of laser products or laser products containing lasers. A computer that can directly issue operation and control commands. The server sends commands first to the slave computer, and then the slave computer controls the device according to this command. The slave computer reads the device status data from time to time, converts it into a digital signal, and feeds it back to the server. The configuration personnel should have expertise and experience in the
Laser equipment Server Configuration personnel	A combination of laser products or laser products containing lasers. A computer that can directly issue operation and control commands. The server sends commands first to the slave computer, and then the slave computer controls the device according to this command. The slave computer reads the device status data from time to time, converts it into a digital signal, and feeds it back to the server. The configuration personnel should have expertise and experience in the relevant field and have sufficient experience to evaluate whether the
Laser equipment Server Configuration personnel	 A combination of laser products or laser products containing lasers. A computer that can directly issue operation and control commands. The server sends commands first to the slave computer, and then the slave computer controls the device according to this command. The slave computer reads the device status data from time to time, converts it into a digital signal, and feeds it back to the server. The configuration personnel should have expertise and experience in the relevant field and have sufficient experience to evaluate whether the machine is in a safe operation status after using protective equipment.
Laser equipment Server Configuration personnel	A combination of laser products or laser products containing lasers. A computer that can directly issue operation and control commands. The server sends commands first to the slave computer, and then the slave computer controls the device according to this command. The slave computer reads the device status data from time to time, converts it into a digital signal, and feeds it back to the server. The configuration personnel should have expertise and experience in the relevant field and have sufficient experience to evaluate whether the machine is in a safe operation status after using protective equipment. Although the product design meets the Class 1 eye safety standard, to
Laser equipment Server Configuration personnel Eve safety	A combination of laser products or laser products containing lasers. A computer that can directly issue operation and control commands. The server sends commands first to the slave computer, and then the slave computer controls the device according to this command. The slave computer reads the device status data from time to time, converts it into a digital signal, and feeds it back to the server. The configuration personnel should have expertise and experience in the relevant field and have sufficient experience to evaluate whether the machine is in a safe operation status after using protective equipment. Although the product design meets the Class 1 eye safety standard, to protect your safety to the greatest extent, do not use amplification
Laser equipment Server Configuration personnel Eye safety	A combination of laser products or laser products containing lasers. A computer that can directly issue operation and control commands. The server sends commands first to the slave computer, and then the slave computer controls the device according to this command. The slave computer reads the device status data from time to time, converts it into a digital signal, and feeds it back to the server. The configuration personnel should have expertise and experience in the relevant field and have sufficient experience to evaluate whether the machine is in a safe operation status after using protective equipment. Although the product design meets the Class 1 eye safety standard, to protect your safety to the greatest extent, do not use amplification equipment (such as a microscope and magnifying glass) to look at the laser
Laser equipment Server Configuration personnel Eye safety	A combination of laser products or laser products containing lasers. A computer that can directly issue operation and control commands. The server sends commands first to the slave computer, and then the slave computer controls the device according to this command. The slave computer reads the device status data from time to time, converts it into a digital signal, and feeds it back to the server. The configuration personnel should have expertise and experience in the relevant field and have sufficient experience to evaluate whether the machine is in a safe operation status after using protective equipment. Although the product design meets the Class 1 eye safety standard, to protect your safety to the greatest extent, do not use amplification equipment (such as a microscope and magnifying glass) to look at the laser light in transmission directly.
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Appendix D. Revision history

Revision history

Version number	Revised content	Revision time
V2.1.2	The draft for Resource Hub	2024/03/19