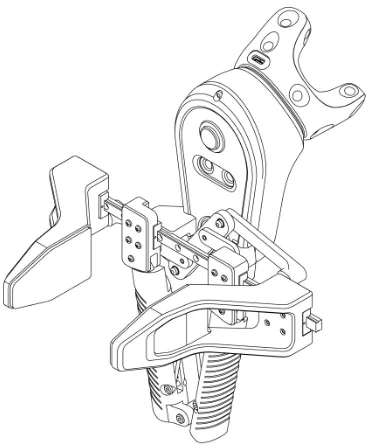
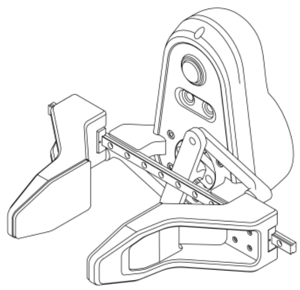
Pika Product User Manual beta（EN）

Version	Change Information	Edited by	Reviewer	Date
V1.0.0	Establish documentation	Dennis		20250409
V1.1.1	Updated software environment	Cynthia		20250425

PIKA User Manual





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Directory

Safety Information

This chapter contains important safety information. Any individual or organization must read and understand this information before using the equipment, especially before the first power-on. It is of great importance to comply with and execute all the assembly instructions and guidelines in this manual. In particular, pay attention to the text related to warning signs. Before using the equipment, be sure to obtain and read the "PIKA User Manual". If you have any questions regarding the use, you can contact us at support@agilex.ai.

Warning Sign： ⚠This indicates a situation that may lead to danger. If not avoided, it can cause personal injury, property damage, and serious equipment damage.

Warning⚠： If the PIKA device is damaged, altered, or modified in any way, Agilex Robotics will not assume any responsibility. Agliex Robotics will not assume any responsibility for any damage caused to the device or any other equipment due to program errors or operational malfunctions.

Limitation of Liability:

● Conduct a risk assessment of the complete data acquisition system.

● Connect additional safety equipment for other machines defined in the risk assessment.

● Confirm that the design and installation of the entire data acquisition system, including software and hardware systems, are accurate.

● Equipment-related functions require integrators and end customers to follow relevant regulations and practical laws and regulations for safety assessments to ensure that the developed data acquisition system does not have any major dangers and safety hazards in actual applications.

● Be aware of possible safety risks before operating and using the equipment.

● Ensure that users do not modify any safety measures

Validity and Liability

- Conduct a risk assessment of the complete data collection system.
- Connect additional safety devices of other machinery as defined in the risk assessment.
- Confirm the accurate design and installation of the entire data collection system, including both software and hardware systems.
- Integrators and end - customers are required to conduct a safety assessment of device - related functions in compliance with relevant regulations and practical laws and

regulations, ensuring that the developed data collection system has no significant risks and potential safety hazards in practical applications.

- Be aware of possible safety risks before operating and using the device.
- Ensure that users do not modify any safety measures.

Environment

- Before the first use, carefully read this manual to understand the basic operation procedures and operation specifications.
- Select a relatively open area for use. The PIKA device does not come with any automatic obstacle - avoidance sensors.
- Use it in an ambient temperature range of 0℃ to 40℃.
- It has a waterproof and dust-proof rating of IP22.

Inspection

- Ensure that there are no obvious abnormalities with the equipment.
- Ensure that the wiring harness is properly connected during use.

Operation

- Ensure that the surrounding area is relatively open during operation.
- Operate within line of sight.
- In case of any abnormalities in the device, immediately stop using it to avoid secondary injuries.
- If the device malfunctions, contact relevant technicians and do not attempt to handle it on your own.
- Use the device in an environment that meets the requirements of its IP protection rating.

Usage Warnings⚠：

- Ensure that the PIKA device and tools/end - effectors are always correctly and firmly fixed in place.
- Ensure that the PIKA device has sufficient space for free movement.
- Ensure that safety measures have been established as defined in the risk assessment.
- Do not wear too loose clothes during operation. Make sure long hair is tied back.
- Do not use the device if it is damaged or shows any abnormalities.
- Ensure that people are warned to keep their heads, faces, or other body parts outside the reach of the operating or about - to - operate PIKA device.
- Never modify the PIKA device. Modifications to the PIKA device may cause

unpredictable dangers for integrators.

- Do not expose the PIKA device to a permanent magnetic field continuously. A strong magnetic field can damage the device.
- Connecting different machines may increase risks or trigger new ones. Always conduct a comprehensive risk assessment of the entire installation. Depending on the risk assessment, different functional safety levels may apply; thus, when different safety and emergency - stop performance levels are required, always choose the highest performance level. Always read and understand the manuals of all devices used in the installation.
- The PIKA device is not suitable for use by individuals under 18 years old and those who do not have full capacity for civil conduct.

1 Product Introduction

1.1 Product Overview

The Pika Data Set product (hereinafter referred to as "Pika") is a **spatial data collection product** designed for data collection scenarios in the field of **Embodied Intelligence**. It is a lightweight, portable, integrated solution for data collection and execution, catering to general - purpose operations. It consists of a collection device, a model inference actuator, a supporting positioning base station, and a data backpack. Pika enables the efficient, accurate, rapid, and lightweight collection of spatial operation data of robots.

Pika has the ability to collect **spatial information with ultra-high precision at the millimeter level**. It supports the collection of data including six DOFs precise spatial information, depth information, ultra-wide-angle and visible-light visual information, and gripping information, meeting the **multi-information fusion requirements for data collection** in the field of embodied intelligence. The actuator can serve as the terminal for model inference based on the data collected by the collector.

Pika consists of a portable data collection unit (Pika Sense), an end-effector (Pika Gripper), a positioning base station (Pika Station), and a portable data package (Pika Package) (as shown in the figure below). Pika Sense and Pika Station can be used with Pika Package or a laptop for data collection. Pika Gripper can be used independently for inference actions. Pika Sense, Pika Station, together with Pika Gripper and a laptop, can be used for teleoperation data collection.

Portable data collection unit

Pika Sense

Portable data package

Pika Package

End effector

Pika Gripper

Positioning base station

Pika Station

1.2 Product Characteristics

- **Lightweight handheld terminal:** It is lightweight and more portable compared to UMI.
- **High pose positioning accuracy:** With a spatial accuracy of up to 1.5mm, it is not afraid of high texture degradation scenarios such as walls/tables.
- **Rich sensors:** Equipped with a fisheye camera with a viewing angle of nearly 200°, which is visible between two handheld terminals and is of great help for two-arm tasks. A binocular depth camera is added to collect high-precision depth data. And a high-precision position encoder is configured to collect position gripping information.
- **Complete actuator configuration:** The sensor configurations of the collection terminal and the actuator terminal are consistent, facilitating the reproduction of model algorithms.
- **Direct output of position information :** No need for post-processing or post-synchronization of data. The data quality is high, and data collection is more efficient.
- **Friendly interaction:** It meets the design of human-computer interaction, and users will not

feel tired after long-time operation.

1.3 Product Parameters

Catagory	Item		Parameter
Pika Sense	Dimension		L 215×W 220×H 257mm
	Weight		550g
	Maximum Clamping Force		2KG
	Spatial Positioning Accuracy		±1.5mm（/in the case of no obstruction）
	Positioning Data Output Frequency		120HZ
	Positioning Tag Battery Life		9h
	Output Data		● 6D Spatial Coordinates ● Gripper Opening and Closing Rotating Shaft Angle ● Depth Data ● RGB Data ● IMU Data
	Secondary Development		ROS1 ROS2 URDF
	Communication Interface		TYPE-C
	Gripper	Gripper Types	Two-finger Gripper
		Maximum opening and closing size	95mm
		Minimum opening and closing size	0（can hold paper）
		Rotational accuracy of the opening and closing rotating shaft	±0.1°
		Output feedback frequency	100hz
	Inertial	Type	9-axis Gyroscope

	Sensor	Gyroscope Zero Drift S tability	2.5°/H
		Accelerometer Zero Dr ift Stability	30ug
		Output Feedback Frequency	100hz
	Depth Camera	Optimal Depth Distance	7cm - 50cm
		Exposure Method	Global Shutter
		Depth Measurement M ethod	Binocular Vision
		Depth Field of View (F OV)	87°(Horizontal)×58°(Vertical)
		Minimum Depth Dista nce	7cm @ 480p
		Maximum Depth Output Resolution	1280×720
		Depth Measurement Ac curacy	±2% at 50cm
		Maximum Depth Frame Rate	90FPS
		RGB Output	Supported
		RGB Field of View	87° (Horizontal) × 58° (Vertical)
		RGB Maximum Resolution	1280×720
		RGB Maximum Frame Rate	90FPS
	Wide-angle Ca	View Angle	Diagonal 200°

	mera	Outputtable Frame Rate	•1280*720 @ 30fps •640*480 @ 30/60/90fps
Pika Gripper	Size		L215xW191xH143mm
	Weight		690g
	Maximum Clamping Force		2KG
	Mechanical Interface Description		Flange Connection
	Gripper	Gripper Type	Two-finger Gripper
		Maximum Opening and Closing Size	95mm
		Minimum Opening and Closing Size	0（can hold paper）
		Opening and Closing Measurement Accuracy	±0.1°
	Inertial Sensor	Type	9-axis Gyroscope
		Gyroscope Zero Drift S tability	2.5°/H
		Accelerometer Zero Dr ift Stability	30ug
		Output Feedback Frequ ency	100hz
	Depth Camera	Optimal Depth Distanc e	7cm - 50cm
		Exposure Method	Global Shutter
		Depth Measurement M ethod	Binocular Vision
		Depth Field of View (F	87°(horizontal)×58°(vertical)

		OV)	
		Minimum Depth Distance	7cm @ 480p
		Maximum Depth Output Resolution	1280×720
		Depth Measurement Accuracy	±2% at 50cm
		Maximum Depth Frame Rate	90FPS
		RGB Output	Supported
		RGB Field of View	87°(horizontal)×58°(vertical)
		RGB Resolution	1280×720
		RGB Maximum Frame Rate	90FPS
	Wide-angle Camera	View Angle	Diagonal 200°
		Output Frame Rate	•1280*720 @ 30fps •640*480 @ 30/60/90fps
Pika Station	Base Station	Horizontal Field of View (FOV)	110°
		Vertical Field of View (FOV)	150°
	Base Station Tripod	Maximum Height	2.1m
		Pitch Adjustment	Supported
	Battery Specification		12V@10AH
	Typical Power Consumption		3W
	Battery Life		30H

	Working Voltage	12V
Pika Package	Portable Data Package	

1.4 Physical Display

Portable data collection unit

Pika Sense

End effector

Pika Gripper

Portable data package

Pika Package

End effector installed on the Pika

Pika Gripper + Piper

Positioning station

Pika Station

1.5 Product List

Product	Model	Quantity	Remarks

1.5 Usage Process

Pika can be used in four methods:

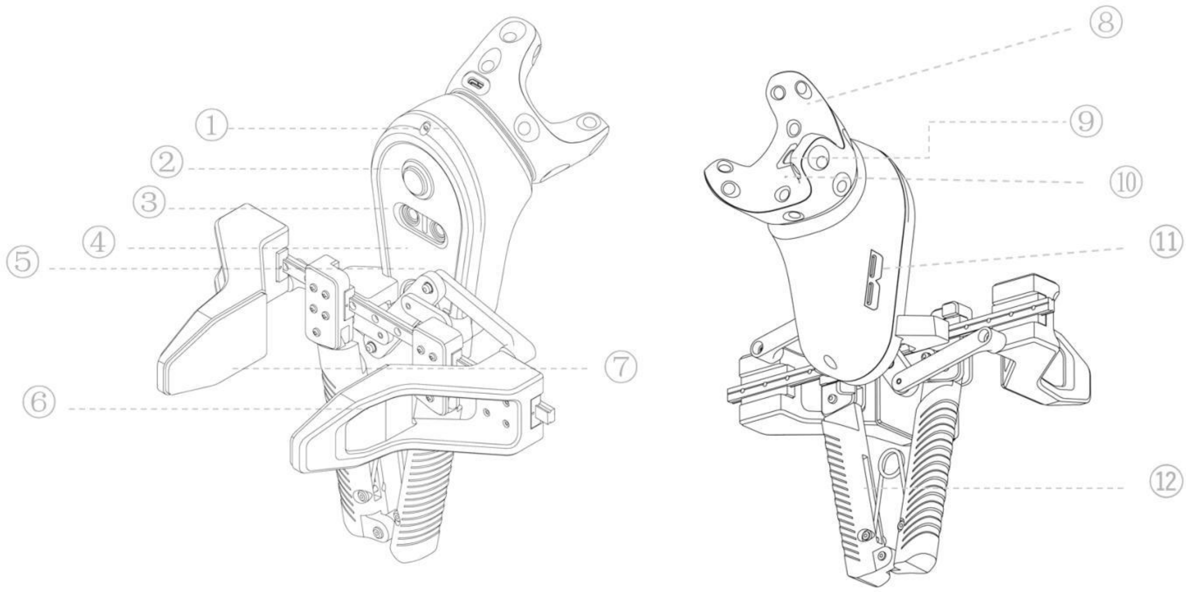
- Use Pika Sense and Pika Station together independently for data collection.
- Use Pika Gripper alone for inference execution.
- Use Pika Sense, Pika Station, and Pika Gripper together for teleoperation data collection.
- Use Pika Package to replace a computer or industrial computer to achieve data collection programming.

1.6 Module Introduction

The complete Pika product includes the Pika data collector (Pika Sense), the Pika execution unit (Pika Gripper), the high-precision positioning base station (Pika Station), and the data backpack (Pika Package). The Pika data collector consists of a handheld operator, a high-precision depth camera, a wide-angle monocular camera, a high-precision encoder, a multi-redundant IMU unit, and a two-finger gripper. The Pika actuator/end effector consists of a two-finger gripper, a depth camera, a wide-angle camera, and a high-precision brushless motor. The high-precision positioning base station system includes a mobile fixed bracket and a supporting battery, which satisfies the millimeter-level spatial positioning of the Pika data unit in space.

1.5.1 Data collector: Pika Sense

The Pika data acquisition unit is mainly used for data collection, and it can perform independent data collection actions by hand. It consists of a handheld operator, a high-precision depth camera, a wide-angle monocular camera, a high-precision encoder, a multi-redundant IMU unit, and a two-finger gripper.



1	Positioning Tag Charging Port	7	Inner Pad of Gripper
2	Positioning Status Indicator	8	Positioning Tag
3	Ultra Wide-Angle	9	Positioning Tag Power

	Camera		Button
4	Depth Camera	10	Positioning Tag Indicator
5	Depth Camera	11	TYPE-C
6	Two-Finger Gripper	12	Handheld Operator

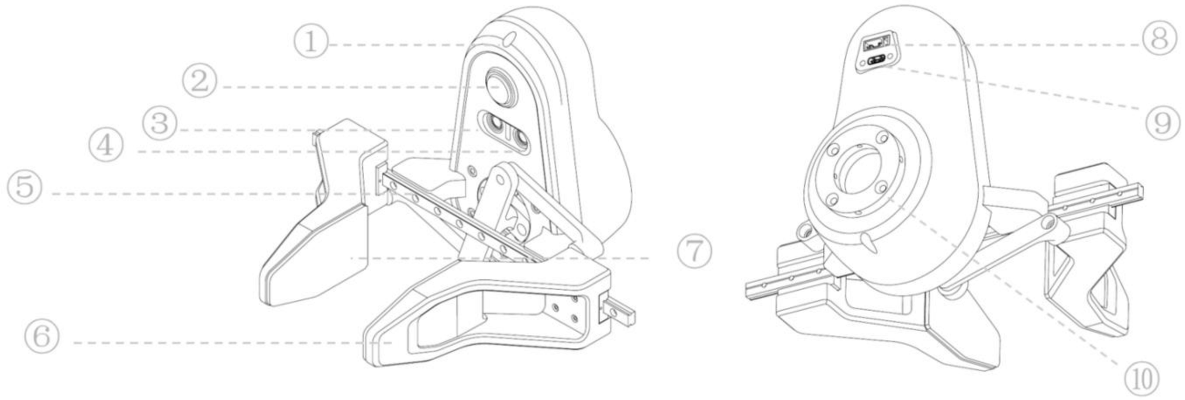
Wireless communication between the positioning base station and the data collection host is carried out via USB. Therefore, each positioning tag on the Pika Sense needs to be paired with a USB receiver for use. The receiver is shown in the following figure:

Explanation of the meaning of the positioning tag status indicator:

Color	State	Meaning
Green	Constantly On	The wireless receiver is successfully connected
Blue	Constantly On	The wireless receiver is connecting
Blue	Flashing	The wireless receiver is pairing. (Applicable to software pairing for initial use)
Red	Flashing	The battery level is below 10%.
Yellow	Constantly On	Charging in progress
White	Constantly On	Fully charged

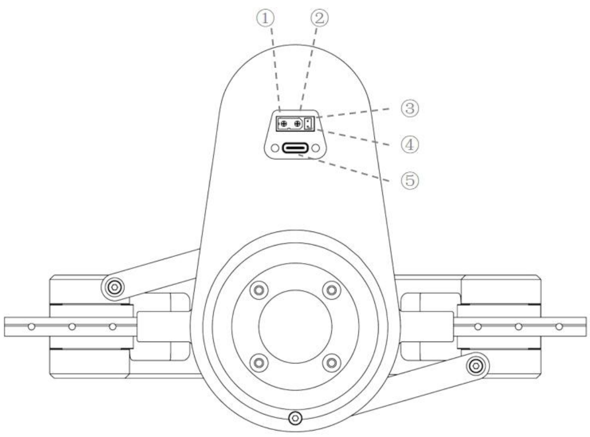
1.5.2 Data Actuator: Pika Gripper

The Pika actuator (hereinafter referred to as the actuator) unit consists of a two-finger gripper, a depth camera, and a wide-angle camera. The actuator is equipped with a standard fixed structure and can be optionally equipped with different mounting flanges (this flange is an optional accessory, and you need to contact us separately for procurement), which is used to be fixed on different robotic arms, such as the Piper six-degree-of-freedom robotic arm of AgileX Robotics, or other third-party robotic arms. It includes an actuator motor power supply interface and a Type-C interface for communication with various sensors.



1	Indicator Light	6	Two-Finger Gripper
2	Wide-Angle Camera	7	Inner Pad of the Gripper
3	Depth Camera	8	Power Supply Interface
4	Depth Camera	9	Communication Interface
5	Movement Slide Rail for the gripper	10	Structural Fixing Interface

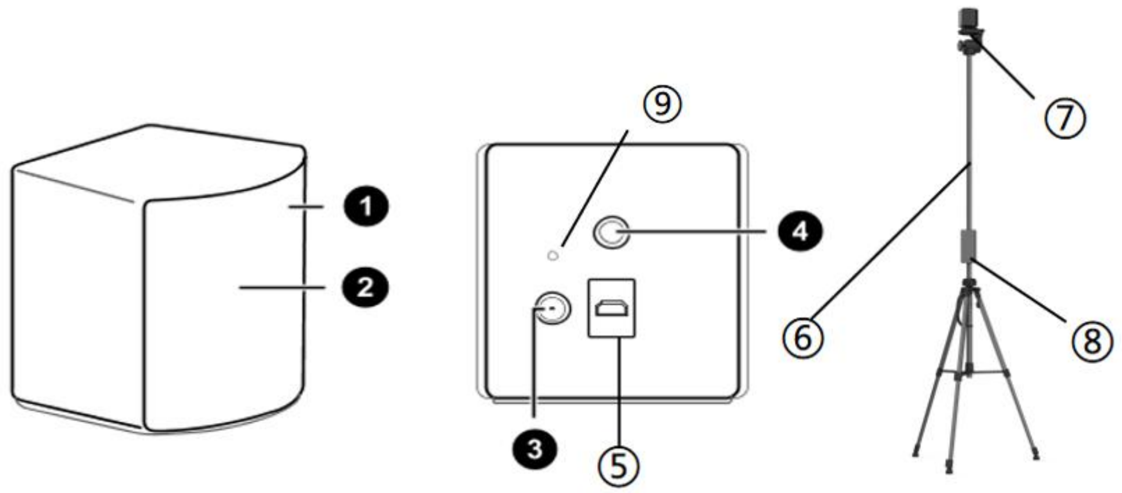
The power supply interface type is XT30 (PB), among which the multiplexed communication port is not used. The communication and control interfaces uniformly use the Type-C interface for communication. When in use, simply connect the gripper with a wire harness of USB 3.0 or above. The power interface and interface definitions are as shown in the following table:



1	24V Power Supply +	4	CAN-H（Reserved）
2	24V Power Supply -	5	TPYE-C
3	CAN-L (Reserved)	---	---

1.5.3 Positioning Base Station: Pika Station

The high-precision positioning base station system includes a mobile fixed bracket and a supporting battery, which meets the millimeter-level spatial positioning requirements of the Pika data unit in space.

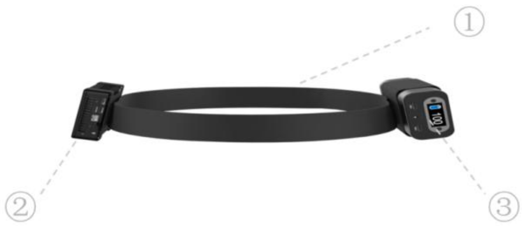


1	Status Indicator	6	Base Station Tripod
2	Front Panel	7	Positioning Base Station
3	Power Port	8	Battery
4	Threaded Mounting Hole	9	Channel Setting Hole
5	Micro-USB Port	---	---

1.5.4 Data Backpack Pika Package（Optional）

Pika Package is an optional accessory and is not provided by default. If you want, please contact our sales or relevant personnel to purchase it.

The data backpack includes a data recording industrial computer, the battery required for its operation, and fixed straps. Through the built-in software and algorithms, it can achieve data collection, storage, and data export of the data collector. The data recording industrial computer supports up to two data collectors working simultaneously. Its basic operating memory is XX GB, and its storage space is XX GB.



1	Fixed Straps	2	Data Recording Industrial Computer
3	Battery	---	---

2 Base Station and Collector Use

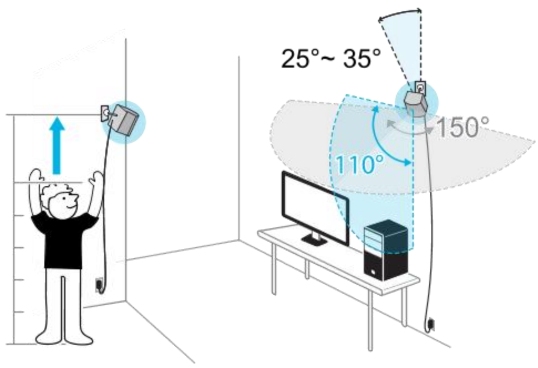
Before carrying out data collection operations, it is necessary to first install and deploy and debug the base station, then perform pairing and calibration of the base station, and finally turn on the collector (when using the collector for the first time, software adaptation between the collector and the receiver is required) for data collection.

- Set up the base station
- Calibrate the base station
- Connect the computer
- Start collection

2.1 Base Station Deployment

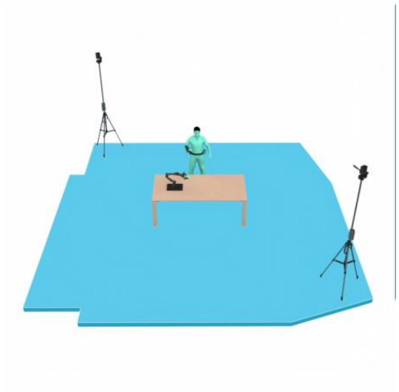
The deployment of the base station will affect the positioning of the manipulator. Before data collection, the first step is to deploy and test the base station.

Base Station Perspective: The horizontal field of view of the base station is 150 degrees, and the vertical field of view is 110 degrees. To maximize the operating area, please install the base station at a position higher than the head (the distance from the ground should preferably be greater than 2 meters or 6.5 feet), and adjust the angle of each base station to between 25 degrees and 35 degrees. (The field of view is shown in the figure below)



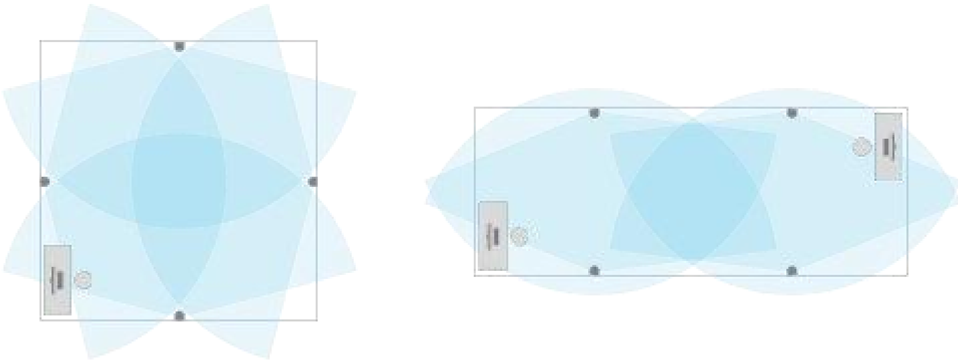
Base Station Coverage Description:

Two base stations: The required minimum operating area is 2 m x 1.5 m (6 ft 6 in x 5 ft), and it can reach up to 5 m x 5 m (16 ft 5 in x 16 ft 5 in).

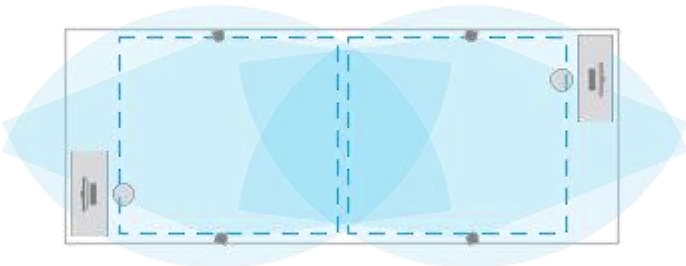


Four base stations: The maximum coverage area supported by four base stations is 10 m x 10 m (32 ft 10 in x 32 ft 10 in). (A maximum of 4 base stations can be used in one scene)

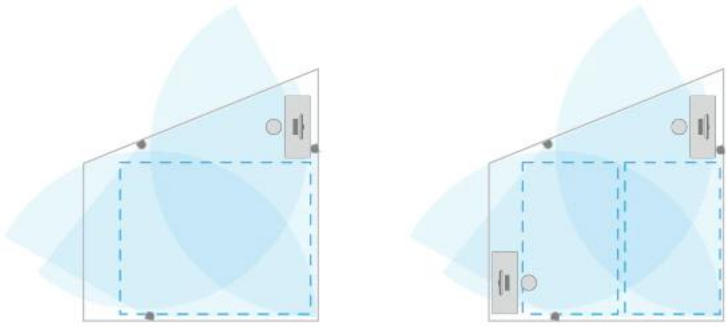
Single-person operation:



Double-person operation:

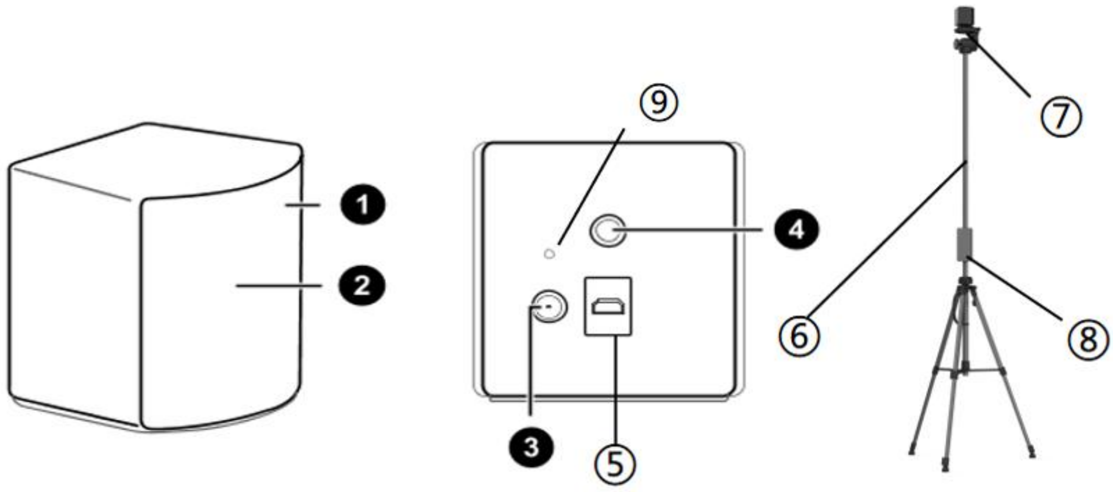


Three base stations: If the environment is an irregular area, more than 3 base stations still need to be arranged, which can be referred to the following figure.



Installation steps:

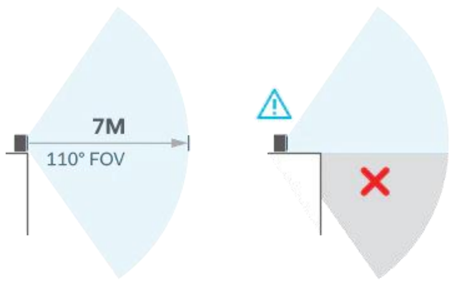
1. Install the base stations. It is recommended to install the base stations at diagonal positions in the room and they can be directly fixed on the wall. If the space does not allow such installation, the base stations can also be installed on tripods or placed on stable surfaces such as desks. Avoid using unstable installation methods or installing on surfaces that are prone to vibration.
2. Adjust the angle of the base stations so that the front panel faces the center of the collection area. Set each base station to a minimum height of 0.5 m (1.6 ft). Depending on the set height, the angle of the base stations needs to be adjusted up or down to fully cover the operating area. Fix the two positioning base stations to ensure that the range of motion of the teaching pendant is within the field of view of the two base stations. For optimal performance, the collector should be at least 0.5 m (1.6 ft) away from the base stations. This operation will be automatically handled by the SteamVR software.
3. Connect the power cable to each base station, and then insert it into the power socket respectively or connect to the battery carried by the tripod to turn on the power.
4. When using the positioning base stations for the first time, the channels of the positioning base stations need to be set manually. Use a sharp object to poke the button on the back of the base station (as shown in position 9 in the following figure). Pressing it once will increase the channel by one, with the range from 0 to 15. The base stations in the same scene need to be set to different channels.



5. When everything is ready, the LED of the positioning base station is constantly green, indicating normal operation.

Installation Precautions:

- Do not let any object cover the front panel of the base station.
- Infrared light in the sun can affect the reception and transmission of base station data. Please use it indoors without sunlight.
- Please ensure that the base station is installed outside the collection area and firmly installed to avoid damage or performance degradation due to accidental bumping, falling or collision.
- Do not install it in areas with strong illumination, otherwise it may have a negative impact on the performance of the base station.
- After installing the base station, please remember to remove the protective film on the front panel.
- After the base station is turned on, it may affect some nearby infrared sensors, such as the sensors used by TV infrared remote controls.
- To achieve accurate positioning, please ensure that the distance between any base station and the collector is within 7 meters (23 feet). It should be ensured that there are no physical obstacles (such as protruding shelves) at the location where the base station is placed so as to fully cover the field of view of the collector and ensure that the signal is not blocked.



2.2 Pairing the collector positioning tag

When using the collector for the first time, it needs to be paired with the wireless signal receiver.

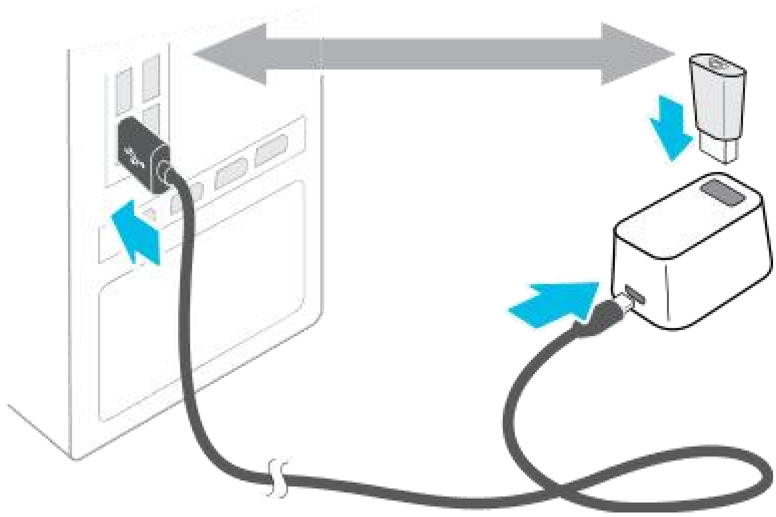
Before pairing, the wireless receiver needs to be connected to the computer through a USB cable harness.

The steps are as follows:

1.Connect one end of the USB Type-C data cable to the receiver base, and then insert the wireless signal receiver into the base.

2.Connect the other end of the USB Type-C data cable to the USB port on the computer.

The distance between the wireless signal receiver and the computer should be at least 45 centimeters (18 inches), and it should be placed in a position that will not move. The specific connection is shown in the following figure.



Start pairing after the connection is completed:

First, install the STEAM software and complete user registration.

1.On the Windows system, open the SteamVR application.

2. Click ☰ > Devices > Pair Controller

⚠Note: If you do not see the VIVE Tracker (3.0) in the controller pairing window, click I want to pair other types of controllers > HTC Vive Tracker.

3. Hold the power button for about 2 seconds, and the status indicator will flash in blue.
4. Wait for the status indicator to turn green. This indicates that the pairing has been successful.
5. In the controller pairing window, click Done.

⚠**Note:**

The wireless connector and the tracker are in a one-to-one relationship and cannot be one-to-many.

After pairing is completed, the connector can be directly connected to the computer without using the **receiver base** anymore.

2.3 Computer Connection

If you prepare the computer to connect with the collector by yourself, the software/hardware requirements of the computer are as follows:

Software/Hardware Requirements	Reference Parameters
PC Chip Architecture	i5 9th generation and above
PC Storage Space	More than 1TB
PC Interface	USB3.0 x 3 (Docking stations cannot be used)
Operating System	Ubuntu 20.04
ROS Version	ROS1-noetic

Connect the TYPE-C interface on the side of the collector to the computer.

At this point, all hardware installation and preparation work has been completed, and you can start preparing the software part.

2.4 Software Environment Deployment Preparation

1. Install ROS1-noetic，recommend to use fishros, follow the prompts to install

```
cd ~ && wget http://fishros.com/install -O fishros && . fishros
```

2. Clone code.

```
git clone https://github.com/agilexrobotics/pika_ros.git
```

3. Install dependency

```
sudo apt-get update && sudo apt install libjsoncpp-dev
ros-noetic-ddynamic-reconfigure libpcap-dev  ros-noetic-serial
ros-noetic-ros-numpy python3-pcl libqt5serialport5-dev build-essential zlib1g-dev libx11-dev
libusb-1.0-0-dev freeglut3-dev liblapacke-dev libopenblas-dev libatlas-base-dev cmake  git
libssl-dev  pkg-config libgtk-3-dev libglfw3-dev libgl1-mesa-dev libglu1-mesa-dev g++
python3-pip  libopenvr-dev

pip3 install opencv-python
```

4. Config USB rules

In pika_ros directory, run:

```
sudo cp scripts/81-vive.rules /etc/udev/rules.d/

sudo udevadm control --reload-rules && sudo udevadm trigger
```

After this step, you need to replug the usb receiver.

5. Install Realsense-sdk

Go to pika_ros/source, unzip librealsense-2.50.0.zip and curl-7.75.0.tar.gz, and modify /home/agilex/pika_ros/source/curl-7.75.0 in the librealsense-2.50.0/CMake/external_libcurl.cmake file to change its path to the path under your curl-7.75.0.

RUN:

```
cd librealsense-2.50.0

bash install.bash
```

Put the install.zip compressed package in the source directory into the ~/pika_ros directory.
Add permissions to the install directory:

```
chmod 777 -R install/
```

6. Add environment variables

```
echo 'source ~/pika_ros/install/setup.bash' >> ~/.bashrc
```

The file storage structure of pika_ros is as follows:

```
├── img
├── install
├── README.md
├── scripts
└── source
```

The software code configuration is now complete.

2.5 Positioning base station calibration

The purpose of using a positioning base station to calibrate the positioning tag is to obtain the absolute coordinate value of the positioning tag in three-dimensional space.

The positioning base station performs calibration by transmitting and receiving infrared light.

Before starting calibration, please ensure that:

- ⚠Note:
- Open the positioning tag and place it within the FOV of the base station and keep it still.
- Make sure the lights of the base station and the positioning tag are green.
- Make sure the film of the base station is torn off and there is no obstruction in front of the base station.
- The base stations are located on **different channels.**
- Make sure there is no sunlight in the current room. The base station will also affect the use of other infrared devices.
- If the positioning base station is deployed for the first time, or the positioning base station has moved, or the positioning effect is not good, or the channel has been switched, calibration should be performed. Run the following command to calibrate the positioning tag.
- The program will not be closed automatically after calibration. You should close the program manually (press Ctrl + C).

There are several types of calibration, and different commands need to be run according to the situation:

1. If it is the first time to calibrate the base station on your computer, run:

```
cd ~/pika_ros/install/lib && ./survive-cli --force-calibrate
```

2. If the number of station is added or removed, run:

```
cd ~/pika_ros/install/lib && ./survive-cli --force-calibrate
```

3. If the channel is switched, run:

```
cd ~/pika_ros/install/lib && ./survive-cli --force-calibrate
```

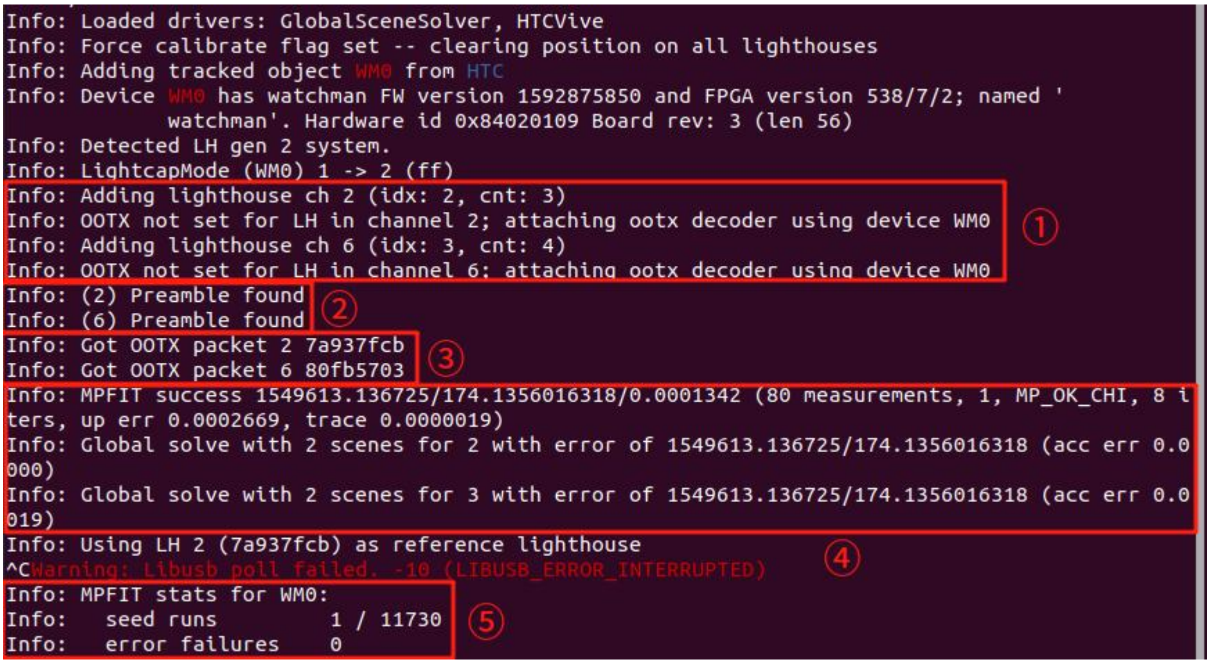
4. If the positioning is accurate, or the station is moved during the usage, run:

```
cd ~/pika_ros/install/lib && ./survive-cli
```

After starting the calibration procedure, make sure that the tracker is within the positioning range of th e two positioning base stations. The normal calibration process takes about 10 s, when the terminal dis plays the following information:

```
Info: MPFIT success 283446.053347/90.8577511297/0.0000793 (81
measurements, 1, MP_OK_CHI, 5 iters, up err 0.0002793, trace
0.0000035)
Info: Global solve with 2 scenes for 0 with error of
283446.053347/90.8577511297 (acc err 0.0013)
Info: Global solve with 2 scenes for 3 with error of
283446.053347/90.8577511297 (acc err 0.0007)
Info: Using LH 3 (80fb5703) as reference lighthouse
Info: MPFIT success 145.370101/114.4120840723/0.0000773 (121
measurements, 1, MP_OK_CHI, 34 iters, up err 0.0001909, trace
0.0000071)
Info: Global solve with 3 scenes for 0 with error of
145.370101/114.4120840723 (acc err 0.0015)
Info: Global solve with 3 scenes for 3 with error of
145.370101/114.4120840723 (acc err 0.0007)
Info: Using LH 3 (80fb5703) as reference lighthouse
```

Press Ctrl+C to close the calibration program. When you see the terminal showing that seed runs have sent data and the number of error failures is 0, the calibration is complete. As shown in the following fi gure:



①: Base stations of channels 2 and 6 have been added

②: This message will appear during the first calibration, indicating that base stations of channels 2 and 6 have been found and added

③: The computer receives data packets from base stations of channels 2 and 6

④: The error of the positioning tag (unit/meter) is displayed. When you see the terminal output this information, you can turn off the calibration program. Use Ctrl+C to turn it off

⑤: The information that will appear when Ctrl+C turns off the calibration program. Error failures is 0, which means no packet loss and successful calibration. If it is not 0, you need to check the placement of the base station and the current environment (such as direct sunlight) and whether the USB port of the computer has an impact on the calibration. After eliminating the impact, calibrate again until error failures is 0.

When pressing Ctrl+C to terminate the program, a red error appears:

```
Warning: Libusb poll failed. -10 (LIBUSB_ERROR_INTERRUPTED)
```

You can just ignore it. This won't affect the positioning.

If you use two senses during the calibration, the terminal will show:

```
Info: MPFIT stats for WM0:
Info:  seed runs          1 / 11730
Info:  error failures     0
Info: MPFIT stats for WM1:
Info:  seed runs          2 / 10790
Info:  error failures     0
```

The difference is WM1 is added.

⚠Common calibration questions

1. During the calibration command, the driver_openvr.so file cannot be found

Install dependency: sudo apt install libopenvr-dev, and calibrate again

2. The terminal stays still during calibration and no positioning error is displayed

rm ~/.config/libsurvive/config.json

Remove the config.json file and calibrate again

3. After calibration, error failures are displayed

Error failures means that the calibration has failed. Check whether there is sunlight in the current environment or whether there is a device that actively emits infrared light in the current environment. Check the position of the base station again to ensure that the sense is within the FOV of the base station. When all the above items are checked, run the calibration program again.

4. After the calibration is completed, the TF coordinates are found to be floating after a period of use

Check whether there is sunlight in the current environment or whether there is a device that actively emits infrared light in the current environment. Check the position of the base station again to ensure that the sense is within the FOV of the base station. When all the above items are checked, run the calibration program again.

2.6 Setting up left and right cameras

Bind devices

⚠**Note:**

If a single gripper is used, you do not need to set this item. You can skip this item and directly perform data collection. If two grippers are used, you need to configure them. If you replace the USB port after the configuration, reconfigure the USB port.

When you want to use two Pikas, you need to set the left and right hands, otherwise the data of the left and right hands will not be recorded correctly.

1. Obtain the USB port

First insert the left clamp USB to the industrial computer (ensure that the industrial computer is connected to only one device), read the serial number of the left arm serial port connection

```
cd /dev && ls | grep ttyUSB
```

result shows below:

```
(base) agilex@agilex:/dev$ cd /dev && ls | grep ttyUSB
ttyUSB0
```

then, run

```
udevadm info /dev/ttyUSB0
```

result shows below:

```
(base) agilex@agilex:/dev$ udevadm info /dev/ttyUSB0
P: /devices/pci0000:00/0000:00:14.0/usb1/1-6/1-6.4/1-6.4:1.0/ttyUSB0/tty/ttyUSB0
N: ttyUSB0
L: 0
S: ttyUSB22
S: serial/by-path/pci-0000:00:14.0-usb-0:6.4:1.0-port0
S: serial/by-id/usb-1a86_USB_Serial-if00-port0
E: DEVPATH=/devices/pci0000:00/0000:00:14.0/usb1/1-6/1-6.4/1-6.4:1.0/ttyUSB0/tty/ttyUSB0
E: DEVNAME=/dev/ttyUSB0
E: MAJOR=188
E: MINOR=0
E: SUBSYSTEM=tty
E: USEC_INITIALIZED=13148557437
E: ID_BUS=usb
E: ID_VENDOR_ID=1a86
E: ID_MODEL_ID=7522
E: ID_PCI_CLASS_FROM_DATABASE=Serial bus controller
E: ID_PCI_SUBCLASS_FROM_DATABASE=USB controller
E: ID_PCI_INTERFACE_FROM_DATABASE=XHCI
E: ID_VENDOR_FROM_DATABASE=QinHeng Electronics
E: ID_VENDOR=1a86
E: ID_VENDOR_ENC=1a86
E: ID_MODEL=USB_Serial
E: ID_MODEL_ENC=USB\x20Serial
E: ID_REVISION=0264
E: ID_SERIAL=1a86_USB_Serial
E: ID_TYPE=generic
E: ID_USB_INTERFACES=:ff0102:
E: ID_USB_INTERFACE_NUM=00
E: ID_USB_DRIVER=ch341
E: ID_USB_CLASS_FROM_DATABASE=Vendor Specific Class
E: ID_PATH=pci-0000:00:14.0-usb-0:6.4:1.0
E: ID_PATH_TAG=pci-0000_00_14_0-usb-0_6_4_1_0
E: ID_MM_CANDIDATE=1
E: DEVLINKS=/dev/ttyUSB22 /dev/serial/by-path/pci-0000:00:14.0-usb-0:6.4:1.0-port0 /dev/serial/by-id/usb-1a86_USB_Serial-if00-port0
E: TAGS=:systemd:
```

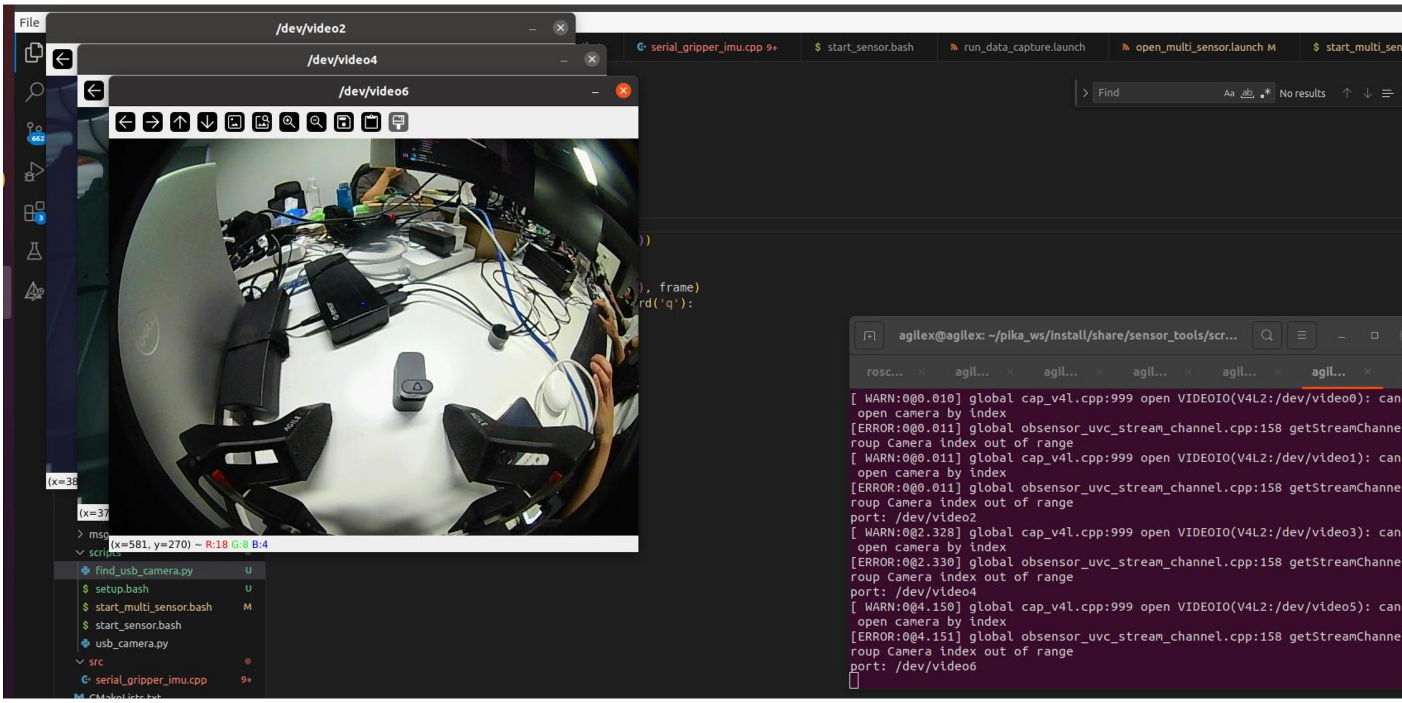
1-6.4:1.0 is the left USB port. The right gripper USB port is also available

2. Obtain the camera port

First insert the left clamp USB to the industrial computer (make sure that the industrial computer is connected to only one device), read the port of the left arm fisheye camera

```
cd ~/pika_ros/scripts/
python3 scripts/find_usb_camera.py
```

Press the 'q' button in the camera window until the fisheye camera screen is displayed, as shown in the following picture, then the fisheye camera is /dev/video6.



then, run

```
udevadm info /dev/video6
```

result shows below:

```
(base) agilex@agilex:/dev$ udevadm info /dev/video6
P: /devices/pci0000:00/0000:00:14.0/usb1/1-6/1-6.3/1-6.3:1.0/video4linux/video6
N: video6
L: 0
S: v4l/by-path/pci-0000:00:14.0-usb-0:6.3:1.0-video-index0
S: video22
S: v4l/by-id/usb-DECXIN_CAMERA_DECXIN_CAMERA_01.00.00-video-index0
E: DEVPATH=/devices/pci0000:00/0000:00:14.0/usb1/1-6/1-6.3/1-6.3:1.0/video4linux/video6
E: DEVNAME=/dev/video6
E: MAJOR=81
E: MINOR=6
E: SUBSYSTEM=video4linux
E: USEC_INITIALIZED=13148353802
E: ID_V4L_VERSION=2
E: ID_V4L_PRODUCT=DECXIN  CAMERA: DECXIN  CAMERA
E: ID_V4L_CAPABILITIES=:capture:
E: ID_VENDOR=DECXIN_CAMERA
E: ID_VENDOR_ENC=DECXIN\x20\x20CAMERA
E: ID_VENDOR_ID=1bcf
E: ID_MODEL=DECXIN_CAMERA
E: ID_MODEL_ENC=DECXIN\x20\x20CAMERA
E: ID_MODEL_ID=2cd1
E: ID_REVISION=0235
E: ID_SERIAL=DECXIN_CAMERA_DECXIN_CAMERA_01.00.00
E: ID_SERIAL_SHORT=01.00.00
E: ID_TYPE=video
E: ID_BUS=usb
E: ID_USB_INTERFACES=:0e0100:0e0200:
E: ID_USB_INTERFACE_NUM=00
E: ID_USB_DRIVER=uvcvideo
E: ID_PATH=pci-0000:00:14.0-usb-0:6.3:1.0
E: ID_PATH_TAG=pci-0000_00_14_0-usb-0_6_3_1_0
E: ID_FOR_SEAT=video4linux-pci-0000_00_14_0-usb-0_6_3_1_0
E: COLORD_DEVICE=1
E: COLORD_KIND=camera
E: DEVLINKS=/dev/v4l/by-path/pci-0000:00:14.0-usb-0:6.3:1.0-video-index0 /dev/video22 /dev/v4l/by-id/usb-DECXIN_CAMERA_DECXIN_CAMERA_01.00.00-video-index
E: TAGS=:uaccess:seat:
```

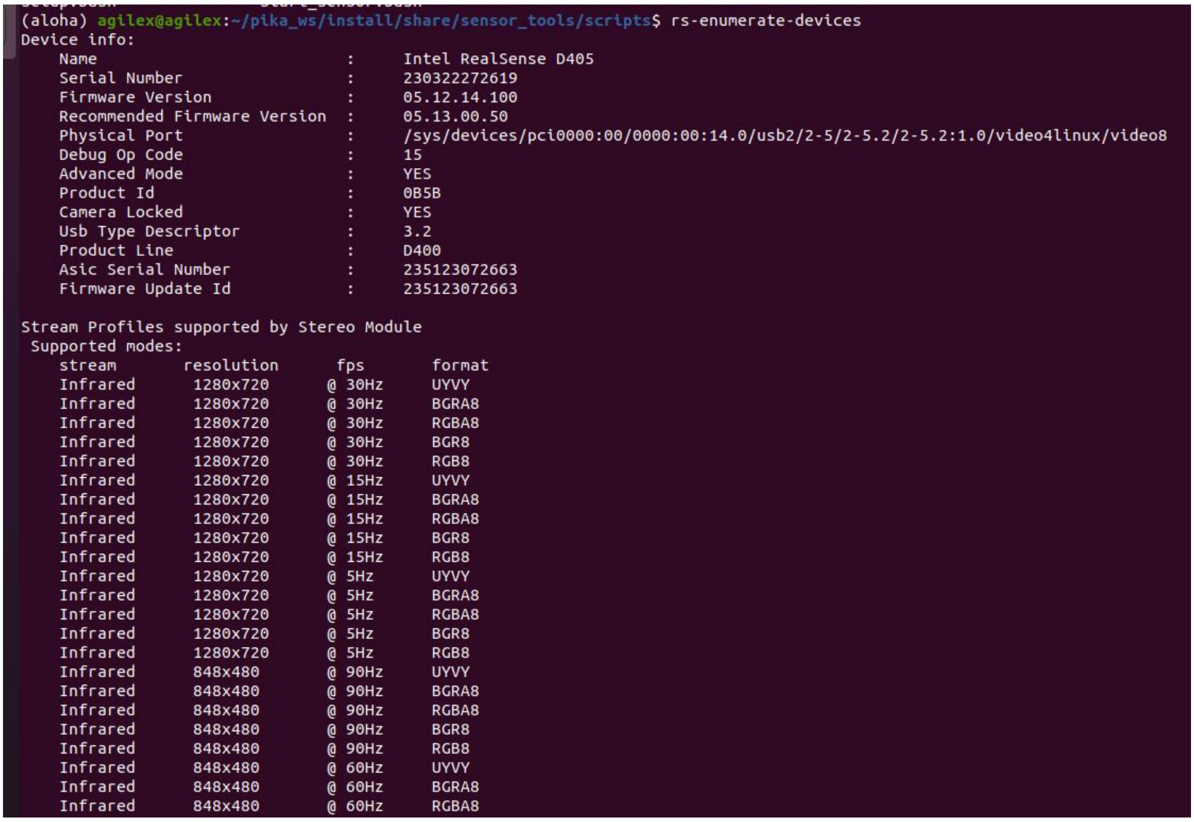
Where 1-6.3:1.0 is the port of the left gripper fisheye camera. The same goes for the right gripper fisheye camera port.

3. Obtain the serial number of the depth camera

First insert the left gripper USB to the industrial computer (make sure that the industrial computer is only connected to one device) and run

```
rs-enumerate-devices
```

result shows below:

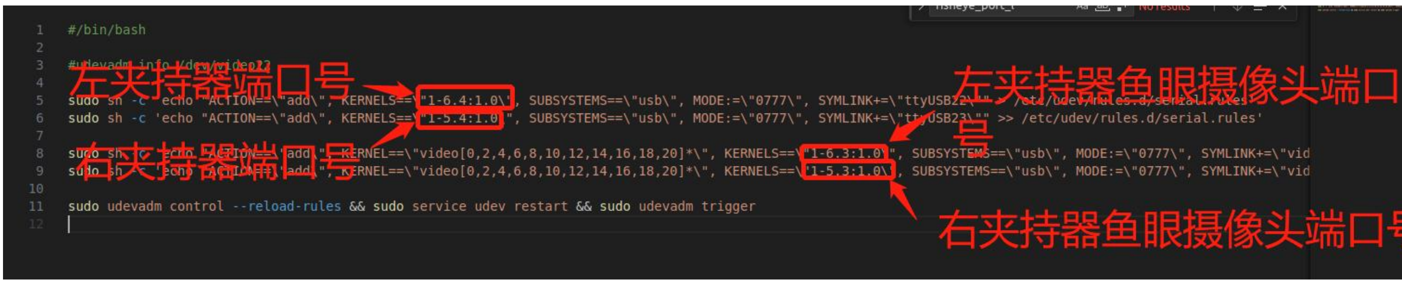


230322272619 is the serial number of the left gripper depth camera. Similarly, the serial number of the right clamp depth camera can be obtained.

In the end，run

```
gedit ~/pika_ws/install/share/sensor_tools/scripts/setup.bash
```

result shows below:

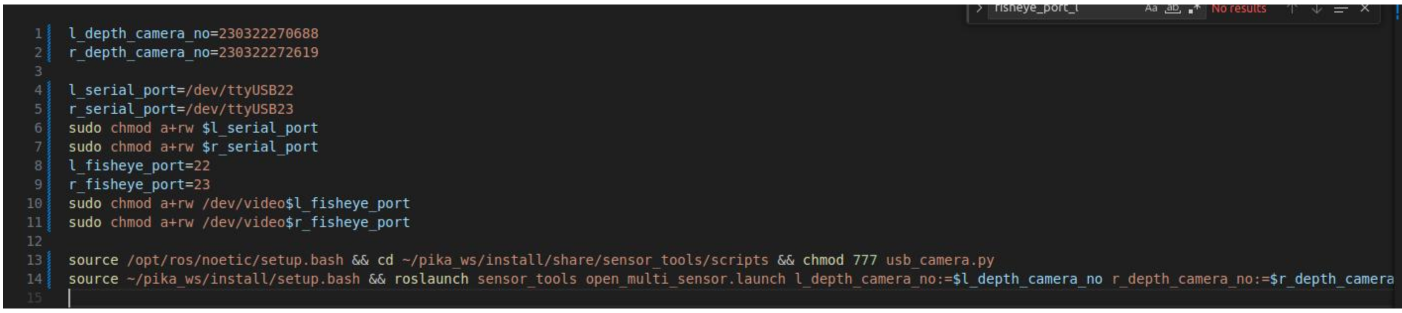


Fill in the required port number and save.

then, run

```
bash ~/pika_ros/scripts/setup.bash
gedit ~/pika_ros/scripts/start_multi_sensor.bash
```

result shows below:



```
l_depth_camera_no=230322270688
r_depth_camera_no=230322272619

l_serial_port=/dev/ttyUSB22
r_serial_port=/dev/ttyUSB23
sudo chmod a+rw $l_serial_port
sudo chmod a+rw $r_serial_port
l_fisheye_port=22
r_fisheye_port=23
sudo chmod a+rw /dev/video$l_fisheye_port
sudo chmod a+rw /dev/video$r_fisheye_port

source /opt/ros/noetic/setup.bash && cd ~/pika_ws/install/share/sensor_tools/scripts && chmod 777 usb_camera.py
source ~/pika_ws/install/setup.bash && roslaunch sensor_tools open_multi_sensor.launch l_depth_camera_no:=$l_depth_camera_no r_depth_camera_no:=$r_depth_camera
```

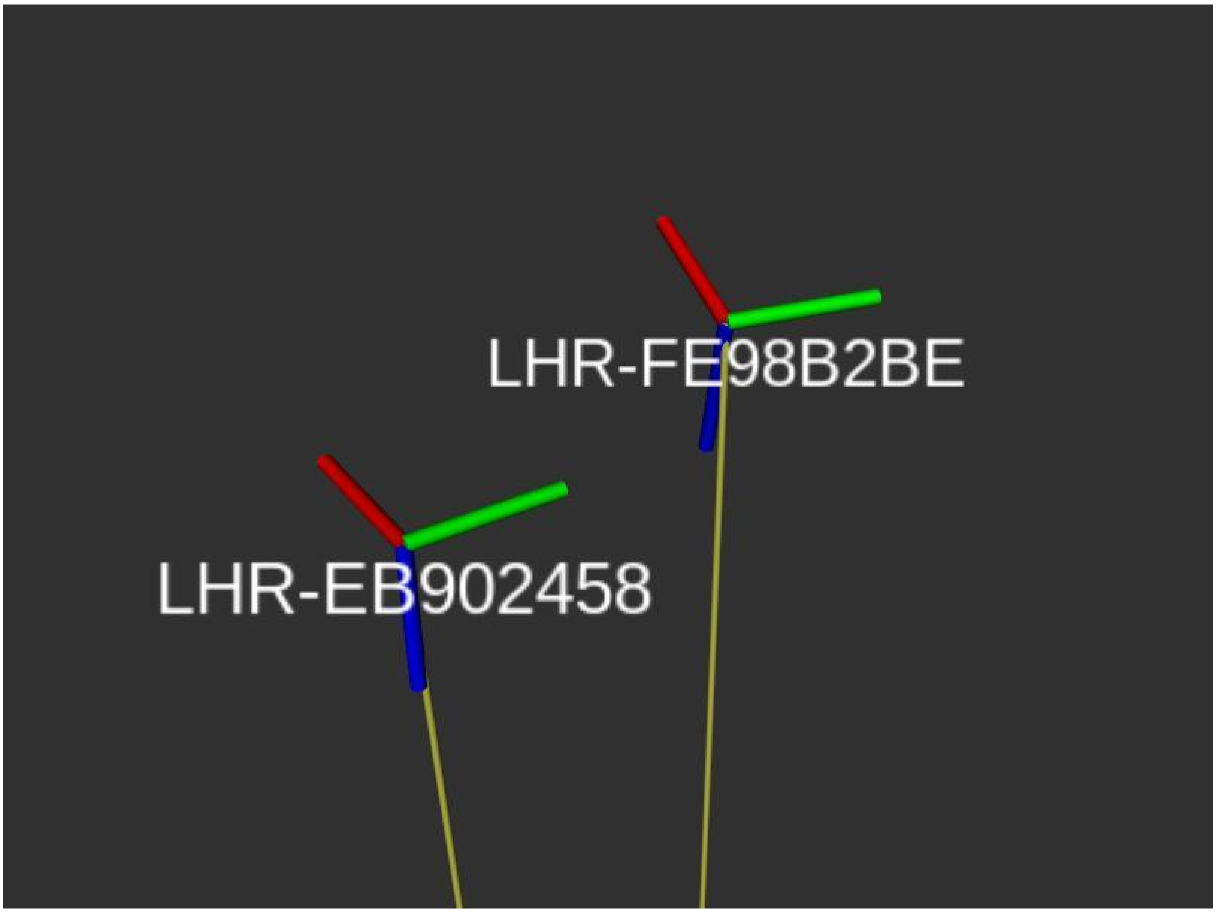
l_depth_camera_no Enter the serial number of the left clamp depth camera, and r depth camera no enter the serial number of the left clamp depth camera. Fill in as required and save.

2.7 Setting the Left and Right hand Locators

1. First calibrate the positioner.
2. Then, run the program to obtain the serial number of the left and right positioning tags, and use the serial number to distinguish the left and right hands.

```
roslaunch pika_locator get_code.launch
```

3. If all goes well, you will see in rviz in addition to the base link, there are two coordinate systems.



At this point move the pika and record the name of the coordinate system you want to set the left and right hand, for example: LHR-EB902458 is set to the left hand and LHR-FE98B2BE is set to the right hand. Then run the following command to write the left and right hand configurations into the environment variables:

```
echo 'export pika_L_code=LHR-EB902458' >> ~/.bashrc

echo 'export pika_R_code=LHR-FE98B2BE' >> ~/.bashrc

source ~/.bashrc
```

If **.bashrc** already has pika_L_code or pika_R_code, just change the value.

4. Run the left and right hand programs to see if they are wron

```
roslaunch pika_locator pika_double_tracker.launch
```

5. run here you can start to collect the data of the left and right hand.

At this point, all the preparatory work of the software is completed, and data collection can begin.

2.8 (Optional) Setting Camera Parameters

We default to a camera resolution of 640x480 and a frame rate of 30 FPS.
If this does not meet your needs, follow the steps below to modify the camera configuration parameters.
We offer two resolutions to choose from

Resolution	Frame rate
640x480	30/60/90
1280x720	30

run：

```
gedit ~/pika_ros/scripts/start_multi_sensor.bash
```

result shows below:

```
#/bin/bash
camera_fps=30
camera_width=640
camera_height=480
sudo sh -c 'echo "KERNEL==\"video*\", ATTRS{idVendor}==\"1bcf\", ATTRS{idProduct}==\"2c
sudo udevadm control --reload-rules && sudo service udev restart && sudo udevadm trigge

sudo chmod a+rw /dev/ttyUSB0
sudo chmod a+rw /dev/video22

source /opt/ros/noetic/setup.bash && cd ~/pika_ws/install/share/sensor_tools/scripts &&
source ~/pika_ws/install/setup.bash && roslaunch sensor_tools open_sensor.launch serial
```

Select the parameters suitable for you in the red box and fill in the parameters, camera_fps is the camera frame rate, camera_width is the image width, camera_height is the image height

Note:

The parameters of the Pika Sense and Pika Gripper are the same. Just refer to the above instructions

3 Data collection

3.1 Launch Software

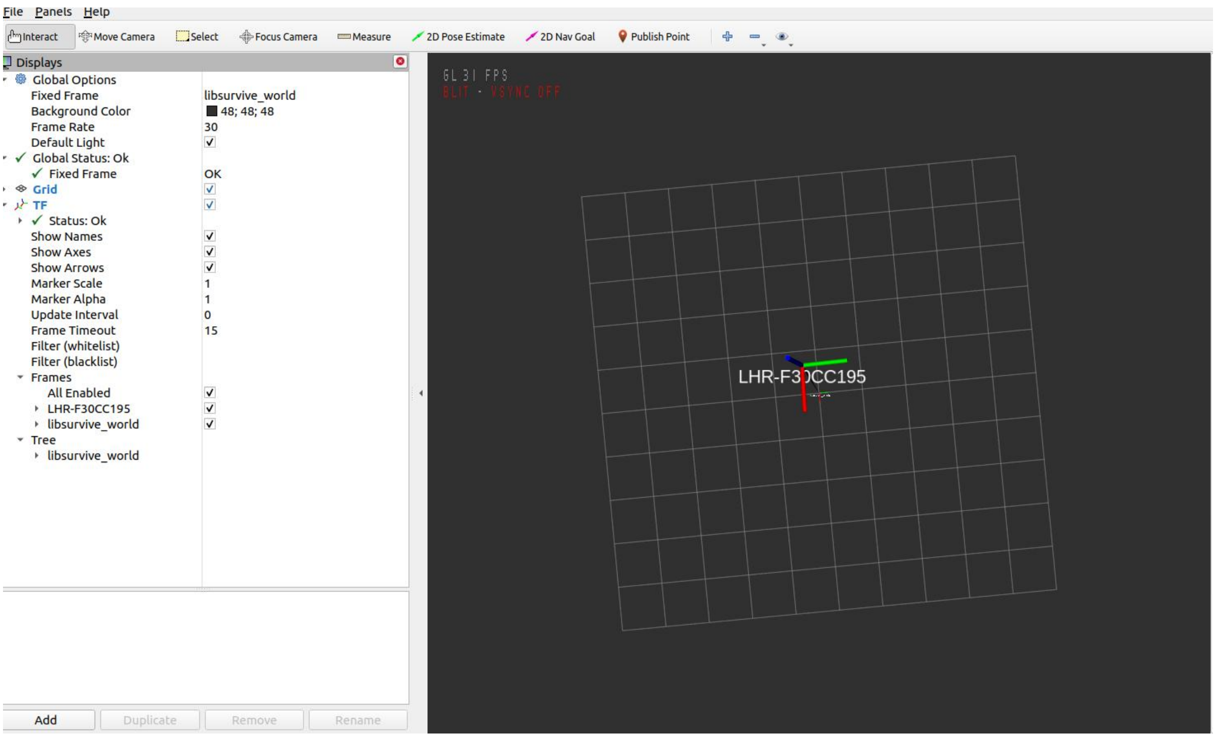
Ensure that the base station is powered on and the sensor devices are connected to the industrial control computer, then execute the startup command.
If you are using a Conda virtual environment, please exit the virtual environment first.

```
conda deactivate
```

Turn on the fisheye camera, gripper encoder, and pikaDepthCamera.

```
cd ~/pika_ws/install/share/sensor_tools/scripts/
bash start_sensor.bash  # Single gripper
bash start_multi_sensor.bash  # Double grippers
```

After running the startup code, the tf coordinates of pika are displayed in the RViz interface



Ensure that Pika's tf transformation in RViz is stable and free of anomalies.

If significant jitter occurs even in an unobstructed environment, recalibration is required.

3.2 Data Collection

Run the following command to perform data collection. The datasetDir parameter specifies the data dir ectory, while the episodeIndex parameter indicates the data group. Typically, data groups increment se quentially, with a setting of 0 representing group 0.

```
source ~/pika_ws/install/setup.sh
roslaunch data_tools run_data_capture.launch datasetDir:=/home/agilex/data episodeIndex:=0  #
Single gripper
roslaunch data_tools run_multi_data_capture.launch datasetDir:=/home/agilex/data
episodeIndex:=0  # Double grippers
datasetDir:=/home/agilex/data/episode0
```

If data collection program run successfully, the terminal shows as follow:

```
path: /home/agilex/data/episode0
 total time: 7.0014
topic: frame in 1 second / total frame
/camera/color/image_raw: 0 / 165
/camera_fisheye/color/image_raw: 0 / 0
/camera/depth/image_rect_raw: 0 / 165
/camera/depth/color/points: 0 / 165
/vive_pose: 0 / 0
/gripper/data: 0 / 367
/imu/data: 0 / 367
sum total frame: 1229
```

During the collection process, ensure that the "frame in 1 second" of each topic corresponds to the sen sor data frequency.

Press " Enter" to end the collection. The following information is displayed as the end of the collectio n

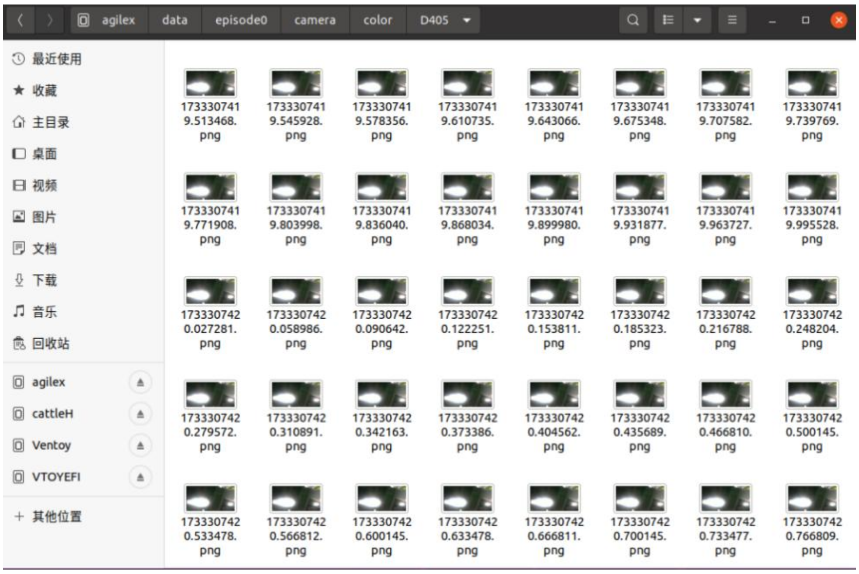
```
Done
[data_tools_dataCapture-1] process has finished cleanly
log file:
/home/noetic/.ros/log/21114750-1995-11ef-b6f1-578b5ce9ba2e/data_tools_dataCapture-1*.log
all processes on machine have died, roslaunch will exit
shutting down processing monitor...
... shutting down processing monitor complete
done
```

Sample data：

Save data directory:

Directory	Data Type	Description
/home/agilex/data/episode0/camera/color/pikaDepthCamera	.png	pikaDepthCamera Camera RGB data path
/home/agilex/data/episode0/camera/color/fisheye	.png	Fisheye camera RGB data path
/home/agilex/data/episode0/camera/depth/pikaDepthCamera	.png	pikaDepthCamera Camera depth data path
/home/agilex/data/episode0/camera/pointCloud/pikaDepthCamera	.pcd	pikaDepthCamera Camera pcd data path
/home/agilex/data/episode0/localization/pose/pikaLocator	.json	Locator data （position x、y、z、roll、pitch、yaw）
/home/agilex/data/episode0/gripper/encoder/pika	.json	Gripper opening and closing data （Motor angle、gripper distance）
/home/agilex/data/episode0/imu/9axis/pika	.json	Imu 9 axis （angular_velocity.x\y\z linear_acceleration.x\y\z orientation.x\y\z\w）

Take the RGB data of pikaDepthCamera as an example, with the timestamp as the file name, its structure is as follows:



⚠Common abnormal handling during data collection

- Q: The frame rate of the collected data is abnormal?
- A: Please check the stability of the wiring harness connection first, and check the data frame rate after re-plugging the wiring harness.

4 Data processing

4.1 Data Synchronism

Run the following command to synchronize data. The datasetDir parameter indicates the data directory. episodeIndex refers to the groups that need to synchronize data. If -1, Episodeindex refers to all data g roups in the datasetDir directory.

```
source ~/pika_ws/install/setup.sh
roslaunch data_tools run_data_sync.launch datasetDir:=/home/agilex/data/ episodeIndex:=-1  # Single gripper
roslaunch data_tools run_multi_data_sync.launch datasetDir:=/home/agilex/data/ episodeIndex:=-1  # Double grippers
```

After the synchronization is complete, a sync.txt file is generated in each specific data path. For example, the image data synchronization index file path: / home/agilex/data/episode0 / camera/color/pikaDepthCamera/sync. txt.

sync.txt file description:

Take the RGB data of the pikaDepthCamera as an example, and its sync.txt file is shown below. The fi le name is included. The number of lines in sync.txt after the sensor is synchronized is the same.

4.2 Data Conversion

4.2.1 Convert data to HDF5

Run the following command to generate the data.hdf5 file under each episode path. The datasetDir parameter indicates the data directory.

If use PCD data, first the pcd needs to be converted.

```
cd ~/pika_ros/scripts
python3 camera_point_cloud_filter.py --datasetDir $HOME/agilex/data/  # single gripper
python3 multi_camera_point_cloud_filter.py --datasetDir $HOME/agilex/data/  # double grippers
```

After that, convert to hdf5

```
cd ~/pika_ros/scripts
python3 data_to_hdf5.py --datasetDir $HOME/agilex/data/  # single gripper
python3 multi_data_to_hdf5.py --datasetDir $HOME/agilex/data/  # double grippers
```

If hdf5 data isn't used, it can directly be converted.

```
cd ~/pika_ros/scripts
python3 data_to_hdf5.py --datasetDir $HOME/agilex/data/ --useCameraPointCloud ""  # single gripper
python3 multi_data_to_hdf5.py --datasetDir $HOME/agilex/data/ --useCameraPointCloud ""  # double grippers
```

The data.hdf5 file contains synchronized image path indexes, pose data, and more.
Document description:

Name	Type	Dime	Description

		nsion	
camera/color/pikaDepthCamera	String	(n,)	pikaDepthCamera Camera RGB data path
camera/color/fisheye	String	(n,)	Fisheye camera RGB data path
camera/depth/pikaDepthCamera	String	(n,)	pikaDepthCamera Camera depth data path
camera/pointCloud/pikaDepthCamera	String	(n,)	pikaDepthCamera Camera point cloud dat a path
localization/pose/pikaLocator	Float	(n,6)	The locator data x\y\z\roll\pitch\yaw
gripper/encoderAngle/pika	Float	(n,)	Gripper opening and closing distance
gripper/encoderDistance/pika	Float	(n,)	Angle of gripper opening and closing mot or
imu/9axisAngularVelocity/pika	Float	(n,3)	Imu 9 axis angular_velocity.x\y\z
imu/9axisOrientation/pika	Float	(n,4)	Imu9 orientation.x\y\z\w
imu/9axisLinearAcceleration/pika	Float	(n,3)	Imu9 axis acceleration x\y\z
size	Int	(n,)	Data collection step size

4.2.2 Data conversion to Lerobot data

4.2 Data replay

Please ensure that data has been synchronized.
Run the following command to replay the data by reading sync.txt. The datasetDir parameter indicates the data directory. The episodeIndex argument is the group of data that needs to be replayed.

```
source ~/pika_ros/install/setup.sh
roslaunch data_tools run_data_publish.launch datasetDir:=$HOME/agilex/data/ episodeIndex:=0
# single gripper
roslaunch data_tools run_multi_data_publish.launch datasetDir:=$HOME/agilex/data/
episodeIndex:=0  # double gripper
```

If the data has generated HDF5, you can also use the following command to replay the data by reading HDF5. The datasetDir parameter indicates the data directory. The episodeIndex argument is the group of data that needs to be replayed.

```
roscore
cd ~/pika_ros/scripts
python3 data_publish.py --datasetDir $HOME/agilex/data/ --episodeIndex 0  # single gripper
python3 multi_data_publish.py --datasetDir $HOME/agilex/data/ --episodeIndex 0 # double
grippers
```

The data from the replay will be republished as a topic, which can be viewed by subscribing to the topi c.

4.3 Data loading

Load data during training

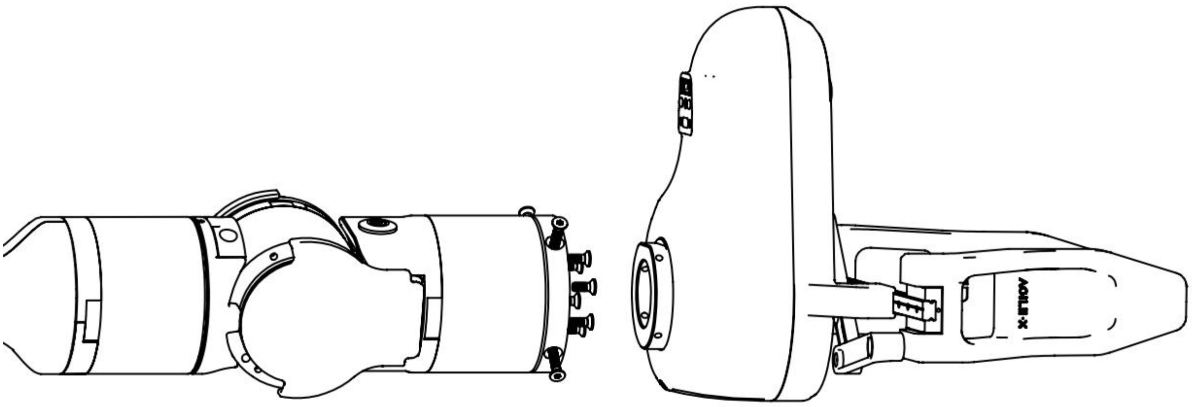
To provide an example of loading data, refer to the ~/pika ws/install/share/data tools/scripts/load data example.py file. Run the following command to test loading data. The datasetDir parameter indicates the data directory.

```
python3 load_data_example.py --datasetDir $HOME/agilex/data/
```

5 The use of actuators: Gripper

5.1 Structural assembly

Pika Gripper is suitable for end-installation of various operators. Here, the Piper arm of the loose robot is taken as an example. As shown in the figure below, the end of the Gripper is reserved for installation holes, and the side is reserved for 4 M3 threaded through holes, which need to be assembled by means of flanges. The flange structure needs to be designed according to the installation holes at the end of the manipulator or other operators.



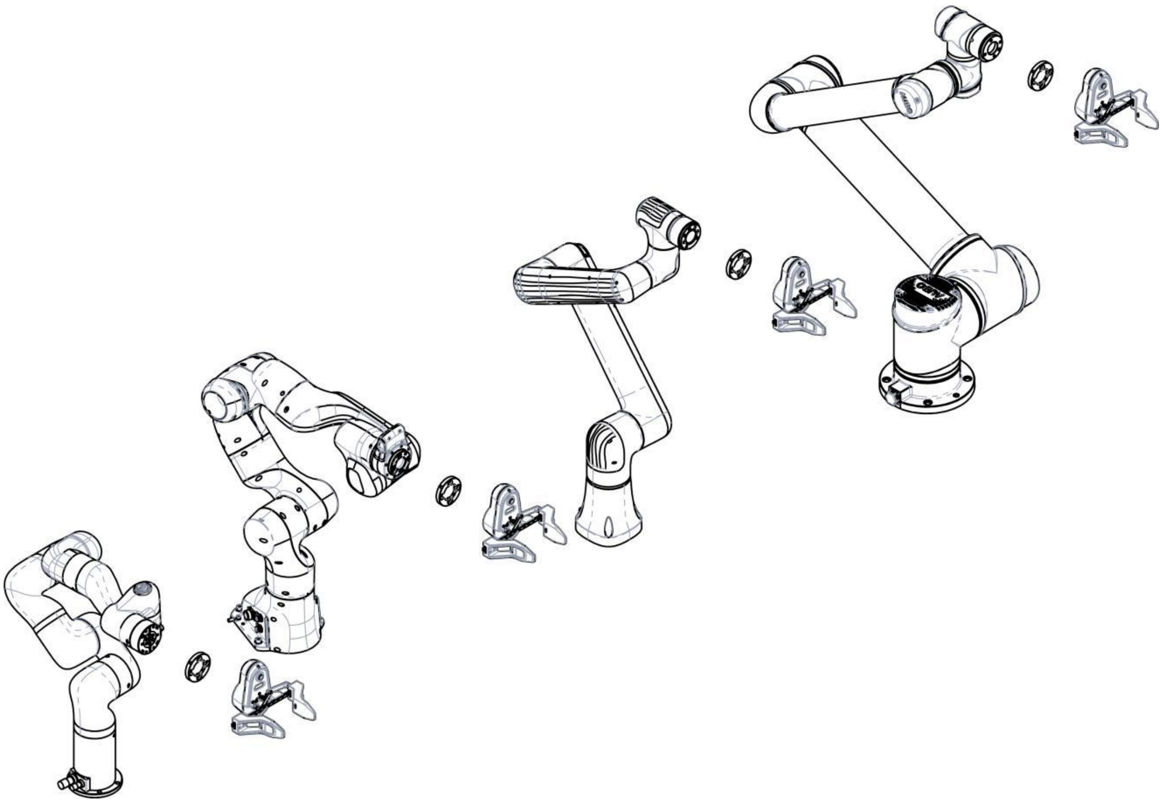
Pika Gripper and other robotic arms installation instructions

When installing Gipper with other robotic arms, you only need to install an adapter flange. Currently, all flanges can be used with most industrial-grade robot arms, and special robot arms can also be customized with flanges.

Installation steps:

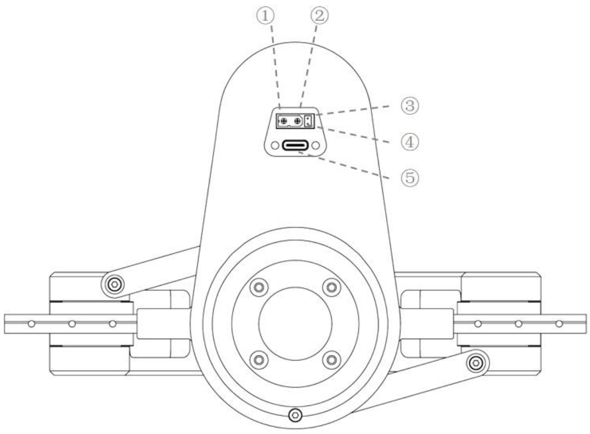
●First install the flange to the end of the robot arm

●Then install Pika Gripper and the flange



5.2 Electrical Connection

Electrical connection: Use the XT30 series female head to insert the XT30 2+2 port of the Pika Gripper and connect the 24V power supply (see the following figure for the line sequence). The Type of power supply interface is XT30(PB), in which the multiplexed communication port is not used, the communication and control interface uses the Type-C interface for communication, and can be connected with a USB3.0 cable harness and a clamp claw. Power interfaces and interface definitions are as follows:



1	24V＋	4	CAN-H（Reserved）
2	24V－	5	TPYE-C
3	CAN-L（Reserved）	---	---

5.3 Communication connection

Communication connection: Type-C wiring harness in Figure 5 is connected to the industrial computer. If you prepare your own computer to connect to the collector, the software and hardware requirements are as follows:

Software and hardware requirements	Refer to this parameter
PC chip architecture	X86
PC storage	1TB above
PC port	USB3.1 x 3
OS	Ubuntu20.04
ROS version	ROS1-noetic

5.4 ROS packages for actuators

The actuator does not need to use a positioning tag. Before using the actuator, ensure that the actuator is powered on. If the left and right actuators are used, modify the file

gedit ~/pika_ros/scripts/setup.bash   and

gedit ~/pika_ros/scripts/start_multi_gripper.bash

After that, open the fisheye camera, pikaDepthCamera and motor control serial port:

```
cd ~/pika_ws/install/share/sensor_tools/scripts/
bash start_gripper.bash  # single gripper
bash start_multi_gripper.bash  # double gripper
```

Control motor：

1. Disabled: Post topic /gripper/ctrl message as follows:

```
(base) agilex@agilex:~/pika_ws$ rostopic pub /gripper/ctrl sensor_tools/Gripper "he
ader:
  seq: 0
  stamp: {secs: 0, nsecs: 0}
  frame_id: ''
angle: 0.0
distance: 0.0
effort: 0.0
velocity: 0.0
enable: false
setZero: false"
```

In the case of dual actuators, the topic of the left actuator is /gripper l/ctrl, and the topic of the right actuator is /gripper r/ctrl.

2. Enable: Publish Topic /gripper/ctrl as follows：

```
(base) agilex@agilex:~/pika_ws$ rostopic pub /gripper/ctrl sensor_tools/Gripper "he
ader:
  seq: 0
  stamp: {secs: 0, nsecs: 0}
  frame_id: ''
angle: 0.0
distance: 0.0
effort: 0.0
velocity: 0.0
enable: true
setZero: false"
```

In the case of dual actuators, the topic of the left actuator is /gripper l/ctrl, and the topic of the right actuator is /gripper r/ctrl.

3. Control motor Angle: Publish topic /gripper/ctrl message below：

```
(base) agilex@agilex:~/pika_ws$ rostopic pub /gripper/ctrl sensor_tools/Gripper "he
ader:
  seq: 0
  stamp: {secs: 0, nsecs: 0}
  frame_id: ''
angle: 1.0
distance: 0.0
effort: 0.0
velocity: 0.0
enable: true
setZero: false"
```

电机角度 Motor angle

In the case of dual actuatorss, the topic of the left actuator is /gripper l/ctrl, and the topic of the right actuator is /gripper r/ctrl.
Or post a topic /joint states message as follows:

```
(base) agilex@agilex:~/pika_ws$ rostopic pub /joint_states sensor_msgs/JointState
"header:
  seq: 0
  stamp: {secs: 0, nsecs: 0}
  frame_id: ''
name: ['']
position: [1.2]
velocity: [0]
effort: [0]"
```

电机角度 Motor angle

In the case of dual actuators， the left actuator topic is /joint_states_l and the right actuator topic is /joint_states_r.

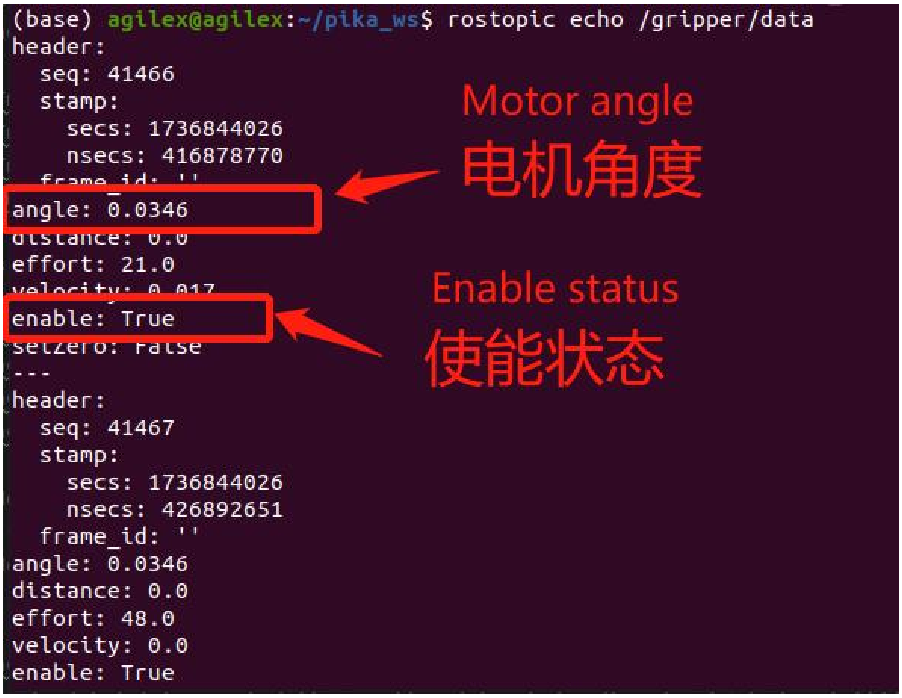
4. Set zero position: Please enable it first, close the claw, and then set zero. Publish the topic /gripper/ctrl message as follows:

```
(base) agilex@agilex:~/pika_ws$ rostopic pub /gripper/ctrl sensor_tools/Gripper "he
ader:
  seq: 0
  stamp: {secs: 0, nsecs: 0}
  frame_id: ''
angle: 0.0
distance: 0.0
effort: 0.0
velocity: 0.0
enable: false
setZero: true"
```

In the case of dual actuators, the topic of the left actuator is /gripper l/ctrl, and the topic of the right actuator is /gripper r/ctrl.
Subscribe to Motor
Information:

```
rostopic echo /gripper/data  # single gripper
rostopic echo /gripper_l/data  # double gripper, left
rostopic echo /gripper_r/data  # double gripper, right
```

output data shows as follow:



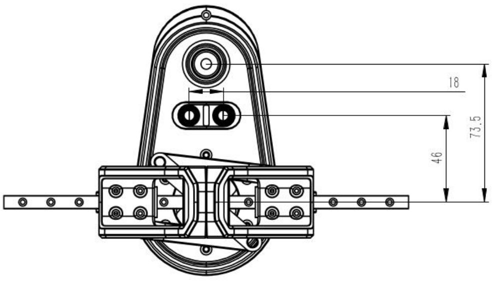
or:

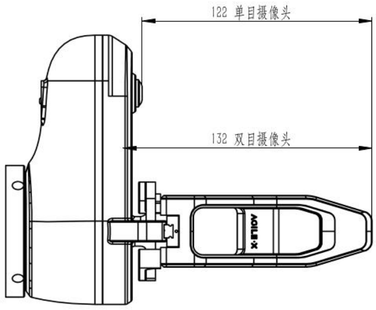
```
rostopic echo /gripper/joint_states  # single gripper
rostopic echo /gripper_l/joint_states  # double gripper, left
rostopic echo /gripper_r/joint_states  # double gripper, right
```

output data shows as follow:

5.5 The internal and external parameters of the actuator are described

The distance from the camera to the center of the gripper (unit: mm), without any deflection, as shown in the figure below:





The transformation matrix from camera to gripper center can be obtained.

6 Use Pika sense to teleoperate Piper arm

6.1 Preparation

Before starting the teleoperation, you need to enable the robot arm CAN module. The enabling methods for single arm and dual arms are slightly different.

1. Enable CAN module

https://github.com/agilexrobotics/piper_ros/blob/noetic/README(EN).md

Please refer to section 2.1 to enable the can module.

If you teleoperate a single arm, the CAN port name should be can0.

If you teleoperate dual arms, the CAN modules should be left_piper and right_piper deperately.

2. Configure environment

```
conda create -n tv python=3.9
conda activate tv
conda install pinocchio -c conda-forge
pip install meshcat
pip install casadi
```

6.2 Teleoperate single arm

After enabling the CAN module, run:

```
roslaunch pika_locator teleop_single_piper.launch
```

After starting the program, the robot arm will go to the initial position. Just hold Pika and quickly close its gripper to the center twice to start teleoperation.
After starting teleoperation, follow the same steps as above to return the robot arm to its initial position.

6.3 Teleoperate dual arms

To teleoperate the two arms, you need to set the port numbers of the left and right grippers. For specific operations, see [2.6 Setting the left and right hand cameras].
After successfully enabling the CAN modules of the left and right robotic arms, run the command

```
roslaunch pika_locator teleop_double_piper.launch
```

After starting the program, the robot arm will go to the initial position. Just hold Pika and quickly close its gripper to the center twice to start teleoperation.
After starting teleoperation, follow the same steps as above to return the robot arm to its initial position.

7 Common problem handing

7.1 Daily Maintenance Guide

1 Base station daily cleaning:：

Ensure to keep the base station and its power adapter dry and away from liquids to avoid electric shock injury. Follow these steps to clean the base station:

Unplug and remove base station.

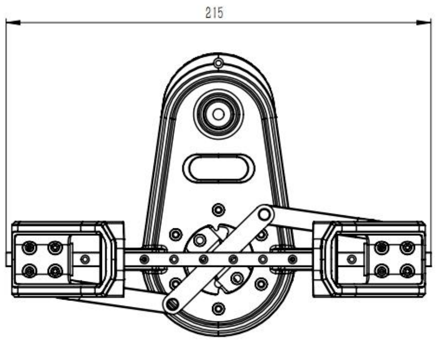
Use a non-abrasive cleaning cloth dampened with a small amount of water to clean the base station. Do not use cleaning agents.

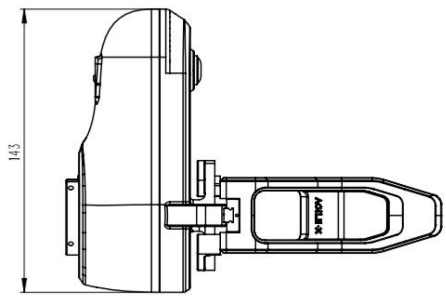
When cleaning the base station, do not scratch the front panel or remove any of its components.

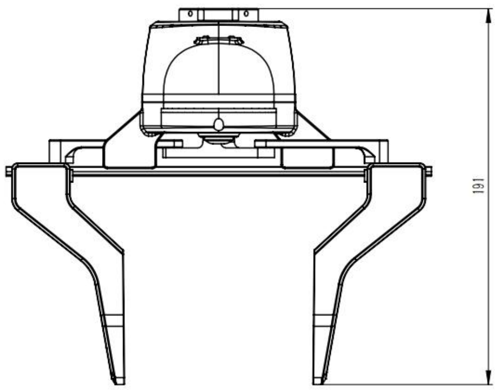
7.2 Common problems and solutions

Appendix 1：Dimensional Drawing

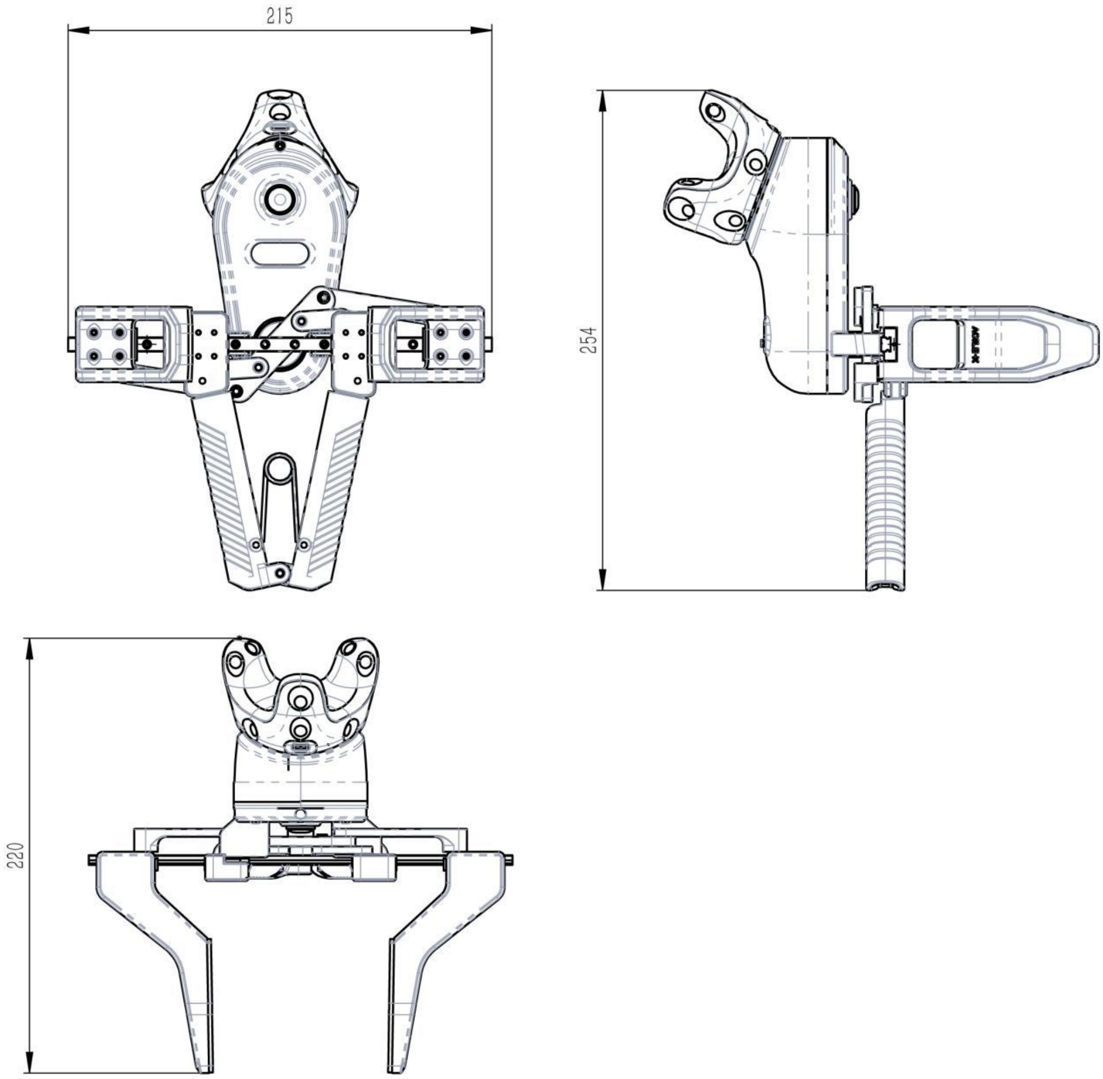
Pika Gripper



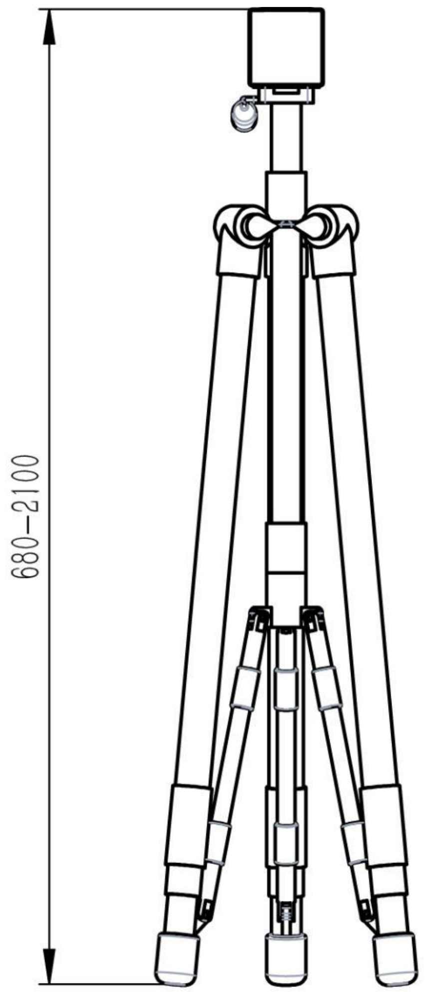


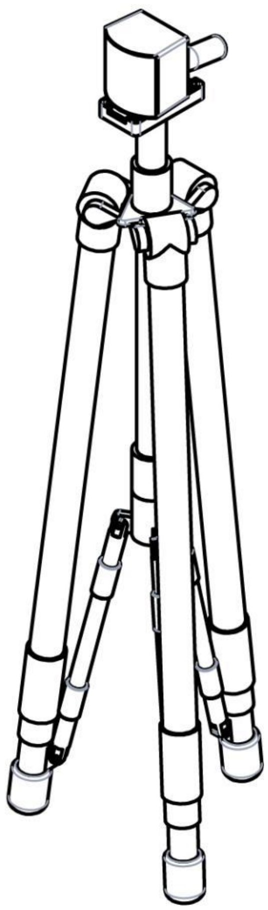


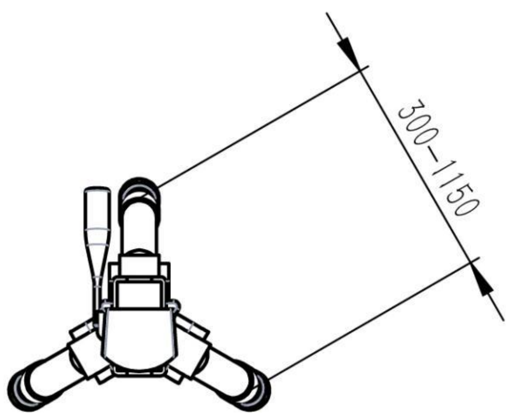
Pika Sense



Pika Station







Appendix 2： Recommended configuration scheme

configuration scheme	configuration list	applicable scene

Configu ration 1	Recommend ed configura tion	Pika Station X 2 Pika Sense X 1 Pika Gripper X1 Piper X 1	Single-arm Pick Place and operation scenario, collect data with a single data collector, and then install the actuator to the robot arm for data inference; Among them, the computer/industrial computer for data acquisition and storage needs to be provided by oneself, the robot arm needs to be prepared by oneself, and the industrial computer or computing card for model reasoning needs to be configured by oneself. Meet the work space coverage of 6*6M
Configu ration 2	routine confi guration	Pika Station X 2 Pika Sense X 2 Pika Gripper X 2	The complex operation scenario of double-arm Pick Place, using two data acquisition for double collectors to collect data synchronously, and then using actuators to install to the robot arm for data inference; Among them, the computer/industrial computer for data acquisition and storage needs to be provided by oneself, the robot arm needs to be prepared by oneself, and the industrial computer or computing card for model reasoning needs to be configured by oneself. It is expected to meet 5*5M work space co verage;
Configu ration 3	Large space configuratio n	Pika Station X 4 Pika Sense X 2 Pika Gripper X 2	The complex operation scenario of double-arm Pick Place, using two data acquisition for double collectors to collect data synchronously, and then using actuators to install to the robot arm for data inference; Among them, the computer/industrial computer for data acquisition and storage needs to be provided by oneself, the robot arm needs to be prepared by oneself, and the industrial computer or computing card for model reasoning needs to be configured by oneself. It is expected to meet 10*10M working sp ace coverage;
Configu ration 4	Whole set co nfiguration	Pika Station X 2 Pika Sense X 1 Pika Gripper X1 Pika Package X1 Piper Arm X1	