AI ToF People Counting Sensor

VS133-P

User Guide

Safety Precautions

Milesight will not shoulder responsibility for any loss or damage resulting from not following the instructions of this operating guide.

❖ Though the device is compliant with Class 1 (IEC/EN 60825-1:2014), please DO NOT look at the ToF sensor too close and directly.

❖ The device must not be disassembled or remodeled in any way.

❖ To avoid risk of fire and electric shock, do keep the product away from rain and moisture before installation.

❖ Do not place the device where the temperature is below/above the operating range.

❖ Do not touch the device directly to avoid the scalds when the device is running.

❖ The device must never be subjected to shocks or impacts.

❖ Make sure the device is firmly fixed when installing.

❖ Do not expose the device to where laser beam equipment is used.
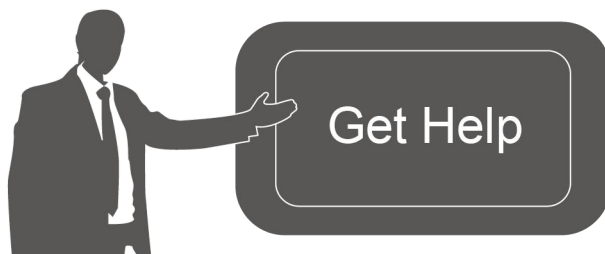
❖ Use a soft, dry cloth to clean the lens of the device.

Declaration of Conformity

VS133-P is in conformity with the essential requirements and other relevant provisions of the CE, FCC, and RoHS.
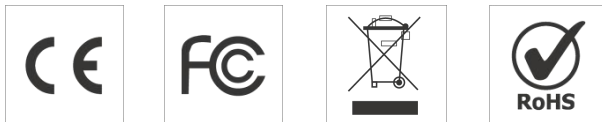
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Revision History

Date	Doc Version	Description
May 24, 2023	V 1.0	Initial version
Aug. 10, 2023	V 1.1	1. Add staff lanyard accessory; 2. Add multi-device stitching feature; 3. Add installation height detection feature; 4. Add DHCP feature; 5. Display HTTP/MQTT connection status and support data re-transmission feature; 6. Add DST time feature; 7. Add ToF frequency setting.

Contents

1. Product Introduction

1.1 Overview

VS133-P is a sensor that uses second-generation ToF technology to accurately count people. This technology provides more precise depth maps and longer detection distances while maintaining an excellent privacy protection rate. The advanced ToF technology combined with an AI algorithm enables the sensor to handle complex scenes and distinguish non-human objects with up to 99.8% accuracy. With easy installation, VS133-P is ideal for entrances or corridors in retail stores, malls, offices, subways, and other locations.

1.2 Key Features

- Up to 99.8% accuracy combining the 2nd generation ToF technology and AI algorithm
- Allow to collect people counting data by differentiating between children and adults and detecting staffs via identification features for clearer people analysis
- Support the linking of multiple devices to expand coverage
- Wider field angle to obtain longer-distance depth maps and cover a larger area
- Working well even in low-light or completely dark environments with great lighting adaptability
- Free from privacy concerns without image capturing
- Smart U-turn counting to filter redundant counting of people wandering in the area
- High compatibility of data transmission from Ethernet port (HTTP/MQTT/CGI)
- Various serial ports are equipped
- Support local data storage and data retransmission to collect data securely
- Easy configuration via Ethernet port for web GUI configuration
- Quick and easy management with Milesight DeviceHub

2. Hardware Introduction

2.1 Packing List

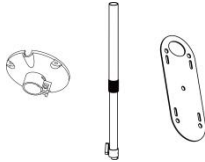| 1 × VS133-P Device | 4 × Ceiling Mounting Kits | 1 × Mounting Sticker | 8 × Staff Tags |

| 1 × Multi-interface Cable | 1 × Warranty Card | 1 × Quick Guide |

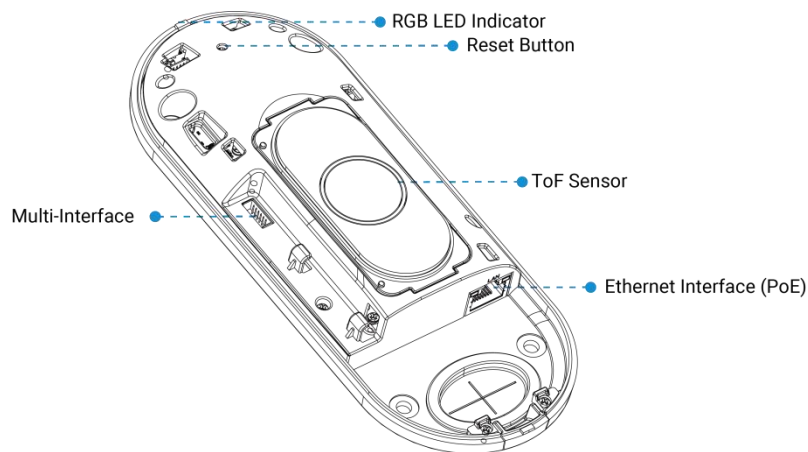| 1 × VB01 Multifunctional Bracket Kit(Optional) | 8 × Staff Lanyards (Optional) |

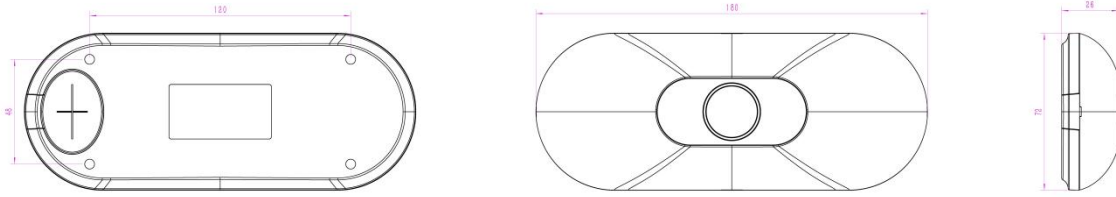⚠️ **If any of the above items is missing or damaged, please contact your sales representative.**

2.2 Hardware Overview

- RGB LED Indicator
- Reset Button
- ToF Sensor
- Multi-Interface
- Ethernet Interface (PoE)

2.3 Reset Button

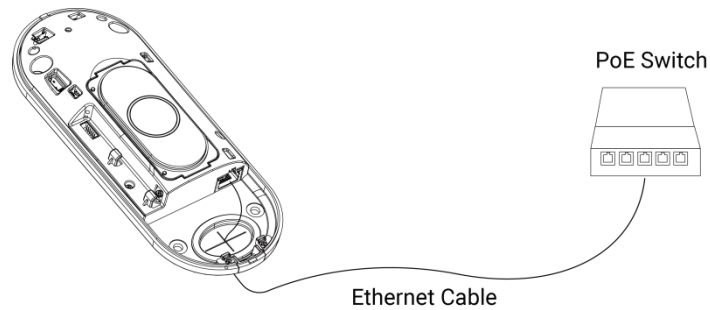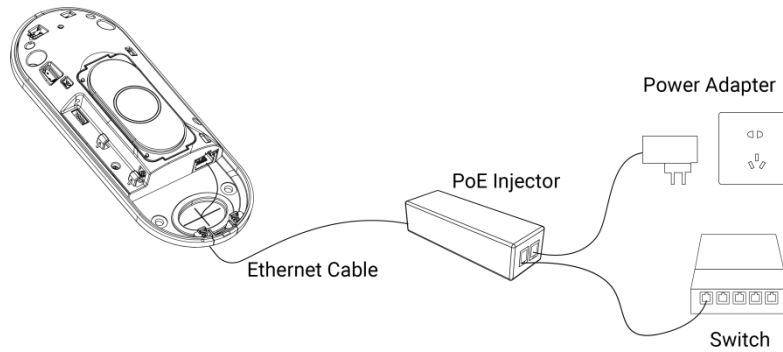| Function	Action	LED Indication
Reset to Factory Default	Press and hold the reset button for more than 10 seconds.	Green Blinks.

2.4 Dimensions (mm)

3. Power Supply

VS133-P can be powered by 802.3at PoE+. Choose one of the following methods to power up the device.

● **Powered by a PoE Switch**


● **Powered by a PoE Injector**

4. Access the Sensor

VS133-P sensor provides user-friendly web GUI for configuration and users can access it via Ethernet port. The recommended browsers are Chrome and Microsoft Edge. The default IP of Ethernet port is **192.168.5.220** (can be found on the device label).

Step 1: Power on the device and connect the Ethernet port to a PC.
Step 2: Change the IP address of computer to 192.168.5.0 segment as below:
    a.   Go to **Start➔ Control Panel➔ Network and Internet ➔ Network and Sharing Center➔ Ethernet➔ Properties➔ Internet Protocol Version 4 (TCP/IPv4)**.
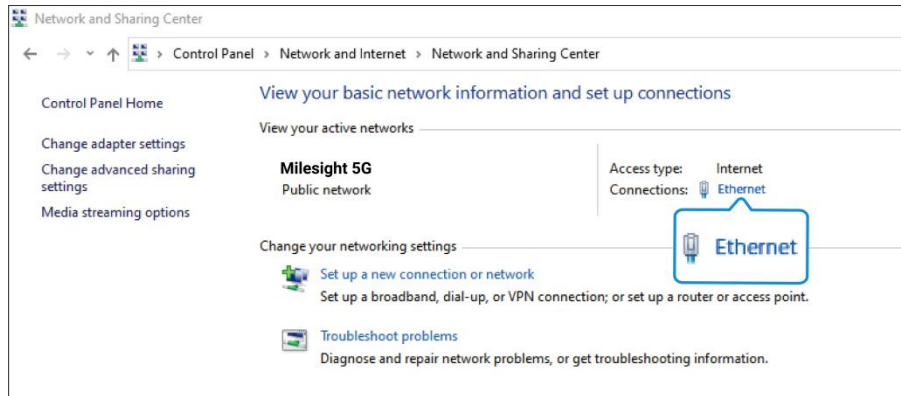
b. Enter an IP address that in the same segment with sensor (e.g. 192.168.5.61, but please note that this IP address shall not conflict with the IP address on the existing network);
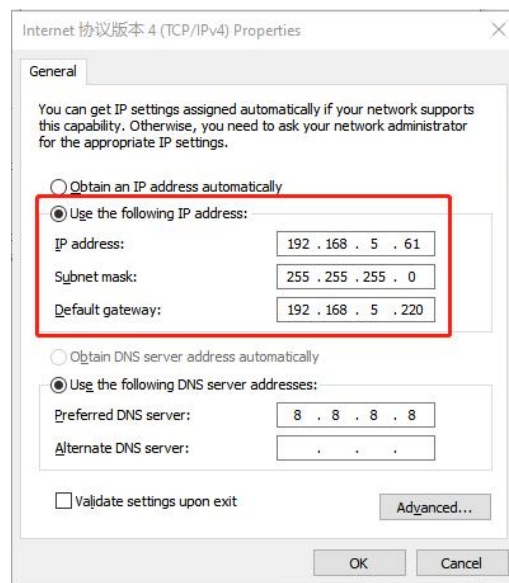

Step 3: Open the Browser and type 192.168.5.220 to access the web GUI.

Step 4: Select the language.

Step 5: Users need to set the password and three security questions when using the sensor for the first time (three questions can be skipped by refreshing webpage). After configuration, log in with username (admin) and custom password.

Note:

1) Password must be 8 to 16 characters long, which contains at least two kinds or more in combination with numbers, lowercase letters, uppercase letters and special characters .

2) You can click the "forgot password" in login page to reset the password by answering three security questions when you forget the password if you set the security questions in advance.
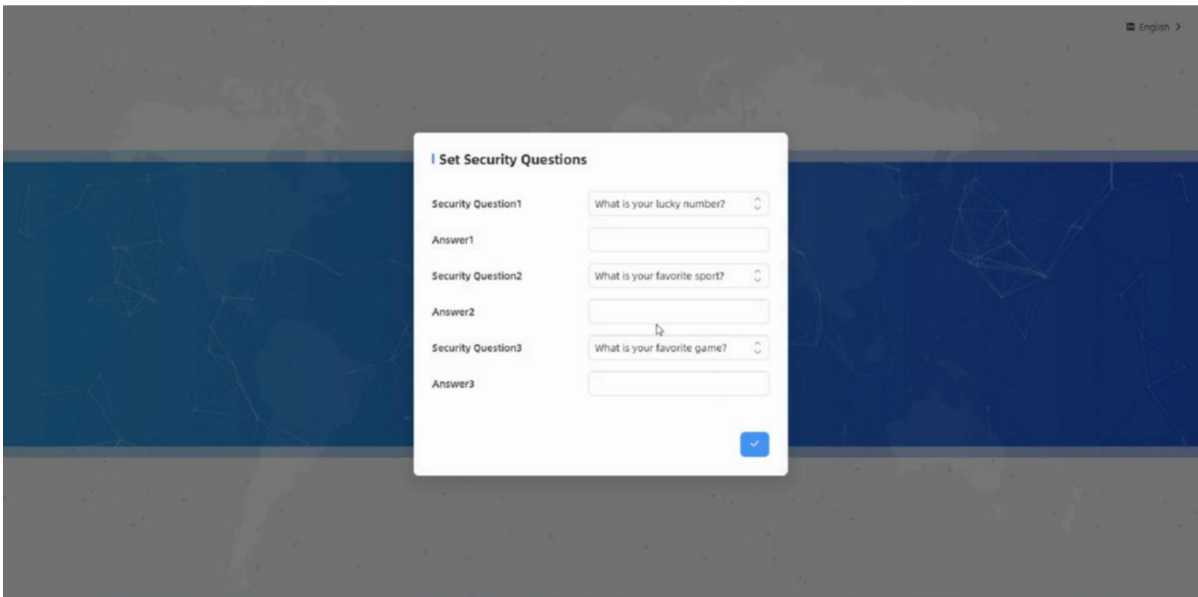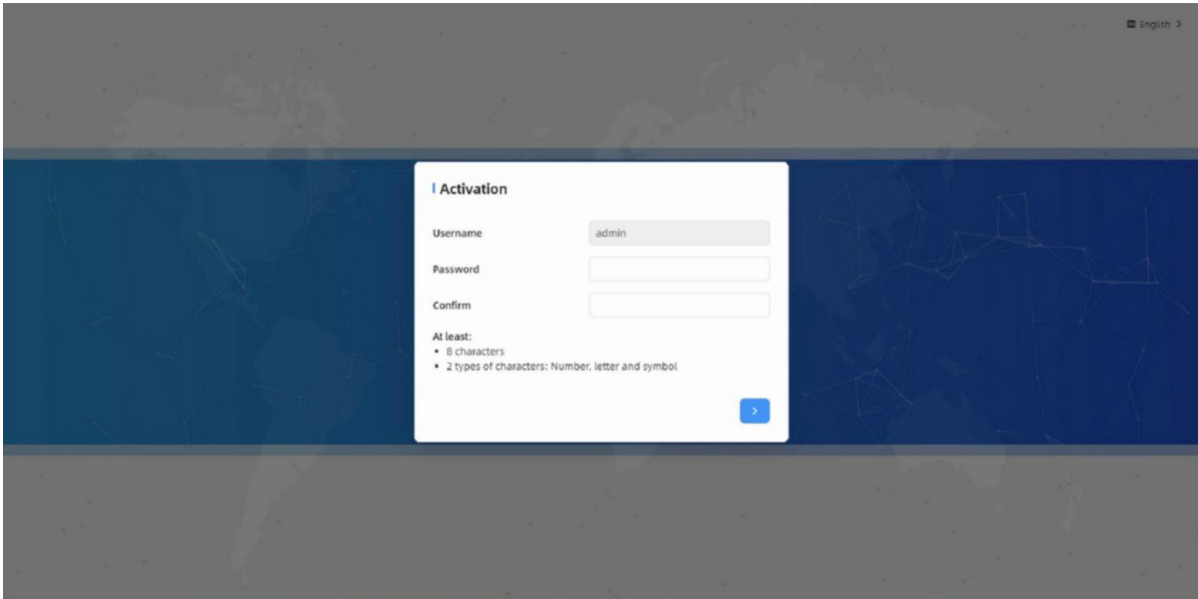
5. Operation Guide

5.1 Dashboard

After logging on to the device web GUI successfully, user is allowed to view live video as follows.
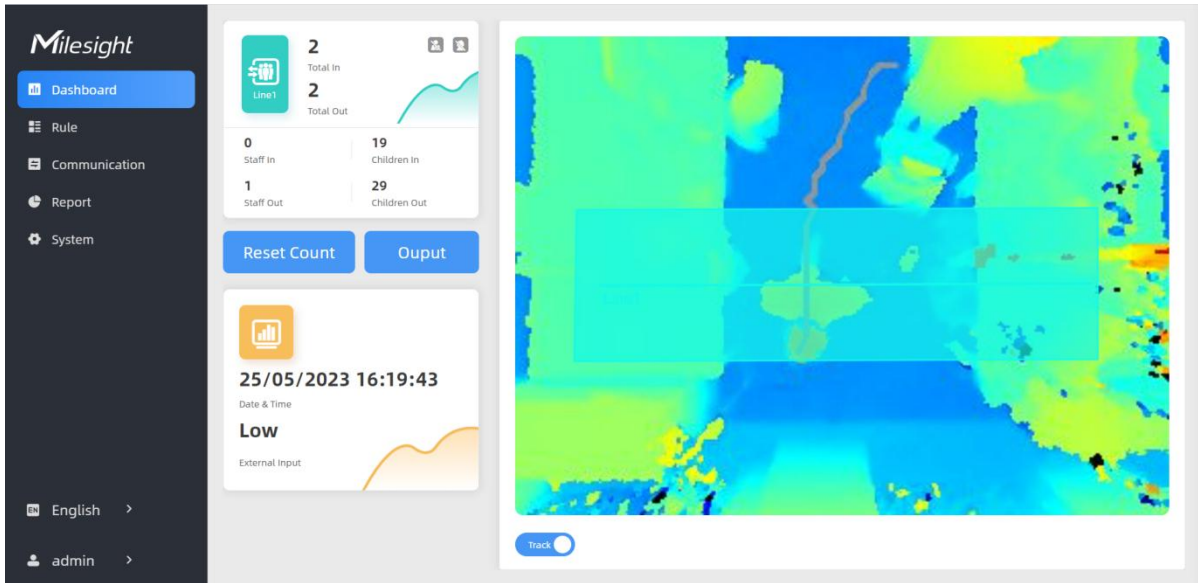
| Parameters	Description
Reset Count	Clear all accumulated entrance and exit people counting values.
Output	Click to output a 5s high level signal from alarm out interface. **Alarm Output:** dry contact, output=two contacts closure
Track	When enabled, there is tracking line when people pass the detection area.

Note: When working mode is Node mode, the device will not show people counting data.
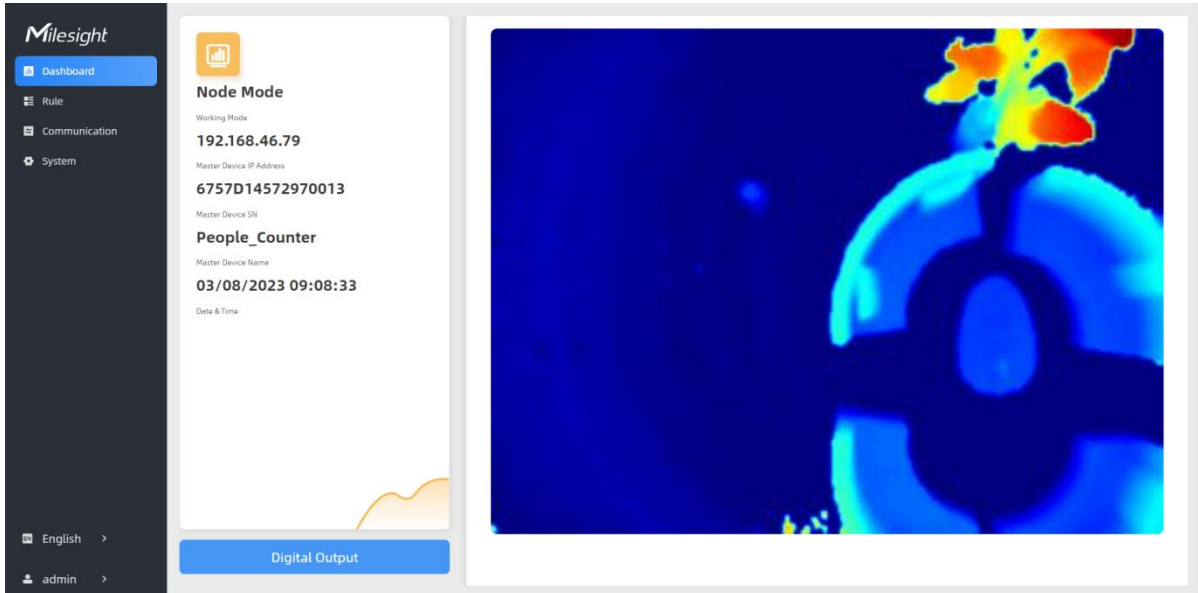
5.2 Rule

VS133-P supports 3 working modes:

Standalone Mode: works as a standalone device to count people.

Master Mode: works as a master device to receive live view and tracks from other node devices.
One master device can connect 3 node devices at most.

Node Mode: works as a node device to forward live view and tracks to the master device.

5.2.1 Basic Counting Settings

Draw Detection Lines

Users can draw detection lines to record the people count values which indicate the number of people enter or exit.

Step 1: Click **Draw Detection Lines.**

Step 2: Left-click to start drawing and drag the mouse to draw a line, left-click again to continue drawing a different direction edge, and right-click the mouse to complete the drawing. The line can be dragged to adjust the location and length. One device supports at most 4 broken lines with maximum 4 segments each.

Step 3: If users need to delete the line, click **Draw Detection Lines** and select the line which need to be deleted, then click **Clear This Line** or click **Clear All**.
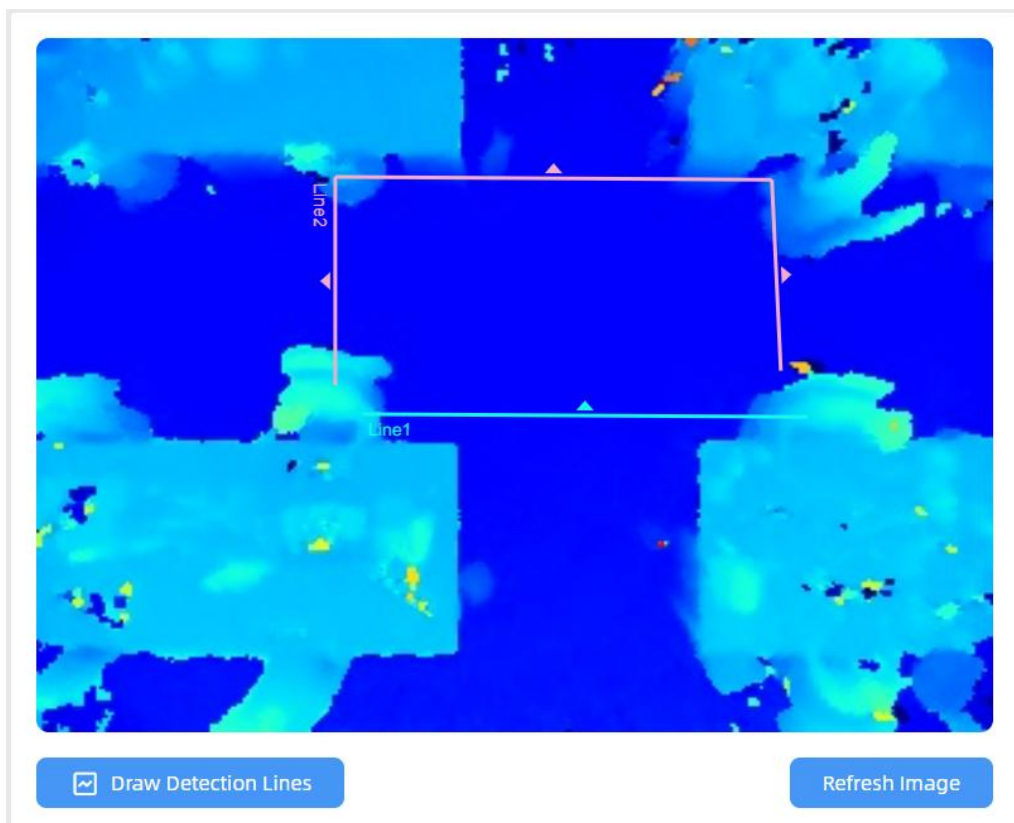
Note:
1) The arrow direction of the detection line depends on your drawing direction.
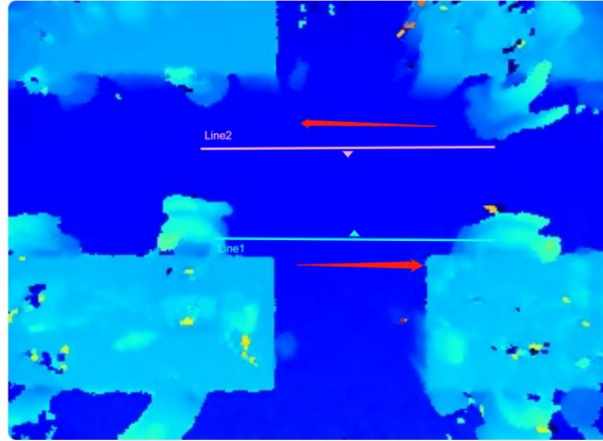
2) Ensure that the detected target can pass through the detection line completely. It's recommended that the detection line is perpendicular to the In/Out direction and on the center of the detection area without other objects around.

3) A redundant identification area needed to be left on both sides of the detection line for the target. This is to ensure that the sensor has stable recognition and tracking of this target before it passes the detection line, which will make the detection and count more accurate.

Deployment Parameters

Parameters	Description
Installation Height	Set the device installation height. Click **Detect** to detect the current installation height automatically. **Note:** Dark floor/carpet (black, grey, etc.) does not support to detect the installation height automatically.
Max Target Height	Set the maximum target height, then the device will ignore the objects higher than this setting value.
Min Target Height	Set the minimum target height, then the device will ignore the object shorter than this setting value.
Child Filter Height	Set the max child height when children distinction feature is enabled.

Note: Due to the error in ToF distance measurement (0.035 m), the Max. Target Height should be set as maximum pedestrian height plus 0.035 m and the Min. Target Height as minimal pedestrian height minus 0.035 m in the actual applications. For example, if the pedestrian height

is 1.6 m to 1.8 m, the Max. and Min. Target Height should be configured as 1.835 m and 1.565 m respectively.

Counting Strategy

| Parameters	Description
U-turns Filtering	When enabled, it allows to draw an area for every line and the device will count the In and Out values only when people passed this area. Users can left-click to start the drawing and add edges for this area, then right-click to stop drawing.
Children Distinction	The device will detect the people shorter than child filter height as children.
Staff Detection	The device will detect the people who wear reflective stripes as staff tags on the visible parts (neck, shoulders, etc.) as staffs. Reflective stripe requirements: width > 2cm, 500 cd/lux.m^2
Input Enable Count Externally	Only when alarm input status is the same as the preset trigger status, will the device count the data. **Alarm Input:** dry contact, low level=two contacts disconnected, high level=two contacts closure

Report Strategy

Parameters	Description
Trigger Report	Report the people counting data immediately when the in/out value changes.
Periodic Report	Report the people counting data periodically.
Period	Set the period of reporting periodic report. Range: 1-1080 mins, default: 10 mins

5.2.2 Multi-Device Stitching

Multi-device stitching is mainly used to monitor a larger detection area than just the area covered by a single device. When using this feature, devices should be installed next to each other and ensure the **detection areas** tangent or overlapping. It only uses one master device to output total counting data.
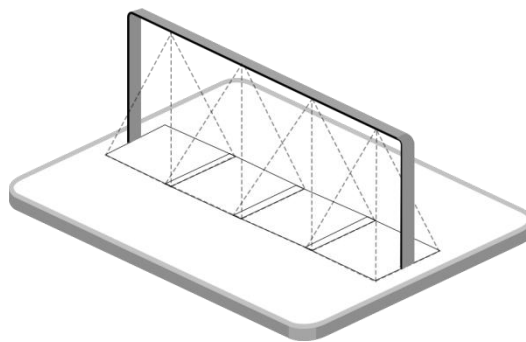
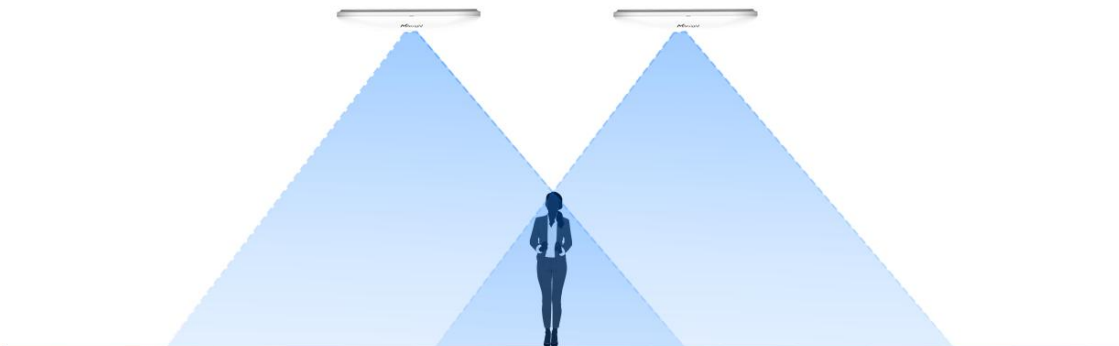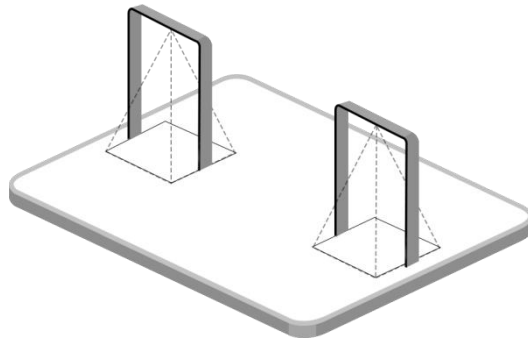Before using this feature, set one device as **Master Mode** and other devices as **Node Mode**.

Note:

1) Ensure the head of one person can be seen on both live views at the same time.

2) The devices can also be installed without overlapping as required.

Device Positioning

Device positioning is done via X&Y coordinates. For example, the installation direction of the master device is shown as below. When the master device's coordinate is (0, 0), the coordinates of the node devices are all positive values.
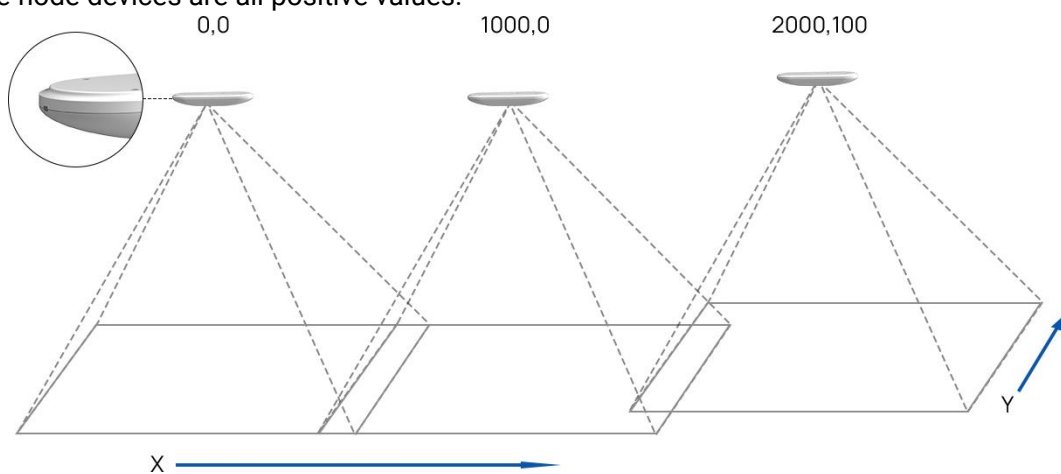
Add Node Devices

Step 1: Go to the master device web GUI, then click **BindNode** on Multi-Device List. The device will search for the unbound node devices under the same local network.
Step 2: Select the node device and type the login password of the node device.
Step 3: Fill in the installation height of a node device and relative position information if these parameters are already measured. If not, save default settings and skip to Step 4.

Step 4: Select the node device on the Mult-Device List, click **Adjust Relative Position**.

Drag the live view of node device to adjust the location and angle, and the relative position parameters will change automatically as your operations. Besides, users can also adjust the size of this live view.

<mark>Tips:</mark> cut the staff tags or other reflective stripes into pieces and stick them to the ground of overlapping areas, then drag the live view of node devices to make highlight markers in the two live views overlap.

Step 5: Click **Set & Testing Track**, then check if the tracking lines are connected and smooth when people pass on the live views of multiple devices. If not, click **Stop Testing** to adjust the node device's live view location slightly.
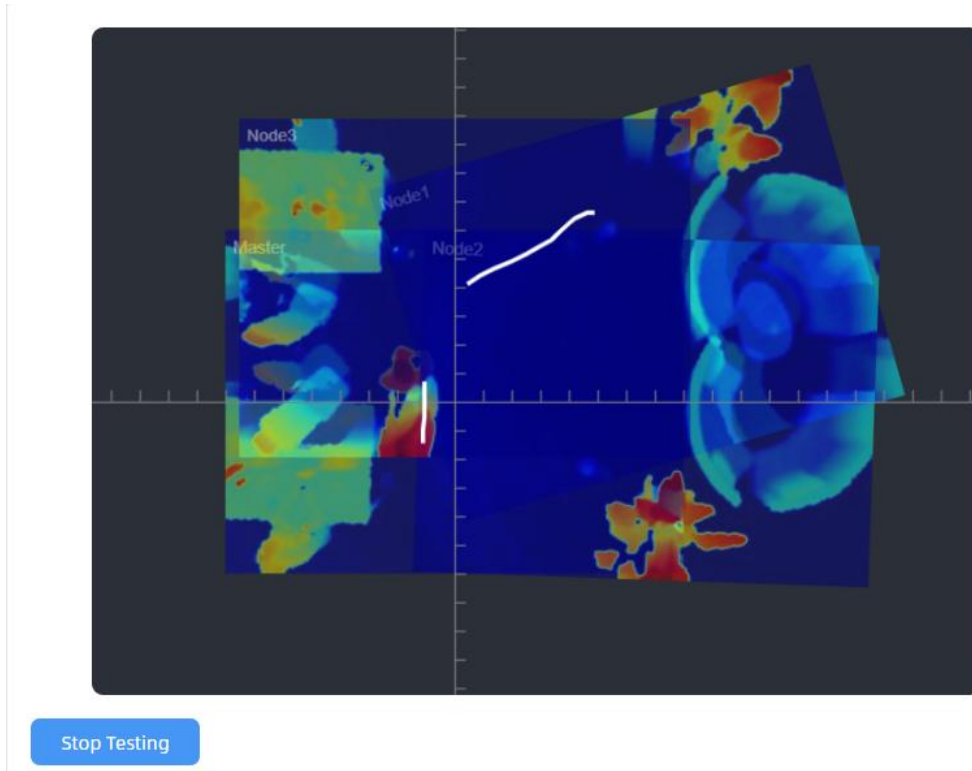
Step 6: When all settings are completed, users can draw detection lines and even U-turn areas on the new stitching live view the same as standalone mode devices.

Step 7: Click **Unbind** to disconnect the node device if necessary.

Device	IP Address	SN	Device Name	Operation
Master	192.168.46.79	6757D14572970013	People_Counter	
Node1	192.168.46.80	6757D16179950018	People Counter	
Node2	192.168.46.83	6757D16866970013	People Counter	
Node3	192.168.46.90	6757D16909050013	People Counter	

Node Mode

Parameters	Description
Connection Status	Show the connection status between the node device and master device.
Master Device IP Address	Show master device's IP address. When this IP address is under the same network with node device, the node device can bind to the master device.
Master Device SN	Show the master device's serial number.
Master Device Name	Show master device name.
Unbind Master Device	Click **Unbind** to release the connection status, this device will be deleted from the list of the master device.

5.3 Communication

VS133-P provides a Ethernet port for wired access. Besides, users can get the people counting data or configure the device via CGI.

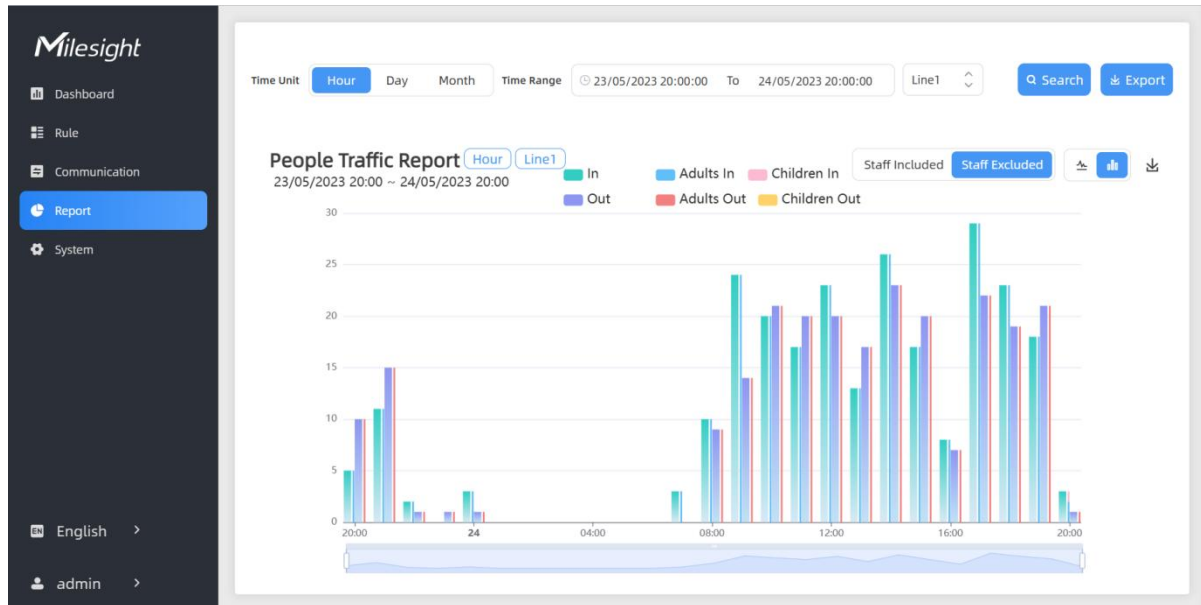| Parameters	Description
IP Assignment	Manual or Automatic (DHCP) is optional.
IP Address	Set the IPv4 address of the Ethernet port, the default IP is 192.168.5.220.
Subnet Netmask	Set the Netmask for the Ethernet port.
Default Gateway	Set the gateway for the Ethernet port's IPv4 address.
Primary DNS Server	Set the primary IPv4 DNS server.
Secondary DNS Server	Set the secondary IPv4 DNS server.
Test	Click to test if the IP is conflicting.

Note: When working mode is the Node mode, the device will not support HTTP/MQTT settings.

Parameters	Description
Protocol	HTTP (post) or MQTT is optional.
Status	Show connection status from device to HTTP server or MQTT broker. **Note:** When it is being disconnected, the device will store up to 100,000 pieces of data and re-transmit them when the connection is back.
HTTP	
Connection Test	Click **Test** to send test message to URL to check connectivity.
URL	The device will post the people counting data in json format to this URL.
User	The username used for authentication.
Password	The password used for authentication.
MQTT	
Host	MQTT broker address to receive data.
Port	MQTT broker port to receive data.
Client ID	Client ID is the unique identity of the client to the server. It must be unique when all clients are connected to the same server, and it is the key to handle messages at QoS 1 and 2.
Username	The username used for connecting to the MQTT broker.
Password	The password used for connecting to the MQTT broker.
Topic	Topic name used for publishing.
QoS	QoS0, QoS1, QoS2 are optional.
TLS	Enable the TLS encryption in MQTT communication.
Certificate Type	CA Signed Server or Self Signed is optional. **CA signed server certificate:** verify with the certificate issued by Certificate Authority (CA) that pre-loaded on the device. **Self signed certificates:** upload the custom CA certificates, client certificates and secret key for verification.

5.4 Report

VS133-P supports to generate visual line chart or bar chart to display the people traffic and supports to export the report. Before using this feature, ensure that the device time is correct on System page.

Note: When working mode is Node mode, the device will not generate this report.

Parameters	Description
Time Unit	Select the unit to generate the graph or export the data.
Time Range	Select the time range to generate the graph.
Line1	Select the line to display the graph.
Search	Click to generate the graph according to the time range and line option.
Export	Export the historical traffic data as CSV file according to the selected time unit. The device can store up to one million data records to CSV file.
Staff Included/Excluded	Select whether to contain staff counting values on the graph.
(line/bar icon)	Select the display type as line or bar.
(download icon)	Download the graph screenshot.

5.5 System

5.5.1 Device Info

All information about the hardware and software can be checked on this page. Besides, users can modify the device name, customize device ID and site ID for large amounts of devices

management.

5.5.2 User

Parameters	Description
Modify	Click the admin on the user list, then you can click Modify to change the login password of this device.

	I Users modify Username admin Password New Password Confirm At least: • 8 characters • 2 types of characters: Number, letter and symbol
Security Question	Click to type administrator password, then set three security questions for your device. In case that you forget the password, you can click **Forget Password** button on login page to reset the password by answering three security questions correctly. **I Secure Question Settings** (Already Set) Password Security Question1 What is your lucky number? Answer1 Security Question2 What is your favorite sport? Answer2 Security Question3 What is your favorite game? Answer3

5.5.3 Time Configuration

Parameters	Description
Time Zone	Choose the time zone for your location.
Daylight Saving Time	Enable or disable Daylight Saving Time (DST). **Start Time:** the start time of DST time range. **End Time:** the end time of DST time range. **DST Bias:** the DST time will be faster according to this bias setting.
Synchronize Mode	NTP Timing or Manual Timing is optional.
Server Address	NTP server address to sync the time.
Time Interval	Set the interval to sync time with NTP server.
Setting Time	Set the device time manually.
Synchronize with computer time	Synchronize the time with your computer.

5.5.4 Remote Management

Users can connect the device to the Milesight DeviceHub management platform on this page so

as to manage the device centrally and remotely. For more details, please refer to _DeviceHub User Guide_. Before connecting, ensure the device has connected to network via Ethernet port and Internet connection is seamless.

Parameters	Description
Status	Show the connection status between the device and the DeviceHub.
Server Address	IP address or domain of the DeviceHub management server.
Activation Method	Select activation method to connect the device to the DeviceHub server, options are **Authentication Code** and **Account**.

5.5.5 System Maintenance

Parameters	Description
Frequency Adjustment	Adjust the ToF frequency modulation mode to avoid the interference of surrounding IR devices. When using Multi-Device Stitching, please avoid using the same mode with other node devices.
Reset	**Recovery device basic configuration:** keep the IP settings and user information when resetting.
	Recovery device to factory settings: reset device to factory default, which needs to verify admin password.
Reboot	Restart the device immediately.
Upgrade	Click the folder icon and select the upgrading file, then click the **Upgrade** button to upgrade. The update will be done when the system reboots successfully. Note: The upgrade process takes about 1-10 minutes. Do not turn off the power and complete automatic restart after the upgrade.
Backup and Restore	**Export Config File:** Export configuration file.
	Import Config File: Click the file icon and select the configuration file, click **Import** button to import configuration file.

6. Installation Instruction

Parameter definition:

Parameters	Explanation	Value
H	Installation height	≤3.5 m
d	Minimum detection distance of VS133-P	0.5 m
Δd	Distance measurement error of VS133-P	0.035 m

h_{max}	Maximum pedestrian height	Example 1.8 m
h_{min}	Minimum pedestrian height	Example 1.7 m
α	ToF horizontal field of view angle	98°
β	ToF vertical field of view angle	80°
x	Length of detection range	
y	Width of detection range	

6.1 Installation Height

The maximum installation height is 3.5 m and the minimum installation height is $h_{max}+d+\Delta d$. For example, when the maximum pedestrian height is 1.8 m, then the minimum installation height is 1.8+0.5+0.035=2.335 m.

6.2 Covered Detection Area

The detection area covered by the device is related to the field of view angle of the device, the installation height and the target height. The length of the detection area is approximately x=2.300×(H-h_{min}) and the width of the detection area is approximately y=1.678 x (H-h_{min}).
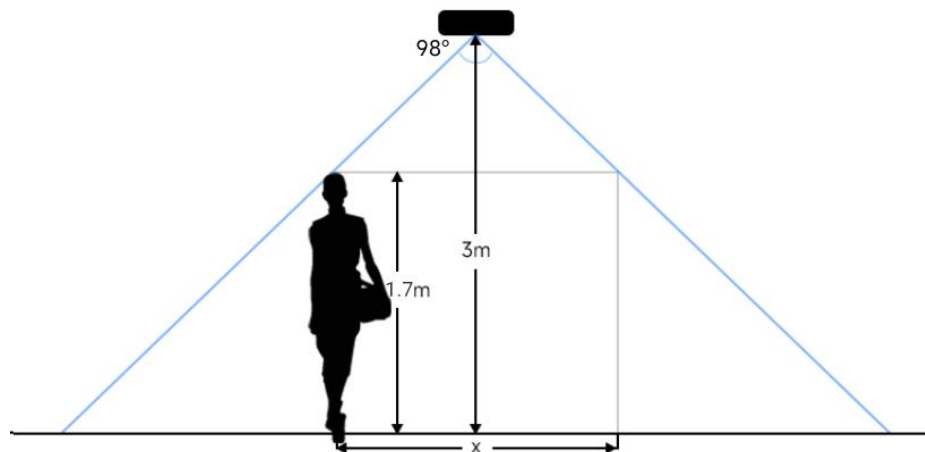
For example, if the Minimum height of pedestrians is 1.7 m, the detection area corresponding to each installation height is as follows:

Installation Height	FoV Monitored Area (m)	Detection Area (m)
2.5	5.75 × 4.20	1.84 × 1.34
2.6	5.98 × 4.36	2.07 × 1.51
2.7	6.21 × 4.53	2.30 × 1.68
2.8	6.44 × 4.70	2.53 × 1.85
2.9	6.67 × 4.87	2.76 × 2.01
3.0	6.90 × 5.03	2.99 × 2.18
3.1	7.13 × 5.20	3.22 × 2.35
3.2	7.36 × 5.37	3.45 × 2.52
3.3	7.59 × 5.54	3.68 × 2.69
3.4	7.82 × 5.71	3.91 × 2.85

3.5	8.05 × 5.87	4.14 × 3.02

6.3 Environment Requirements

- Dark floor/carpet (black, grey, etc.) will affect the device to count staffs when Staff Detection is enabled.
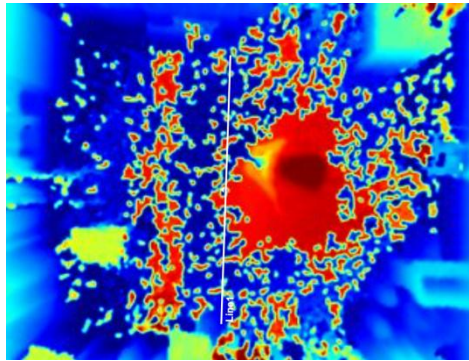
- Avoid 940nm light which may result in incorrect counting.
- Outdoor sunlight shining on the over channel will not have any effect, but the mirrored reflections that allow sunlight to shine on the ToF Sensor should be avoided.

6.4 Installation

Ceiling Mount

Step 1: Ensure the thickness of the ceiling is more than 30 mm, then attach the mounting sticker to the ceiling and drill 4 holes with a diameter of 6mm. If the wire needs to be extended to the interior of the ceiling, a wire hole with a suitable size is also required to be drilled.

Step 2: Fix the wall plugs into the ceiling holes.

Step 3: Remove the cover on the device, and then connect all required wires and pass them through the wire hole behind the device or block on the side of the device if the wires need to be protruded from the side of the device.

(**Note:** if the alarm I/O of VS133-P is going to be used, please connect a multi-interface cable to the device)
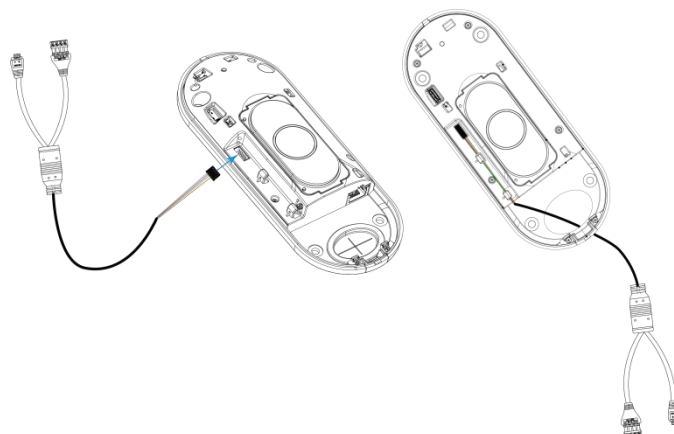
Step 4: Fix the device to the wall plugs via mounting screws; remember to adjust the mounting direction according to the detection area requirement.
Step 5: Fix the cover back to the device.
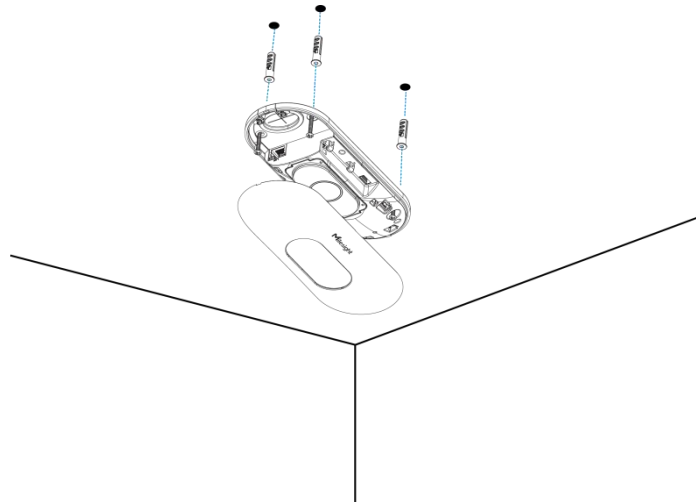
Ceiling/Lintel Mount (with Optional VB01 Multifunctional Bracket)

Step 1: Attach the mounting plate to the device with 4 screws.
Step 2: Fix the pole to the mounting plate with the hole on the plate.
Step 3: Adjust the length of the pole, then adjust the direction of 3-axis ball and tighten it with the handle.
Step 4: Determine the mounting location and drill 3 holes, fix the wall plugs into the mounting holes, then fix the bracket base to the wall plugs via mounting screws.
(**Note:** If the wire needs to be extended to the interior of the ceiling or wall, a wire hole with a suitable size is also required to be drilled.)
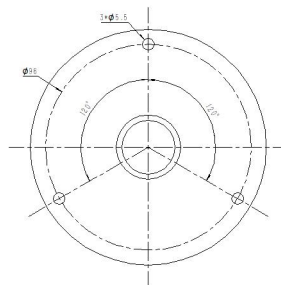
Step 5: Remove the cover on the device, and then connect all required wires and pass them through the inside of pole.
(**Note:** if the alarm I/O of VS133-P is going to be used, please connect a multi-interface cable to the device)
Step 6: Fix the pole to bracket base with screws and nuts.
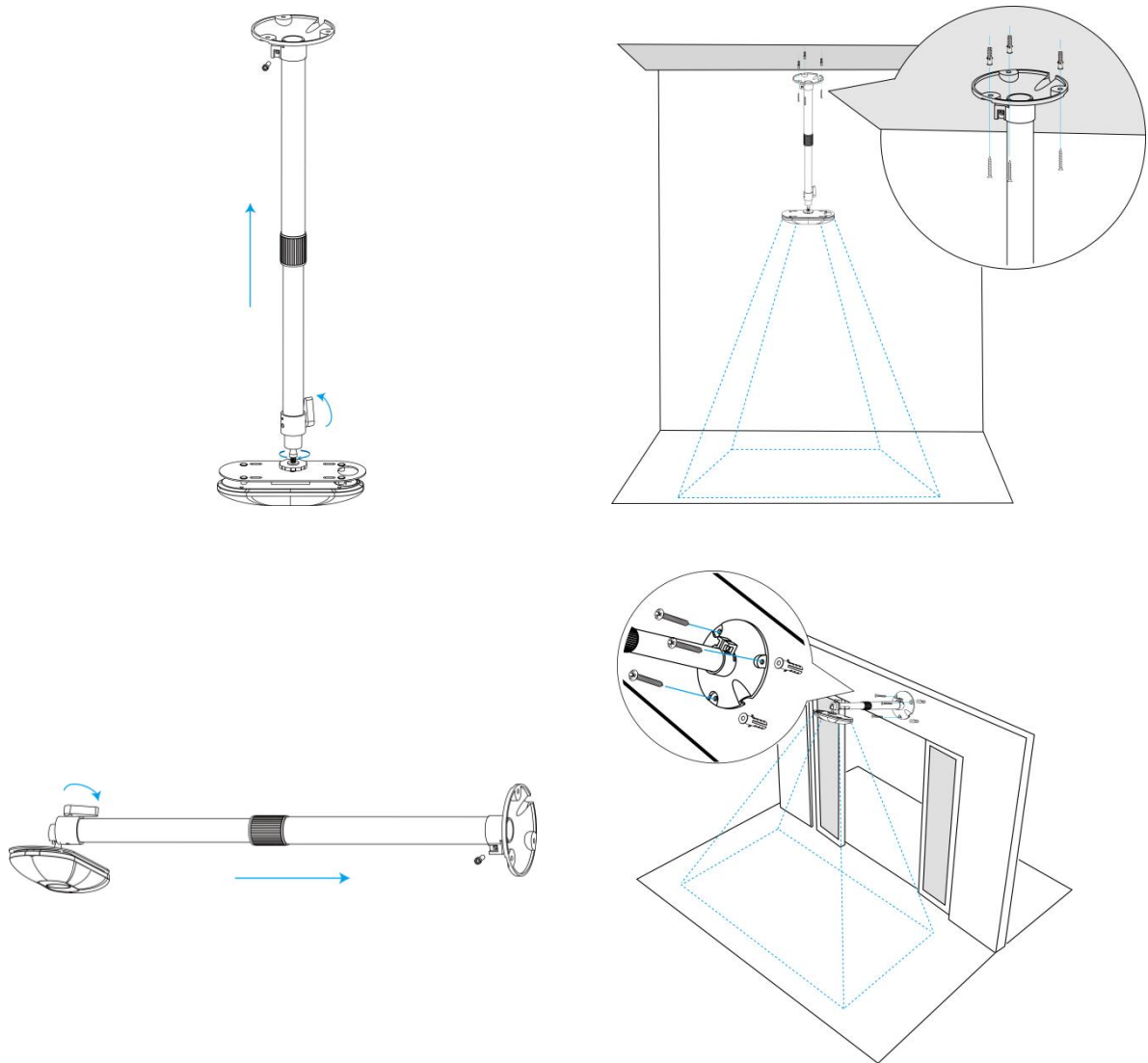
Note:

- Tilt installation should be avoided. Ensure that the front of the device and the ground plane are paralleled.
- Avoid installing the device against the wall and ensure that the device keeps away from the wall at least 30 cm on the short side and 50 cm on the long side.
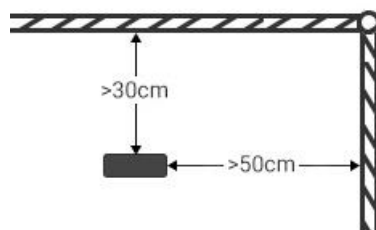
- Ensure that there are no other objects blocking the ToF light within a 30 cm radius of the front of the device.
- When you install devices on the top of swinging doors, it is suggested to keep the door normally open. If the door must be normally closed, please install the device on the other side of the door to keep away from the door movement. And it is suggested to keep away from the door with a distance of at least 30 cm.
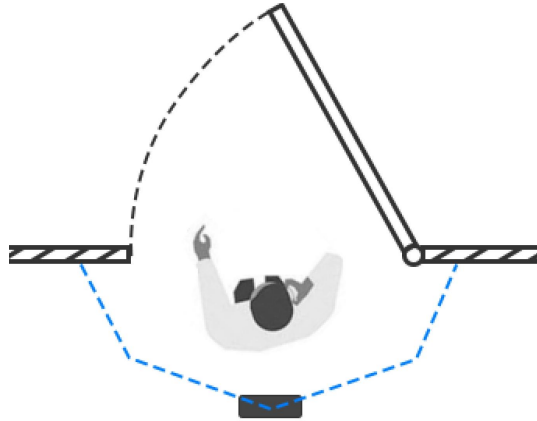
6.5 Factors Affecting Accuracy

- Wearing a fisherman's hat or carrying a cardboard box on the shoulder: The target will not be recognized because it will become unlike a human in depth map.
- Handheld or cart-carrying a humanoid doll with sufficient height to pass by: The doll will be mistakenly detected as people because it is human-like in depth map.

7. Communication Protocol

VS133-P will post the people counting data in json format to HTTP URL or MQTT broker.

- **Periodic Report**

```
{
"event":"People Counting",
"report_type": "period",
"device_info":{
                "device_name":"People Counter",
                "device_sn":"369362028335",
                "device_mac":"00:16:28:FA:8E:68",
                "ip_address":"192.168.0.99"
                "cus_device_id":"123468773",          //Customized device ID
                "cus_site_id":"asdfasf1231231"        //Customized site ID
                "running_time": 1564648484648         //unit: s
                },
"time_info":{
                "time_zone":"UTC-11:00 Samoa Standard Time (SST)",
                "enable_dst":false, //DST time is enabled or disabled
                "dst_status":false, //Whether DST takes effect
                "start_time":"2022-12-20T18:15:52+03:00",   //Period start time
                "end_time":"2022-12-20T19:15:52+03:00"      //Period end time
                },
"period_data":[
                {
```

```
                              "line":1,
                              "in":10,
                              "out":10,
                              "staff_in":1,
                              "staff_out":1,
                              "children_in":1,
                              "children_out":1
                              },
                              {
                              "line":2,
                              "in":10,
                              "out":10,
                              "staff_in":1,
                              "staff_out":1,
                              "children_in":1,
                              "children_out":1
                              }
          ]
          "total_data":[
                        {
                              "line":1,
                              "in_counted":10,        //accumulated in counter
                              "out_counted":10,          //accumulated out counter
                              "capacity_counted":0,      //=in_counted-out_counted
                              "staff_in_counted":1,
                              "staff_out_counted":1,
                              "children_in_counted":1,
                              "children_out_counted":1
                              }
                        {
                              "line":2,
                              "in_counted":10,
                              "out_counted":10,
                              "capacity_counted":0,
                              "staff_in_counted":1,
                              "staff_out_counted":1,
                              "children_in_counted":1,
                              "children_out_counted":1
                              }
          ]
          }
```

● **Trigger Report**

```
{
"event":"People Counting",
"report_type": "trigger",
"device_info":{
```

```
       "device_name":"People Counter",
       "device_sn":"369362028335",
       "device_mac":"00:16:28:FA:8E:68",
       "ip_address":"192.168.0.99"
       "cus_device_id":"123468773",              //Customized device ID
       "cus_site_id":"asdfasf1231231"            //Customized site ID
       "running_time": 1564648484648             //unit: s
       },

"time_info":{

       "time_zone":"UTC-11:00 Samoa Standard Time (SST)",
       "enable_dst":false, //DST time is enabled or disabled
       "dst_status":false, //Whether DST takes effect
       "time":"2022-12-20T18:15:52+03:00",    //Triggering time
       },

"trigger_data":[
       {
       "line":1,
       "in":1,                    //One person in
       "out":0,
       "staff_in":1,             //The person is staff
       "staff_out":0,
       "children_in":0,
       "children_out":0
       },
       {
        "line":2,
       "in":1,
       "out":0,
       "staff_in":1,
       "staff_out":0,
       "children_in":0,
       "children_out":0
       }
]
}
```

-END-