

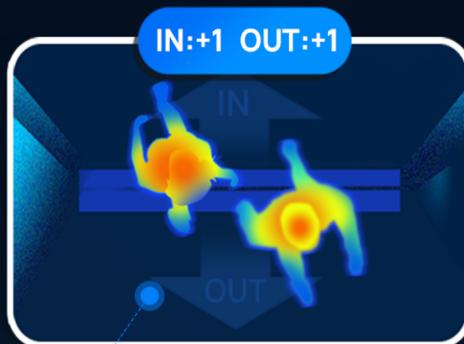
Milesight

Accuracy Testing Report

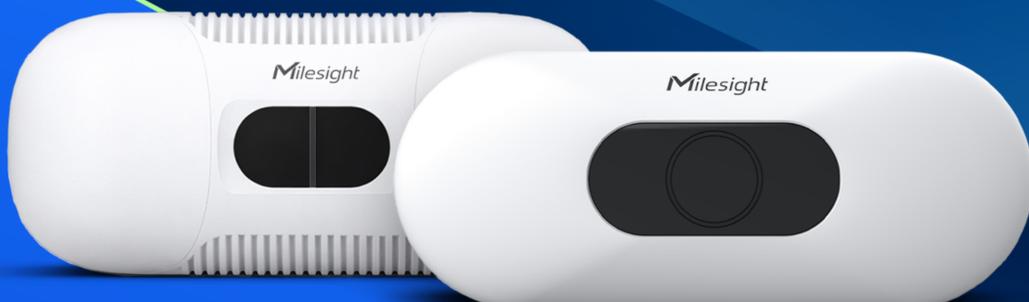
# AI ToF People Counting Sensor VS133 / VS135

Informed Insights via High Accuracy People Counting

ToF · AI · LoRaWAN®



Up to 99.8%  
Ultra High Accuracy



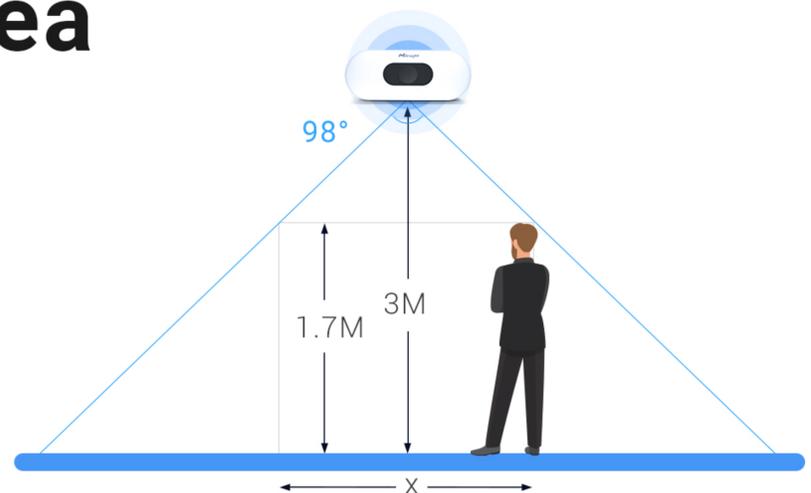
\*This report is not applicable to the  
VS135 high ceiling mount version



Milesight is a fast-growing and innovation-driven technology company with a focus on 5G, AI, IoT and Lo-RaWAN®. With advanced IoT insights, it helps customers worldwide optimize their business operations efficiently and sustainably in an actionable and locally adapted way. By deepening vertical market segments, the Occupancy & People Counting Series is developed for space occupancy and people counting in diverse applications. AI ToF People Counting Sensor as a member of the series specializes in people counting for data-driven management. Different from many devices on the market, the sensor featuring AI and ToF technology helps to accurately and anonymously get statistics by 3D depth images. Testing in a large data volume, you will find out how it works in an accurate way.

## Covered Detection Area

The detection area covered by the AI ToF People Counting Sensor 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  $x=2.300 \times (H-h)$  and the width of the detection area is approximately  $y=1.678 \times (H-h)$ . (H: Installation height, h: Pedestrian height )



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 (m)	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

# Testing Environment

Stairway Entrance  
Installation Height: 3050mm  
Entrance Width: 2979mm

# Configuration

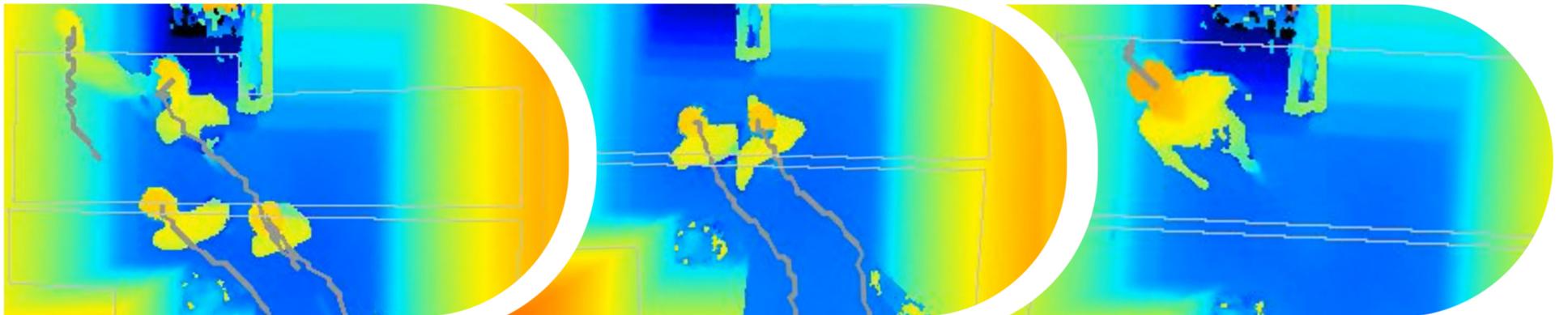
Max. Target Height: 2000mm  
Min. Target Height: 1000mm  
U-turn Filtering: ON

# Testing Results

## 1 Real Time Testing

### Scenarios included:

- Crowded People Flow
- People Walk Shoulder to Shoulder
- People with Height of between 1.5m and 1.9m
- Women with Long Black Hair
- Bald People
- People in Various Colors (Including Black)
- Frequent Light Changes Due to Motion Sensor Lights
- People Wandering



### Testing Results

Average Accuracy: 99.72%

Testing Time: 2023-04-27

Testing Items	Total Number of People	Counting Number of People	Accuracy
Entrance	53	53	100%
Exit	85	85	100%

Testing Time: 2023-05-15

Testing Items	Total Number of People	Counting Number of People	Accuracy
Entrance	35	35	100%
Exit	76	75	98.68%

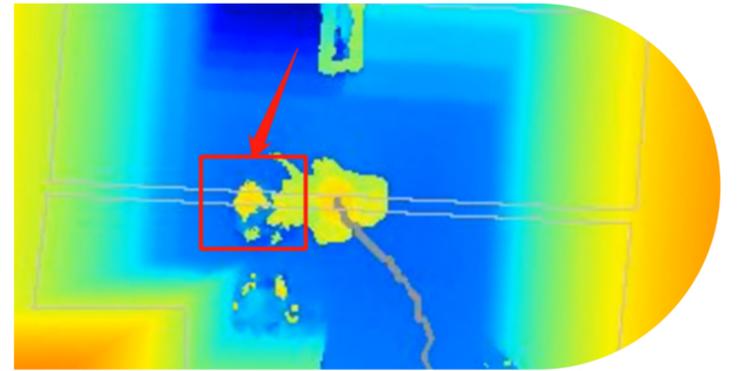
Testing Time: 2023-05-18

Testing Items	Total Number of People	Counting Number of People	Accuracy
Entrance	34	34	100%
Exit	75	75	100%

## Missed Detection

Time: 2023.5.15 18:01:55

Since the target was wearing a low-reflective black T-shirt and had volume black hair, the in-depth information missed at some angles, which led to the discontinuous trajectory line, resulting in the missed counting. It is an occasional problem, and will be optimized.



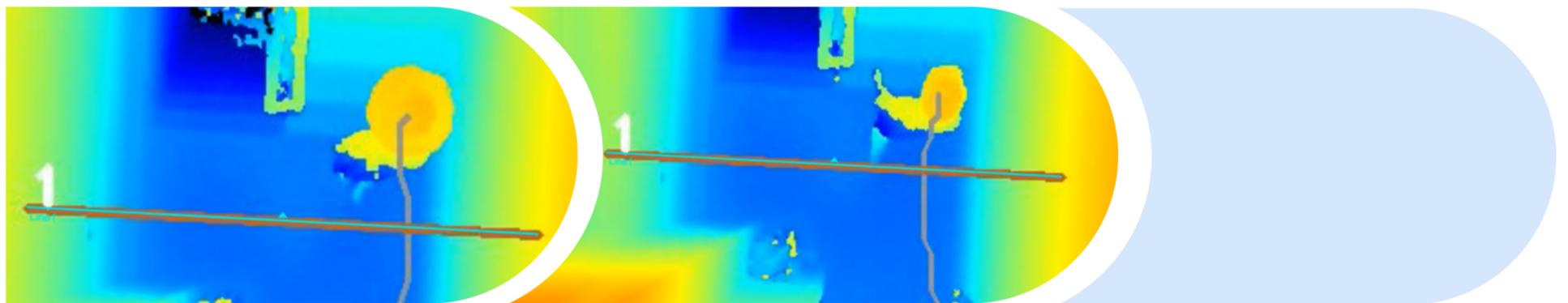
## Analytics

The accuracy is high counting people in actual scenarios. It will be at an ultra-high level whenever it is detecting crowds or people walking shoulder to shoulder, and the **Smart U-Turn** helps to filter unnecessary counting when people are just wandering but don't truly enter. The targets with different heights and in different colors can be detected accurately. What's more, the complicated lighting conditions will not influence the counting results. It should be noted that long black hair girls in black may cause missed counting with a very low probability.

# 2 Special Scenarios Testing

## Hat Testing

Testing Items	Total Number of People	Counting Number of People	Accuracy
People with Bucket Hat	20	19	95%
People with Helmet	20	20	100%



People with Bucket Hat

People with Helmet

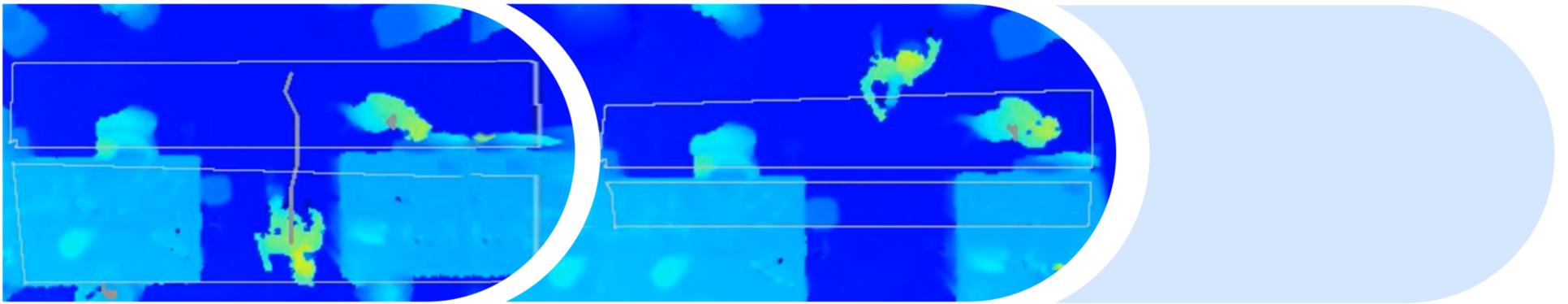
## Analytics

Since the device is installed above. It may cause a loss because bucket hats could change the objects' three dimension imaging.

## Fast Running Testing

Testing Items	Total Number of People	Counting Number of People	Accuracy
Walk Fast	20	20	100%
Run Fast	20	20	100%

## Missed Detection Analytics:



Run Fast

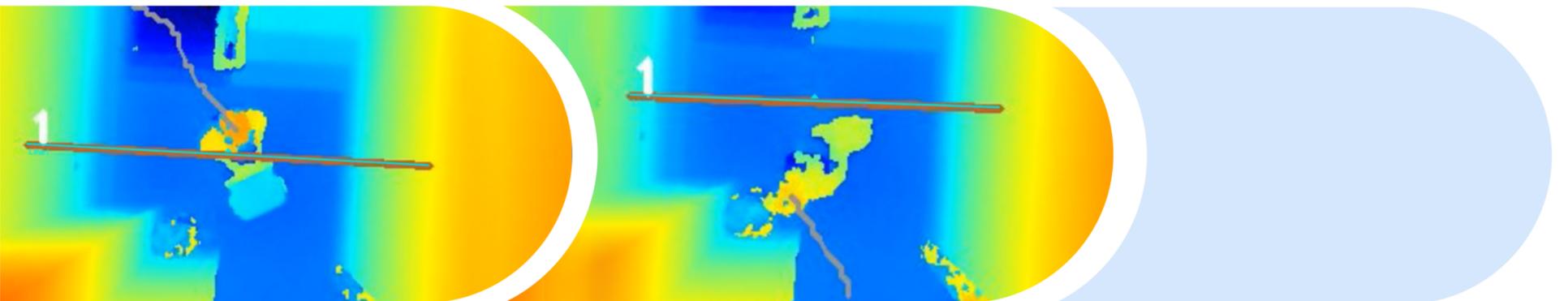
Walk Fast

## Analytics

The frame rate of VS133 / VS135 reaches 20fps. So the detection of even fast-running objects will have a good accuracy.

## Sundries Testing

Testing Items	Total Number of People	Counting Number of People	Accuracy
People with Sundries or Equipment	20	20	100%



Push Chairs and Pass

Pass with Sundries

## Analytics

Thanks to the onboard AI algorithm, VS133 / VS135 is barely influenced by handheld sundries and hardly has errors in people counting except mannequins.

# 3 Advanced Functionalities Testing

Except for regular people counting functionalities, VS133 / VS135 also features superior functionalities of Staff Detection and Adults/Children Differentiation which detect staff with special tags and differentiate adults & children by the preset height respectively, realizing actual and efficient people-flow counting and analysis.

## Staff Detection

Testing Items	Total Number of Staff/Non-staff	Counting the Number of Staff/Non-staff	Accuracy
Staff Detection	20/20	20/20	100%

## Analytics:

It requires staff to wear reflective stripes or reflective badge lanyards with a reflection coefficient of 500CD/Lux. When detecting, the targets on the ToF amplitude images will show special peaks and the targets with the peaks will be marked and counted as staff. By complying with the detection rules, the accuracy can be kept at a high level.

- Note:**
- Avoid close distances between staff and non-staff targets when wearing reflective stripes, or it may mistakenly count non-staff targets as staff. So the distance between staff and non-staff targets should be >30cm.
  - Avoid being blocked by hairs when wearing reflective badge lanyards, or it may influence the performance of the judgment towards peaks.



**Note:** it is the testing interface but not the interface feature

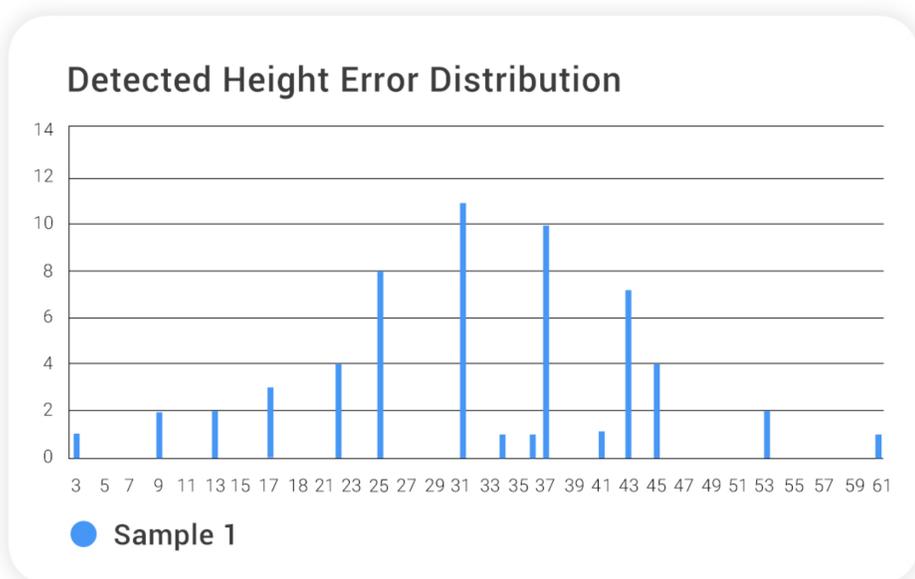
Staffs with Reflective Stripes in A Proper Distance

Staffs with Reflective Badges Lanyards without Being Blocked

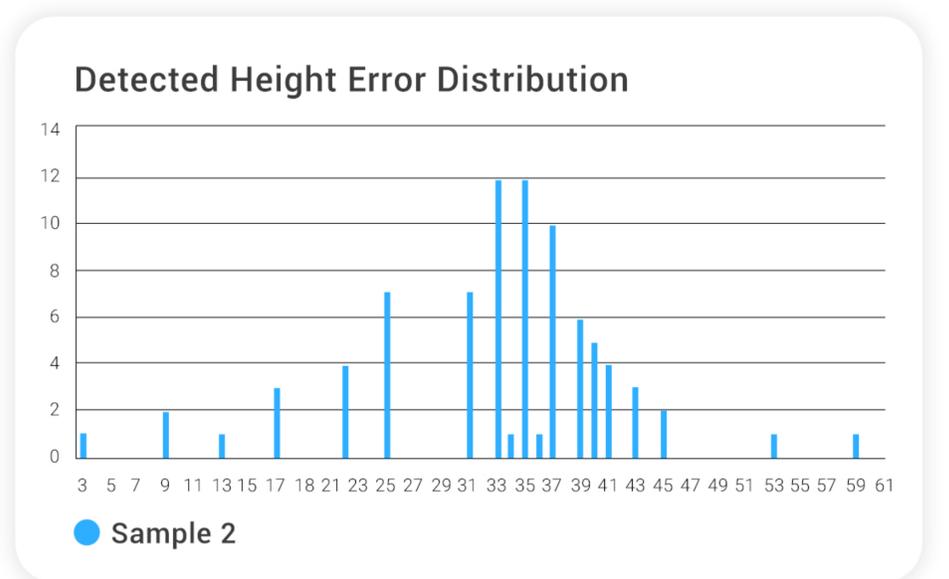
## Adults/Children Differentiation

Testing Items	Testing Samples (in Different Heights)
People with Sundries or Equipment	Sample 1 with a Height of 1761mm
	Sample 2 with a Height of 1870mm

**Note:** The testing result is exported from an internal database. It is not the feature displayed on the Web GUI



Detected Height Error Distribution of Sample 1 (mm)



Detected Height Error Distribution of Sample 2 (mm)

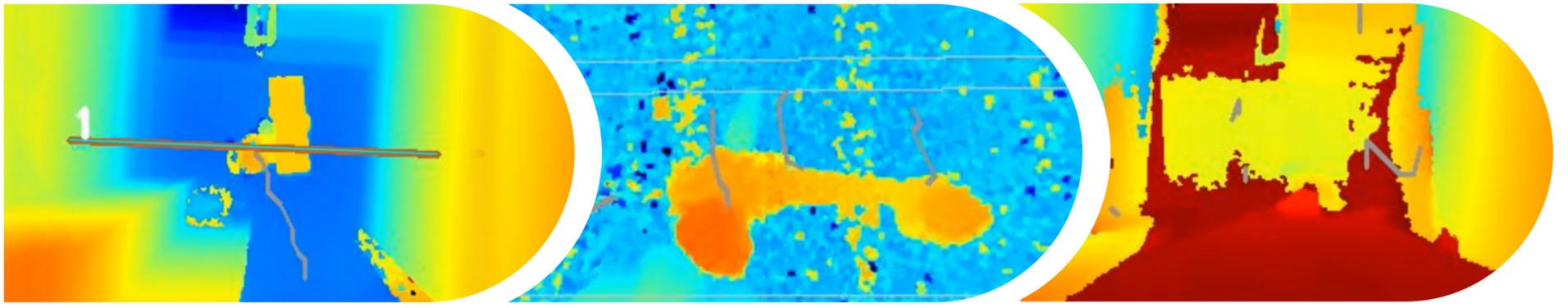
## Analytics:

Since the ToF technology can recognize the height of the targets. The adults and children's differentiation can be realized by detecting target's height and comparing with the preset threshold value. The accuracy of the adults/children differentiation depends on the accuracy of the height detection. The testing result of the samples shows that the height error of the sample testing meets the normal distribution, the median is about 35mm which is reasonable.

# Influence Factors

Influence Factors		Influenced or Not	Description
Object	Hair Color	No	The color is not the detection dimension of ToF, which is different from images produced by the RGB principle. So it won't influence the counting results.
	Peaked Cap / Helmet	No	Under ceiling mount circumstances, it won't change the shape of the objects detected and influence the counting results.
	Bucket Hat	Yes	It will influence the 3D depth information of detected objects, which is not a human-like shape. It lowers the counting accuracy.
	Carry Plank	Yes	
	Moving Objects with Human-like Shapes	Yes	It may cause false detection if the object can't be filtered by height. For example, the mannequins.
	Non Moving Objects That Are Not Human-like Shapes	No	Carts, suitcases, movable desks and wheelchairs won't make confusion as objects not in human-like shapes won't influence the counting results.
Environment	Jump over Line	Yes	The jump will change the height of the detected objects to affect the counting results.
	Lighting Condition	No	Low light or completely dark environments won't cause any problem for accurate people counting.
	Directly Lighting	No	The visible light has little influence on the people counting while only direct 940nm infrared light will influence the ToF sensor.
	Outdoor Sunlight Shines on the Indoor Area	No	It doesn't influence the counting results.
	The Sensor Installed Leaning Against the Wall	Yes	When the sensor is installed leaning against the wall, the ToF light source will reflect from the wall, which influences the distance judgement. It will cause people counting accuracy problems.
	The Sensor Installed Near Light Source	NO	Most indoor lighting sources are visible light, the Infrared band is weak, and the ToF infrared light is modulated. So the factor has little influence to counting results.
	The Sensor Installed Aslant	Yes	The suggested installed angle of inclination is $-5^{\circ}\sim 5^{\circ}$ . The over angle of inclination will cause influence.

## Sample Testing Images



| Carry Plank

| Pass with Human-Like Objects

| Installed Leaning Against the Wall

## Conclusion

The AI ToF People Counting Sensor truly accomplishes its values for reliable data-driven management on condition that the high accuracy of up to 99.8% is ensured. Through massive testing, the accuracy result is obvious. With onboard AI algorithm and 2nd generation ToF technology, it can efficiently count people regardless of the effects of complicated objects, environments and installations. But Inevitably, some factors like human-like objects, installation leaning against the wall, etc., still challenge the results. Avoiding those adverse factors, it will unleash its best performance for applications.



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