Operator Assist System with Pedestrian and Object Detection With truck control

SEnS+

Smart ENvironment Sensor plus

FAQ

Sample Answers to FAQ

Operator Assist System with Pedestrian and Object Detection **With truck control**

SEnS+

Smart ENvironment Sensor plus

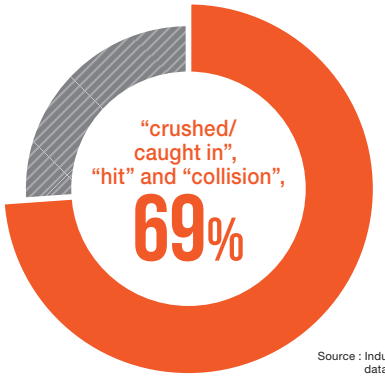
High-performance stereo camera !

The high-performance stereo camera, exclusive design for forklifts detects objects behind the truck.

Reduction of accidents caused by hitting to pedestrians in moving backward is a priority issue at logistics worksites.

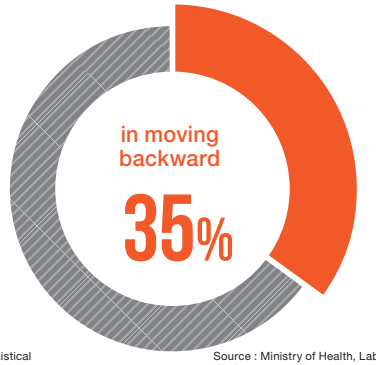
In 2020, there were 1,989 industrial accidents caused by forklift in Japan, and the accidents due to contact between trucks and pedestrians, accounted for approximately 70% of the total accidents. Also, many of accidents happened in moving backward. This is a significant issue at logistics worksites.

[Industrial accidents related with forklift, classified by accident type (n=1,989)]



Source : Industrial accident statistical data by Ministry of Health, Labor and Welfare (Japan)

[Analysis on accidents in load handling by forklift in Japan (2013) (n=100)]



Source : Ministry of Health, Labor and Welfare commissioned project in 2013 : Description for Load Handling Safety Guidelines

Main features of SEnS+

What is SEnS+?

Detects pedestrians by distinguishing from obstacles.

Notifies the operator of the approaching obstacle with a warning buzzer and warning lamps. And controlling the traveling speed and start of the truck.

What is its key feature?

Supports the operator with Automatic notification range adjustment and Traveling speed and start control (Industry's first*) for achieving safe operation.

*Based on our own research

What is its design concept?

People safety is our first priority

Considers the influence on work efficiency / productivity

This Guidebook is divided into four categories, with answers to FAQ for SEnS+.

01 : Detection

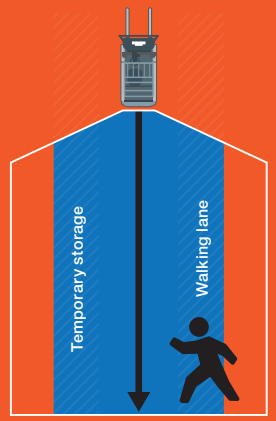
SEnS+ Detects pedestrians by distinguishing from obstacles.

Pedestrians : In a wide range
Objects : Detection priority given primarily to direction of movement

When detection target is pedestrian

Pedestrians are detected and notified not only in the direction of truck movement, but also in a wide range, as they can move in an unexpected manners.

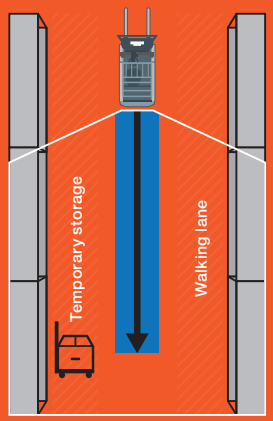
■ =Image of pedestrian notification range during Straight ahead



When an object is detected:

The notification range is narrowed to minimize unnecessary notifications of shelfs or loads on walking lane.

■ =Image of object notification range during Straight ahead



FAQ

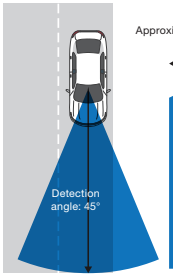
Q. In what range is an object detected?

A. Horizontal detection angle is 130°, maximum distance is approximately 10 m, and width is approximately 5.5 m from the right and left side from stereo camera.

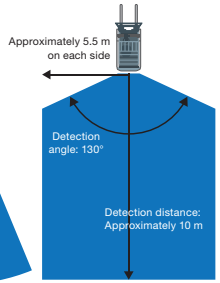
Reference information:
Difference between forklift sensor and automobile sensor

Automobiles are generally used in an environment with fewer objects than forklifts since they are, in principle, separated from pedestrians as stipulated by the traffic rules.
Forklifts are often used where other material handling equipments and unspecified objects are exsisting.
Therefore, forklifts require a sensor capable of detecting close and moderately distant surroundings in a wide range.
SEnS+ has the industry's widest detection range*.
*Based on our own research

[For automobiles]



[For forklifts (SEnS+)]

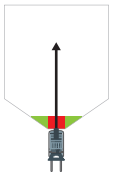
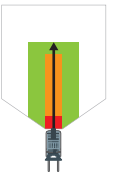
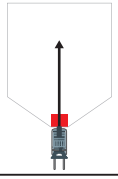
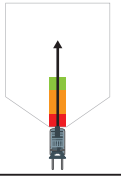
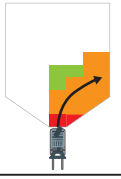


Q. How about the system's notification range?

A. The system's notification range is adjusted automatically according to the traveling speed, steering angle and detection target (pedestrian or object).

The 3-level notification range is set (Area A, B, and C). Linked with the truck status, the notification range is adjusted automatically according to the traveling speed, steering angle and detection target (pedestrian or object). First priority is people's safety and considers the influence on work efficiency / productivity.

■ Image of automatic notification range adjustment

Traveling speed	Slow	Medium	Fast
Traveling direction	Straight	Straight	Turning
When detection target is pedestrian = Area A = Area B = Area C			
When detection target is objects = Area A = Area B = Area C			

02 : Notification

SEnS+

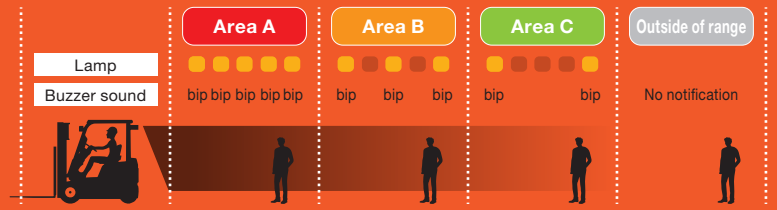
Notifications are issued using 3-level sounds and lights according to the distance to obstacles.

Characteristics of warning lamps

- Installed at four positions (left and right at both front and rear) of the truck which are highly visible to the operator.
- Clearly visible in dark and bright areas.
- Useful visual warning in a noisy environment.

Characteristics of warning buzzer

- Located in a position where operators can easily notice the sound.
- For the warning buzzer, the tone and interval are different from those of the back buzzer so that it can be distinguished from each other easily.

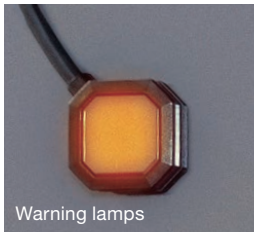


FAQ

Q. My work environment is very noisy. Is the warning buzzer sound easily noticeable?

A. **The system supports safe operation by not only notifying the operator with a warning buzzer and warning lamps, but also controlling the traveling speed and start of the truck considering the customer's work environment .**

In addition to the buzzer, 4 warning lamps installed to the front, rear, right, and left sides of the truck will help notify the operator of obstacles visually, and also the truck control is performed according to the operating condition.


Warning lamps

Q. Can I adjust the buzzer sound volume?

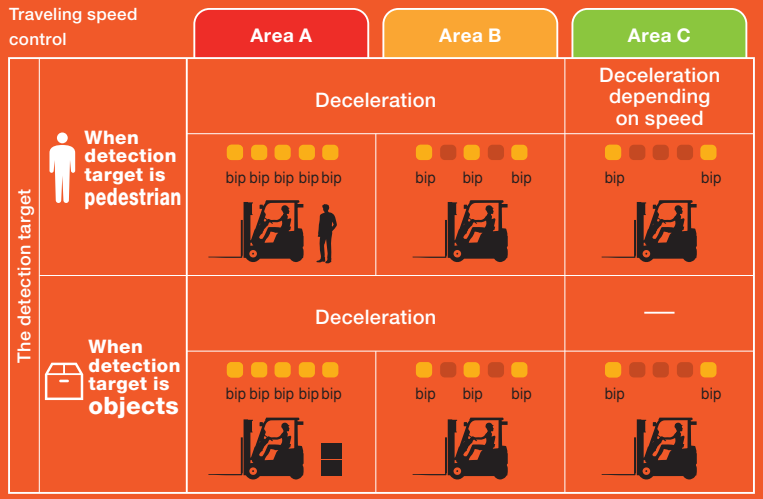
A. **It is not possible to change the sound volume.**

The current design of the SEnS+ system does not include sound volume adjustment function. For the safety-related SEnS+ system, the first priority is given to early notification to the operator. The system has a simple mechanism which allows the camera's detection of objects to directly trigger the buzzer's warning sound.

03 : Traveling speed control

SEnS+

SEnS+ automatically controls the traveling speed according to the traveling speed, steering angle and detection target (pedestrian or object).



SEnS+ is not the system of automatic braking to stop the moving truck. As an Operator Assist System, when SEnS+ detects obstacles, and if needed, the system issues notification and shuts down the power for gradual deceleration in order to encourage the operator to apply the brake.

FAQ

Q. How does traveling speed control work?

A. **The notification range is automatically adjusted according to the traveling speed, steering angle and detection target (pedestrian or object).**

■ When detection target is pedestrian (8FBE series)

	Area A	Area B	Area C
Distance of notification range	Approximately 1 m behind from the rear edge of the truck	Approximately 1 to 8 m behind from the rear edge of the truck, varying with the traveling speed	Approximately 1 to 10 m behind from the rear edge of the truck, varying with the traveling speed
Width of notification range	Approximately 1.5 m		Approximately 1.5 m on each side of area B

Note : This range varies depending on the operating condition, check the function with demo truck.

Q. How is the traveling speed control canceled?

A. **When pedestrian or object moves from the notification range, the traveling speed control is canceled.**

Even if the traveling speed control is canceled, acceleration is limited to prevent sudden acceleration until the accelerator pedal is returned or the direction lever is set in the forward position.

Q. Why does the system have no automatic braking capability?

A. **SEnS+ does not automatically stop the truck by the brake because sudden deceleration may cause the load spill**

The SEnS+ supports safe operation considering the influence on efficiency / productivity of load handling. The system notifies the operator of obstacles with a buzzer, lamps and deceleration and encourages the operator to apply the brake.
Operators should always monitor their surrounding conditions and needs to prioritize safe operation not to over-rely on the system.

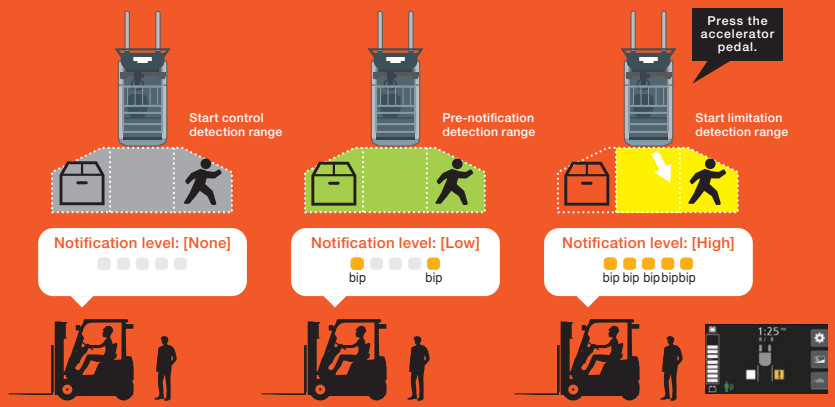
04 : Start control

SEnS+

Pre-notification and start limitation supports safe starting operation during reverse traveling.

In a situation where an obstacle exists in the traveling direction, the system limits the start

01 Before parking brake is released	02 Parking brake is released	03 Reverse operation
No notification	Pre-notification (notification only)	Start limitation (notification and control)



*Note: Notification is issued regardless of the direction lever position.

Unnecessary notifications can be minimized.	Pre-notification is issued to encourage the operator to check around the truck.	When the operator does not avoid obstacles by pre-notification, notification and start limitation are activated.

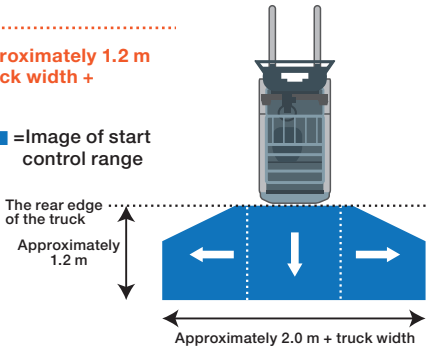
FAQ

Q. What is the start control range?

A. For the start control range, distance of approximately 1.2 m from the rear edge of the truck, width is truck width + approximately 2.0 m.

With the direction lever set in the reverse position, if an obstacle is detected in the range corresponding to the steering angle, and the operator press the accelerator pedal, the system will issue a notification by the warning lamps and warning buzzer and limit the start of the truck.
The notification range can be adjusted. Please contact your local distributors.

■ =Image of start control range



Q. How is the start control canceled?

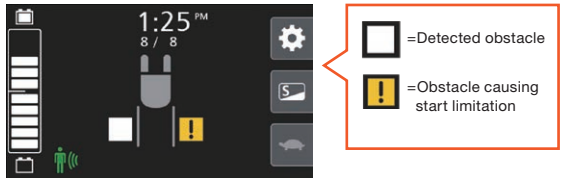
A. Release the accelerator pedal and then depressing it again, then start limitation to be canceled and enable traveling. The traveling speed is limited to 3 km/h.

While the start limitation is activated, release the accelerator pedal and then depressing it again, then start limitation to be canceled and enable traveling. The traveling speed is limited to 3 km/h to prevent sudden acceleration until detected obstacles are removed from the start control range.

Q. How can the operator view the positions of detected objects?

A. When the start limitation is activated, the positions of detected objects are indicated on the display.

The positions of objects are indicated on the display only while the truck is stopped. This prevents the operator from unnecessarily losing sight of the direction of travel during operation.



Adjustment

The notification range and the truck control level can be adjusted according to the customer's request, operating condition and work environment with the customer's consent.

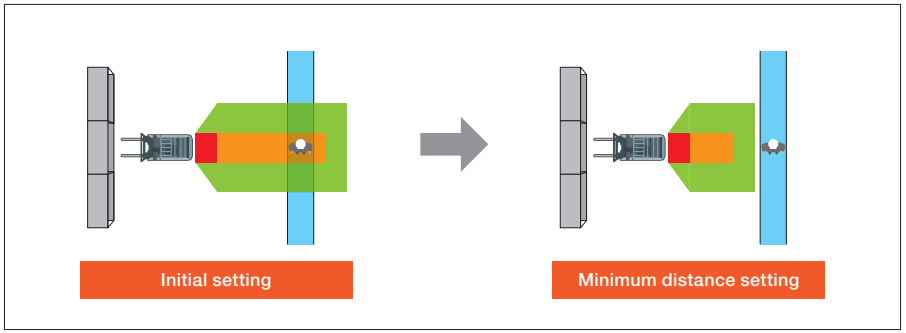
[Adjustment example 1]

The forklift is operated near workers

Issues	Adjustment sample	
Notify the operator frequently by detecting workers inside the walk lane, in reverse operation for loading / unloading.	Traveling speed control level (Detection target:pedestrian)	Change from initial setting to shorten the notification range. (no change in detection width)

■ Distance of notification range

Area A　Area B　Area C



If the notification range and the truck control level is changed, the effect of this system to be limited.
Please contact your local distributors for details.

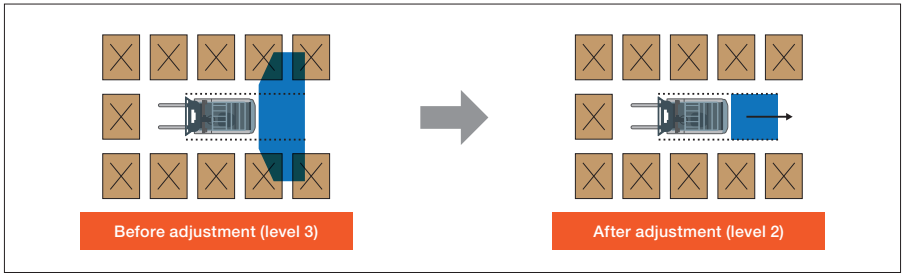
[Adjustment example 2]

Operation in Narrow Areas (between Loads, etc.)

Issues ① While stopping for loading / unloading, a notification by detecting loads on each side of the truck is issued.	Adjustment sample ①	Start control level	Linked with steering angle.
	Adjustment sample ②	Width of start control range	Change from initial setting 1.0m to shorten the notification range.
Issues ② Cannot start the truck when performing the reverse operation for picking a load.	Adjustment sample ①	Width of start control range	Change from initial setting 1.0m to shorten the notification range.
	Adjustment sample ②	Length of start control range	Change from initial setting 1.2m to shorten the notification range.
Issues ③ While moving backward for loading / unloading, a notification by detecting loads on each side of the truck is issued.	Adjustment sample	Traveling speed control level (Detection target:object)	Change to shorten the notification range. (When the situation does not improve after changing the notification range, the start control function changes can be disabled.)

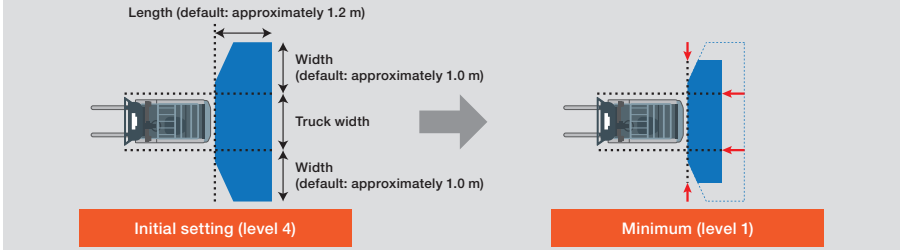
■ Image of Issues ① and Adjustment sample ① and ②

Before adjustment, notification is issued regardless of the direction lever position. After adjustment, notification is issued linked with steering angle.



【Image of start control range】

The start control function can be disabled.
Please contact your local distributors for details.



The start control range varies depending on the tonnage.

SEnS+

Other FAQ

Detection

Q. Is detection of the front side of the truck possible?

A. **The detection range of this system is limited to the area behind the truck.**

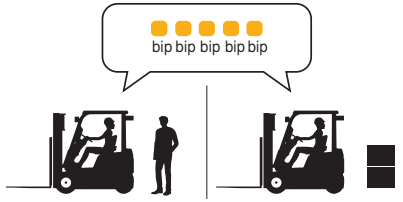
Basically, customers' requirement is for the safety to the area behind the truck. Also, the front side of the truck has no position suited for installing the SEnS+ system.

Notification

Q. Are different warning sounds given for pedestrians and objects?

A. **The same warning sound**

For details, see page 6 of this brochure.



Detection

Q. Can pedestrians in the blind area or pedestrians who appear suddenly be detected?

A. **Pedestrians in the blind area or pedestrians who run out of the shades of shelves or racks suddenly cannot be detected.**

The detection range of SEnS+ is limited where captured by the camera. Pedestrians in the blind area or pedestrians who run out of the shades of shelves or racks suddenly cannot be detected.

General

Q. Can the system be installed on the forklifts in use.

A. **The SEnS+ cannot be installed on the forklifts in use.**

Notification

Q. Is it possible to change the warning lamp position according to operator's body height?

A. **The installation position of the warning lamps can be changed according to the customer's request.**

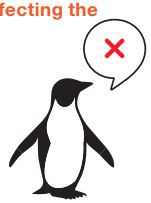
The warning lamps are fixed using double-sided tape. The position can be changed by reattaching the warning lamps using new tape.
Please contact your local distributors for details.

General

Q. Does this system be activated in a cold storage warehouse?

A. **It is not available in cold storage warehouses due to condensation on the camera lens affecting the system's operation.**

This system recognizes obstacles by image processing with camera. Therefore, we do not recommend the use in an environment where the lens of the camera gets cloudy or dirty all the time.



Notification

Q. Is it possible to disable the function?

A. **Object detection traveling speed control and start control (Pre-notification / Start limitation) can be disabled.**
Pedestrian detection traveling speed control cannot be disabled.

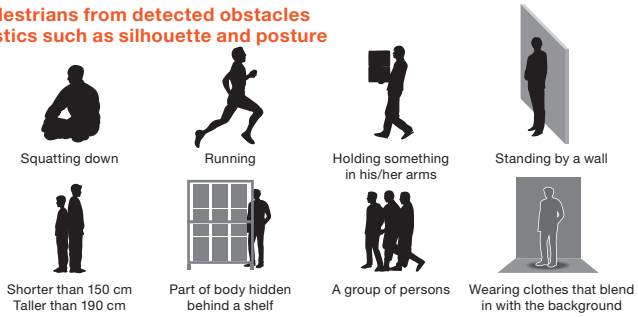
Some of the functions can be disabled, the effect of this system may be limited.

Detection

Q. How does the SEnS+ system distinguish pedestrians from detected obstacles?

A. **SEnS+ distinguishes pedestrians from detected obstacles based on the characteristics such as silhouette and posture in standing and walking.**

The SEnS+ has been developed using a large amount of photographic data collected at actual worksites. Its ability to distinguish human obstacle is highly accurate. Note, however, that it may not always be able to recognize people as pedestrians in the situations illustrated (right).



General

Q. In what worksite is the SEnS+ system useful?

A. **This system is useful in worksites where forklifts are used with surrounding workers.**

This system is useful in worksites where forklifts are used with surrounding workers and unspecified pedestrians (truck driver, office worker, etc.) are going in and out of the work area of forklifts.

We prepare the promotion video to check the features of the SEnS+ in our website / YouTube.

Website

YouTube

Attention!

**The system is an Operator Assist System.
It is important that an operator should not over-rely on the system and an operator is solely responsible for safe operation.**

- The system is an Operator Assist System with Pedestrian Detection that has been developed based on the premise of safe operation by operator.
- The system controls deceleration by shutting down the power, not by the brake. Also, it is not the function to automatically stop the truck.
- There are limitations to the recognition performance of the system. It is important that an operator should not over-rely on the system and an operator is solely responsible for monitoring their surrounding conditions and needs to prioritize safe operation.

The data in this brochure was determined based on our standard testing condition. Operating performance may vary depending on the actual specifications and condition of the vehicle, as well as the conditions of the operating area.
Due to photography and printing, color of actual vehicle may vary from this brochure. Some photos have been computer-enhanced.
Availability and specifications are determined by market and are subject to change without notice.
Safe forklift operation is achieved by proper operator training and proper worksite rules. Please consult your Toyota representative regarding forklift selection and operator training.
Please consult your Toyota representative for details.

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