White papers

Loitering

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Contents

1. Introduction

Hanwha Vision's **"Loitering"** detection triggers an event when a Person or Car object stays or loiters within a user-defined area longer than the user-configured "Minimum duration." Going beyond simple intrusion detection, it proactively detects anomalies by considering both an object's dwell time and its behavioral context.

This white paper systematically explains the concept, algorithm, installation guide, limitations, and application cases of the loitering detection technology, helping readers understand the feature and highlighting the strengths unique to Hanwha Vision's solution.

2. Background

Structural blind spots and environmental factors are the most persistent sources of malfunction in loitering detection systems. Issues such as occlusion caused by physical obstructions and limitations in AI object detection due to environmental conditions make it difficult to ensure stable detection reliability.

In high-security environments such as **ATM vestibules** or store storage access corridors, the mere presence of an individual lingering for an extended period can serve as a critical early warning signal. However, conventional, generally operated loitering detection systems have faced limitations in securing stable detection performance across diverse environments and behavioral patterns.

The most fundamental limitation lies in the system's inability to distinguish between two cases: when an object has actually exited the designated region, and when it remains within the region but is temporarily undetected due to occlusion. Because both cases are treated identically, if an object briefly disappears within physical blind spots—such as the camera's field-of-view limitations, obstructions, or the area directly beneath the camera—the dwell time is reset.

For example, during low-traffic hours, if a person enters an area of interest and then disappears into a blind spot, the system may fail to trigger an event even though the individual actually continues to linger. Additionally, because a minimum detection count cannot be specified, operators often repeatedly receive unnecessary alarms, such as when resident staff members remain in the area.

Advanced "Loitering detection" capabilities address these limitations by enabling more granular user-defined zone configurations and applying dwell time management methods optimized for specific installation environments, thereby enhancing loitering detection performance.

To achieve effective loitering detection, it is essential to combine proper camera installation, optimized AI object detection settings, and the selection of loitering detection types tailored to the operational environment.

3. Technology

3.1 Overall System Architecture

Loitering detection is implemented in two ways: a Hanwha Vision AI camera generates and provides the metadata on its own, or an AI Box is connected to a non-AI camera for processing. The AI-camera approach is further divided into the **"Loitering"** detection located under AI-object-based IVA, and the advanced **"Loitering detection,"** which adds virtual-area-based loitering detection.

The overall detection workflow is as follows:

1. Object detection: An NPU-based deep-learning model detects people or vehicles in the video frames.
2. Object tracking: When an object is detected in the area of interest, it is tracked in real time and a timer starts.
3. Zone determination: The system determines whether the object has entered the predefined region of interest (ROI). For advanced loitering detection, the Door and Hidden zones are configured to match the environment, distinguishing objects passing through the Door from objects that disappear in the Hidden zone.
4. Timer management: Dwell time is measured from the moment of entry (or first detection); for advanced loitering detection, the time spent invisible in the Hidden zone is also accumulated.
5. Minimum number of objects check: For advanced loitering detection, the system checks whether the number of objects meeting the dwell-time condition is at or above the configured minimum.
6. Event generation: When the configured minimum duration is exceeded, the event is delivered via ONVIF metadata and SUNAPI. IVA-based loitering generates the event once at the moment the threshold is exceeded, whereas advanced loitering detection generates the event continuously from that moment until the loitering ends.
7. Control-room integration: A VMS and the control center receive real-time alarms and respond.

3.2 Key Technologies and Components

3.2.1 Object detection and tracking

For loitering detection to work accurately, uninterrupted object detection is essential. Depending on the operational environment, sensitivity settings and minimum/maximum object-size settings are important to improve detection accuracy and minimize false detections, and technology to continuously detect and track objects within the area of interest is required.

If an object is briefly occluded by another object and recognized as a new object, the dwell time may be reset, or the object may be mistakenly judged to have entered from outside the area of interest—failing to meet the event conditions and resulting in a missed event. When object detection and tracking are limited by the field-of-view constraints of a fixed camera, the existing dwell time of the object can be utilized to prevent missed events, provided that a newly appearing object can be judged identical to the existing one.

While there are methods to adjust object detection sensitivity or the field of view for seamless tracking, advanced loitering detection can enhance detection accuracy simply by adding a few configurations optimized for the installation environment.

3.2.2 IVA Loitering

A loitering detection event starts counting time from the moment an object is recognized as being in the area of interest. Based on the initial object detection point, the object is continuously checked while time is counted; when the preconfigured time-threshold condition is met, the result is delivered through event actions such as FTP transfer, email notification, or alarm output. This result is generated as a one-time event at the exact instant the threshold condition is met.

The most common error in event configuration occurs when an object being tracked within the area of interest is briefly occluded by a pillar or another object, causing a loss of recognition, and then recognized again. At this point, the system treats the reappearing object as a first-seen object and restarts the timer from zero. As a result, even if the object actually loitered beyond the threshold, it fails to reach the threshold, leading to a situation where no notification is received.

3.3 Advanced Loitering Detection

Built on Hanwha Vision's patented technology, the **advanced "Loitering detection"** addresses these limitations by adopting stable, continuous object detection and accurate dwell-time management as its basic principles. To implement this, two auxiliary areas are placed inside the region of interest (ROI) where loitering is to be detected:

- **Door:** Clearly determines whether an object has actually left the ROI or has newly entered.
- **Hidden:** A zone where objects may be occluded is designated in advance, ensuring that the loitering timer is not reset even if an object disappears at this location.

Under this design, as long as an object does not exit through the Door, it is considered "still within the area of interest" and internal counting continues. Counting can continue even if object tracking is lost and then re-acquired.

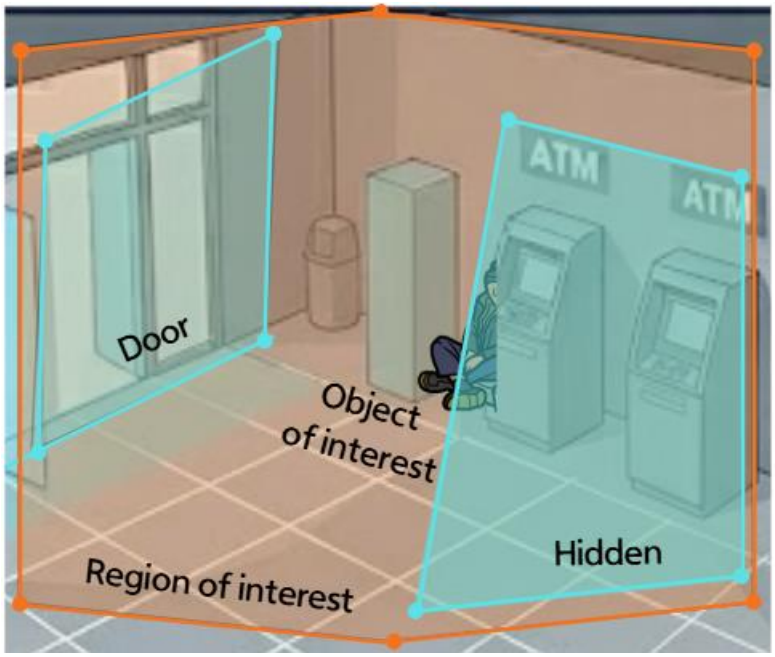


Figure 1. Example of setting Hidden and Door zones within the area of interest

Advanced "Loitering detection" also differs from ordinary **"Loitering"** detection in its alarming method. Ordinary "Loitering" detection outputs a one-time alarm at the moment the configured loitering time threshold is exceeded. However, **advanced "Loitering detection"** continues counting internally, so it continuously reports the presence of a loitering object via a VMS or alarm output until the object disappears.

While the existing area-based **"Loitering"** detection had no setting for an "object count," **advanced "Loitering detection"** adds a minimum "object count" setting. For example, in a space such as an ATM vestibule where only one person should ideally be in the area of interest, setting the minimum number of objects to two or more allows operators to verify only the special situation where two or more people remain in the vestibule beyond the threshold time.

4. Key Features and Advantages

4.1 Advanced Loitering Detection Overview

Loitering detection operates on the basis of stably and continuously detecting objects and accurately managing dwell time. To this end**, advanced "Loitering detection"** utilizes the Door and Hidden zones along with the minimum "object count" setting, providing an optimal solution for environments that have entrance doors and potential occlusions, such as ATMs and unmanned stores.

4.2 Door

This sets the door area through which objects enter the detection region. When an object disappears within this area, it is considered to have actually moved outside the region, meaning the existing dwell time is reset rather than retained. This prevents unnecessary dwell-time accumulation that can occur when different objects cross paths at the door, and it enhances the algorithm's decision accuracy by precisely determining whether a person simply disappeared within the area or left through the door.

4.3 Hidden

The Hidden zone refers to areas where objects may become temporarily occluded—such as around corners, behind obstacles, or directly beneath the camera—yet are still considered to be loitering. In conventional loitering detection, when an object exits the defined region, it is treated as a departure, and dwell-time accumulation stops. In contrast, within a Hidden zone, even if an object disappears from view, it is assumed to remain in place, allowing the dwell time to continue uninterrupted.

For example, during low-traffic hours, if a person enters, settles down, and covers themselves with a blanket, they may no longer be detected as a person. However, if the person was initially detected upon entry—triggering the timer—and that location is designated as a Hidden zone, the dwell time continues to accumulate even during the detection gap. Once this accumulated time exceeds the threshold, a loitering event can capture a scenario that conventional systems would have missed.

During periods of detection loss, the object's tracking ID may also be disconnected. In such cases, the system treats a newly appearing object within the Hidden zone as the same object that disappeared shortly before. If multiple objects have disappeared, the system conservatively accumulates time based on the longest recorded dwell time among them, ensuring that actual loitering events are not overlooked.

The Hidden zone is designed under the assumption that it is an area where objects "remain." Therefore, configuring it near actual entry or exit points may lead to false events, as objects that have already exited could be misinterpreted as staying. Similarly, placing it at the center of a region of interest may cause malfunctions. It is highly recommended to position Hidden zones near the edges of the monitored area, specifically close to actual blind spots.

4.4 Number of Objects

By configuring the minimum number of objects required to classify a situation as loitering, operators can reduce unnecessary alarms caused by the temporary presence of a single or a small number of objects. The minimum observation time and the object count can be configured independently for each detection zone, enabling threshold conditions tailored to the specific characteristics of the site.

4.5 Loitering Detection Types

Category	Conventional “Loitering” detection	Advanced “Loitering detection”
Occlusion Handling	Recognized as a new object; timer restarts from zero	Inherits the same object identity; dwell time is maintained
Exit Determination	Cannot distinguish between temporary detection loss and actual exit	Clearly determines entry and exit using Door zones
Blind Spot Handling	Dwell time resets when detection is lost	Continuous dwell time management using Hidden zones
Detection Conditions	Minimum observation time	Minimum observation time and object count
Alarm Behavior	One-time alert triggered upon reaching the threshold	Continuous alert generated until loitering ends
Recommended Environment	Open spaces without defined entry points	Enclosed spaces with defined entry points (e.g., ATM vestibule)

Table 1. Differences and characteristics of loitering detection types

5. Application Scenarios

5.1 Use Cases and Expected Benefits

Loitering detection is commonly applied in the following environments:

- **Banking (ATM vestibules):** Detects suspicious behavior involving prolonged presence inside ATM vestibules.
- **Retail (Store entrances):** Detects suspicious behavior such as standing in blind-spot corners or lingering near display shelves for extended periods.
- **Public Safety:** Detects suspicious vehicles or individuals parked in no-parking zones for longer than a specified duration or loitering within designated areas for extended periods.

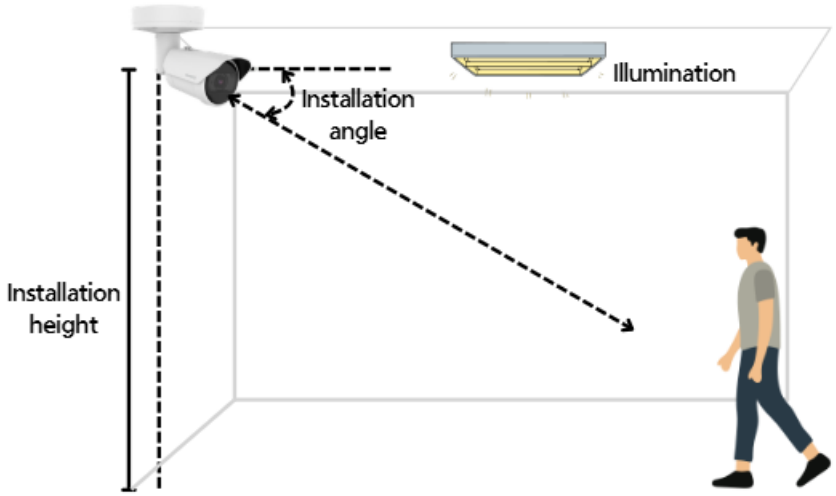
5.2 System Configuration Guidelines

To achieve optimal loitering detection performance, the following factors should be comprehensively considered:

1. **Loitering Detection Type Selection:** Choose between standard loitering detection under IVA and advanced loitering detection (specialized for environments like ATM Vestibule), depending on the operational environment.
2. **Region of Interest (ROI) Configuration:** Precisely configure only the areas requiring actual monitoring. When using advanced loitering detection, set up the Door and Hidden zones tailored to the specific site environment.
3. **Object Size Configuration:** Set appropriate minimum and maximum object sizes based on the distance between the camera and the target to minimize false detections.
4. **Dwell Time Threshold Setting:** Establish an appropriate minimum observation time that effectively distinguishes between normal presence and suspicious loitering in that specific environment.
5. **Minimum Object Count Setting:** When using advanced loitering detection, configure the threshold number of objects to reduce frequent duplicate alarms depending on the environment.
6. **VMS/Alarm Integration:** Integrating with a VMS or alarm output devices (e.g., IP speakers) via ONVIF events enables real-time alert reception without a separate server. Advanced loitering detection allows operators to receive alerts continuously until the loitering behavior ends.

5.3 Recommended Camera Installation Conditions

Loitering detection performance depends on the camera installation height, angle, FOV (field of view), and distance. Generally, the following installation guidelines are recommended. Additionally, it is recommended to select locations that minimize backlight or extreme low-light environments.



	Requirement
Installation Height	3 m to 6 m (9.84 ft to 19.69 ft)
Installation Angle	45°~70°
Illumination level	≥ 300 lux

Table 2: Recommended AI Camera Installation Conditions

Event detection performance may degrade or fail under the following conditions:

- When a target person continuously maintains an unusual posture.
- In high-density crowd situations (e.g., people putting arms around each other's shoulders or crowding in close contact).
- When visual identification is difficult due to degraded image quality, defocus, or low-light conditions.
- When the camera installation angle and height significantly deviate from the installation guidelines.

Note: In the web viewer, the display of an object's dwell time is limited to a maximum of 12 hours. Additionally, both the maximum number of objects that can be displayed simultaneously and the maximum number of objects for event delivery are limited to 32.

5.4 Recommended Camera Configuration

The loitering detection feature is natively embedded in Hanwha Vision AI cameras. Configuration methods may vary depending on the camera model and the selected type of loitering detection.

Cameras running Open Platform version 5.10 and those running Open Platform version 26.02 can be distinguished by where AI-based events, such as loitering detection, are configured. In version 5.10, these events are located within the camera's native settings, whereas in version 26.02, they are configured through the WiseAI App on the open platform.

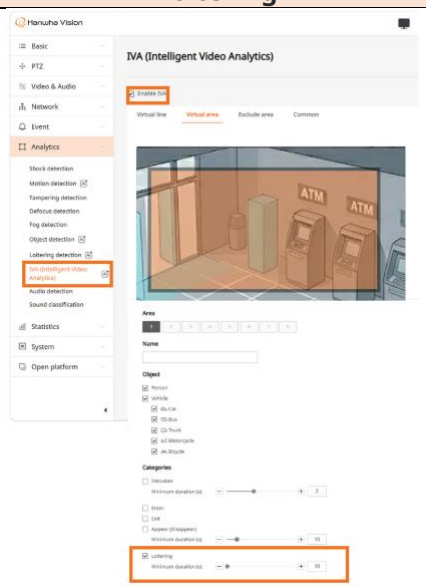
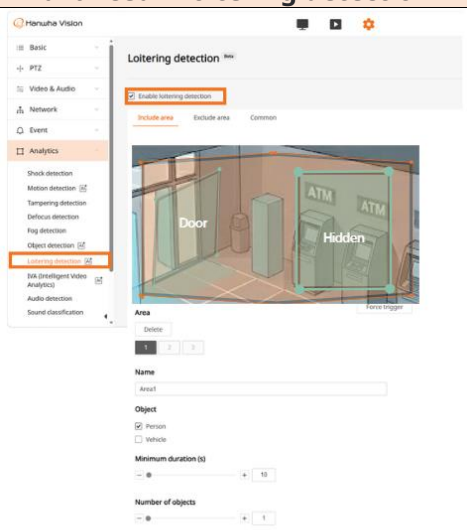
Open platform version 5.10 "Loitering"	Open platform version 5.10 Advanced "Loitering detection"
	

Table 3: Open Platform 5.10 Version UI

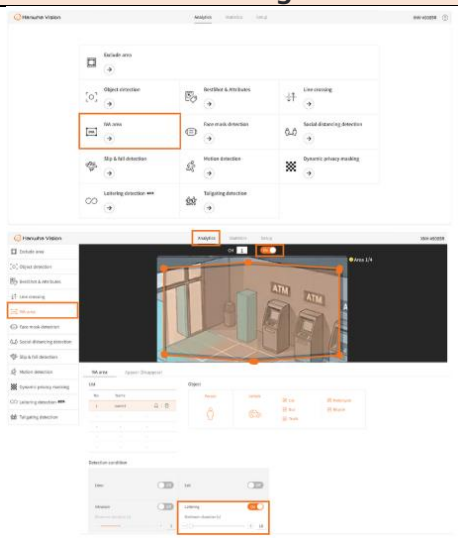
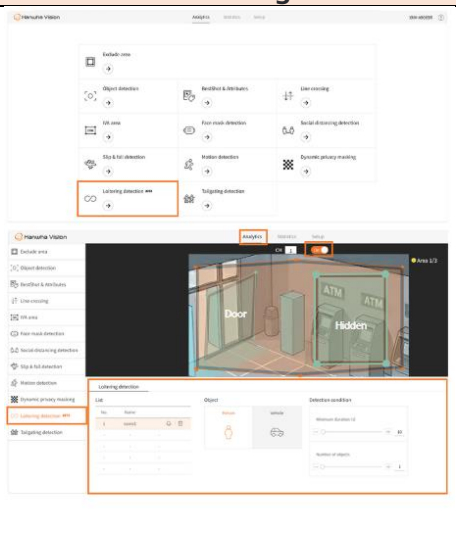
Open platform version 26.02 "Loitering"	Open platform version 26.02 Advanced "Loitering detection"
	

Table 4: Open Platform 26.02 Version, WiseAI App UI

- **Loitering:** Loitering detection can be configured by enabling IVA (Intelligent Video Analytics) in the "Virtual Area" tab, setting a region of interest (ROI), and defining a minimum observation time.
- **Advanced Loitering Detection**: Click the separate "**Loitering Detection [AI]"** tab and select a region of interest. This automatically creates one "**Door**" zone and one "**Hidden**" zone. Each ROI supports only one of each zone type, and they can be deleted if not needed.

The dwell time of a detected object within the configured area is displayed directly over the object in the video stream. If an object loiters in a section where multiple detection areas overlap, the loitering time is displayed based on the timestamp when the object first entered the detection area. Advanced Loitering Detection can display the loitering time for up to 32 objects simultaneously.

Whether the camera supports Advanced Loitering Detection can be verified by checking for **advanced "Loitering Detection"** under the "Analytics" section of the product datasheet. Loitering detection is disabled by default, and the function can be enabled using the activation button at the top. The number of vertices composing a detection area must be a minimum of 4 and a maximum of 8.

Regions of Interest (ROI) can be added, modified, or deleted. An area can be reconfigured after selecting its assigned Area Number. Newly added ROIs are immediately reflected in the area list.

6. Conclusion

Hanwha Vision's loitering detection technology is based on Edge AI, enabling real-time response without reliance on a server by processing object detection, tracking, and event determination entirely at the camera. In particular, **Advanced "Loitering detection"** resolves the fundamental limitations of conventional loitering detection—namely timer reset and undetected blind spots—through the configuration of Door and Hidden areas. In addition, alarms are continuously generated until the loitering ends, helping operators avoid missing situations.

Edge-side processing reduces integration complexity by enabling interoperability with most VMS through standard ONVIF events without the need for VMS or server-side plug-in development. It is advantageous from a Total Cost of Ownership (TCO) perspective, as low-cost and low-latency operation is possible without external GPU acceleration.

Security operators can build a loitering detection system optimized for their environment by referring to the installation guide and application scenarios in this white paper, and Hanwha Vision will continue to enhance the reliability and efficiency of video security through continuous algorithm advancement and expansion of new use cases.

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