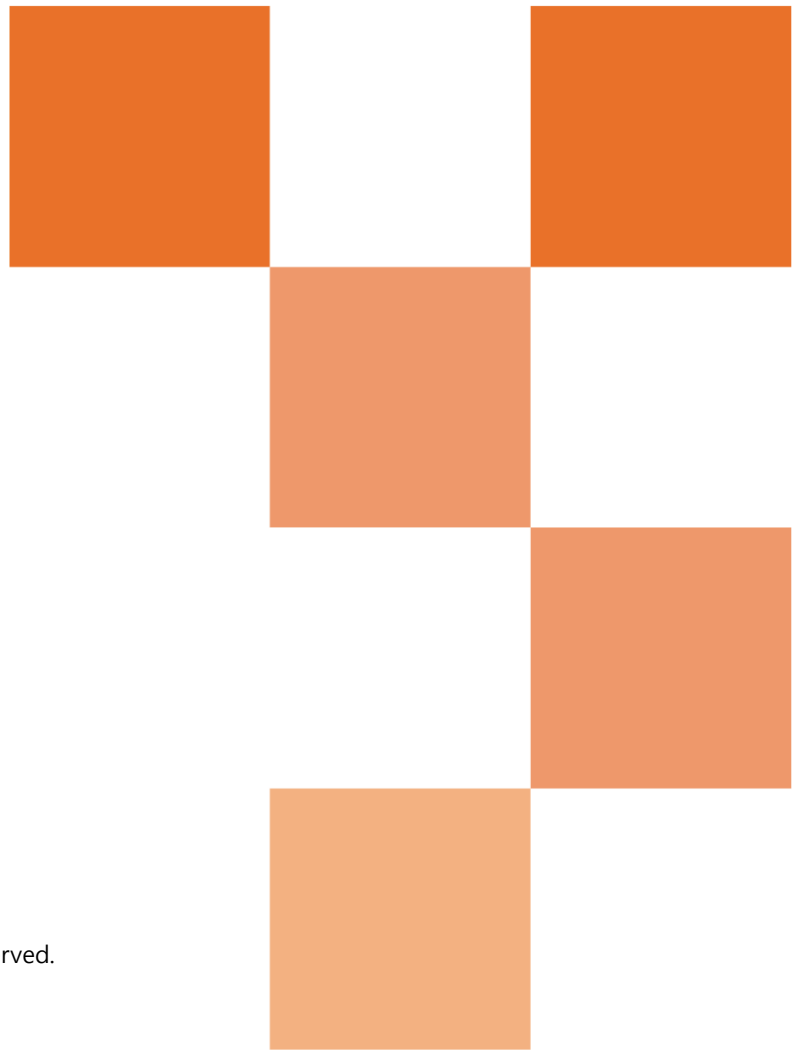


White Paper

# Crowd counting

White paper and Installation guide

April 2026



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## 1. Introduction

Hanwha Vision's Crowd counting technology is an advanced video analytics solution that accurately measures the density and size of crowds within a predefined area using AI algorithms. Unlike People counting, which focuses on tracking the number of individuals passing through specific entry or exit points, Crowd counting provides a deeper insight into how many people are gathered within a certain zone.

Powered by an SoC-integrated Neural Processing Unit (NPU), the camera performs large-scale crowd analysis in real time at the edge, eliminating the need for additional servers, plugins, or extended computational costs. This capability supports efficient crowd management and operational insights across diverse environments such as public safety monitoring, retail spaces, and smart city applications.

This whitepaper introduces the background and core algorithms of Hanwha Vision's Crowd counting technology, outlines installation guidelines and limitations, and highlights the unique strengths of Hanwha Vision's solution.



## 2. Background

With the increasing demand for automated analytics, Edge AI-based technology integrated directly into cameras is gaining significant prominence. The introduction of high-performance System-on-Chips (SoCs) and Neural Processing Units (NPUs) has enabled cameras to autonomously perform complex deep-learning computations that previously required dedicated external servers. This shift provides the advantage of performing AI video analytics more quickly and intuitively while significantly reducing the Total Cost of Ownership (TCO).

Video-based person analytics are generally categorized into two distinct methods based on the analytical objective: 'People counting,' which monitors traffic flow by aggregating the number of individuals passing through specific entrances, and 'Crowd counting,' which assesses the density of people within a specific area in real-time.

While People counting is optimized for managing building entries and exits or collecting hourly visitor statistics in retail environments, Hanwha Vision's Crowd counting technology was developed to accurately determine the exact occupancy in open, expansive areas such as plazas, event venues, and shopping mall courtyards. Moving beyond simply counting individuals entering or leaving, this technology provides real-time congestion data and triggers automated alarms when a specified threshold is exceeded. This serves as a critical resource for proactive accident prevention and efficient space management.

In particular, it can be effectively utilized for statistical density analysis and safety management in high-traffic locations, including large-scale event venues (festivals, concerts, and sports stadiums), commercial facilities (shopping malls and department stores), and major tourist attractions. Furthermore, it is expected to enhance spatial utility in crowded transportation hubs such as subway stations, airports, and bus terminals by providing the data necessary to guide crowd distribution toward less congested areas.



### 3. Crowd counting Technology

#### 3.1. Limitations of Traditional counting methods

Traditional People counting solutions typically set a virtual line within the camera's field of view and count each person who crosses that line. While this approach is effective for tracking entry and exit volumes, it cannot determine how many people are currently gathered in a specific area.

Hanwha Vision's Crowd counting technology overcomes these constraints by using a deep-learning based approach that directly estimates the number and density of people visible in the camera's scene—rather than only those who move past a line. This makes it possible for users to select and apply a solution that matches their operational objectives.

#### 3.2. Deep Learning-Based Head Detection

In crowded environments, people's full bodies are often partially hidden or only upper body regions are visible. To maintain high accuracy even under these conditions, Hanwha Vision's Crowd counting technology employs a deep-learning model specialized in detecting human heads.

This model has been trained on extensive datasets reflecting real-world environmental variables, including various field-of-view (FOV) angles, lighting conditions, genders, and hairstyles. This specialized training allows the system to accurately identify and count individuals within a crowd, even when their bodies are not fully visible. Furthermore, this head-detection approach is ideally suited for CCTV installation angles, offering a significant advantage in high-density environments where inter-object occlusion is frequent.

Hanwha Vision's Crowd counting technology supports the configuration of up to three Virtual Areas. For each area, users can independently set event trigger thresholds for up to 500 people in increments of 10. This allows the system to provide real-time crowd density estimations and issue alerts immediately when the number of people reaches the user-defined limit.



### 3.3. Training for Occlusion Handling

One of the most significant technological hurdles in crowd monitoring is 'Occlusion'—a situation where individuals are partially or fully blocked by those in front of them or where multiple people appear overlapped. Simple object detection algorithms often struggle with these scenarios, leading to significant inaccuracies such as undercounting or overcounting.

Hanwha Vision's Crowd counting algorithm addresses this by learning specific patterns found in high-density areas and identifying objects as human even when only a portion of the body is visible. By proactively accounting for these occlusion patterns, the system minimizes counting deviations and maintains stable accuracy, even in complex and congested scenes.

### 3.4. Edge-Based Real-Time Metadata Generation

Conventional Crowd counting systems typically rely on server-based architectures, where video streams are transmitted to a central server for AI analysis. This design demands costly GPU servers and introduces performance issues such as transmission delay, network bandwidth strain, and scalability limits—especially in large deployment environments.

Hanwha Vision's solution leverages the Wisenet 9 SoC's Neural Processing Unit (NPU) to perform all AI analysis directly on the camera edge. Instead of handling heavy real-time video streams, operators can review lightweight metadata, summary reports (daily or weekly), or alerts triggered when crowd density exceeds predefined thresholds. This dramatically reduces network load while enabling real-time analysis and event response.

By implementing edge-based Crowd counting, Hanwha Vision delivers a cost-efficient and highly scalable solution—particularly beneficial for environments with large camera deployments, such as public safety monitoring, traffic management, and retail operations.

### 3.5. Key Features and Use Cases

Hanwha Vision's Crowd counting solution does more than simply display a number. It provides a variety of functions that support safety management and operational efficiency.

When the number of people in a predefined area exceeds a set threshold, the system can trigger real-time alerts and immediately send alarms to a control center or mobile application. This helps operators detect and prevent potential risks in advance, including stampede incidents and delayed evacuations.

By connecting multiple cameras to a VMS and calculating the number of people relative to each area's size, the system can classify crowd conditions into levels such as safe, normal, crowded, and critical. This makes it possible to systematize crowd monitoring and take proactive measures in densely populated areas.

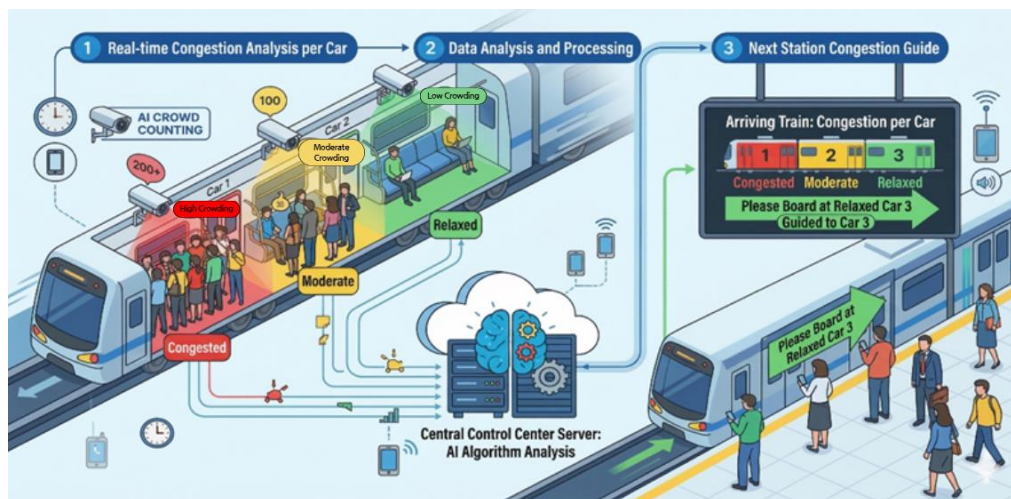


Figure 1. Example of Crowd counting Use Cases

In the Public Safety sector, Crowd counting can be used as real-time decision-making intelligence for crowd dispersion and evacuation planning during emergencies. Hanwha Vision's Crowd counting analyzes people counting data per defined zone in real time to monitor crowd density and distribution, helping operators identify overcrowding risks early and take proactive measures for safety and flow control.

In Retail, the solution can analyze busy periods and high-traffic areas inside a store to optimize staffing, promotion timing, and merchandising strategies, supporting revenue growth and operational planning. Hanwha Vision's AI-based analytics is designed to convert video into actionable intelligence for smarter operations and data-driven decision-making.

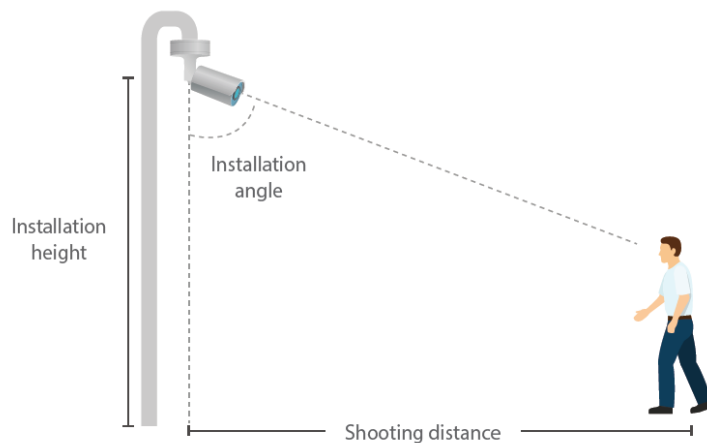
In Smart City applications, the system can continuously collect and analyze pedestrian flow data in key commercial districts, tourist sites, and transportation hubs without requiring manual counting, providing valuable long-term data for traffic policy, pedestrian safety, urban renewal, and commercial development planning. Hanwha Vision also highlights city surveillance as a way to improve public services, traffic flow, and operational efficiency through AI-powered video data.

## 4. Camera Installation Guide

### 4.1. Recommended Camera Installation Conditions

Crowd counting performance depends on camera mounting height, angle, FOV (Field of View), and distance. The following guidelines are recommended:

Lens focus and FOV should ensure the target area appears undistorted with sufficient resolution. Select positions minimizing backlighting or extreme low-light, leveraging WDR (Wide Dynamic Range) features. Pre-site surveys with simulations are essential to optimize placement.



Appropriate camera installation environment	4K Resolution camera	2MP Resolution camera
Installation height	8 ~ 12m	
Installation angle	45 ~ 60°	
Shooting distance	10-25m	10-20m
Maximum number of people in ROI	500 people	
Tolerance	+/-15%	

Table 1. Recommended AI Camera Installation Conditions



Figure 2. Example of camera installation



## 4.2. VMS and External System Integration

Hanwha Vision's greatest strength lies in the high compatibility between its hardware and software. Through AI-based cameras, optimized deep-learning models, and broad interoperability with various VMS and platform environments, customers can achieve maximum results with minimal infrastructure.

One of the most significant economic advantages is that a single camera can identify crowds of up to 500 people and transmit the data to a VMS without requiring a separate, expensive analytics server. This helps substantially reduce total cost of ownership (TCO), not only by lowering infrastructure expenses such as servers, networks, and storage, but also by minimizing system maintenance and power consumption. In addition, a single camera can run multiple video analytics functions at the same time, including Crowd counting, People counting, zone-based analytics, and intrusion detection, allowing the system to scale flexibly according to the deployment environment and size.

In particular, Hanwha Vision's Crowd counting solution supports intuitive monitoring and alarm handling in control room environments through integration with VMS platforms. When two or more channels (ex, Multi Sensor Camera) are used, detailed settings can also be configured for each channel individually. This enables the solution to go beyond simple surveillance monitoring and deliver data-driven insights that can be applied to business and operational decision-making.

### 4.3. Recommended Camera Settings

The Crowd counting feature is available on cameras running the WiseAI App. To confirm whether the feature is supported, check the camera specification sheet under the Business Intelligence category.

In the user interface, open the WiseAI App from OpenPlatform, then navigate to the [Statistics] tab at the top and select [Crowd counting] menu.

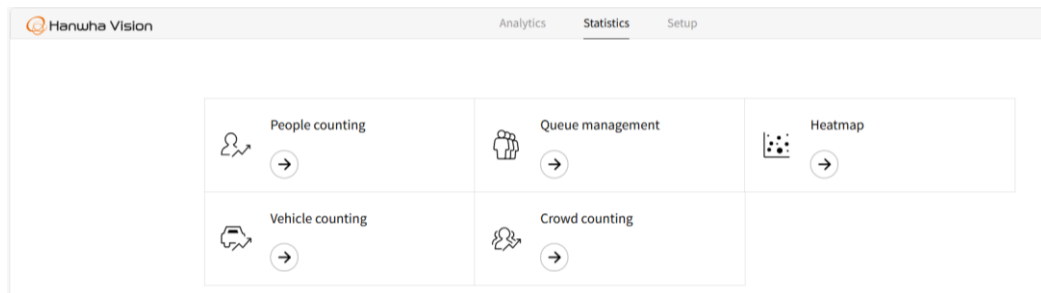


Figure 3. Statistics UI of the WiseAI App

The feature is initially disabled, and users can enable or disable Crowd counting by clicking the Enable button at the top. A single Virtual Area must contain a minimum of 4 vertices and a maximum of 8 vertices. When the cursor is placed over a line, a plus (+) icon appears; clicking it adds a vertex. When the cursor is placed over a vertex, a minus (-) icon appears; clicking it removes the vertex.

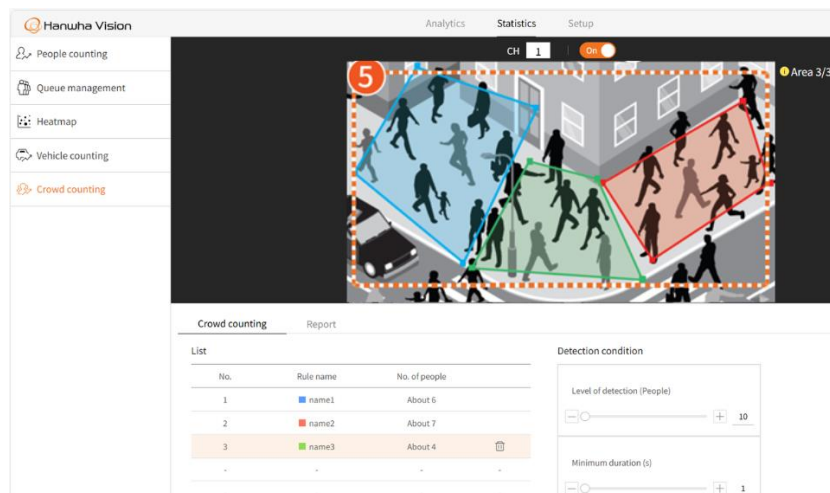


Figure 4. Virtual Area Configuration UI

Virtual Areas can be added, edited, or deleted. To modify a configured area, select its area number and reconfigure the region. Added Virtual Areas are also reflected in the Chart section.



#### 4.4. Limitations of Detection Performance

While the Crowd counting feature delivers high performance by leveraging environmental variable training and occlusion handling, physical or optical constraints may lead to performance degradation or inaccuracies under extreme conditions. In particular, since the system utilizes the human 'head' as the primary detection point, it is important to note that detection accuracy for configured events may decrease in scenarios where head features are difficult to distinguish.

- When the heads of the people in the crowd are not seen due to obstacles, dark environments, overly dense crowds, etc
- When only the backs of the heads of people, not their faces, are seen.
- When people are wearing helmets or hats, etc
- When people are densely concentrated, making it hard to distinguish the heads from other objects
- When a non-head object is detected as a head
- When the head size is smaller than the minimum detectable object size<sup>1</sup> configured under [Settings] > [Common Settings]

For stable Crowd counting operation, please note that a delay of approximately 3 to 5 seconds may occur when the feature starts, when settings are changed, or when the crowd count changes before an accurate result is displayed.

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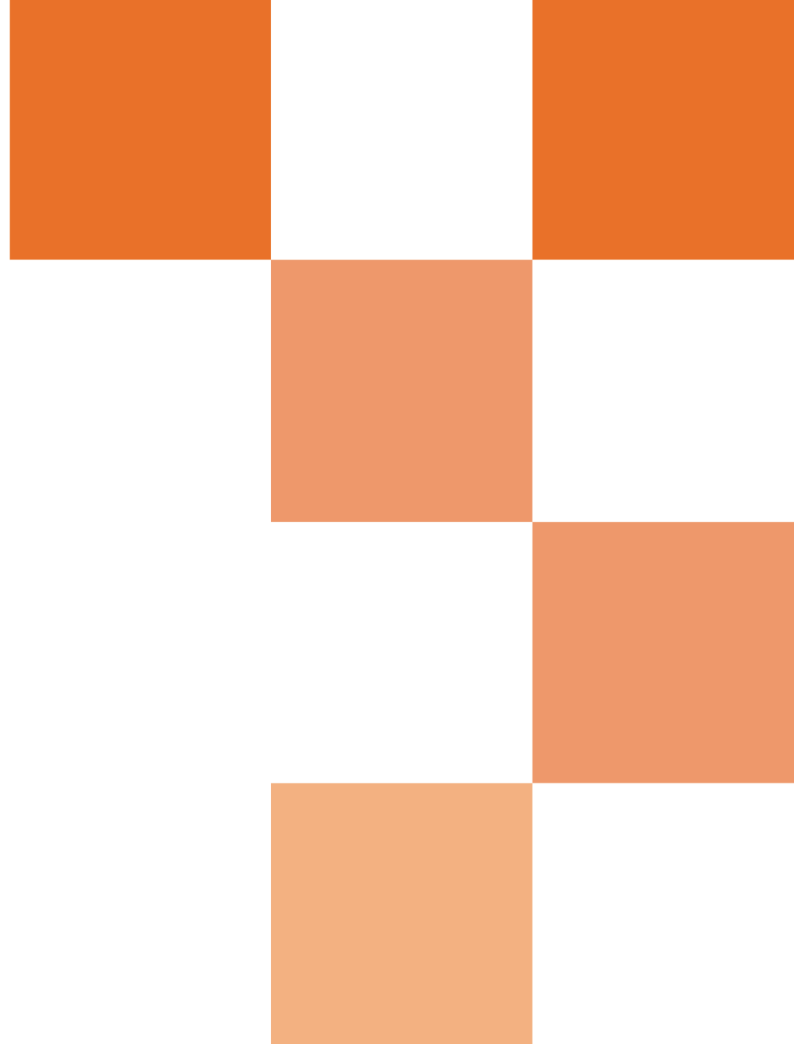
<sup>1</sup> The default minimum detectable size is 20 pixels x 20 pixels, and it can be adjusted by the user.



## 5. Conclusion

Crowd counting is more than a tool for answering “how many people entered and exited.” It is a core solution for showing, in data form, how safe a space is right now and how efficiently it is being operated. Hanwha Vision’s Crowd Counting solution supports decision-making across public safety, retail, and smart city environments through high-performance edge AI and sophisticated deep-learning algorithms, and it can operate reliably even in critical infrastructure environments. Hanwha Vision’s AI analytics also supports Crowd counting up to 500 people per zone.

Going forward, Hanwha Vision will continue advancing camera hardware, AI analytics software, and platform integration technologies to help customers design safer and more efficient spaces.



**Hanwha Vision Co.,Ltd**  
13488 **Hanwha Vision** R&D Center,  
6 Pangyo-ro 319-gil, Bundang-gu, Seongnam-si, Gyeonggi-do  
**TEL** 070.7247.8771      **FAX** 031.8018.3715  
[www.HanwhaVision.com](http://www.HanwhaVision.com)