

White paper / Installation guide

Wisenet AI NVR

White paper & Installation guide

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Since the development of CCTVs, humans have been responsible for simultaneous monitoring of multiple cameras and event detection from each of them. However, the number of video a human can review at the same time is limited, leading to fatal human errors and lowering the efficiency of operation.

To overcome such limitations, AI (Artificial Intelligence) technology is widely incorporated in video surveillance, offering a range of video analytics. AI-enabled video analytics can identify persons and vehicles and alert meaningful events to operators through attributes extraction and Automatic Number Plate Detection (ANPD). This enabled effective monitoring of more number of cameras and maximized the efficiency of operation.

Hanwha Techwin is offering AI-enabled video analytics with its Wisenet AI NVRs.

- Detect persons, vehicles, and license plates from the video
- Extract attributes from detected persons and vehicles
- Recognize and search texts from detected license plates
- Recognize and search detected faces from AI cameras

This document is designed to help users better understand and conveniently use our products and features while installing and operating Hanwha Techwin's AI NVRs.

2.1. Object Detection

Object Detection technology classifies the types of objects (person, face, vehicle, license plate) and identifies their location in the video. Object Detection adopts deep learning algorithms to learn images of objects (person, face, vehicle, license plate) and detect similar objects within an image.

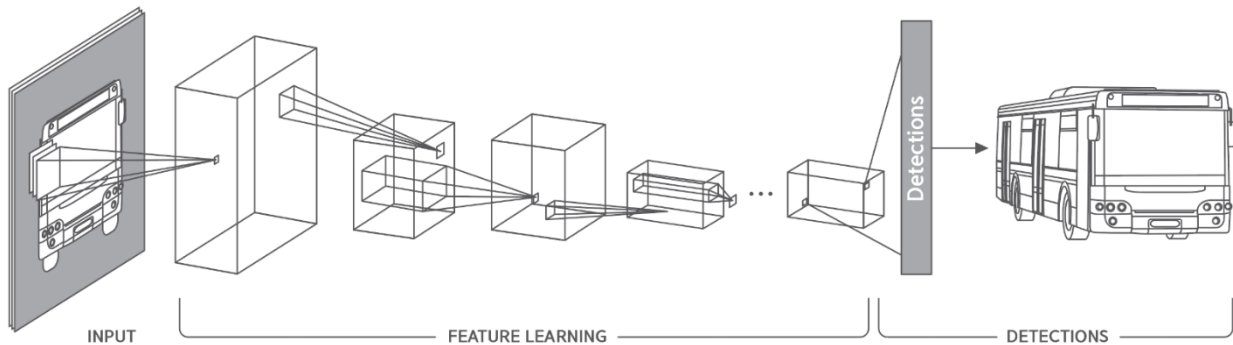


Image 1. Deep learning algorithms for detecting four types of AI objects

2.2. BestShot capture

Wisenet AI NVRs offer BestShot images of each detected object (person, vehicle, license plate) in maximum 4K resolutions. Each BestShot image contain metadata of the objects' distinctive attributes, allowing operators to easily find specific objects in the video. Search scenarios include facial detection (with Wisenet AI Camera) and license plate recognition.

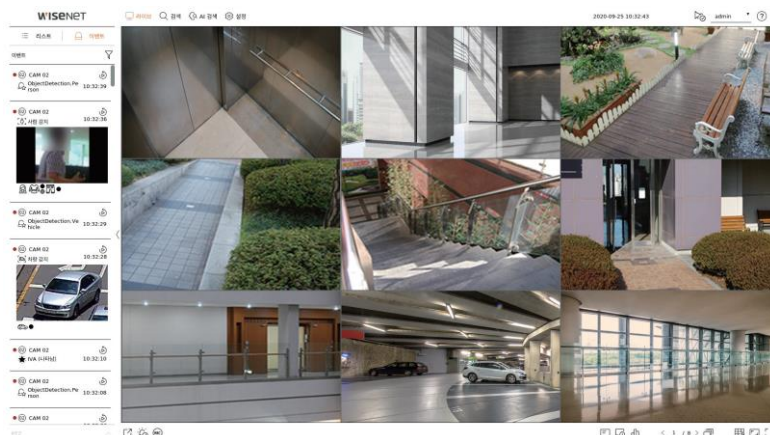


Image 2. AI NVR BestShot images

2.3. Attributes extraction

Attributes extraction technology utilizes deep learning algorithms to classify detected objects (person, face, vehicle) into detailed and meaningful categories for each object type. For instance, persons can be categorized by their gender, clothing color or bags, while vehicle attributes are classified by color or vehicle types such as trucks, buses, or motorcycles. Users can utilize such attributes information to increase efficiency in searching objects from large sized data in video recorders.

2.4. License Plate Recognition Search

License Plate Recognition (LPR) search technology using deep learning algorithms can search license plates detected in the video with texts by recognizing and saving texts on license plates. Alarms with real-time comparison are not supported. With LPR search, users can enter the information of license plates in letters (Korean, English) and numbers and search the timing the plate appears in the footage.

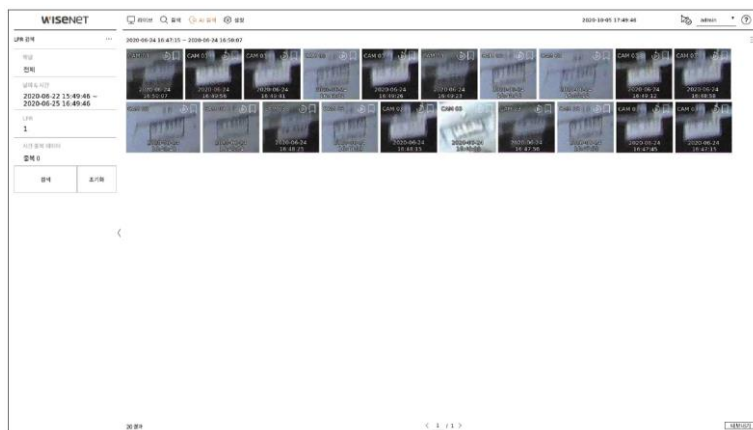


Image 3. Vehicle license plate search in AI NVRs

Hanwha Techwin’s AI features can achieve the optimal performance when the cameras are installed and operated in accordance with this guide. For best results, please refer to the following instructions as the NVRs’ AI video analysis can be affected by lighting or camera field of view.

- This installation guide outlines minimum requirements and recommendations for using AI features of the NVRs. Performance of each feature cannot be guaranteed if the instructions are not followed properly.
- Video analysis can offer optimal performance under stable lighting conditions. Minimum 300 lux is suggested as suitable lighting level.

3.1. Recommendations for camera installation

This section illustrates recommendations for installing Wisenet AI NVRs to ensure reliable AI performance. If a camera is installed at a height of minimum 3 meters (9.9ft) with a tilt of 45-degree angle, objects at least one meter away and higher than 170cm (5.58ft) can be recognized. Detection is possible until more than two-thirds of the object is visible up to a distance of 5.6m (18.4ft) from the camera. For reliable detection of AI cameras, it is recommended to install cameras at an angle of 45 degrees or larger, creating a side-view. With Wisenet (Non-AI) cameras, vibration or shaking can cause failed or false object detection.

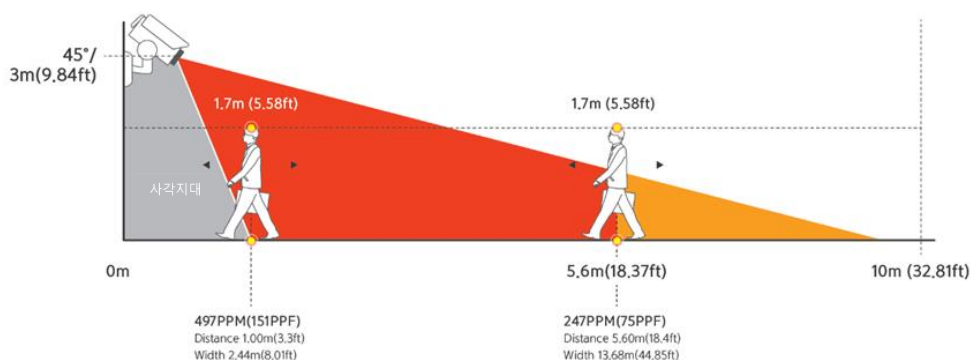


Image 4. Recommendations for camera installation (3m, 45 degrees)

- 4K (3840x2160) camera installed at 3m (9.9ft)/ 45 degrees (lens focal length: 4.5mm)

Resolution : 497 PPM (151 PPF) @ 1.0m (3.3ft)

247 PPM (75 PPF) @ 5.60m (18.4ft) (Over 2/3 of object)

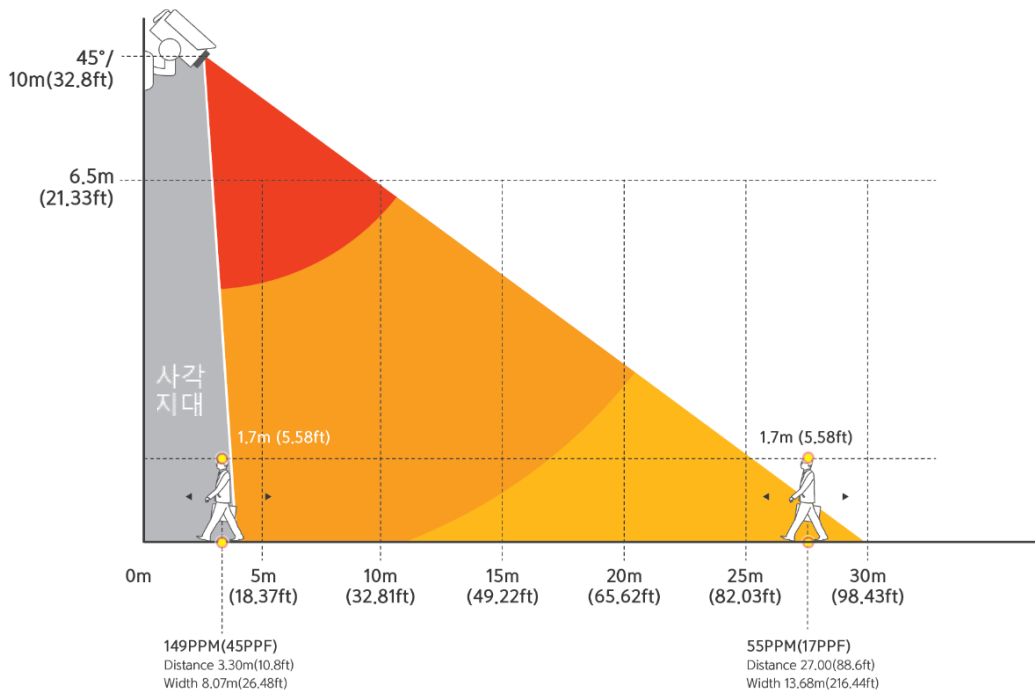


Image 5. Recommendations for camera installation (10m, 45 degrees)

- 4K(3840x2160) camera installed at 10m (32.8ft)/ 45 degrees (lens focal length: 4.5mm)

Resolutions: 149 PPM (45 PPF) @ 3.30m (10.8ft)

55 PPM (17 PPF) @ 27.0m (88.6ft) (Over 2/3 of object)

※ For 2MP cameras' recommended installation condition, please check the Toolbox PLUS on our official website.

	Recommendations	Install height	Focal length	Max. install distance (in day)
4K	Min	Over 3m (9.9ft)	4.5mm 10mm	28.4m 83.1m
	Max	Below 10m (32.8ft)	4.5mm 10mm	26.7m 82.6m
2MP	Min	Over 3m (9.9ft)	4.38mm 9.33mm	13.5m 42.6m
	Max	Below 10m (32.8ft)	4.38mm 9.33mm	9.6m 41.5m

Table 1. Recommended AI camera installation conditions

[Distance between Camera-Object (m), P 4K, W(4.5mm), in Day]

PPM	Installation height (10m)	Installation height (3m)
250	-	5.5
125	7.6	12.2
63	22.9	24.8
55	26.7	28.4
25	62.0	62.7

(Unit=m)

※ In the case of shaded gray, will result in installation angle below 45 degrees.

[Distance between Camera-Object (m), P 4K, T(10mm), in Day]

PPM	Installation height (10m)	Installation height (3m)
250	15.3	18.1
125	35.2	36.5
63	72.0	72.6
55	82.6	83.1
25	182.7	183.0

(Unit=m)

[Distance between Camera-Object (m), P 2MP, W(4.38mm), in Day]

PPM	Installation height (10m)	Installation height (3m)
250	-	0.5
125	-	5.3
63	6.8	11.7
55	9.6	13.5
25	28.8	30.4

(Unit=m)

※ In the case of shaded gray, will result in installation angle below 45 degrees.

[Distance between Camera-Object (m), P 2MP, T(9.33mm), in Day]

PPM	Installation height (10m)	Installation height (3m)
250	-	8.9
125	15.9	18.5
63	35.9	37.1
55	41.5	42.6
25	93.5	94.0

(Unit=m)

Criteria for PPM (Pixels per meter) / PPF (Pixels per foot)

※ Wisenet ToolBox: https://www.hanwha-security.com/wisenettoolbox_plus/index.html#!/en/home

- Pixels per meter is the number of pixels to represent one meter. With a greater number of PPM, the higher the resolution will be.

- Pixels per foot is the number of pixels to represent one foot. With a greater number of PPM, the higher the resolution will be.

1) 25 PPM (8 PPF) or higher for general video surveillance: Detect an object's shape, color, rough size, or gender.

Not sufficient to recognize facial features or letters.

1) 63 PPM (19 PPF) or higher for object detection: Observe human faces or license plates from the video analysis module.

2) 125 PPM (38 PPF) or higher for object recognition: Recognize facial features or letters on a license plate.

3) 250 PPM (76 PPF) or higher for identifying details. Sufficient picture quality to identify details. Identify facial scars, eye colors, or tattoos.

3.2. Configuring camera lens Field of View

- When using Wisenet cameras, it is recommended to keep a straight horizon line for aligned images.
- Objects should be right-side-up for reliable performance.
- If an image in camera is reversed, go to 'Setup' > 'Video and Audio' > 'Video setup' and enable 'Upside down' or 'Left and right reverse.'

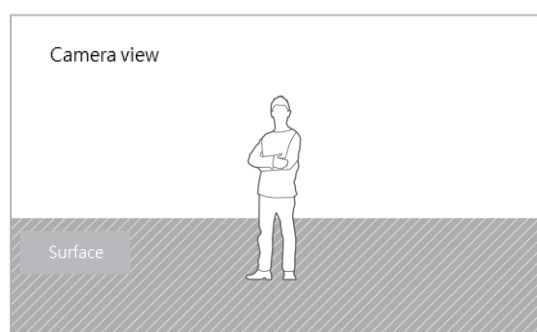


Image 6. Recommended Field of View

3.3. Precautions for camera installation

False or failed detection could result if cameras are not properly installed according to recommended requirements. The following conditions can reduce the cameras' performance.

- 1) Camera installation angle at less than 30 degrees (Direct under)
- 2) Challenging lighting conditions with shadows or low-light environments
- 3) Scenes with strong background lighting such as direct sunlight, backlighting, or direct lighting

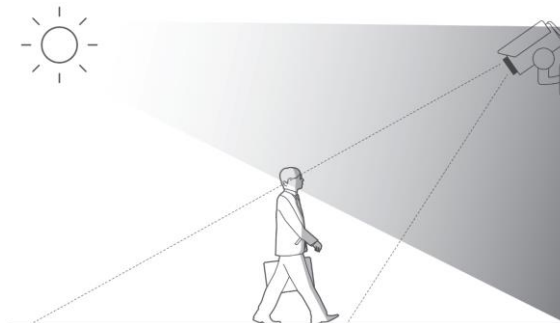


Image 7. When cameras get affected by direct sunlight, backlighting or direct lighting

- 4) Motion blur caused by slow shutter speed or low frame rate
- 5) Increased Dynamic Range)¹
Dynamic range can be reduced with Wide Dynamic Range (WDR).
- 6) Objects have similar illumination or color as the background.
- 7) Random objects occlude different objects

¹ Dynamic Range: The difference between the darkest and lightest tones in an image



Image 8. When random objects occlude different objects

- 8) Several objects moving together
- 9) Objects reflected in reflectors such as mirrors



Image 9. When objects are reflected in reflectors such as mirrors

- 10) Objects moving fast
- 11) To detect fast moving objects, it is recommended to increase the field of view.
- 12) Designating object detection size as smaller than its actual size
- 13) Designating object detection size as bigger than its actual size
- 14) The ratio of the object's size to the whole image is too large.
- 15) Object occlusion or partial objects can still be detected in object detection AI, but can cause false positives as the detection is enabled only by attributes from detected areas.

3.4. Guidelines on recommended requirements

Wisenet AI NVRs can detect persons, vehicles and license plates. The number of objects that can be detected simultaneously is 256 (person, car, license plate, head information in total). AI NVRs can also extract best images (BestShot) of each object. As BestShot is enabled by AI object detection, its performance can be impacted if the performance of person/vehicle/license plate detection degrades. This section describes recommended requirements to detect each object. The NVRs' recording resolution shall be Full HD 1920 x 1080 and above. The requirements can vary for each object. Even if all the requirements are met, the performance may vary according to different operating environments.

3.4.1. Recommended requirements for person detection

- The minimum size supported for detecting a person in an image is 15 pixels for the shorter axis. The recommended size is 30 pixels or higher.
- Detection might not be possible if a full body (face/body/leg) is occluded more than 50% from left to right.



Image 10. When a full body (face/body/leg) is occluded more than 50% from left to right.

- Detection might not be possible if upper or lower body is occluded more than 50.
- The following conditions can reduce the accuracy of detection.

- Only parts of the body is captured in an image
- A person moving faster than 0.5m/sec ~ 1.5m/sec
- In high density crowds (e.g., standing shoulder to shoulder, large crowds)

3.4.2. Recommended requirements for person BestShot

- The minimum size supported for person BestShot in an image is 96 pixels in width and 192 in height.
 - Detection is possible for objects existing in an image for more than one second.
 - The following conditions can fail or reduce the accuracy of person BestShot.
- Only parts of the body, not full body (face/body/leg) is captured in an image
 - In high density crowds (e.g., standing shoulder to shoulder, large crowds, multiple people standing overlapping each other)
 - Fast movement of an object
 - Change of pose: Not standing straight (e.g., sitting down, lying down, or bending)
 - Unidentifiable to the naked eye due to poor quality or blurry images

3.4.3. Recommended requirements for person attributes extraction

- The minimum size supported for person attributes extraction in an image is 112 pixels for the longer axis. The recommended size is 352 pixels or higher.
 - Types of person attributes
- Gender: Male, female
 - Top/bottom wear color: Black, blue, gray, green, orange, red, purple, white, yellow (1~2 colors can be extracted from each wear at a time)
 - Bag: Carrying, not carrying

- The following conditions can fail or reduce the accuracy of attributes extraction.
 - Only parts of the body, not full body (face/body/leg) is captured in an image
 - Back images can lower the accuracy of gender classification.
 - In high density crowds (e.g., standing shoulder to shoulder, large crowds)
 - Persons riding two wheelers (motorcycle/bicycle)
 - Change of pose: Not standing straight (e.g., sitting down, lying down, or bending)
 - Unidentifiable to the naked eye due to poor quality or blurry images

3.4.4. Recommended requirements for vehicle detection

- If a vehicle is front-facing in an image, the minimum size supported for detection is 15 pixels for the shorter axis. The recommended size is 40 pixels or higher.
- If a vehicle is side-facing in an image, the minimum size supported for detection is 15 pixels for the shorter axis. The recommended size is 35 pixels or higher.
- Detection might not be possible if the front of a vehicle is occluded more than 75% from left to right.

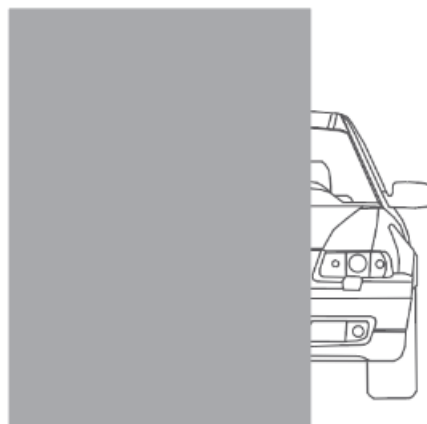


Image 11. When the front of a vehicle is occluded more than 75% from left to right

- Detection might not be possible if the front of a vehicle is occluded more than 50% from top to bottom.
- Detection might not be possible if the side of a vehicle is occluded more than 25% from left to right.
- Detection might not be possible if the side of a vehicle is occluded more than 50% from top to bottom.

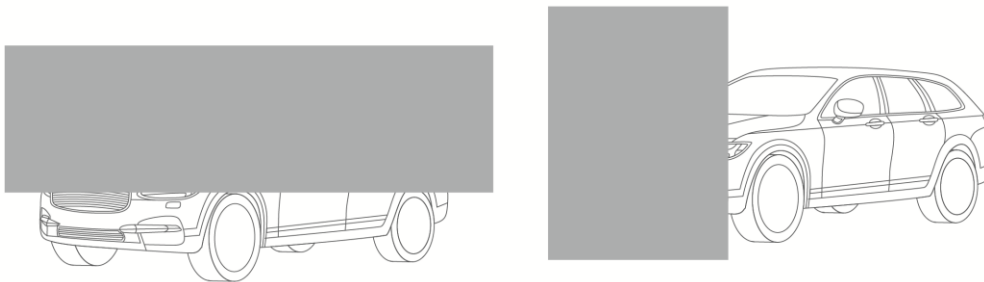


Image 12. When the side of a vehicle is occluded more than 50% from top to bottom (left), 25% from left to right (right)

- Detection might not be possible if a vehicle is overturned.
- The following conditions can reduce the accuracy of object detection.
 - Only parts of a vehicle is captured in an image
 - If a camera is installed within 10m high at an angle of 45 degrees or higher or a vehicle is moving faster than 80Km/h
 - If a camera is installed at an angle of 30 degrees or higher or a vehicle is moving faster than 40Km/h
 - In high density crowds (e.g., traffic congestion, waiting at red light)

3.4.5. Recommended requirements for vehicle BestShot

- The minimum size supported for vehicle BestShot in an image is 80x 80 pixels for four wheelers and 50x50 pixels for two-wheelers. Detection is possible for objects existing in an image for more than 0.3 seconds.

- The following conditions can reduce the accuracy of vehicle BestShot.
 - Only parts of a vehicle is captured in an image
 - Vehicles are overlapped in high density crowds
 - Fast movement of an object
 - Unidentifiable to the naked eye due to poor quality or blurry images

3.4.6. Recommended requirements for vehicle attributes extraction

- The minimum size supported for classifying vehicle attributes extraction in an image is 50 pixels for the shorter axis for two-wheelers and 80 pixels for four-wheelers. The recommended size is 100 pixels or higher.
- Types of vehicle attributes
 - Vehicle type: Car, bus, truck, bicycle, motorcycle
 - Vehicle color: Black, blue, gray, green, orange, red, purple, white, yellow (1~2 colors can be extracted from each vehicle)
 - The following conditions can reduce the accuracy of attributes extraction.
 - If a vehicle is occluded more than 50% or on the edges of the screen
 - If vehicles are overlapped by others
 - Vehicle color unidentifiable due to reflection
 - Unidentifiable to the naked eye due to poor quality, blurry images, or nighttime conditions

3.4.7. Recommended requirements for license plate detection

- If a license plate is front-facing in an image, the minimum size supported for detection is 12 pixels for the shorter axis. The recommended size is 15 pixels or higher.
- Detection might not be possible if a license plate is not facing the front in

the image.

- Detection might not be possible if a license plate is occluded more than 25% from left to right.

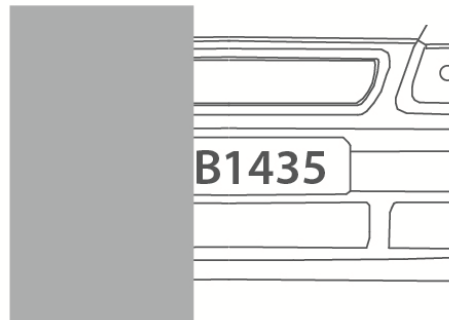


Image 13. When a license plate is occluded more than 25% from left to right.

3.4.8. Recommended requirements for license plate BestShot

- The minimum size supported for license plate BestShot in an image is 80 pixels wide and 30 pixels high. Detection is possible for objects existing in an image for more than 0.3 seconds.
- The following conditions can reduce the accuracy of license plate BestShot.
Only parts of a license plate is captured in the image
 - A license plate is occluded or overlapped in high density crowds
 - Fast movement of an objectUnidentifiable to the naked eye due to poor quality or blurry images

Object	Min. pixel for detection (Shorter axis) (@4K(3840x2160))	Recommended speed for detection (@ Within 100m)
Person	30 pixels or above	0.5m/sec ~ 1.5m/sec (Cannot guarantee accuracy for objects walking faster than the normal walking speed)
Vehicle	(Front) 40 pixels or above (Side) 35 pixels or above	Below 80km/h (Installed at 45° or larger) Below 40km/h (Installed at 30° or smaller)
License plate	15 pixels or above	-

Table 2. Recommended requirements for AI object detection

Object	Min. pixel for detection (@4K(3840x2160))	Recommended pixels for attributes extraction (@4K(3840x2160))
Person	112 pixels or above (Longer axis)	352 pixels or above (Longer axis)
Vehicle	50 pixels or above (Shorter axis, two-wheeled) 80 pixels or above (Shorter axis, four-wheeled)	100 pixels or above (Shorter axis)

Table 3. Recommended requirements for AI attributes extraction

3.4.9. Recommended requirements for license plate recognition search

The minimum size supported for license plate recognition search in an image is 80 pixels wide and 30 pixels high. In the domestic market, the search performance for two-wheelers and specialized license plates (military, government, heavy machinery vehicles, etc) cannot be guaranteed. In the overseas market, the middle area in the license plates is analyzed, while the

performance of two-wheelers and specialized license plates is not guaranteed.

The following conditions can reduce the accuracy of license plate detection search.

- Nighttime or low-light environments
- Strong lighting such as direct sunlight, lamps, and headlight causing reflection, blur, or shadow.
- Motion blur caused by fast movement
- Parts of license plates occluded by objects or persons
- Strong snow, rain, wind or at sunrise or sunset
- License plate appears too small in the footage.
- Rotation of license plates
- Texts in license plates is unrecognizable.
- Motion blur caused due to lower shutter speed

Hanwha Techwin's Wisenet AI cameras provide top notch video analytics technologies through AI. By accurately detecting and classifying attributes of meaningful objects (person, vehicle, face, license plate) in video surveillance, users can utilize the information in various applications.

Hanwha Techwin offers a range of video analytics that can take full advantage of camera devices (systems). All video analytics features adopt intuitive Webviewer of cameras for easy configuration and operation. The features are expected to help users build efficient video surveillance systems and engage in systematic information gathering and analysis.

WISENET

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