Range Performance for DRI and IVS

How Far Dahua Thermal Camera Can Detect Targets

White Paper by Dahua Technology

Release 1.0

Contents

1 Introduction

- **DRI** → stands for Detection, Recognition, and Identification. It is a combined result of subjective factors and objective factors. Subjective factors include the observer's vision, psychology, experience, and other factors. To answer the question, "How far can a thermal camera see?" one must first understand, "What does it mean to see clearly?" When detecting a target, one person may judge they can see it clearly, while another may think it is not clear, making it important to have a unified objective evaluation standard. This paper explains DRI distance, also referred to Johnson's criteria, which is the universal standard for describing both spatial domain and frequency domain approaches to analyze the ability of observers to perform visual tasks using image intensifier technology.
- **IVS** → The Intelligent Video System (IVS) is a built-in video analytics algorithm that delivers intelligent functions to monitor a scene for tripwire violations, intrusion detection, and abandoned or missing objects.

2 Johnson's Criteria

Almost all customers want to be certain that the thermal camera they buy is the right one for their application environment. One of the most frequent questions customers ask is, "How far can I see?" For example, when you want to see a target, what is the size of the target in the thermal view, and how do you determine it is clear or not as an observer? Many influencing factors that affect the answer are beyond the scope of this document, the temperature of object, the temperature difference between object and background, air conditions, etc.

This paper describes the distance the camera can see under ideal conditions, ensuring you understand the best case scenario limitations. In this paper, three main elements will be used to calculate the answer:

- The size of object
- The focal length of lens, or the camera field of view
- The camera's image resolution

Taking into account the size of the object, for example, when using the same camera to view a person or a vehicle, the size of vehicle is bigger, and has more pixels in the view. This results in a higher resolution, increasing the probability of an accurate assessment. Different applications require different resolution levels, so a common standard is needed to determine the distance performance and the basis of assessment. This paper uses a common standard, Johnson's criteria [http://en.wikipedia.org/wiki/Johnson's_criteria], which predicts the performance of sensor systems under different environmental and operational conditions. Using Johnson's criteria, the DRI (Detection Recognition Identification) is defined in terms of the number of pixels on the object for Dahua thermal cameras:

- **Detection** - At least 1.5 vertical pixels on target, an object is present [something is there].
- **Recognition** - At least 6 vertical pixels on target, object classification can be distinguished [e.g., human, truck, building, etc.].
- **Identification** - At least 12 vertical pixels on target, object characteristics can be

distinguished [e.g., soldier, pickup truck, gas station, etc.].

3 DRI Definition

When using thermal cameras, the most frequently asked question is how far the thermal camera can detect a target. With Johnson's criteria in mind, DRI is a universally accepted set of standards that provides a means of measuring the distance at which a thermal sensor can produce an image of a specific target, and it is easy to understand the spatial resolution of a thermal camera. Clearly, the more pixels there are, the better the spatial resolution will be.

3.1 Detection

At this distance, a target initially appears in the scene. The observer knows that something is there, but cannot confirm what the target is. It should be visible on at least two pixels in the view, enough to distinguish the object from the background. In reality, this object is just warmer or cooler than the ambient environment.

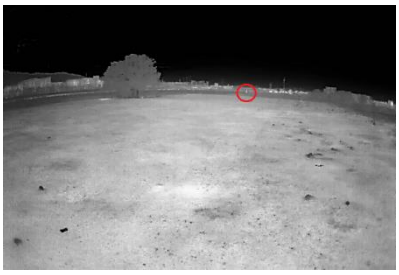

Figure 1: Detection

3.2 Recognition

Contrary to what one might think, recognition does not mean that you can recognize an individual. Recognition refers to the distance at which you can distinguish the object's class (animal, human, vehicle, boat, etc.), as in recognizing the object is a person versus a car.

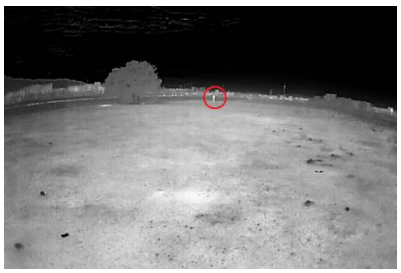

Figure 2: Recognition

3.3 Identification

Identification of a target refers to the distance at which one is able to differentiate between objects. For example, being able to identify the type (is it a truck, tank, or car) of vehicle and not only class. Likewise, one would be able to tell if a human is a soldier or civilian.

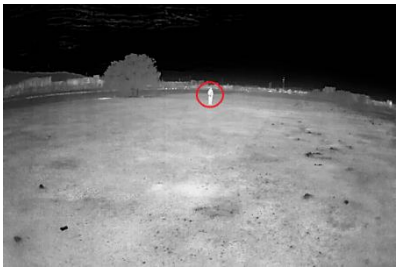

Figure 3: Identification

3.4 Industry Standards

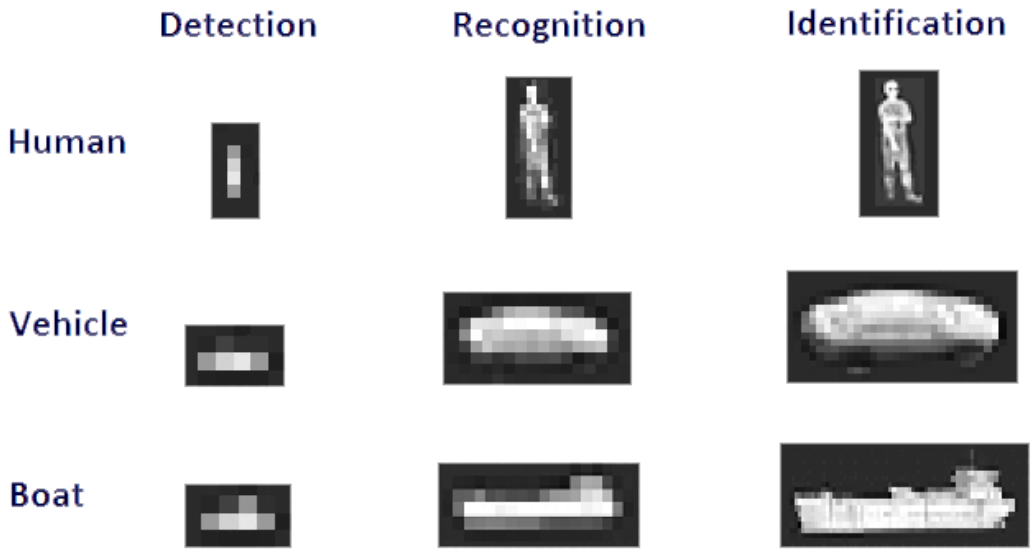

Figure 4: Industry standard DRI requirements

3.5 DRI Parameters for Persons and Vehicles

Resolution	Lens (mm)	FOV (H)	FOV (V)	(1.8m*0.5m) Person (m)		
				Detection	Recognition	Identification
336x256	**7.5**	45	35	240	60	30
	13	25	19	450	110	60
	19	17	13	640	160	80
	25	13	10	1000	250	125
	35	9.3	7.1	1300	320	160
	50	6.5	5	1700	430	220
	60	5.5	4.2	2000	510	260
	100	3.3	2.5	3000	750	380
640x512	**9**	69	56	290	70	40
	13	45	37	450	110	60
	19	32	26	640	160	80
	25	25	20	1000	250	125
	35	18	14	1300	320	160
	50	12.4	9.9	1700	430	220
	60	10.4	8.3	2000	510	260
	100	6.2	5	3000	750	380

Table 1: DRI of people detection for various resolutions and lens configurations

Resolution	Lens (mm)	FOV (H)	FOV (V)	(2.3m*2.3m) Vehicle (m)		
				Detection	Recognition	Identification
336x256	**7.5**	45	35	720	180	90
	13	25	19	1300	350	180
	19	17	13	2000	500	250
	25	13	10	3000	720	360
	35	9.3	7.1	4000	1000	500
	50	6.5	5	5000	1400	700
	60	5.5	4.2	6000	1600	800
	100	3.3	2.5	8800	2300	1200
640x512	**9**	69	56	880	220	110
	13	45	37	1300	350	180
	19	32	26	2000	500	250
	25	25	20	3000	720	360
	35	18	14	4000	1000	500
	50	12.4	9.9	5000	1400	700
	60	10.4	8.3	6000	1600	800
	100	6.2	5	8800	2300	1200

Table 2: DRI of vehicle detection for various resolutions and lens configurations

Note: for some of the ranges in the table above, DRI distances will be influenced by atmospheric transmission, especially in hot and humid conditions, so in reality these distances are usually reduced. On average, applications will experience distances 25% less than the rated distance, or up to 90% less in extreme conditions.

4 IVS Analytics

4.1 Basic Requirements of Scene Selection

DRI standards were defined under the assessment that visible information was processed by a human observer. If the information instead is processed by an IVS, there will be specific requirements on the number of pixels needed on the target for reliable operation. The Dahua IVS (Intelligent Video System) is a built-in video analytics algorithm that delivers intelligent functions to monitor a scene for tripwire violations, intrusion detection, and abandoned or missing objects. All video analytics software algorithms require a certain number of pixels on the target to function properly. Even if a human observer is able to detect the object, it may not be not enough for the software algorithm to analyze and auto detect it. Basic requirements of scene selection for Dahua IVS are as follows:

- The total proportion of the target shall not exceed 10% of the image.
- The target size in the image can't be less than 10×10 pixels; the size of an abandoned target can't be less than 15×15 pixels (CIF image); the height and width of the target can't exceed 1/3 of the image. It is recommended that the target height makes up about 10% of the image height.

- The difference in brightness values between target and background can't be less than 10 gray levels.
- Make sure the target appears at least 2 seconds continuously in the field; the movement distance must be bigger than the width of the target itself and make sure it is no less than 15 pixels (CIF image).
- Try to lower the complexity of the monitoring scene if possible; it is not recommended to use IVS functions in environments where the targets are dense and light changes are very frequent.
- Try to keep away from areas with glass, ground reflected light, water surfaces, branches, shadows, mosquitos, etc. Try to keep away from backlit scenes to avoid direct light.

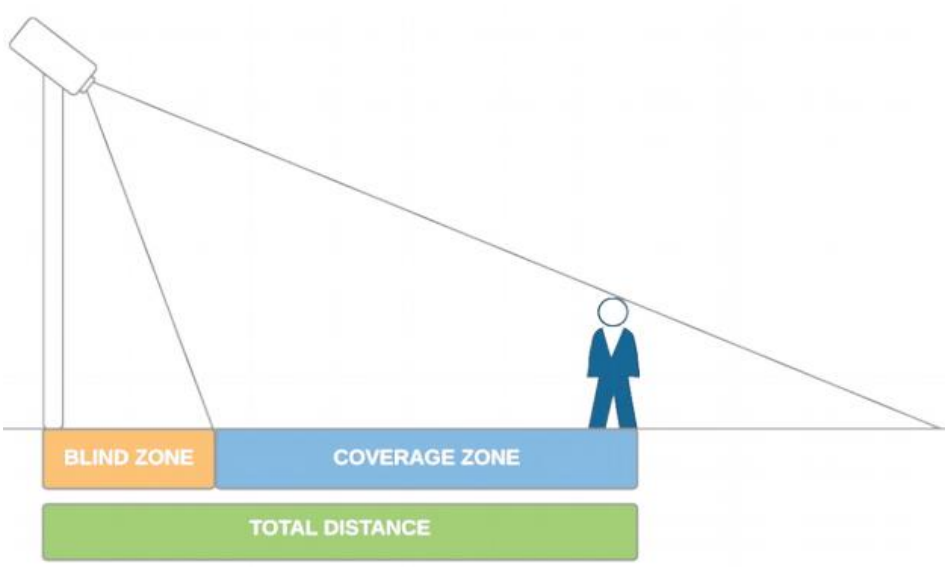

Figure 5: Calculation for IVS detection

Note:

1. *All distances are expressed in meters.*
2. *Thermal target is a 1.8m*0.5m person.*
3. *Neither special weather conditions nor pollution have been taken into account.*
4. *Effective distance values are nominal values; exact values calculations depend on a wide variety of conditions.*

4.2 IVS Configurations

Resolution	Lens (mm)	FOV (H)	FOV (V)	IVS Distance (m)	Installation Height (m)	Total Distance (m)	Blind Zone (m)	Coverage Zone (m)
336x256	**7.5**	45	35	60	5	60	7	53
	13	25	19	100	5	100	15	85
	19	17	13	150	5	150	22	128
	25	13	10	200	5	200	28	172
	35	9.3	7.1	280	5	280	40	240
	50	6.5	5	400	5	400	57	343
	60	5.5	4.2	480	5	480	68	412
	100	3.3	2.5	800	5	800	115	685
640x512	**9**	69	56	35	5	35	3	32
	13	45	37	50	5	50	7	43
	19	32	26	75	5	75	10	65
	25	25	20	100	5	100	14	86
	35	18	14	140	5	140	20	120
	50	12.4	9.9	200	5	200	29	171
	60	10.4	8.3	240	5	240	34	206
	100	6.2	5	400	5	400	57	343

Table 3: IVS people detection for various resolutions and lens configurations

Note: the IVS recognition rate is strongly influenced by the quality of the thermal image, so the results of IVS detection are affected by the detector, the lens, the size of the target, atmospheric conditions, the physical installation, etc.