RANGE PERFORMANCE FOR DRI AND IVS

Thermal Imaging Camera

2020.11

V2.0

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 guide 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 etc.

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. Different companies have different approaches and insights

This guide 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

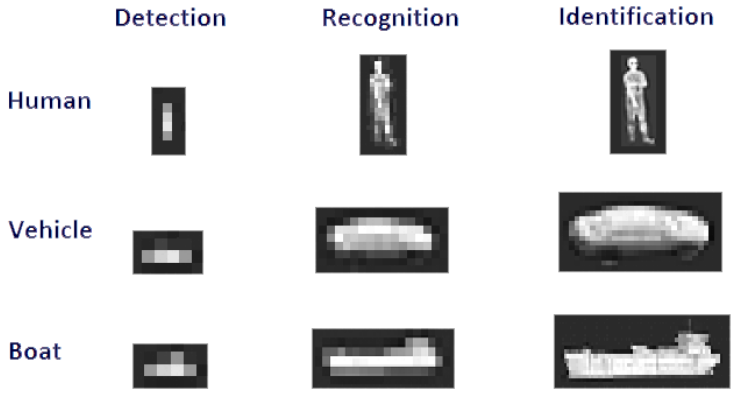
Taking into account the size of the object, for example, when using the same camera to view a person or a vehicle, the size of vehicle is bigger, and has more pixels in the view. This results in a higher resolution, increasing the probability of an accurate assessment. Different applications require 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** – 3.6 pixels /1.8m =2 pixel per meter, an object is present [something is there].
- **Recognition** – 14 pixels/1.8m= 7.8 pixel per meter, object classification can be distinguished [e.g., human, vehicle, building, etc.].
- **Identification** – 28pixels/1.8m =15.6 pixel per meter, 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.



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 several 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.

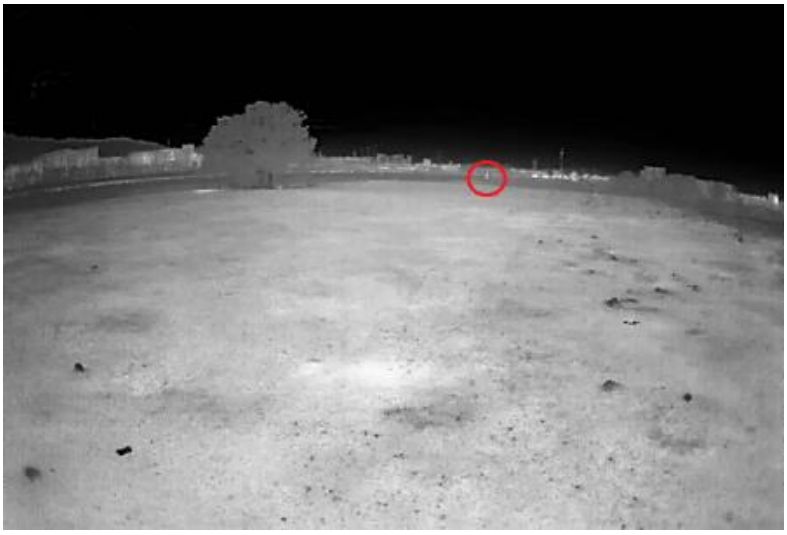


Figure 1: Detection

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.

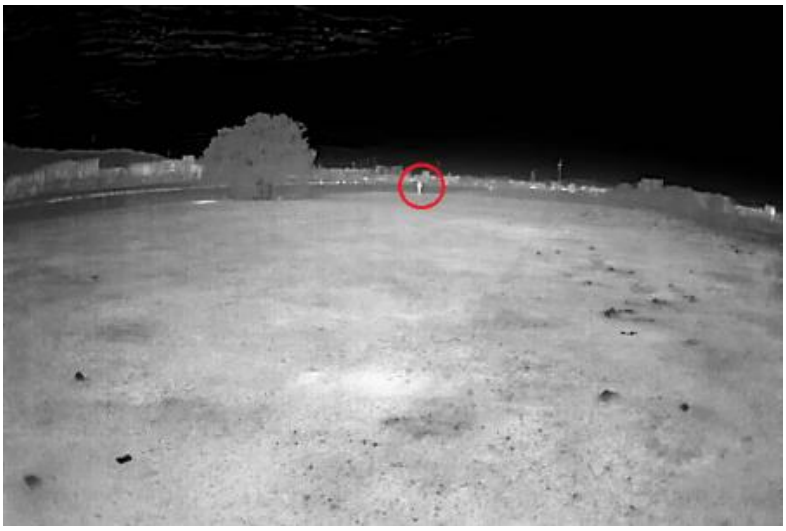


Figure 2: Recognition

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.

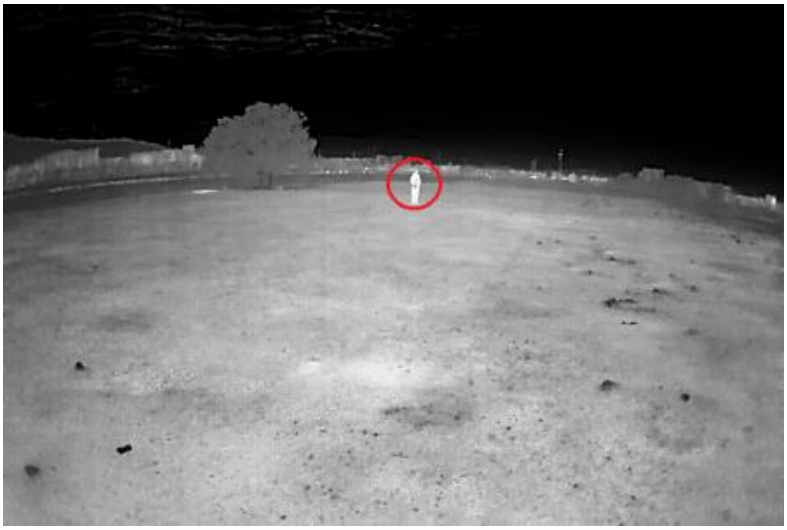


Figure 3: Identification

3.1 DRI distance of Dahua Thermal Camera

Resolution	Series	Lens (mm)	FOV (H x V)	(1.8m*0.5m) Human		
				Detection	Recognition	Identification
256×192	BF1241 DF1241	2mm	87.8°×63.8°	83m	21m	11m
	BF1241 DF1241	3.5mm	50.6°×37.8°	146m	38m	19m
	BF2221 SD2221	7mm	24°×18°	292m	75m	38m
	BF1241 DF1241	10mm	17.3°×13.1°	417m	107m	54m

400×300	**BF5401**	**7.5mm**	53.7°×39.7°	221m	57m	28m
		13mm	30.2°×22.6°	382m	98m	49m
	BF5401 **SD8421** **BF8421**	**25mm**	15.5°×11.6°	735m	189m	95m
	BF5401 **SD8421** **BF8421** **PT8421A**	**35mm**	11.1°×8.3°	1029m	265m	132m
	SD8421 **BF8421** **PT8421A**	**50mm**	7.8°×5.8°	1471m	378m	189m
	BF8421	**75mm**	5.2°×3.9°	2206m	567m	284m
	PT8421A	**100mm**	3.9°×2.9°	2941m	756m	378m
	PT8421B **PT8421C**	**20mm~** **100mm**	3.9°(H)×2.9°(V)~ 19.3°(H) ×14.5°(V)	2941m	756m	378m
		30mm~ **150mm**	2.6°(H) ×1.9°(V)~ 12.9°(H) ×9.7°(V)	4412m	1134m	567m
		38mm~ **190mm**	2.1°(H) ×1.5°(V)~ 10.2°(H) ×7.7°(V)	5588m	1437m	718m
640×512	**BF5601**	**7.5mm**	91.2°×70.3°	221m	57m	28m
		13mm	48.9°×38.8°	382m	98m	49m
	BF5601 **SD8621** **BF8621**	**25mm**	24.6°×19.8°	735m	189m	95m
	BF5601 **SD8621** **BF8621** **PT8621A**	**35mm**	17.6°×14.1°	1029m	265m	132m
	SD8621 **BF8621** **PT8621A**	**50mm**	12.4°×9.9°	1471m	378m	189m
	BF8621	**75mm**	8.3°×6.6°	2206m	567m	284m
	PT8621A	**100mm**	6.2°×5.0°	2941m	756m	378m
	PT8621B **PT8621C**	**20mm~** **100mm**	6.2°(H)×5.0°(V) ~ 31.6°(H)×25.1°(V)	2941m	756m	378m
		30mm~ **150mm**	4.2°(H)×3.3°(V) ~ 20.6°(H)×16.5°(V)	4412m	1134m	567m
		38mm~ **190mm**	3.5°(H)×2.6°(V) ~ 16.7°(H)×12.5°(V)	5588m	1437m	718m

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

Resolution	Series	Lens	FOV (H x V)	(4.0m*1.4m) Vehicle		
				Detection	Recognition	Identification
256×192	BF1241 DF1241	2mm	87.8°×63.8°	222m	55m	27m
	BF1241	3.5mm	50.6°×37.8°	389m	97m	49m
	DF1241 BF2221 SD2221	7mm	24°×18°	778m	194m	97m
	BF1241 DF1241	10mm	17.3°×13.1°	1111m	278m	139m
400×300	BF5401	7.5mm	53.7°×39.7°	588m	147m	74m
		13mm	30.2°×22.6°	1020m	255m	127m
	BF5401 SD8421 BF8421	25mm	15.5°×11.6°	1961m	490m	245m
	BF5401 SD8421 BF8421 PT8421A	35mm	11.1°×8.3°	2745m	686m	343m
	SD8421 BF8421 PT8421A	50mm	7.8°×5.8°	3922m	980m	490m
	BF8421	75mm	5.2°×3.9°	5882m	1471m	735m
	PT8421A	100mm	3.9°×2.9°	7843m	1961m	980m
	PT8421B PT8421C	20mm~ 100mm	3.9°(H)×2.9°(V)~ 19.3°(H) ×14.5°(V)	7843m	1961m	980m
		30mm~ 150mm	2.6°(H) ×1.9°(V)~ 12.9°(H) ×9.7°(V)	11765m	2941m	1471m
		38mm~ 190mm	2.1°(H) ×1.5°(V)~ 10.2°(H) ×7.7°(V)	14902m	3725m	1863m
640×512	BF5601	7.5mm	91.2°×70.3°	588m	147m	74m
		13mm	48.9°×38.8°	1020m	255m	127m
	BF5601 SD8621 BF8621	25mm	24.6°×19.8°	1961m	490m	245m
	BF5601 SD8621 BF8621 PT8621A	35mm	17.6°×14.1°	2745m	686m	343m
	SD8621 BF8621 PT8621A	50mm	12.4°×9.9°	3922m	980m	490m
	BF8621	75mm	8.3°×6.6°	5882m	1471m	735m
	PT8621A	100mm	6.2°×5.0°	7843m	1961m	980m

	PT8621B **PT8621C**	**20mm~** **100mm**	6.2°(H)×5.0°(V) ~ 31.6°(H)×25.1°(V)	7843m	1961m	980m
		30mm~ **150mm**	4.2°(H)×3.3°(V) ~ 20.6°(H)×16.5°(V)	11765m	2941m	1471m
		38mm~ **190mm**	3.5°(H)×2.6°(V) ~ 16.7°(H)×12.5°(V)	14902m	3725m	1863m

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

Note: 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

The specified visible tripwire or intrusion are pre-set in the image, when a target moves across it, the rule will be triggered and the thermal imaging camera will send an alarm.

The alarm direction can be set in one direction or in both directions (which can be understood as entering, leaving or crossing).

4.1 IVS Distance of Dahua Thermal Camera

Resolution	Series	Lens	FOV (H x V)	IVS Distance (1.8m*0.5m) Human	IVS Distance (4.0m*1.4m) Vehicle
256×192	**BF1241** **DF1241**	**2mm**	87.8°×63.8°	15m	42m
		3.5mm	50.6°×37.8°	26m	72.5m
		7mm	24°×18°	52.5m	146.5m
		10mm	17.3°×13.1°	75m	209m
256×192	**BF2221** **SD2221**	**3.5mm**	50.6°×37.8°	28m	78m
		7mm	24°×18°	56m	156m
400×300	**BF5401**	**7.5mm**	53.7°×39.7°	83m	231m
		13mm	30.2°×22.6°	143m	400m

	BF5401 **SD8421** **BF8421**	**25mm**	15.5°×11.6°	275m	770m
	BF5401 **SD8421** **BF8421** **PT8421A**	**35mm**	11.1°×8.3°	385m	1078m
	SD8421 **BF8421** **PT8421A**	**50mm**	7.8°×5.8°	550m	1540m
	BF8421	**75mm**	5.2°×3.9°	825m	2310m
	PT8421A	**100mm**	3.9°×2.9°	1100m	3080m
	PT8421B **PT8421C**	**20mm~** **100mm**	3.9°(H)×2.9°(V)~ 19.3°(H) ×14.5°(V)	1100m	3080m
		30mm~ **150mm**	2.6°(H) ×1.9°(V)~ 12.9°(H) ×9.7°(V)	1650m	4625m
		38mm~ **190mm**	2.1°(H) ×1.5°(V)~ 10.2°(H) ×7.7°(V)	2100m	5860m
640×512	**BF5601**	**7.5mm**	91.2°×70.3°	83m	231m
		13mm	48.9°×38.8°	143m	400m
	BF5601 **SD8621** **BF8621**	**25mm**	24.6°×19.8°	275m	770m
	BF5601 **SD8621** **BF8621** **PT8621A**	**35mm**	17.6°×14.1°	385m	1078m
	SD8621 **BF8621** **PT8621A**	**50mm**	12.4°×9.9°	550m	1540m
	BF8621	**75mm**	8.3°×6.6°	825m	2310m
	PT8621A	**100mm**	6.2°×5.0°	1100m	3080m
	PT8621B **PT8621C**	**20mm~** **100mm**	6.2°(H)×5.0°(V) ~ 31.6°(H)×25.1°(V)	1100m	3080m
		30mm~ **150mm**	4.2°(H)×3.3°(V) ~ 20.6°(H)×16.5°(V)	1650m	4625m
		38mm~ **190mm**	3.5°(H)×2.6°(V) ~ 16.7°(H)×12.5°(V)	2100m	5860m

Table 3: IVS detection for various resolutions and lens configurations

Note: The table is for reference only, the IVS coverage range is strongly influenced by the site condition, such as the size of the target, atmospheric conditions, the physical installation etc.