1.0 WHITE-PAPER ON LONG-RANGE SURVEILLANCE CAMERAS

With the recent advances in CCD sensor technology, long-range optics and signal processing there are many more long-range cameras on the market, offering excellent long-range surveillance for security purposes. Often these cameras are twinned with other long-range sensors such as maritime surveillance radar as slewed devices for positive identification.

For the integrator, like AIS Security Solutions, it is often difficult to select which camera is best for what purpose and what criteria to look for when selecting a camera. Additionally how do these cameras stack up against the Johnson's Criteria for Detection, Recognition and Identification.

We have tried to capture these points in this White-Paper to act as an aid to understand the terminology and advise on what criteria is important in selection. It is a very basic introduction into the subject which we hope you will find useful. We actively encourage comment and inputs to help improve this and any other papers we produce.

2.0 THE JOHNSON'S CRITERIA EXPLAINED

The Johnson criteria created by John B. Johnson, describe both image-and frequency-domain approaches to analyze the ability of observers to perform visual tasks using image intensifier technology. The Johnson criteria is used almost universally to predict range performance. Johnson uses the resolving power of an imager as a metric of sensor "goodness" for target acquisition purposes. For a given target to scene contrast, resolving power is the highest spatial frequency passed by the sensor and display and visible to the observer. He multiplies the resolving power of the imager (in cycles per milliradian) by the target size (in milliradians) to get "cycles on target."

There are two interpretations which defines DRI (Detection Recognition Identification) in terms of the number of pixels required on the object in order to make an accurate assessment.
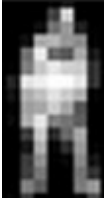
Interpretation 1:

- ➢ *Detection* - an object is present (**4** pixels)
- ➢ *Recognition* - the type object can be discerned, a person vs. a car (**16** pixels)
- ➢ *Identification* - a specific object can be discerned, a woman vs. a man, the specific car (**26** pixels)

The first interpretation assumes that the critical dimension for a human being is 0.75 meters. To get DRI, you need 1.5 pixels, 6 pixels and 12 pixels across 0.75 meters that means:

Detection – 1.5 pixels /0.75m = **4** pixels per meter
Recognition – 6 pixels /0.75m = **16** pixels per meter
Identification – 12 pixels.0.75m = **26** pixels per meter

Assuming that a man is 1.83m by 0.5m, the following would apply:

Detection	**Recognition**	**Identification**
You can see that something is there	You can see that a person is there	You can see that a person looks like a person

Interpretation 2:

Detection – an object is present (of size you want to detect) (**2** vertical pixels on target)
Recognition – the class to which the object belongs (building, truck, man, etc) (**8** vertical pixels on target)
Identification – the object can be described to the limit of the observer's knowledge (motel, pickup truck, and policeman) (**14** vertical pixels on target)

The Johnson Criteria is **very optimistic**. In fact it represents the least number of Pixels on Targets: Vertically - VPoT and Horizontally – HPoT at which it may be possible to be 50% accurate in DRI assessments.

This in reality **is not enough**, and most camera companies recommend **at least 80% accuracy** which requires a much greater number of pixels, both vertically and horizontally, to provide Detection, Recognition and Identification (DRI).

3.0 ADDITIONAL FACTORS AFFECTING DRI

Additionally there are other factors that affect the DRI. Some of these are related to degradation, others to the quality of the sensor system. These are as follows:
Climatic: Fog, Rain, Haze, Sand and other obscurities
Atmospheric: All types of atmospheric attenuation
Contrast Ratios: Scene/Object contrast ratios
Lighting Conditions: Lux Level & Object/ Background Lighting
DSP: Quality of Digital Signal Processing
Optics: Type and Quality of Lens
CCD: Chip Quality and Size of CCD chip
S/N Ratio: Signal to Noise Ratio

In reality, due to the degradations and factors mentioned above, the number of pixels; VPoT and HPoT needed on target needs to be at least twice what Johnson's Criteria is stating.

After discussing with a number of leading sensor suppliers we recommend using the following increased DRI levels for a 6ft man-sized target to achieve more realistic expectations. This is based on a greater than 90% accuracy of detection:

| Recommended DRI level	Johnson's Criteria	Image *
Detection 10 VPoT 3 HPoT	**Detection** 2 VPoT	We can detect the man
Recognition 30 VPoT 12 VPoT	**Detection** 4 VPoT	We can recognize it is indeed a man (not a woman)
Identification 120 VPoT 50 HPoT	**Identification** 6.4 VPoT	We can identify the man

(*courtesy of COHU cameras – www.cohu-cameras.com)

Therefore **realistically we require <u>5 x Johnson's DRI</u> to accurately detect, recognize and identify a typical man-sized target.**

4.0 CAMERA FACTORS AFFECTING DRI

The DRI is driven by the Field of View (FOV) of the camera.
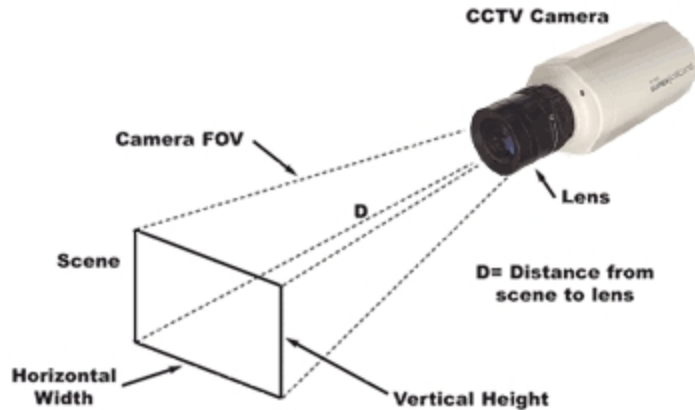
The FOV is the key parameter that affects how far the camera can see. FOV is the amount of a **given SCENE captured** by the camera at maximum distance (D) from the lens. The SCENE is measured horizontally and vertically - horizontal width (in feet) and vertical height in feet).

The FOV is determined by 2 key factors:

1) **RESOLUTION**
2) **OPTICAL ZOOM**
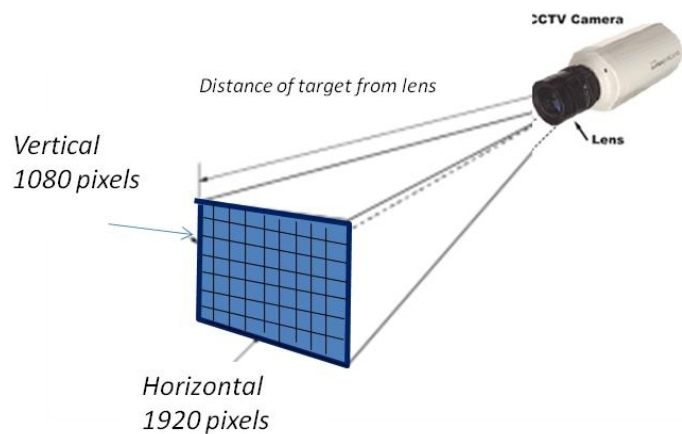
1) **RESOLUTION of Camera**

The greater the resolution of the camera, the greater the number of pixels achieved with the Horizontal and Vertical Scene.

So for a camera with 1080P resolution, the scene offers the following:

No of Pixels for 1080P resolution camera:

Horizontal – 1920 Pixels
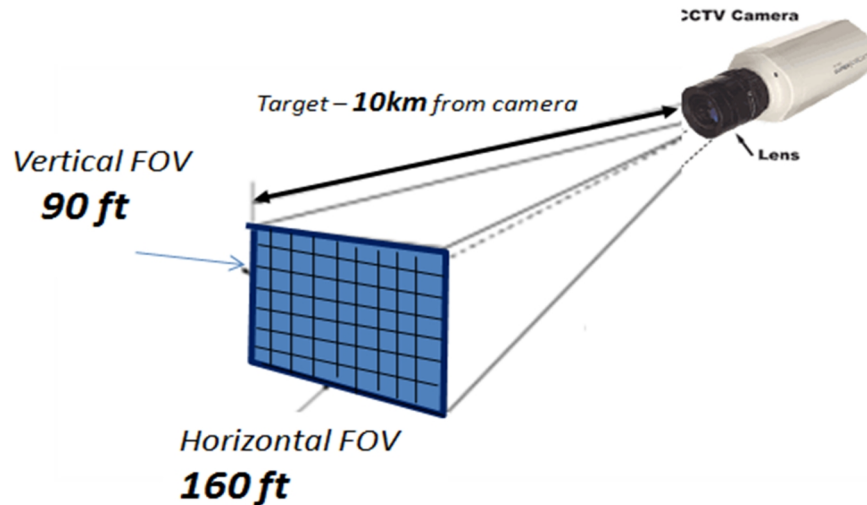
Vertical – 1080 Pixels

2) OPTICAL Zoom

The greater the optical zoom → the greater the distance of the SCENE from lens that **can be filled** with 1920 pixels horizontally and 1080 pixels vertically.
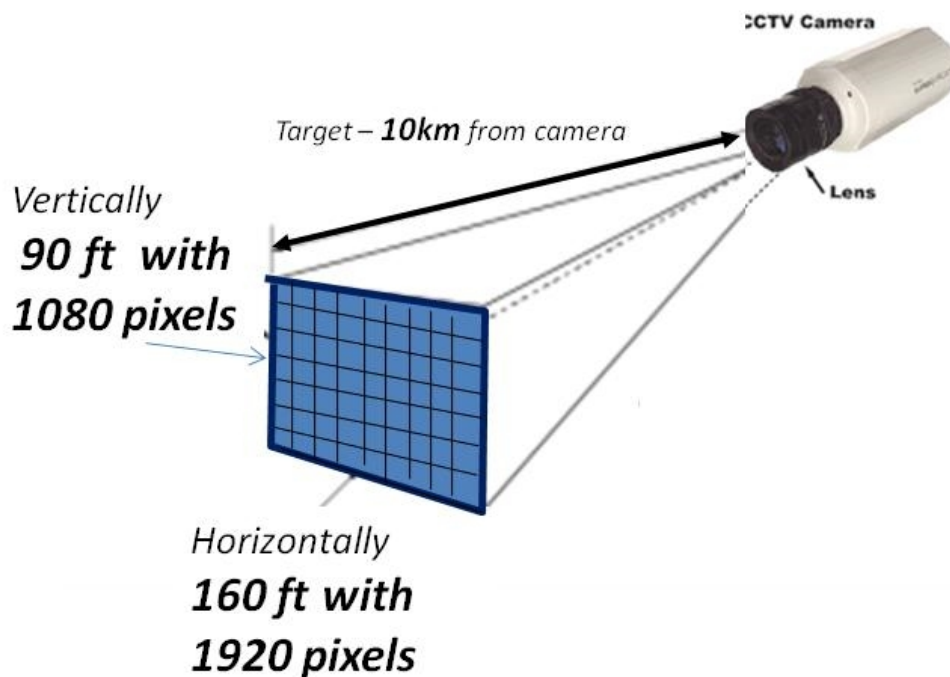
Take the example of a man-sized target at 10 km away from the camera.
Assuming a 63 x OPTICAL Lens this will produce a:
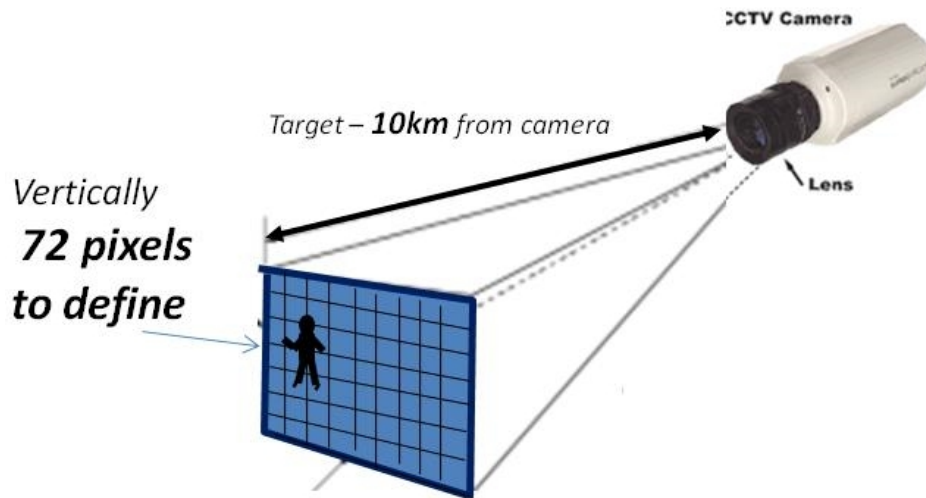- **VFOV of 90ft**
- **HFOV of 160ft**

Therefore **vertically you have 1080 pixels to cover 90ft,** and **horizontally 1920 pixels to cover 160 ft.**

If a man-sized target is 6ft, then you shall have 6/90 X 1080 = **72 pixels vertically** to define the man.

This is significantly more than Johnson's DRI and more than the above stated **Recognition** threshold. It may also be sufficient for positive **Identification** of the man to 70-80% accuracy.

SUMMARY:

Therefore a combination of **HI-RESOLUTION (such as 1080P)** + **HIGH OPTICAL ZOOM (ie x63)** can achieve outstanding image identification properties:

IDENTIFICATION OF A 6ft MAN-SIZED TARGET at 10km WITH 72 vertical pixels on target.

Mary Ann LUMANG

Marketing Executive

ANNEX A – TABLE OF LEADING CAMERAS IN THE MARKET

Here is a table of some leading cameras in the marketplace, considering:
- RESOLUTION
- OPTICAL ZOOM

Camera	Resolution	Optical Zoom	Sensor	
COHU 8800HD	1080P	137x	1/2.7" CCD	
LONG-VIEW2	640 x 480	100x	1/3 " CCD	
L-3 NIGHTHAWK/ PVP NIGHTHAWK	752 X 582	137x	1/3" CCD	
UVS EV3000-P	640 x 480	100x	1/2" CCD	
Visionary EXT	640 x 480	32x	1/3" or 1/2" CCD	

Note: The above is based on publically available data only and may be out-of-date. If this is the case, we apologies in advance and we welcome any corrections/ updates.