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APPLICATION NOTE:

Understanding the actual performance of optical zoom cameras

As the demand for increased image resolution and higher optical magnification continues, there unfortunately are opportunistic firms who press the envelope in making claims that may be true in some respect, but are not true in terms of actually providing you with what you think you are getting.

Lets take a look at a common example in the industry today that has a number of manufactures marketing cameras with HD resolution and 36x optical zoom lenses. On the surface, this would appear to be better technology offering more zoom magnification as compared to an HD camera using a 30x optical zoom lens.

Understanding key specifications - Realized vs Unrealized Optical Zoom Performance

There are two commonly published specifications for zoom lenses that relate to each other mathematically. These are the focal length and the corresponding angular field of view. The formula for this ties the field of view produced by the camera/lens system to its sensor size (d) and the lens focal length (f).

Angular Field of View Formula

$$\alpha = 2 \arctan \frac{d}{2f}$$

A zoom lens focal range ratio/magnification power (i.e. 36x) must have an equal angular field of view range ratio (i.e. 36x). If these two ratio's do not match, then there is a misleading element at play.

This application note shows examples of this misleading behavior.

The Camera/Lens Angular Field of View is KEY

The angular field of view is THE most important specification, as it defines the ACTUAL performance the camera/lens system produces in terms of what an observer actually sees.

Unfortunately, a zoom lens focal length range is published as the ratio that defines the magnification power of a lens. (i.e. A zoom lens that is a reported as 10mm to 100mm range would be a x10 zoom lens (100mm/10mm= x10) . This on "paper" is a correct assessment, but in reality, it may or may not be the actual performance.

The lens focal length ratio (magnification) is an unrealized specification, as the angular field of view that the zoom lens produces, and the observer sees on a video monitor, is the actual realized performance.

To validate a cameras zoom lens realized performance (a.k.a check the manufactures truthfulness), or, understand what you will actually realize in terms of real magnification power, you should use camera systems angular field of view ratio, not the zoom focal length ratio.

To calculate the realized performance using the angular field of view (most commonly published is the horizontal), you simply divide the wide field of view by the narrow field of view.

For example, a lens reporting a 50 degree wide angle field of view and a 5 degree narrow angle field of view would be 50 degree / 5 degree = 10x magnification power.

Again, a cameras focal length ratio must equal its angular field of view ratio. The mathematics require this. When these two specification ratios do not equal each other, you should be aware that there is misleading information presented.

To demonstrate this point, below are some egregious examples of misleading specifications that you should be aware of;

A classic misleading example

3 MP 36x Network PTZ Dome Camera

Focal Length	4.5 mm to 162 mm, 36x
Digital Zoom	16x
Zoom Speed	Approximately 3.3 s (optical wide-tele)
Angle of View	60.6° to 3.68° (wide-tele)

As pointed out previously, the zoom lens focal length ratio (its unrealized performance), supports the 36x magnification. (162mm/4.5mm = x36). But now lets take a look at what you will actually realize in magnification performance using the field of view ratio published. (60.6 deg/3.68 deg= 16.5x). As you can see, the 36x advertised magnification will result in only a 16.5x performance. This is less than half of what you think you would be receiving.

Another classic misleading example

Image sensor	1/3'' Progressive scan CMOS
Lens	Motorised 4.5 - 162 mm, F1.6
Zoom	36x Optical zoom, 16x digital zoom
Focus	Autofocus
Horizontal field of view	54.5° ~ 2.7°

Here again, the advertised magnification is 36x, where the unrealized focal length range ratio is used for this (162/4.5=36), and again, when looking at the field of view ratio (54.5/2.7 = 20x) , the realized performance falls way short of what you would expect the performance to be.

Below is a comparison of these two products to the CohuHD RISE 30x camera system using their published specifications taken from the product data sheets.

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Comparison of published Zoom Lens Performance

Specification	CohuHD RISE	Manufacturer 1	Manufacture 2
Zoom Magnification Published	30x	36x	36x
Zoom Focal Length Range Published	4.4mm to 132mm	4.5mm to 162mm	4.5mm to 162mm
Zoom Field of View Range (Horizontal)	63.4^0 to 2.1^0	60.6^0 to 3.68^0	54.5^0 to 2.7^0
Realized Magnification	30x	16x	20x
Narrow Field of View	2.1^0	3.68^0	2.7^0

Analyzing the information in the table above results in the CohuHD RISE camera system provides superior realized performance in both magnification power (30x vs 16x vs 20x) as well as the CohuHD RISE provides a narrower field of view at full optical zoom (2.1 deg vs 3.68 deg vs 2.7 deg).

CohuHD RISE provides superior actually realized magnification range AND full zoom magnification compared to the misleading camera information provided on many product datasheets.

The data presented above is all published information, downloaded from each manufactures web site; one just needs to understand how to properly interpret the data contained on the datasheet to protect yourself from being misled to believing you are getting performance you actually are not.

Feel free to contact me with any questions or additional information at your convenience.

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