

## Far, Far Away...

### How Far Can Your Camera See?

One of the most frequently asked questions that we receive about our products is “How far can the camera see?” The answer to this question is not the same for every application, so the correct answer depends on who is asking the question.

In a highway traffic application, for example, the customer might want to know how far down the freeway the camera can look and display several lanes of traffic across the video image. In another type of vehicle tracking application, the customer might want to know at what distance the camera is able to resolve license plate numbers.

Let’s consider the highway traffic application first. The Interstate Highway System uses a standard lane width of 12 feet, so we will base our viewing distances on this figure. If we know what the horizontal field of view of the camera is at its maximum zoom setting, we can easily calculate at what distance the video image will show 1, 2, 3 or 4 lanes of traffic to the traffic engineer at the operations center. Here is a table showing the maximum viewing distances for cameras with several different zoom factors and horizontal field of view values:

		<b>Distance at which lane(s) fills video image side to side</b>			
<b>Type of Camera</b>	<b>Horizontal F.O.V. at Maximum Zoom</b>	<b>1 Lane</b>	<b>2 Lanes</b>	<b>3 Lanes</b>	<b>4 Lanes</b>
<b>Day/Night x35 Zoom</b>	<b>1.7 Degrees</b>	404 feet	808 feet	1212 Feet	1616 Feet (0.3 Miles)
<b>Day/Night x23 Zoom</b>	<b>2.5 Degrees</b>	275 Feet	550 Feet	825 Feet	1100 Feet (0.21 Miles)
<b>High Definition x10 Zoom</b>	<b>5.4 Degrees</b>	127 Feet	254 Feet	381 Feet	508 Feet (0.1 Miles)
<b>Thermal Imaging x2 Zoom</b>	<b>18 Degrees</b>	38 Feet	76 Feet	114 Feet	152 Feet (0.03 Miles)

Normally, a traffic engineer would be interested in the inbound traffic in the morning and the outbound traffic at night, so on an 8 lane major thoroughfare, we would use a 4 lane width for calculating the camera viewing distance. We can see from this table that if a traffic engineer was asking “How far can this camera see?”, the answer would probably be about 0.3 Miles for the camera with the x35 zoom capability. With this information, the engineer would be able to determine how far apart the cameras could be placed alongside the highway in order to have adequate coverage for good viewing quality. If these were pan, tilt and zoom cameras capable of looking in either direction down the highway, the cameras could be placed 0.6 miles apart.

Another vehicle related application that depends on knowing how far the camera can see is license plate recognition. Determining the maximum distance at which a license plate can be read is a little more complicated than the straight-forward calculation used in the previous highway application, though. The maximum usable distance in this application will depend on whether the intent is for an operator to be able to read the license plate or if the license plate is going to be read by an automated Optical Character Recognition (OCR), computer based system.

OCR license plate readers are highly sophisticated machine vision systems that usually use special cameras with built in high powered infrared LED strobe lights to enable optimum viewing in all lighting conditions. They also are typically used in situations where the vehicle position and orientation is carefully controlled, like a community guard gate or a toll booth lane. These types of systems usually are specified to operate at distances of about 10 feet to 40 feet.

In the case of conventional color cameras being viewed by an operator during daylight conditions, though (say on a street or highway), we can make some assumptions and come up with a ballpark figure as a guide for how close a vehicle must be for an operator to read the license plate. This might be a situation where a guard is monitoring an entire parking lot with a pan, tilt and zoom camera, and wants to zoom in on the vehicle entering the gate occasionally, and write down the license plate number. In the JPEG image below, which has a 512 x 384 pixel resolution, the vehicle fills up the middle third of the video image, and the license plate number is discernable under these relatively optimal lighting conditions. A resolution of 500 lines of resolution would be about the upper limit under ideal installation conditions for a high quality CCD camera.



The license plate actually encompasses about 81 x 43 pixels in this image. The image below shows the license plate section blown up in size to show the actual resolution of the license plate portion of the image.



As you can see, the license plate number, even at a resolution of only 45 x 23 pixels or so is still just barely discernable by a human operator under good lighting conditions (if you squint a bit). This would probably be the minimum resolution that would work. If we calculate the maximum vehicle distance using the same cameras as before and using the size of the license plate as a guide we get approximately the same results that we did for the one lane calculations.

Type of Camera	Horizontal F.O.V. at Maximum Zoom	Maximum License Plate Viewing Distance
Day/Night x35 Zoom	1.7 Degrees	384 feet
Day/Night x23 Zoom	2.5 Degrees	261 Feet
High Definition x10 Zoom	5.4 Degrees	120 Feet

Naturally this application depends on a lot of variables, like the lighting conditions, the quality and distance of the video cabling, the cleanliness of the license plate, the operator skill and other factors. These numbers are only a very rough guideline. Your results may vary.

So, when considering different applications, the answer to the question “How far can the camera see?” is, “it depends”.

*~Dale Roche, Director of Engineering*

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