Selecting the Right Camera for Intelligent Traffic Systems

Resolution vs. Sensitivity

Resolution is one of the most important factors when choosing digital cameras for Intelligent Traffic System (ITS) applications, such as tolling and speed enforcement. The more pixels in a camera, the higher its resolution and the clearer the images. In the case of ITS applications, more pixels, specifically along the horizontal edge of a camera's sensor, allow for more lanes of traffic to be covered with a single camera, consquently reducing overall system cost. More pixels, however, come at a cost of sensitivity.

When pixel density increases over the area of the sensor, the size of each pixel must be decreased. This reduces the overall sensitivity of the camera thereby minimizing its low light performance, which is essential for capturing accurate and discernible traffic images at night.

The solution? By increasing the size of the sensor, pixel density can increase without losing sensitivity.

Sensor Formats

Common sensor formats can range from 1/3" to what is referred to as "Full Frame" or "35mm", having similar dimensions to that of 35mm film. When comparing both ends of this spectrum, the available area on a full frame

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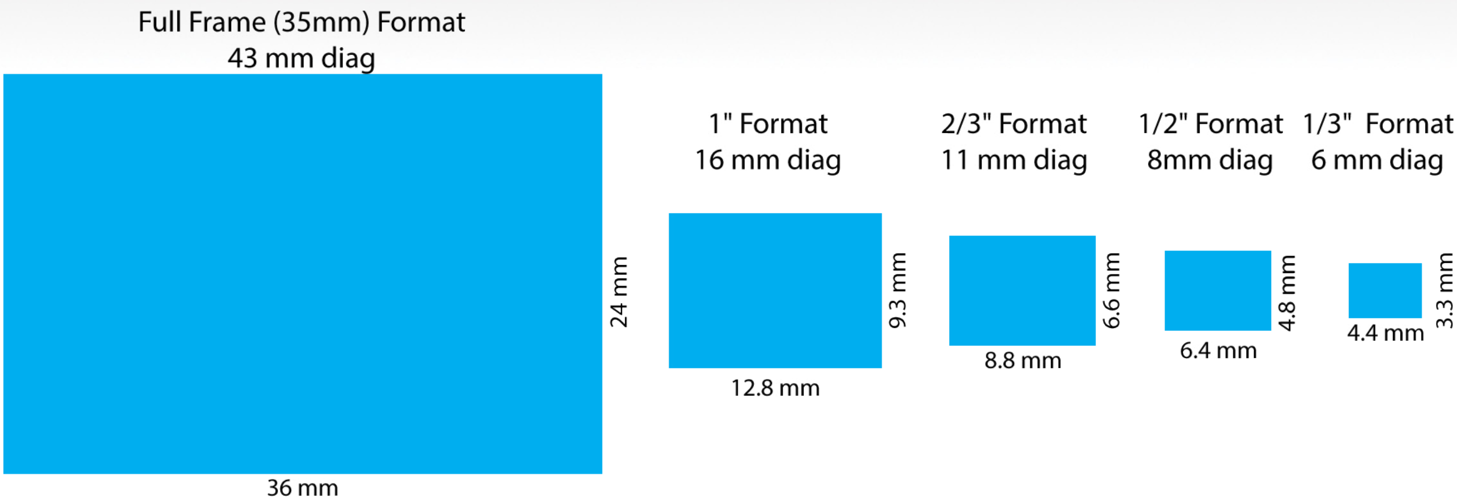
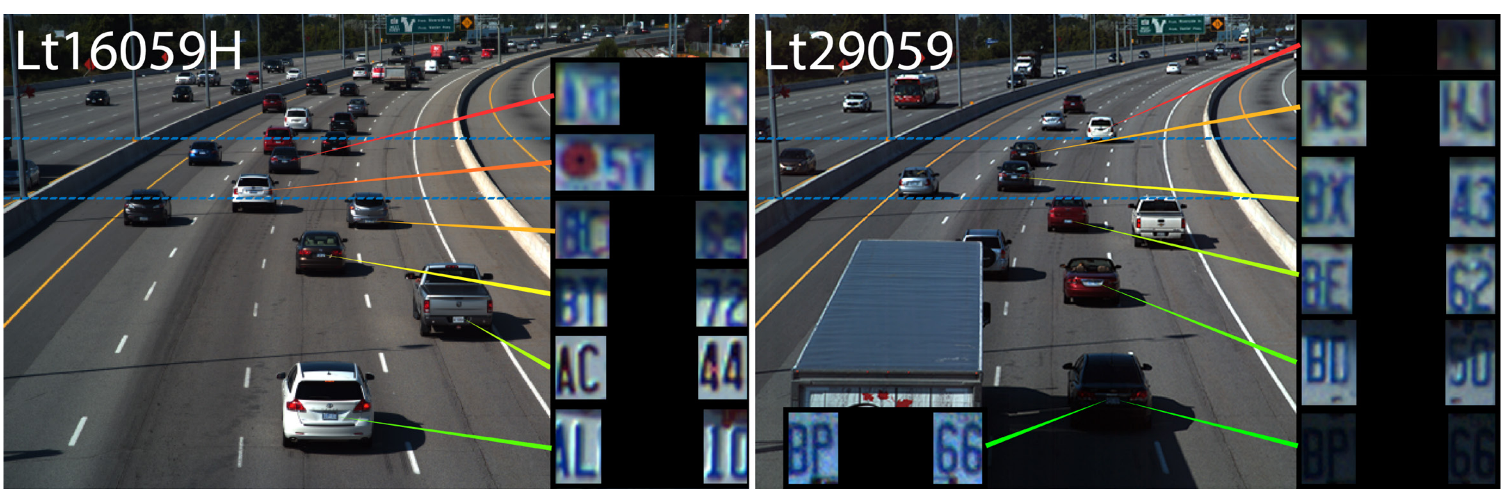
format sensor is roughly 60 times that of a 1/3" format sensor. Two cameras with similar resolutions but varying sensor sizes will therefore vary greatly in the area of low light performance and sensitivity. A simple example of this can be observed when comparing a cell phone camera to a DSLR camera; they can both produce images of similar resolution, but the DSLR will perform better in low light conditions due to its larger sensor size.



Comparing High Resolution Cameras with 35mm Sensors

In the following experiment, the impacts of resolution and sensitivity are explored. It was conducted using two full frame cameras, the Lt16059H and the Lt29059 with 16 and 29 megapixels, respectively. This exercise consisted of imaging cars travelling on a highway with a speed limit of 100 km/h. The image below illustrates a comparison between both cameras.

The license plates are enlarged to show the available resolution at various distances from the cameras. In both cases, the camera was placed on a tripod in the same location, and the same lens was used at a focal length of 105 mm. *(Note: the plates have been partially blurred out to protect the privacy of the vehicle owners.)*



Click on the photos above to view them in full resolution.

The dashed blue lines in the image have been added as a reference point to demonstrate the distance of the cars to the camera. In the case of the Lt16059H, the license plate of the closest car (white), number AL***10, measures 100 pixels across. At this resolution, a critical point for many Automated License Plate Recognition

(ALPR) systems, the Lt16059H can capture the width of five full lanes, as pictured above, thanks to the large width of the sensor, nearly 4900 pixels across. The fourth plate in the Lt16059H image, just before the first dashed line, is still readable by the human eye, reading BC***69. At this point in the frame, there is an equivalent of nearly double the lanes of traffic visible from edge to edge of the image.

The 29 megapixel Lt29059 pushes the number of resolvable lanes of traffic even further due to the impressive pixel width of the sensor, measuring 6576 pixels across. The license plate of the first car in the image (BP***66) measures 115 pixels across. Furthermore, at this point in the frame, the Lt29059 has been able to capture six lanes of traffic and can discern information at further distances from the camera. For instance, the license plate of the vehicle before the 2nd dashed line (N3***HJ) is readable to the human eye. At this distance, there are roughly 1.5 times more equivalent lanes of traffic from edge to edge of the frame than the car with plate number BC***69 from the Lt16059H.

The enhanced resolving capability of the Lt29059 comes at a cost of sensitivity, as discussed above. Although the images appear similar in level of intensity, they were not recorded with the same settings. The exposure for both cameras was set to 1 ms and the iris opening was at f/8. However, the gain for the Lt16059H was set to 3.5 whereas the gain for the Lt29059 was set to 5 and a digital gain of 1.3 was also applied via post processing so that the images appear balanced for the above comparison.

An additional digital gain of 5 was also applied to the Lt29059's first license plate, with the image above showing the original and enhanced versions. This is a clear demonstration of the camera's wide dynamic range of approximately 64 dB. Even with the plate completely shaded by the large truck, the data in the shade is just as readable as the licence plates in the bright sun. The full resolution version of the image from the Lt16059H and the full resolution version of the image from the Lt29059, without digital gain applied, can be found here.

The gains applied to these images easily illustrates the sensitivity difference between both cameras with similar lighting conditions and identical exposure and iris settings. Consquently, these factors need to be taken into consideration when selecting a camera for ITS applications. For example, if an external flash is being used, in either the visible or NIR spectrum, a higher resolution will most likely become more important than sensitivity. However, if the light beam's width doesn't allow coverage for all the lanes of traffic, two lower resolution cameras would be a better solution.

Lumenera has been providing imaging solutions for ITS applications for many years. If you need help selecting the right camera for your application, contact a Lumenera Sales Representative.

Lt16059H and Lt29059 Highlights

	Lt16059H	Lt29059
Resolution	4864 x 3232 pixels	6576 x 4384 pixels
Pixel Size	7.4 x 7.4 µm	5.5 x 5.5 µm
Dynamic Range	66.7 dB	~64 dB
Frame Rate	12 fps at full resolution	6 fps at full resoluton

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