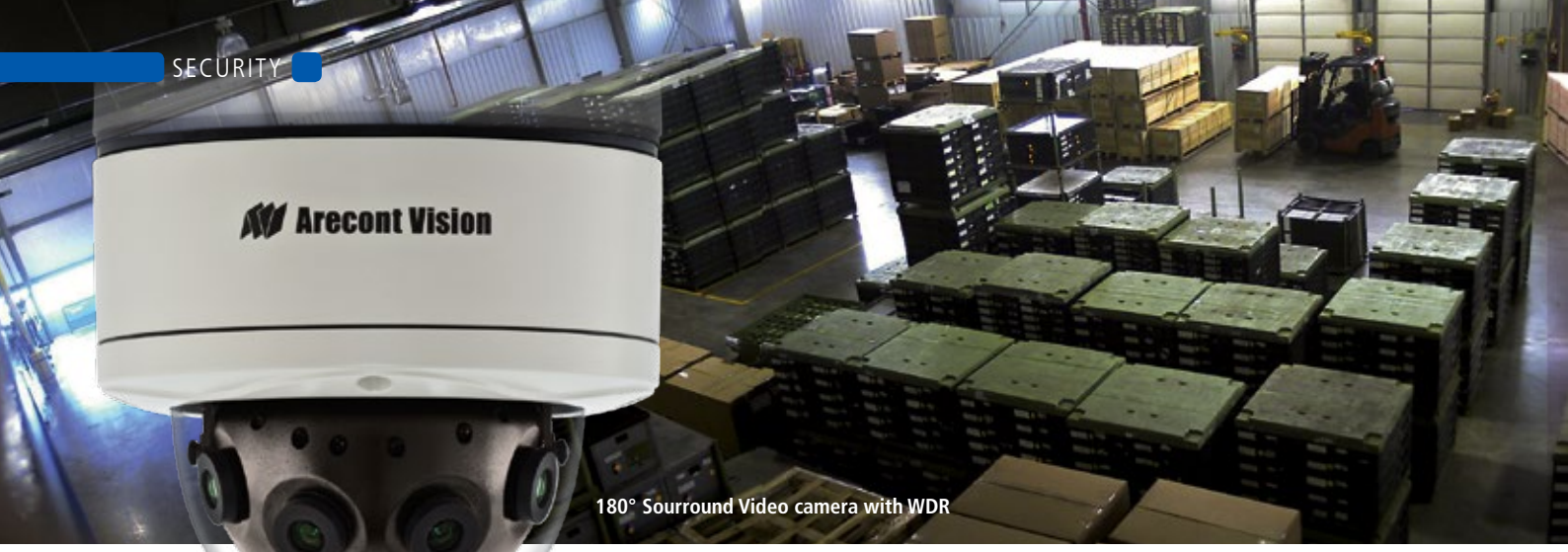


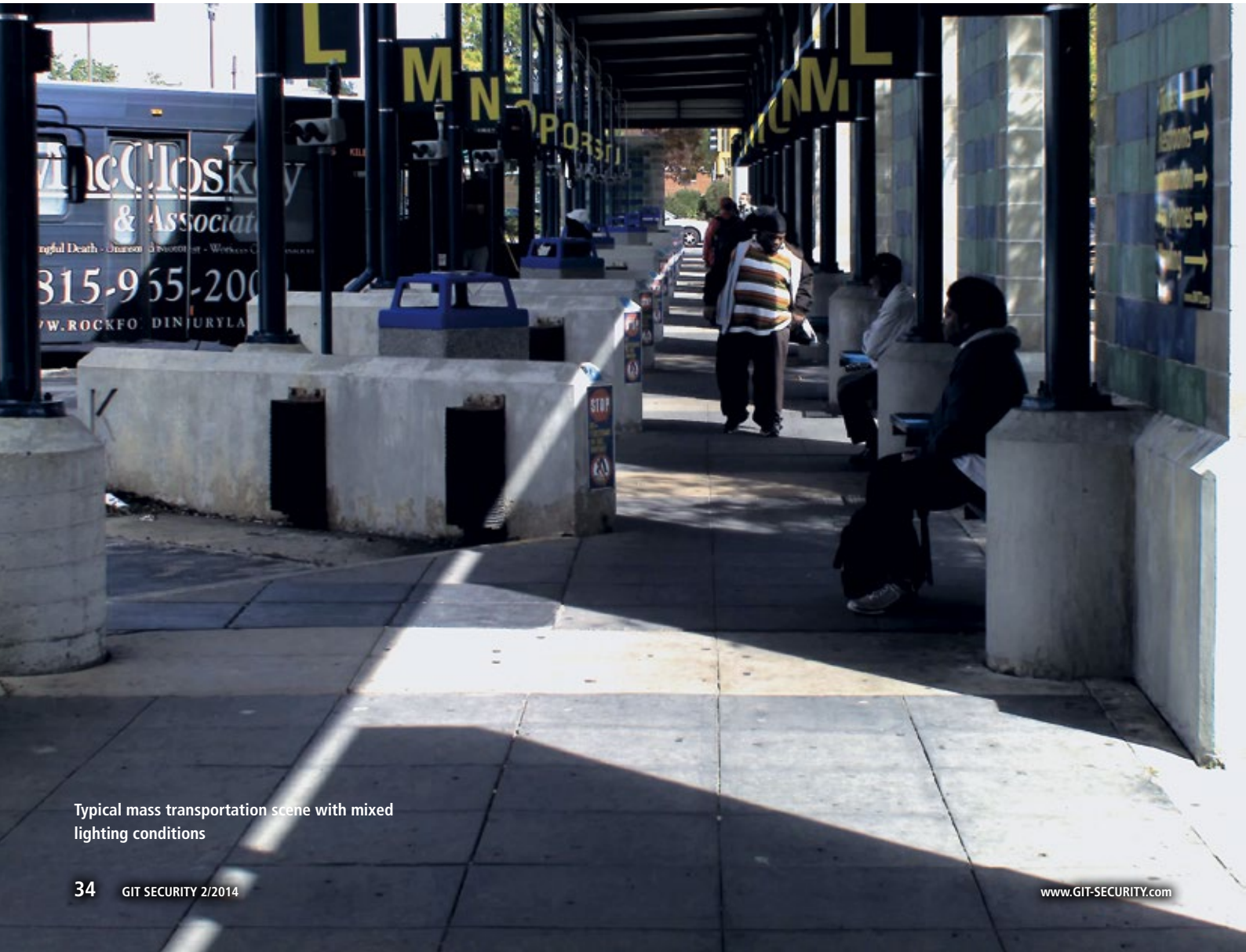
180° Sourround Video camera with WDR

VIDEO SURVEILLANCE

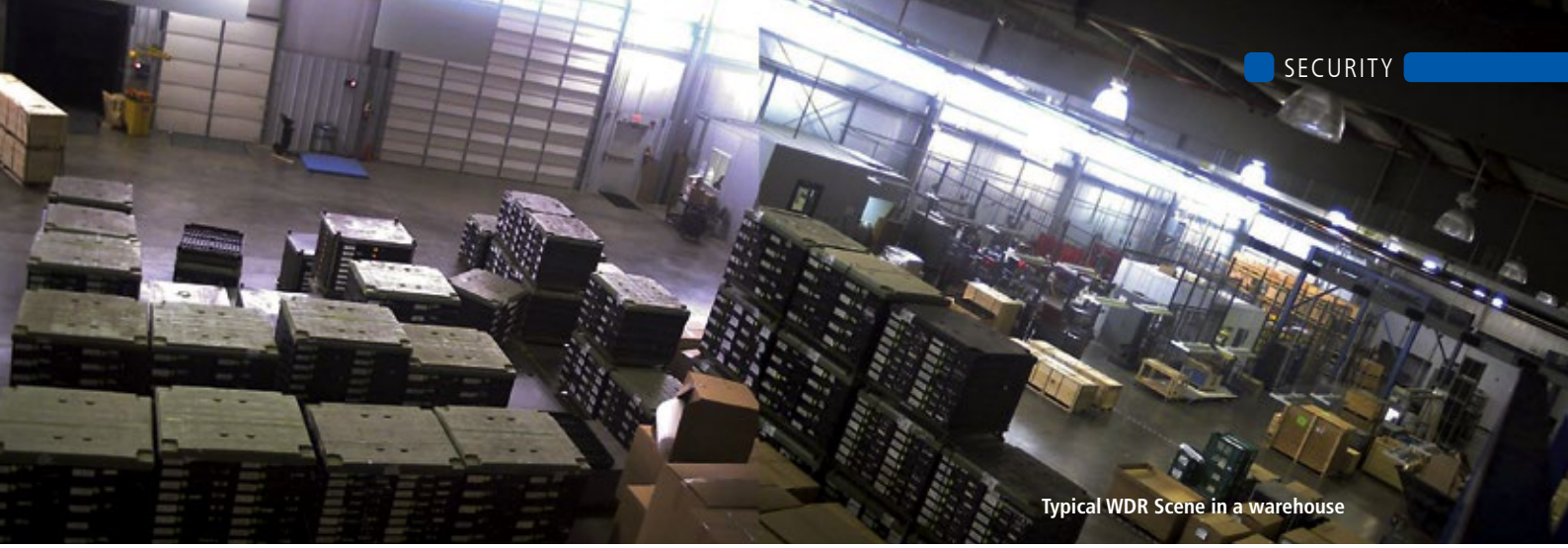
Dynamic Rangers

Understanding Wide Dynamic Range and Its Benefits in Video Surveillance Applications

Wide Dynamic Range (WDR) technology offers an excellent solution to the real world problem in video surveillance of capturing crisp detailed images in varying lighting conditions. The reference to WDR in video surveillance cameras has become so common in usage though that its understanding and the value it provides may have become diluted or even lost. Even comparing WDR cameras can be challenging because of so many variables. Like WDR, we believe the following will bring some clarity to the discussion.



Typical mass transportation scene with mixed lighting conditions



Typical WDR Scene in a warehouse

Matching the Camera's Capability to the Scene

To effectively understand WDR, it is also necessary to understand the correlation of the scene itself with the WDR technology of the camera, and how the two impact the quality of image rendering. By standard definition, dynamic range is a ratio between the largest and the smallest value of a variable quantity such as light or sound. In video surveillance applications, WDR technology is designed to enable appropriate exposure of the entire scene so that the image is a true representation of scene intensity, detail and color profile. Generally, if the dynamic range of the scene is the same or narrower than that of the camera, the resultant images would faithfully convey scene details both in the shadows and in the highlights of the scene with no noise or clipping. If the dynamic range of the scene is wider, the camera would either clip details in the highlights, or mask details in the shadows by excessive noise, or do both at the same time.

A camera specified to support a particular dynamic range will produce different results for different absolute ranges and different apertures because its own capabilities do have absolute limits, primarily due to physical size of its pixels. In particular, a scene with a given dynamic range but a lower average luminosity (or a smaller aperture) would produce more noise even if the dynamic range is fully supported by the camera, while the scene where the range is shifted upwards (or the aperture is larger) may produce clipping, and potentially additional noise in the mid-range, specific to WDR cameras.

Factors Affecting Video Quality

One measurement for judging the quality of a video camera is how well it captures the luminosity variations present in the scene. In particular, is the camera able to capture subtle variations in the highlights of the scene without clipping? Is it able to capture subtle variations in the shadows without drowning them in noise? What about capturing scene details at both ends of the dynamic range at the same time?

The number and size of light-sensitive pixels of the image sensors are a factor in measuring video quality. Smaller sensor pixels increase spatial resolution but have limited dynamic range. Larger sensor pixels have wider dynamic range but decreased spatial resolution. A conflict between the need to increase the size of pixels to achieve a wider dynamic range and the need to make them smaller to increase spatial resolution is always present. Contributing to the conflict between the dynamic range and the spatial resolution is movement in the field of view, causing motion blur. It is analogous to the blurred image in a still photograph when the shutter speed is too slow for the action.

Video quality is also affected by the camera's aperture which limits the amount of light reaching the image sensor. Less light increases the depth of field but increases image noise while more light reduces the depth of field but improves the trade-off between motion blur and image noise.

Understanding the Technology

WDR imaging enhances the cameras capability to capture a true representation of the scene using a multi-exposure method. Two or more snapshots are captured at different exposure times (shutter speeds) and then composed into a single wide dynamic range image. Shorter exposures reveal scene details from the brighter parts of the scene while longer exposures reveal details from the shadows. Cameras with dual sensors ensure capture of highly detailed images in changing lighting conditions by switching from color WDR to monochrome when light levels fall below a specified threshold or by streaming both sensors simultaneously.

Additionally, noise suppression and motion compensation technologies are often applied to correct any effects of multi-exposure. For example, areas less defined in brighter scenes or alternately, more defined in the shadows, may receive inadequate exposure with excessive noise as a result. Noise suppression technology compensates for this condition. As well, due to the different shutter speeds, parts of the scene that were moving at the time of capture will appear at different locations in the two (or more) individual snapshots that make up the composed WDR image, creating motion artifacts. In these instances, motion compensation can help correct the condition.

Tone mapping may also be applied to WDR images to enhance display on conventional monitors or televisions, which have a limited range of brightness that can be produced. The tone mapping process reassigns pixel brightness values to achieve the reduction of global (overall) contrast while preserving the local (specified) one. In other words, in a scene that encompasses both indoor and outdoor light the tone mapping selectively alters the brightness in the scene creating a version that is more natural and appealing to the eye.

The combined effect of tone mapping and multi-exposure image capture becomes especially challenging when it comes to achieving a uniform panoramic image appearance in a multi-sensor panoramic WDR camera. Adjacent parts of the scene captured by individual image sensors may appear entirely different in terms of brightness, noise and contrast just because there is a slight change in scene content from sensor to sensor. In order to produce a more uniform panoramic image, it is often necessary to sacrifice the dynamic range in some of the channels of the multi-sensor camera or perform an additional and elaborate post-processing to equalize the appearance of the resultant multiple WDR images.

In summary, the function of a camera's wide dynamic range technology is to create visual images with consistent brightness levels from a scene where there is simultaneous variation of light and that are suitable for video surveillance observation and recognition. WDR and related technologies offer today's video surveillance professionals a comprehensive and cost-effective solution for achieving this goal and enabling a more secure environment.

Ivo Drent
Vice President Europe,
Arecont Vision

▶ CONTACT

Arecont Vision Europe, Frankfurt, Germany
Tel.: +49 696 953 4600
europe.sales@arecontvision.com
www.arecontvision.com