DW® Solutions for Wide Area Surveillance

Introduction

This paper provides an overview of the DW® line of solutions for wide area surveillance (panoramic scenes). DW® offers a broad range of cameras in our High Definition (HD) IP and Video over Coax product lines that specifically address the need to view and record large scale scenes. Included in this paper is a discussion on the design challenges associated with large scale scenes, the features that enable the capture of these scenes and the DW® products designed to address these requirements.

Prior to the introduction of panoramic cameras, wide area surveillance required the installation of multiple cameras each with their own housings, mounts and cabling. Alternatively, installers opted to install a single pan-tilt-zoom (PTZ) camera and leave it on auto pan. While this solution may work for cases where there is a live monitor, this approach does not bode well for recording. In either case, the resulting video recordings were far less than effective when investigating an incident that spanned across the entire scene. In the multi-camera installation, the viewer was forced to simultaneously view and comprehend activity in multiple display windows. For the PTZ configuration, the camera was only viewing a percentage of the entire scene at any given time.

Recent advances in sensor and video processing capabilities have created a new class of cameras for these scenes, and when paired with the DW Spectrum® IPVMS, these devices are transformed from conventional camera to a system that is capable of generating multiple virtual cameras all from a single installation.

Value proposition:

The DW® line of panoramic cameras offers broad options when addressing the need to view and record large scale scenes. These cameras and their video processing software provide the ability to view a single large format scene or segments of the scene without the loss of video resolution.

1. **Open Platform Solutions:** DW® offers panoramic solutions for both HD Video over Coax and HD IP system architectures.
2. **Multiple Configurations:** DW® offers panoramic cameras with both multiple sensors and single sensor fisheye lens configurations.
3. **DW® Image Quality:** The cameras in these solutions have the same high-quality imaging, resolution and video processing functions as is standard for all DW® cameras.
4. **DW® Integration:** The DW® HD over Coax panoramic cameras integrate with the DW® VMAX® Digital Video Recorders, the VMAX® apps and the C3™ Video Management Software Systems. The MEGApix® IP line of panoramic cameras integrate with the DW® Blackjack® Network Recorders and the DW Spectrum® IP Video Management System.
5. **Virtual Cameras:** Paired with DW Spectrum® IPVMS, a single panoramic camera can collect data from a large-scale scene, then create multiple virtual views of the same space. Providing the coverage of multiple single cameras from a single device. The end user can quickly add and configure new virtual cameras as their needs change.
6. **DW® Flexibility:** As with all DW® camera systems, the panoramic cameras are available in indoor and outdoor configurations with multiple mounting structures. Additionally, DW® now offers a Camera as a System (CaaS™) device with a fisheye lens for standalone panoramic applications.

Problem Space

Panoramic cameras provide potential solutions for a wide range of wide area surveillance scenes. Large scale scenes are those where the dimensions of the space are larger than could be captured by a single camera. One can think of large scale scenes in three categories: wide-angle, tall and omni-directional. Spaces such as parking lots, recreation areas, lobbies and atriums often fall into the wide-angle category. Figure 1 is an aerial view of a business and its parking lot. This scene is a great example of a wide-angle scene in which no single, conventional camera can create usable images of the entire scene.

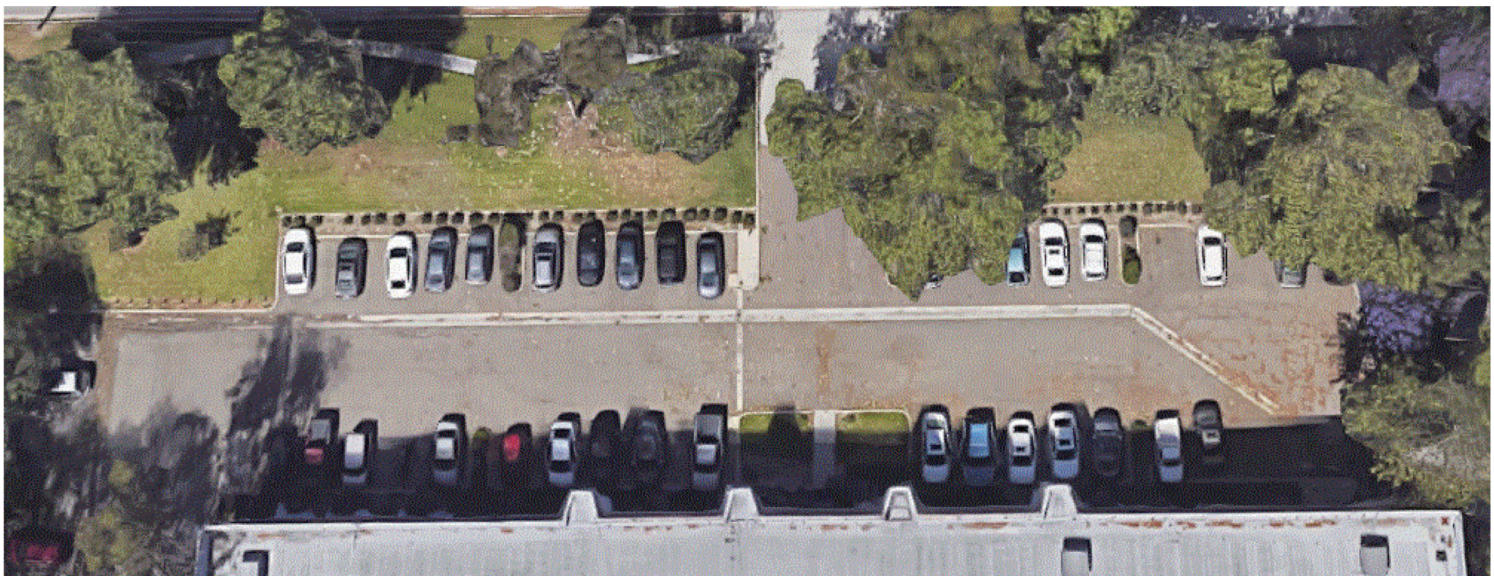

Figure 1: Areal View of Parking Lot

Figure 2 is a composite view of the individual images captured from a PTZ camera mounted to the center of the building looking down at the parking lot. The equivalent of 7 individual cameras is required to capture images of the entire scene. The cost to install, record and maintain 7 cameras is likely to be cost prohibitive, forcing the end user to settle for less than the required coverage. This set of images also demonstrates the amount of space that is unseen by a PTZ camera at any given time.

Figure 2: Composite of Individual Cameras

Tall scenes are those in which the space is elongated and narrow such as corridors, isles of shelving or assembly lines. Omni-directional scenes are those that have content in multiple directions from a center point. Examples of these scenes could include those of the first two categories, as well as intersecting hallways, street intersections and confined spaces. Figure 3 presents examples of tall and omni-directional scenes.

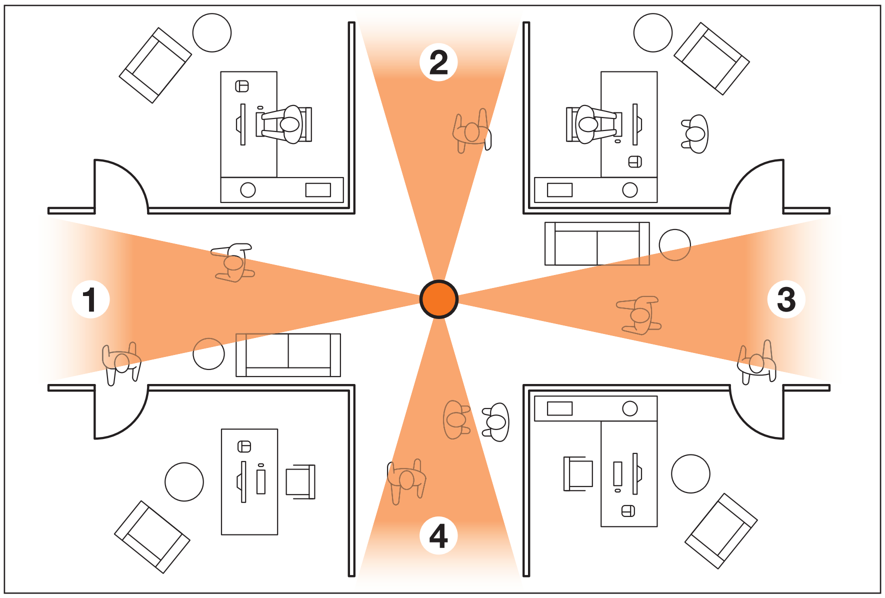

Figure 3: Tall and Omni-directional Scenes

For scenes that are wide and tall (omni-directional) such as those shown in Figure 3, fisheye cameras provide broad flexibility. Fisheye cameras are equipped with a single high-resolution video collection sensor paired with a special lens to collect imagery 360° around the camera. Fisheye cameras can be used for all three scene categories, but their major advantage is the ability to capture images from all directions at the same time in tight quarters. Images created by fisheye cameras are hemispheric in nature where the image is distorted and warped as shown in Figure 5.

As with the wide scene, these cases would require numerous cameras to provide views of the spaces and the resulting collage of images would provide marginal results for the client. Lack of a cohesive view of the scene and the number of individual conventional cameras required create the same cost and performance issues for wide, tall or omni-directional scenes.

Solution Space

Panoramic cameras provide solutions to these challenges by creating a single image of the large-scale scene without sacrificing image quality and spatial perspective. Panoramic cameras come in two form factors: multi-sensor cameras and single-sensor with fisheye lens cameras. Multi-sensor cameras are composed of 2 or more sensors which can create independent views of portions of a scene or the camera video can be interlaced to create one large format view the scene. Multi-sensor devices can be used for both wide and tall scenes. Figure 4 is a view of the same parking lot shown in Figures 1. This image was created by a DW® three-sensor Panoramic camera with video processing software that stitches these individual sensor images into one wide-format view of the parking lot.

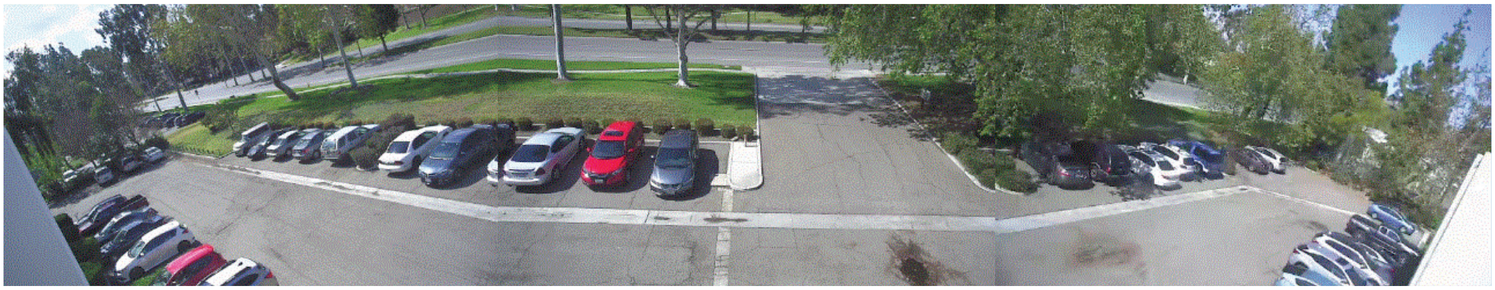

Figure 4: Panoramic View with Multi-sensor camera

The ability to create a single composite image from multi-sensor cameras and the ability to dewarp a hemispheric image into a usable view requires advanced video signal processing.

Virtual Cameras

Recent improvements in the software that dewarps fisheye images have greatly improved the usability of these cameras. Dewarping not only removes the distortion, it provides the viewer an understandable spatial reference to the scene.

Figure 5: Fisheye Camera - Hemispheric View

DW Spectrum® IPVMS creates a completely new way of thinking when it comes to video camera placement and recording. In this new paradigm, the camera depicted in Figure 5 is an omni-directional collection device that captures high resolution data from its 360° field of view. Now think of this data collected and recorded as the source for multiple user-configurable virtual cameras. Each with individual view points of the space captured by the camera and recordable by DW Spectrum® IPVMS.

In the scene demonstrated in figure 5, the user can create multiple virtual cameras on the DW Spectrum® Client then manipulate these cameras as if they were each pan-tilt-zoom or panoramic cameras. Figure 6 was captured from the fisheye camera using the DW Spectrum® Client. The hemispheric image represents what the sensor is collecting and storing. The other images were all independent, live views of the same space created from the data collected by the fisheye cameras.

DW®'s line of multi-sensor cameras provides very similar functionality. The key difference is the way the camera captures the raw data and transmits it to the recorder. The video processor that stitches the separate images into a single wide-format image is built into the camera. Therefore, the raw image received at the client end does not require processing to be viewed. However, when paired with the DW Spectrum® IPVMS, the raw data again can be used to create a series of virtual cameras.

Figure 6: Images Created by a Fisheye Camera

Figure 7 was captured from the parking lot camera in Figure 4. Using the DW Spectrum® Client, multiple virtual cameras were created to highlight different areas of the scene. As with the fisheye cameras, in live and playback mode these views all display simultaneously.

Conclusion

The DW®'s line of Complete Surveillance Solutions for wide area surveillance provides unparalleled performance in video capture and presentation for a wide range of applications. When these sensors are paired with the DW® Recorders and the DW Spectrum® IPVMS, the sensor placement game

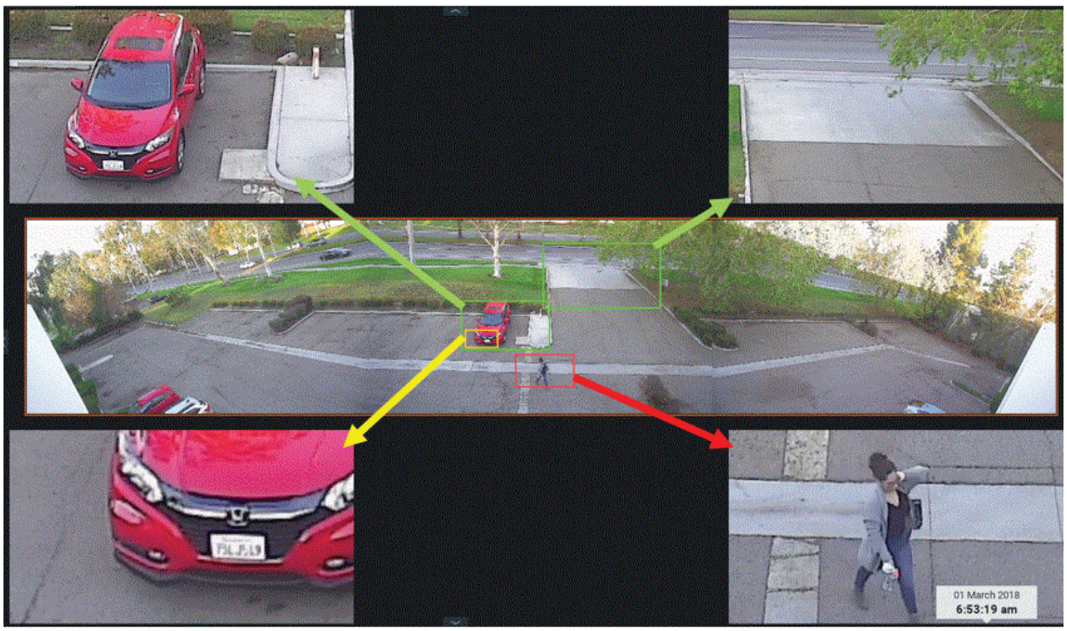

Figure 7: Virtual Cameras created from Multi-sensor Camera

changes completely. No longer is the quality of camera coverage a factor of the number of individual cameras installed. No longer must the end user worry about moving cameras if the high interest assets within a scene change. Using the DW Spectrum® IPVMS, the user can quickly add and configure new virtual cameras to provide focused surveillance of these assets.

For more information on any of the DW® Panoramic Cameras or Video Management Systems please refer to our website:

1. MEGApix® Panoramic Cameras:
   http://bit.ly/303ilKD
2. DW® Star-Light™ Panoramic Cameras:
   http://bit.ly/2LxjADh
3. DW Spectrum® IPVMS:
   https://digital-watchdog.com/spectrum-landingpage/

Appendix A: Video Primer

Photography Concepts

In order to understand the root cause to performance issues in dynamic lighting conditions, it may help to first review how a camera captures an image. All cameras from the first Daguerreotypes to the digital camera in a smartphone capture images by collecting the light reflected off the scene. Originally cameras captured the light on plates or film specially treated to react to varying levels of light, resulting in a negative copy of the image stored on the plate or film. Today, the film has been replaced with electronic sensors such as Charge Coupled Devices (CCD) and Complementary Metal-Oxide Semiconductor (CMOS) Sensors. The light reflected into a camera is a form of energy called photons. Film and electronic sensors react to the photons based on the intensity and duration of the captured energy.

> A video camera takes multiple photos a second that when pieced together represent the scene recorded. Yes, video is a representation of real life because it is only a series of still pictures with spaces between each picture. Depending on the frames per second, the gaps between the pictures can an indiscernible. The human brain requires 30 to 60 frames per second to create the sensation of live video.

Video sensors (digital or film) require a certain level of energy to capture an image. In order to capture the correct level of energy the camera (or its operator) changes the duration of the capture based on the level of energy being received. Known as shutter speed or sampling rate, this is the duration of time the sensor is exposed to the scene to capture an image. In conditions with high levels of light, the duration must be shortened, limiting the number of high power photons captured; otherwise the image is overexposed. In low light conditions the capture time is extended to allow more of the lower power photons to be collected. In this case, insufficient capture time results in an under exposed or dark image.

Modern cameras have the ability to process a wider range of lighting conditions resulting in a mix of the highs and lows. Today, cameras can automatically adjust the shutter speed (iris function) based on the light levels detected by the sensor. The shutter speed affects the total scene and camera can speed up or slow down the exposure rate, but it cannot do both at the same time. Additionally, the camera's sensor has a minimum and maximum level of light that it can process. This is the camera's Range. The greater the range, the wider variation between brightest and dimly lit scenes the camera can processes. One still must pick a shutter speed within that range. When there are multiple light levels in one scene, the camera will try to find a happy medium between the levels. In this case some information is lost due to underexposure (noise) or due to overexposure (clipping). Looking back to the prior images, the camera is either clipping out the high energy portions or loosing the low energy portions as noise.

High Resolution Video

Contrary to most police dramas, a stored video image contains only the information captured in the image. Missing details cannot be created through special software in the crime lab. In order to zoom in on a stored image and read a license plate, the image must first have the information stored within. Two examples of this reality are the satellite images on internet mapping programs and JPEG images. One can only zoom into their house to the level of detail captured in the image or zoom in on a photo to the level of detail stored in the photo.

> Areal images displayed in web-based mapping sites have a resolution of 3m to 15m per pixel. This means that the smallest usable piece of image is 3m to 15m square.
>
> The resolution of the average JPEG image can vary from 72 dots per inch (DPI) or pixels per inch (PPI) to 1200 DPI/PPI

This is where high resolution video comes into play. Higher resolutions images result from a higher number of individual segments captured in the image. The individual segments of digital images are called pixels (short for "picture element"). The greater the number of pixels in the capture device, the greater the resolution of the captured image. Higher resolutions create a better image by capturing a greater level of detail in the image. At a 1:1 viewing ratio the image is crisper and clearer to the viewer. Faces, numbers, letters and other details are clearer. Overall the image has more information with undetectable details becoming detectable when the image is amplified (zoom in). The license plate can be zoomed in on when the license plate is captured in the image.

Light Levels in Video

Where the number of pixels define the image's resolution, the size of the pixel defines the amount of light the sensor can store. In digital imagery, the pixel size is a factor in the sensor's ability to store light energy (photons) over a given period of time (capture rate / shutter speed). Larger pixels are better at adapting in the light range because in high light levels, the sensor can capture more intense light without clipping and in low light there is more area of sensor to capture the reflected light energy.

Remember that in scenes with high light levels, the capture rate is fast and in low light scenes the capture is longer to allow more energy to be captured by the sensor. When the pixel cannot store all of the light energy reflected by the brightly lit scene, washout (clipping) occurs. When the scene is dimly lit, the image will be blurry (noisy) if the capture rate is extended too long. With the capture rate not extended long enough, the image will be dark. High resolution cameras can require a higher minimum light level for an image.

: 866.446.3595 : sales@dwcc.tv : www.digital-watchdog.com