WISENET

White paper

WDR: Wide Dynamic Range

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Hanwha Techwin

Contents

1. Overview

Recently, video processing technology and sensor related to video device have advanced rapidly to make the video looked natural as seen in the eyes.

In particular, video surveillance cameras have been developed actively to provide the best image quality under various environments. The most important part is Wide Dynamic Range (WDR, backlight correction technology), which reacts to the change of light.

WDR is a technology for obtaining excellent image by resolving the difference in brightness in video when the background is brighter than the main object or thick shade is generated by strong light.

Generally, WDR is required in the following situations:

- During daytime, it is dark inside the building and bright outside.
- A car is approaching the camera with its headlights turned on.

Figure 1. WDR is applied when the main object is dark due to the bright background.

The foregoing is a common example in video surveillance environment; therefore, many video surveillance cameras have the WDR function. Performance related to WDR is generally measured as dB; WDR with higher dB can resolve larger difference in brightness and generate image with better quality.

The WDR technology applied to the cameras of Hanwha Techwin provides excellent image quality while minimizing side effects to deliver videos suitable for the customer.

2. Background

Under the general video surveillance environment, part of the image is sometimes not displayed because the dynamic range is too large. To resolve this problem, WDR is used with various methods including variable exposure control, adjustment of charging capacity, measurement of cell saturation time, and dual-size sensor cell type.

Nowadays, the most common method is variable exposure control, which takes photos with differing brightness and composes them to achieve the proper brightness. In order to adjust the amount of light entering into a camera using the exposure time, an object in a brighter area requires short exposure time, whereas an object in a darker area requires long exposure time. To resolve this problem, composition of photos taken with different exposure times is generally used.

In other words, one image is generated using the information on images taken with short exposure and long exposure.

Note, however, that the aforesaid method has some side effects. The most common one involves moving objects. When taking a moving object, artifacts may occur if the object is moving too fast and the exposure time is too long.

Dynamic Range is the ratio between the brightness of the brightest and darkest areas of an image. In case of the CMOS sensor used by video surveillance cameras, dynamic range is determined by the following formula because its output bit is 12bit:

$$\text{Dynamic Range} = 20*\log10(2\text{^}12) = 72\ \text{dB}$$

Ways of increasing dynamic range have been researched in many fields. Although a way to improve the performance of the image sensor's photo diode has been researched, it has limitations in price and performance. As such, variable exposure control composition has been actively researched recently, and related products are released.

3.1. Variable exposure control

As shown in the following figure, Variable Exposure control composition is a technology of composing 2 images after obtaining long-exposure and short-exposure images:

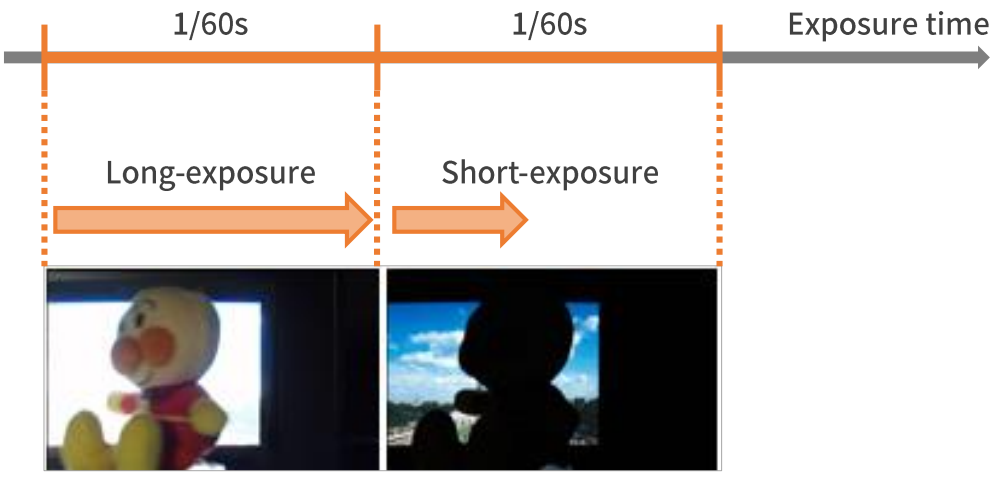


Figure 2. Process of obtaining long-exposure and short-exposure images

For this technology, dynamic range is determined by the ratio of long and short exposures. As shown in the following figure, WDR image is generated based on the natural composition by using short-exposure image for bright area and long-exposure image for dark area.

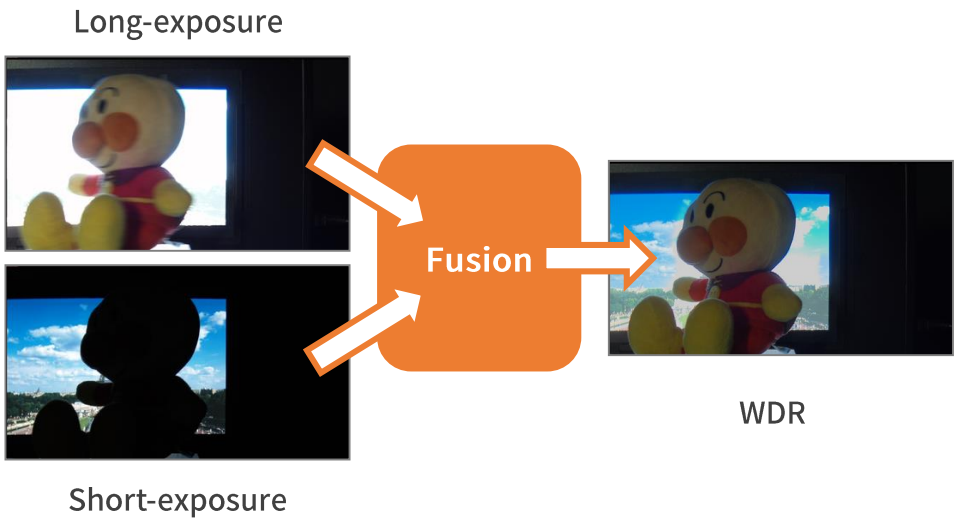


Figure 3. Process of composing long-exposure and short-exposure images

The dynamic range of WDR image generated in this manner can be calculated by the following formula:

$$\text{Wide Dynamic Range} = 20*\log10(2\text{^}(12+\text{exp\_ratio}))$$
$$\text{Where, Exp\_Ratio} = \log2(\text{Long\_Exposure}/\text{Short\_Exposure})$$

For example, if long exposure is 16.7ms and short exposure is 1.04ms, Dynamic Range = 20*log10(2^(12+4)) = 96dB.

On the other hand, this method can generate a WDR image that we want by controlling the exposure of a normal sensor variably, but the variable exposure control composition inevitably generates a time difference between long-exposure and short-exposure images.

If there is a moving object caused by such time difference, motion artifact problem may occur when generating a WDR image as shown in the figure below. In other words, motion artifact is an inevitable component of variable exposure-type WDR, and it is very important to correct it.

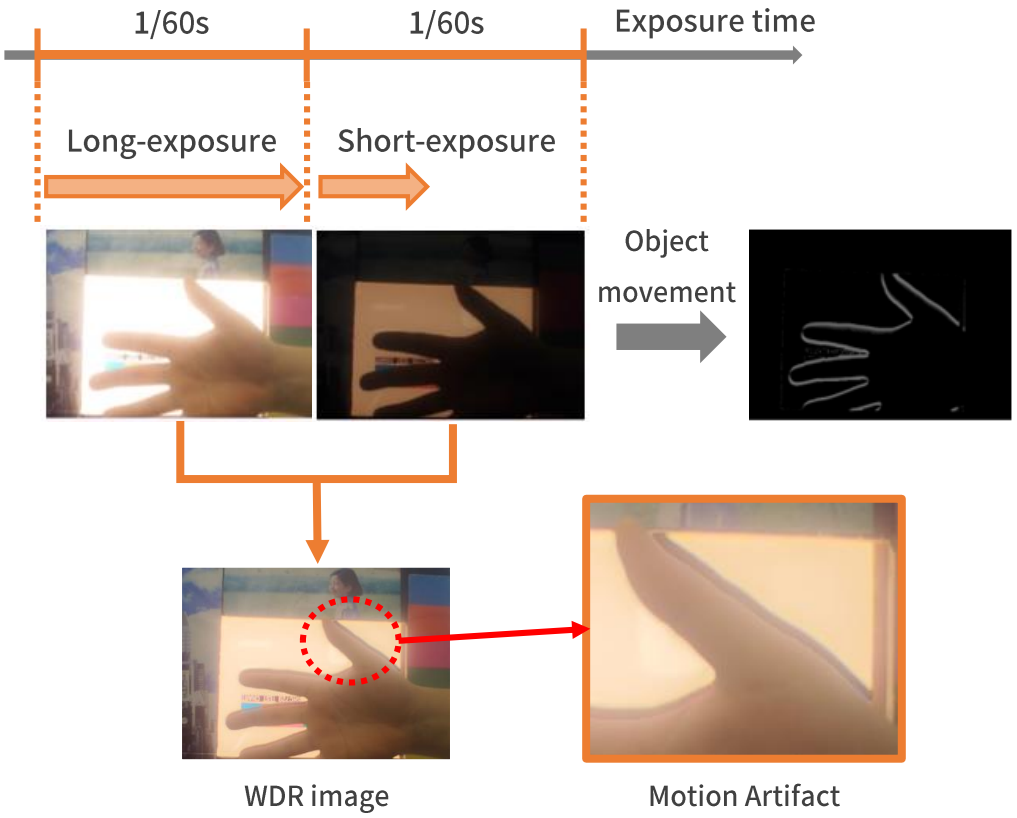


Figure 4. Motion artifact caused by composition of long or short exposures

The WDR technology applied to models that use Hanwha Techwin's Wisenet 5 chipset (X series) adopted the variable exposure WDR; it obtains 4 images with differing exposures to generate 1 WDR image. 4 images are required to obtain an ultra wide dynamic range image.

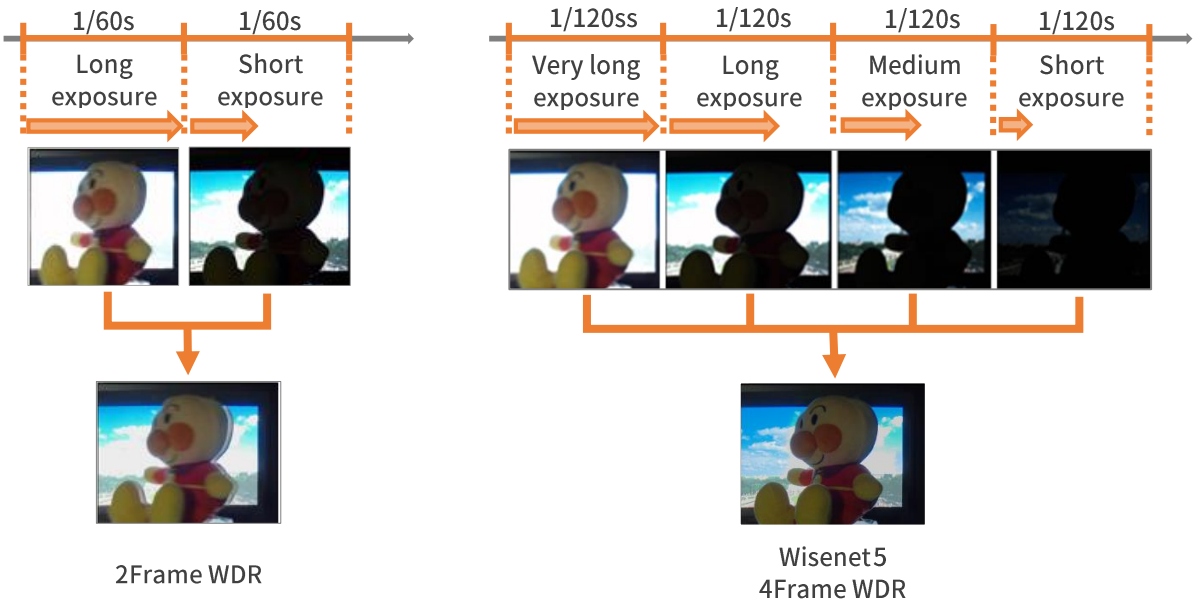


Figure 5. Comparison of the existing 2 fps WDR and 4 fps WDR applied to X series

4.1. Scene Based Adaptive Tone Mapping

Hanwha Techwin's WDR technology uses SBATM (Scene Based Adaptive Tone Mapping), a technology that analyzes and reacts to the surrounding images in order to obtain ultra wide dynamic range and natural image. This technology can generate natural images without loss of information even in the ultra wide dynamic range environment of more than 130dB.

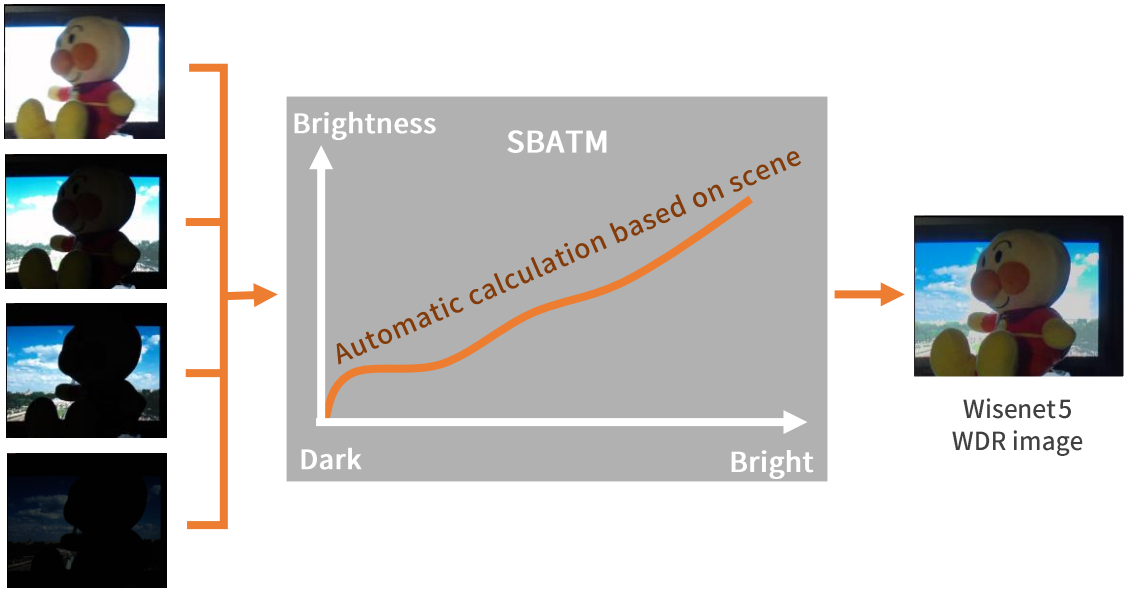
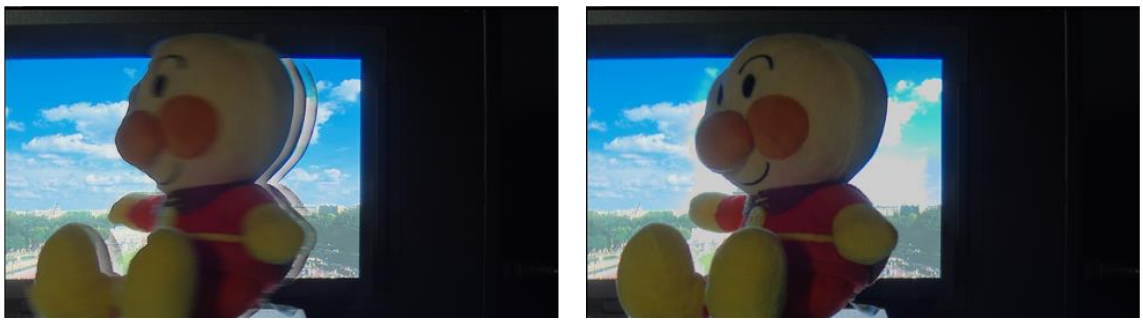


Figure 6. Process of generating an image in ultra wide dynamic range environment

4.2. Motion artifact removal

WDR of Hanwha Techwin's X series developed and applied motion artifact removal technology to reduce the artifacts, a critical weakness of variable exposure WDR. This is a technology for detecting and analyzing movement in an image correctly and conducting adjustment to generate the most natural image with the detected area.



Motion artifact removal OFF
(Wisenet 5)

Motion artifact removal ON
(Wisenet 5)

Figure 7. Effect of Motion Artifact Removal in an X series (Wisenet 5) product

5. Conclusion

For a video surveillance camera used in various conditions, WDR became an essential element in order to secure accurate and reliable images. Therefore, many video surveillance companies are making a lot of effort to develop video processing technologies.

Hanwha Techwin's WDR technology is realized based on Wisenet 5 chipset, an SoC (System on Chip) developed by Hanwha Techwin's accumulated know-how. Therefore, it can generate natural images without loss of information even in the worst environment wherein the background is brighter than the main object, thick shade is generated due to strong light, or screen brightness is very different. In addition, it can significantly reduce the effect of motion artifact, a critical weakness of WDR.

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