WISENET

White paper

WDR: Wide Dynamic Range

Hanwha Techwin

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1. Overview

Recent advances in processing technology and sensors are enabling video surveillance cameras to capture images which look more natural, with some cameras equipped with specific features which enhance the ability to provide the best possible image quality in varying environments. One of the most important of these features is Wide Dynamic Range (WDR) as this is able to help deal with the challenge presented by varying light conditions.

WDR is required in the following examples:

- During the day when it is dark inside the building and bright outside.
- Interior lighting.
- Bright reflection e.g from the sun

Performance related to WDR is generally measured as dB(decibels). WDR with a higher dB can resolve larger differences in brightness and generate a better quality image.

2. Background

A part of the image may not be displayed when the dynamic range is too large. WDR is used to resolve this with various methods including variable exposure control, adjustment of charging capacity, measurement of cell saturation time and dual size sensor cell type.

The most common WDR method used by cameras nowadays is variable exposure control, where a composition of two images is created, each taken with different exposure times. This results in a single composite image using the information from the separate images taken with short exposure and long exposure times.

However, this method has some side effects. The most common one involves moving objects. Blurring may occur when capturing images of a moving object if the object is moving too fast and the exposure time is too long.

3. WDR Technology

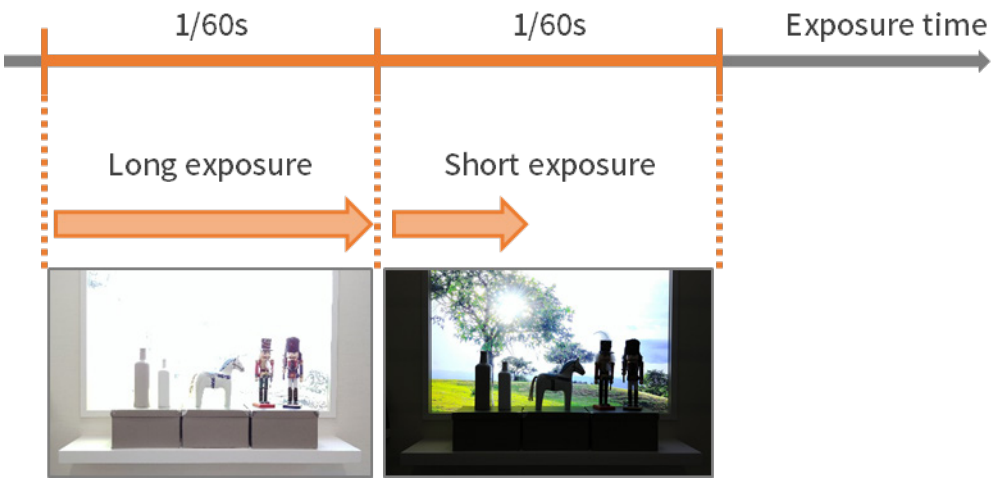
Dynamic Range is the ratio between the brightness and the darkest areas of an image. In the case of the CMOS sensor used by many video surveillance cameras, dynamic range is determined by the following formula because its output is 12bit:

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

Although ways to improve the performance of the image sensor's 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

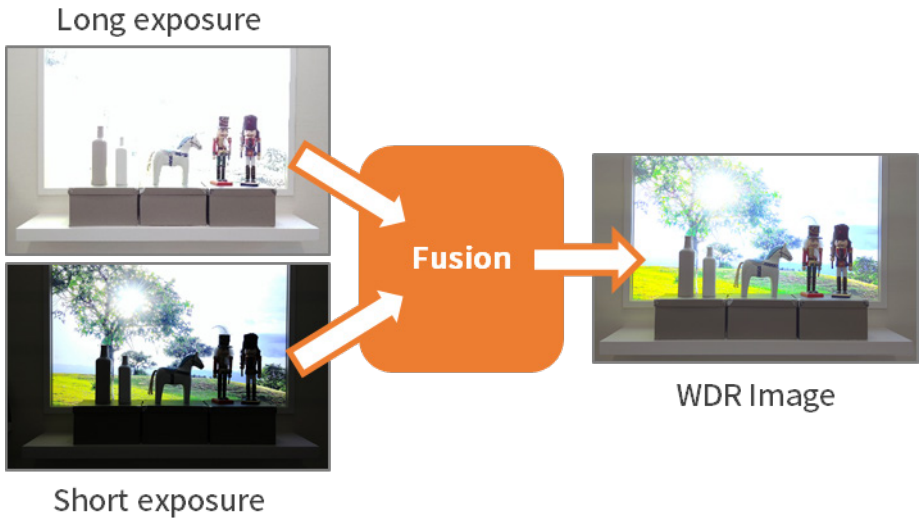
As shown in the following figure, Variable Exposure Control composition is a process of composing 2 images after obtaining separate long-exposure and short-exposure images:



Process of obtaining long-exposure and short-exposure images

WDR technology

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



Process of composing long-exposure and short-exposure images

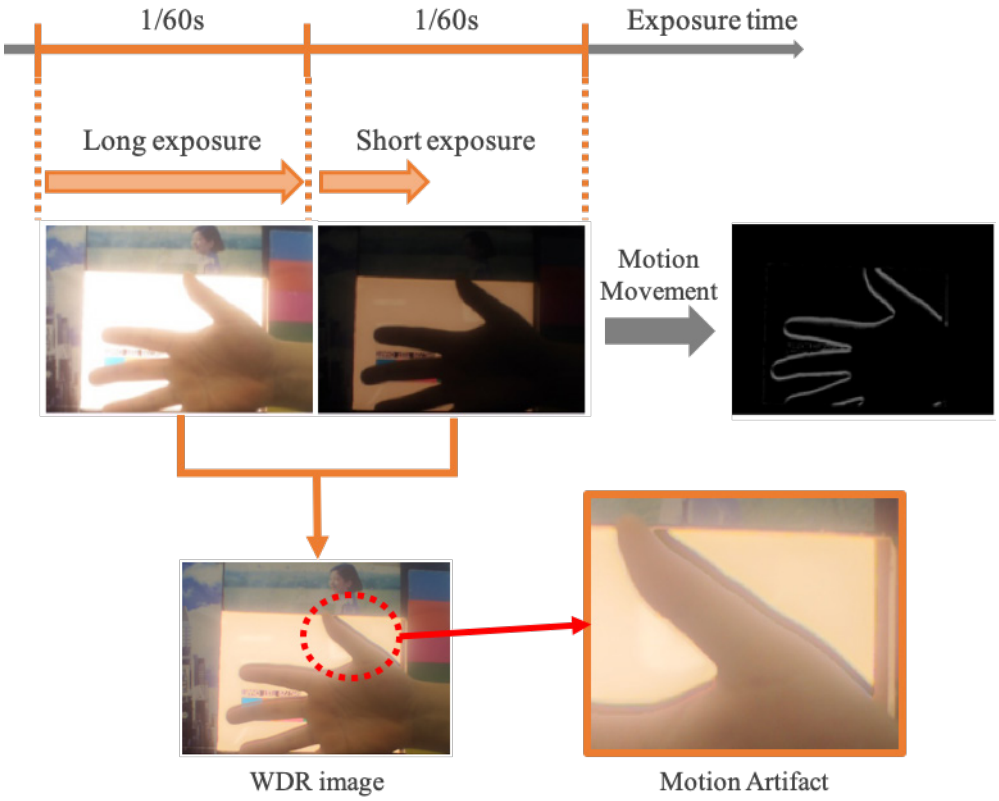
The dynamic range of WDR image generated in this manner can be calculated by the following formula:

Dynamic Range = 20*log10(2^(12+exp_ratio))
Where, Exp Ratio = log2(Long_Exposure/Short_Exposure)

For example, if long exposure is 16.7ms and short exposure is 1.04ms,
Dynamic Range = 20*log10(2^(12+4)) = 96dB. The Hanwha Techwin Wisenet 5 chipset provides a WDR image which has a maximum 150dB dynamic range.

WDR technology

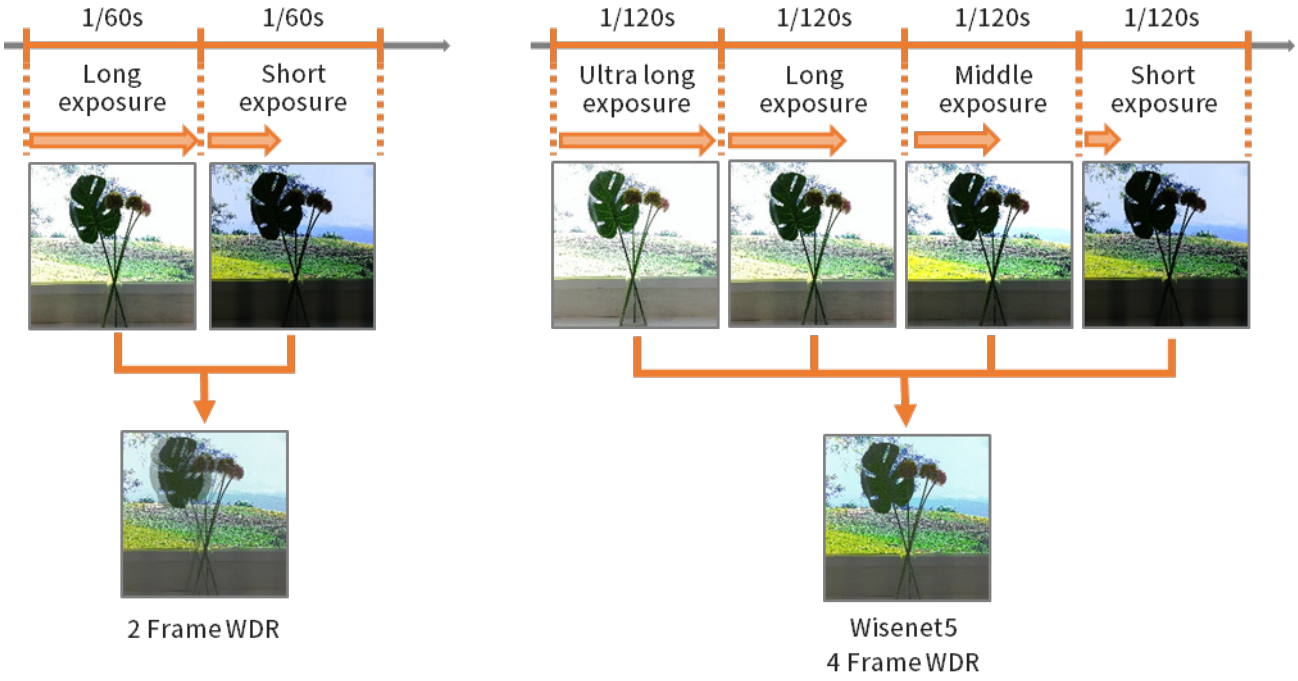
This method is able to generate a WDR image by controlling sensor exposure. However, with a time difference between the long-exposure and short-exposure images used to make up the composite image, motion artefact problems may occur when generating an image of a moving object, as shown in the figure below. In other words, motion artefacts are an inevitable component of variable exposure-type WDR and it is very important this should be corrected.



Motion artefact caused by composition of long or short exposures

4. Wisenet 5's WDR

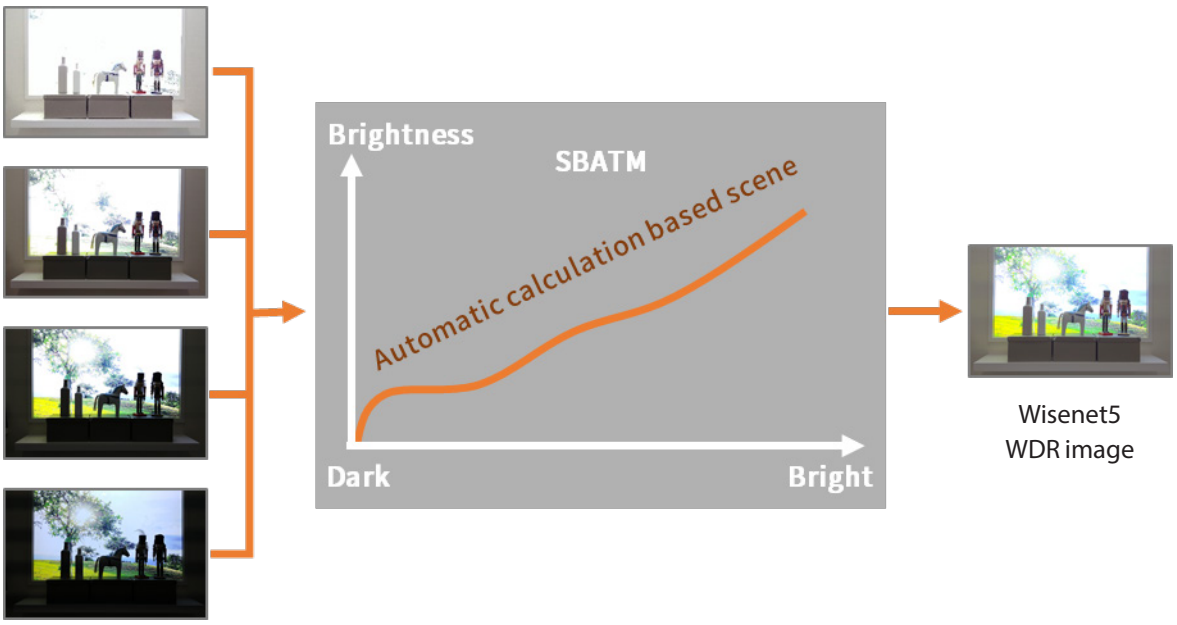
The WDR technology incorporated into Hanwha Techwin's Wisenet 5 chipset (X series) involves 4 separate images with differing exposures being used to generate 1 WDR image.



Comparison of the existing 2 frame WDR and 4 frame WDR applied to the X series

4.1 Scene based Adaptive Tone Mapping

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



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

4.2 Motion Artefact Removal

The WDR in Hanwha Techwin's X series applies motion artefact removal technology to reduce the artefacts, which is a weakness of variable exposure WDR. The technology detects and analyses the movement in an image and makes adjustments to generate the most natural image in the detected area.

Motion artifact removal off

Motion artifact removal on

Effect of Motion Artefact Removal in an X series (Wisenet 5) product

5. Conclusion

For video surveillance cameras used in various lighting conditions, WDR has become an essential element in order to secure accurate and reliable images. Many video surveillance companies are making a lot more effort to develop video processing technologies.

Hanwha Techwin's WDR technology is realised on the Wisenet 5 chipset, an SoC (System on Chip) developed with Hanwha Techwin's accumulated knowhow. It generates natural images without loss of information even in the most challenging of situations where the background of an image is brighter than the main object or heavy shade is generated due to strong light. In addition, it will significantly reduce the effect of motion artefact (or blurring), a critical weakness of WDR.

WISENET

Hanwha Techwin Europe Ltd.

Heriot House, Heriot Road, Chertsey, Surrey,
KT16 9DT, United Kingdom
Tel: +44 (0) 1932 578 100 Fax: + 44 (0) 1932 578 101
www.hanwha-security.eu

Hanwha Techwin