IPC Full-color Technology White Paper

White Paper by Dahua Technology

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1 Foreword

Limited by the performance of components, the quality of images is greatly reduced in low luminance scenarios (such as night or indoor scenarios without illumination). However, scenarios with low light condition are the key scenarios in security surveillance. Thus, improving the object sensing ability of the camera in low luminance scenarios is always the key technical direction of security surveillance manufacturers.

A common solution for improving the sensing ability in low light environment is to adopt IR illuminator. When the average luminance in the scenario is lower than the pre-set value, the camera automatically switches to night mode and turns on the IR illuminator, providing high-quality black-and-white images with the help of the IR illuminator. The main disadvantage of this solution is that the captured images are not colored, thus bringing difficulties in evidence collection and other public security applications.

Black-and-white image misses target details information in the scene

To improve the imaging effect at low luminance, you need to improve optical signals and reduce noise. The main methods to improve optical signals are as follows: increase the light source energy (using illuminator); collect of more light (increasing the aperture and the exposure time); and reduce loss (increasing the light transmission along the optical paths such as lens and ICR filter). The two methods for noise reduction include: Hardware (such as hardware noise reduction circuit) and Software (such as noise reduction algorithm).

2 Principles of Dahua Full-color Technology

To get a 24-hour colored monitoring screen, Dahua provides a full color technology solution. Two versions are provided for different application scenarios: Version without illuminator and version with warm light illuminator.

Version without illuminator: To improve the color restoration effect of the camera, Dahua not only improves optical signals but also reduces noise. We use a combination of technologies to improve optical signals - ultra starlight image sensor (large pixel size + back illumination + large pixel internal gain) + fast lens (large aperture). Through high-performance image processing algorithm, we can minimize noise and smear. Limited by the current software and hardware technology level, we recommend the version without illuminator in scenarios with certain ambient light to get better image quality (colorful, low noise, no smear).

Version with warm light illuminator: Adopts a 3,000K warm LED as illuminator. When the environment is dark enough and the optical signals are as small as the noise level, the monitored object will not be seen clearly. At this point, you can use the warm light illuminator to improve the optical signal input by the camera and increase the signal-to-noise ratio, allowing the monitored object to be seen clearly. The version with warm light illuminator is suitable for scenarios with low light.

The following sections introduce the key technical details of Dahua full-color technology.

2.1 Ultra Starlight Image Sensor

The Ultra Starlight image sensor of Dahua full-color camera has the following features: large pixel size, back-side illumination and higher conversion gain (HCG) at low luminance.

- Large pixel size, with larger photosensitive area and more light energy during the same exposure time.

- Back-side illumination. The metal wiring layer is moved behind the photosensitive layer through structure change. In this case, because the incident light passes through the photosensitive layer first, the blocking of incident light by the metal wiring layer is reduced, thus fully utilizing ability of the fast lens (large aperture lens) to increase input light.
- Using HCG allows a higher conversion gain in pixels of the sensor. Located at the pre-amplifier of the signal link, this conversion gain can reduce the effect of the post-amplifier noise to get a higher signal-to-noise ratio.

(a) Front-side illumination (FSI) (b) Back-side illumination (BSI)

The difference of FSI and BSI structure

For the traditional structure FSI, lenses are arranged on the top of the sensor, and wires are connected between the lenses and the photodiodes (light receiving part). The light obliquely incident on the sensor is blocked by these wires, and some light is reflected to the directly incident light, resulting in a reduction in overall sensitivity.

However, for the new structure BSI type, lenses are fixed to the back of the flat substrate, directly passing light to the photodiodes, and the light is not interfered by wiring, thus greatly improving the sensitivity and overall performance.

2.2 Fast Lens (Large Aperture Lens)

Dahua brings an aspheric lens into the camera, with aperture of F1.0. Compared to F1.6 lens, the light feed of the F1.0 lens theoretically increases by 2.5 times. To get the theoretical value of the increased light feed, you need to use the back-side illumination Ultra Starlight image sensor mentioned in Section 2.1.

Iris is a component that controls the clear aperture of a lens. Increasing the aperture (smaller F-number) can increase the light feed, thus improving the night vision effect of

the camera. Usually, F-number represents the effective aperture. The definition of F-number is f/D, wherein f is focal length, and D is the diameter of the effective clear aperture.

Lens' processing difficulty increases as the aperture gets larger. In addition, because the color difference is larger, more lenses are required. Dahua adopts aspheric lenses to solve these problems, because such lenses have a series of advantages: Good aberration correction ability; reduces the use of lenses; decreases total track lens (TTL); cuts down weight; saves materials; and better image quality (including MTF, purple boundary, infrared correction, and distortion).

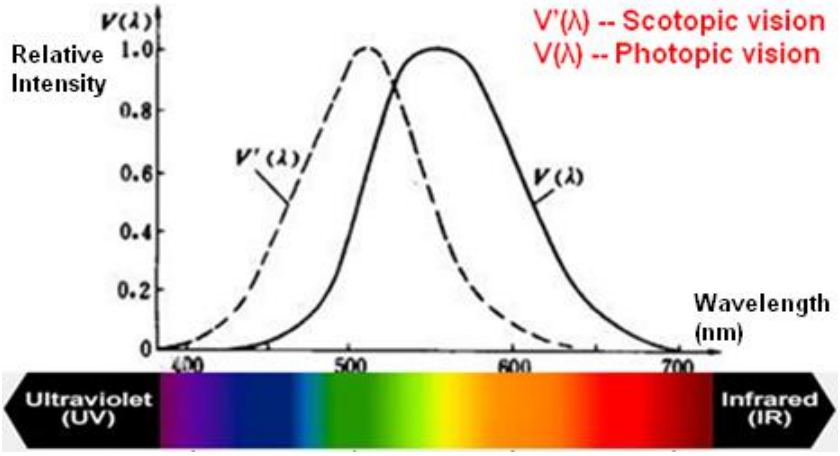
2.3 Noise Reduction Algorithm 4.0

To reduce the noise caused by the imaging process of the camera, transmission channels, the noise reduction algorithm 4.0 of Dahua makes full use of the two-dimensional and three-dimensional statistical information, in order to reduce the noise while enhancing the original signals, without introducing false signals. This not only brings clear night color images to customers, but also provides better performance for motion objects. The default parameters are as follows: the video image is clear; the noise is low without obvious smear; applications in dynamic scenes are easy.

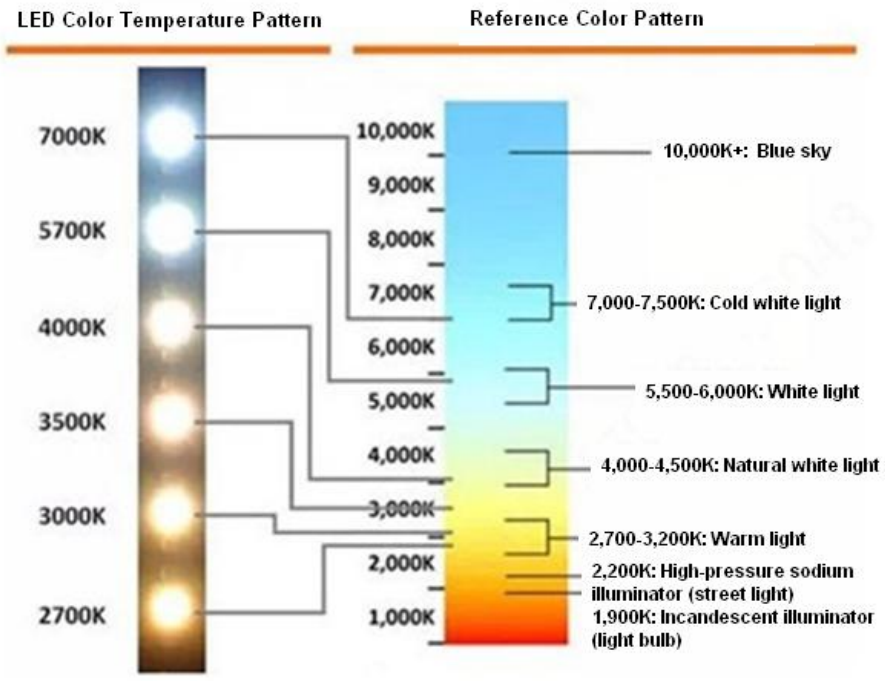
2.4 Warm LED Illumination

Dahua uses a warm light illuminator with a color temperature of 3,000K to ensure the effect of video images in a dark environment while reducing irritation to human eyes.

The peak absorption wavelength of the cone cells which dominate photopic vision in human eyes is around 500 nm (green and blue parts), while the absorption efficiency of the yellow light around 560 nm is about 50% lower. Therefore, in bright scenes, a cold light illuminator seems brighter than a warm light illuminator with the same luminous power. A warm light illuminator can ensure consistent brightness of the images captured by the camera, while reducing the luminous power felt by human eyes.



The photopic response function V(λ) and scotopic response function V'(λ) of human eye



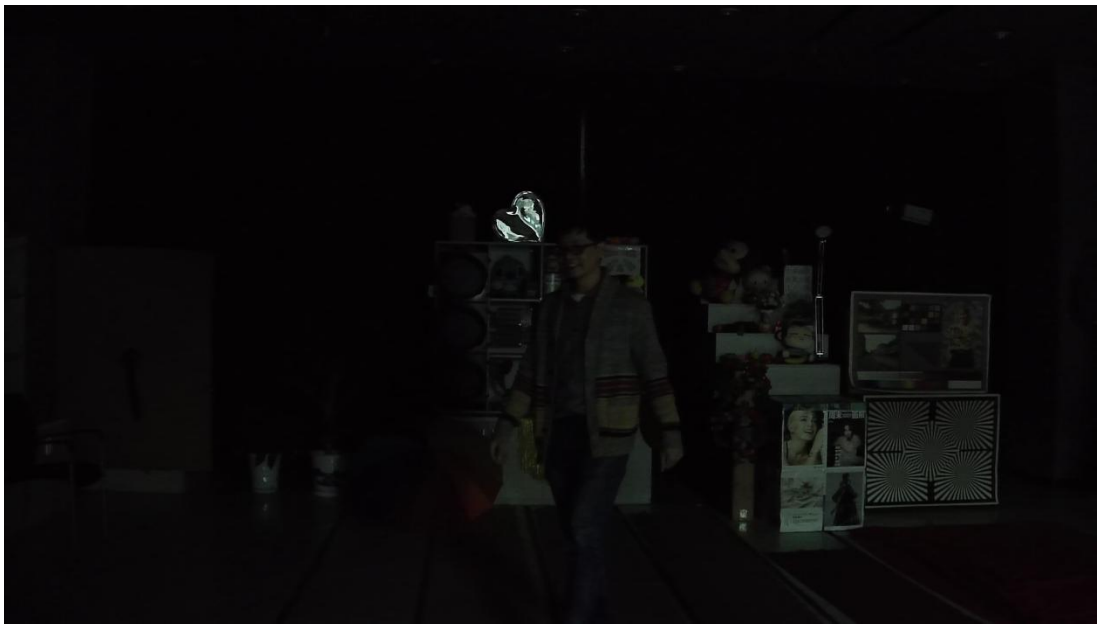
Color temperature of light illuminator

In addition, the 3,000K warm light illuminator complies with the EN62471 standard, ensuring that it does not cause blue light damages to human eyes.

The EN62471 is EU's test standard for light products, and is mainly used to evaluate the light radiation hazards related to the illuminator or illumination system. You should control the brightness and reduce blue light hazards for the white light illuminator. Blue light has extremely high energy and can penetrate the crystalline lens and reach the retina, resulting in atrophy and even death of retinal pigment epithelium. This damage

cannot be restored. The 3,000K warm light illuminator complies with the EN62471 standard and does not cause blue light damages.

3 Effects of Dahua Full-color Technology



Effects of non-full-color cameras

Effects of Dahua full-color camera

4 Summary

Compared to non-full-color cameras, the Dahua full-color camera has obvious advantages in image brightness, color restoration, and detail effects, and can provide a 24-hour colored monitoring screen for users. In low luminance scenarios such as warehouses and outdoor scenarios at night, you can still obtain clear and full-color images. Lawbreakers have nowhere to hide.