Zhejiang Uniview Technologies Co., Ltd.

LightHunter

Technology

Contents

1. Background

With the development of the monitoring industry, the voice for effective monitoring in low-illumination environment in various fields is growing stronger and stronger. Nighttime has always been the high-frequency period of cases, and the dark and unclear environment catalyzes criminal acts. Traditional IPCs cannot provide clear images at night. Though the IR fill light technology can achieve clear images under low illumination, the images are black and white, losing important color information. The LightHunter technology comes into being, solving the need for high-quality video surveillance 24 hours a day, 7 days a week.

2. Key Technologies

In general, less light in the environment means worse quality of images. In order to achieve higher quality images in low-illumination environment, manufacturers often use a variety of methods to increase gain, including slower shutters or better lenses.

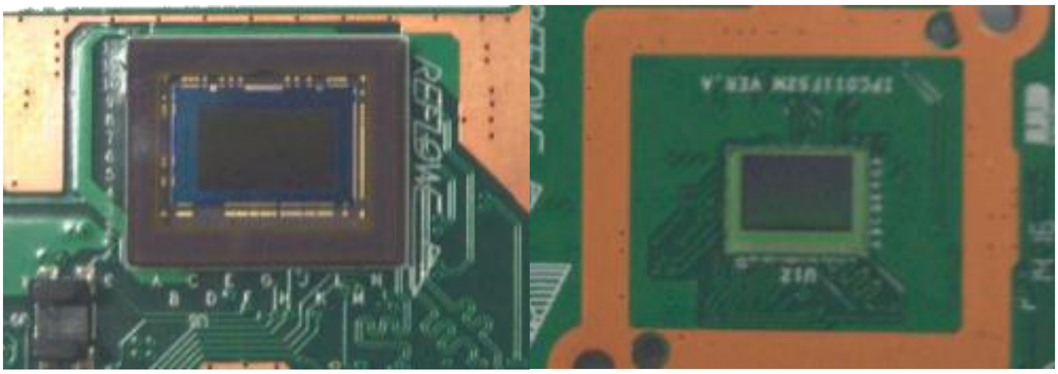
The technical cores behind the LightHunter technology are sensor, lens, U-ISP image processing technology, and hardware structure processing.

2.1 LightHunter Starlight Sensor

As the core components of IPCs, image sensors play a vital role in the image quality. They are indispensable guarantee of image quality in low-illumination environment.

The UNV LightHunter series Starlight sensors include the following two optimization techniques:

1. It is well known that among the same type of sensors, a sensor with larger target surface has better photosensibility. With the specially designed large target-surface sensors, the IPCs have higher photosensibility and sensitivity, and feature high signal-to-noise ratio and WDR.



Large Target Surface | Small Target Surface

Figure 1 Large Target Surface Sensor vs. Small Target Surface Sensor

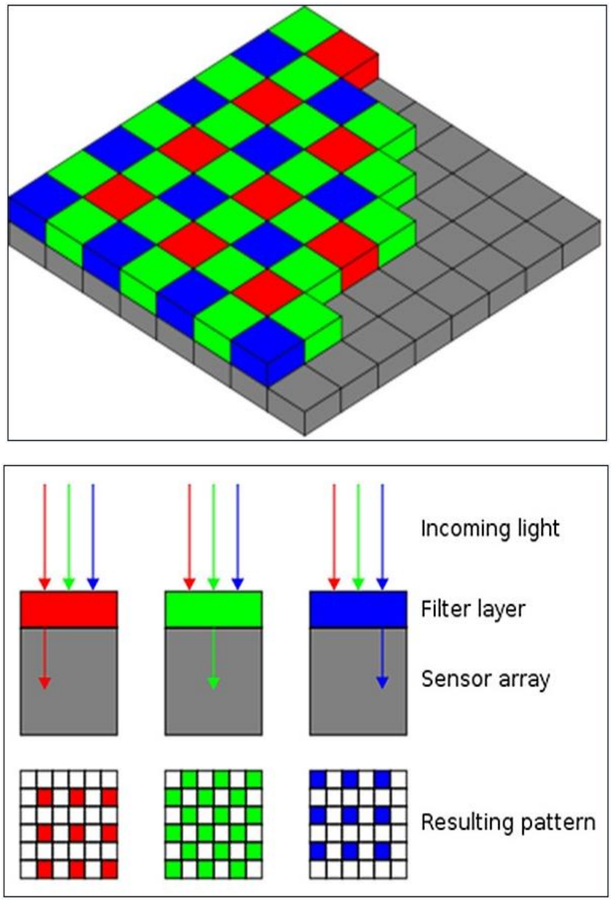


Figure 2 Light Intake Diagram

2. In the traditional CMOS sensor structure, light will be affected by the circuit and transistor between the microlens and the photodiode. LightHunter changes the internal structure of components by turning the direction of the components on the photosensitive layer to allow light to pass directly from the back. The direct effect of the change is that more light enters the sensor's photosensitive surface, which significantly enhances the light efficiency and greatly improves the shooting effect under low-illumination conditions.

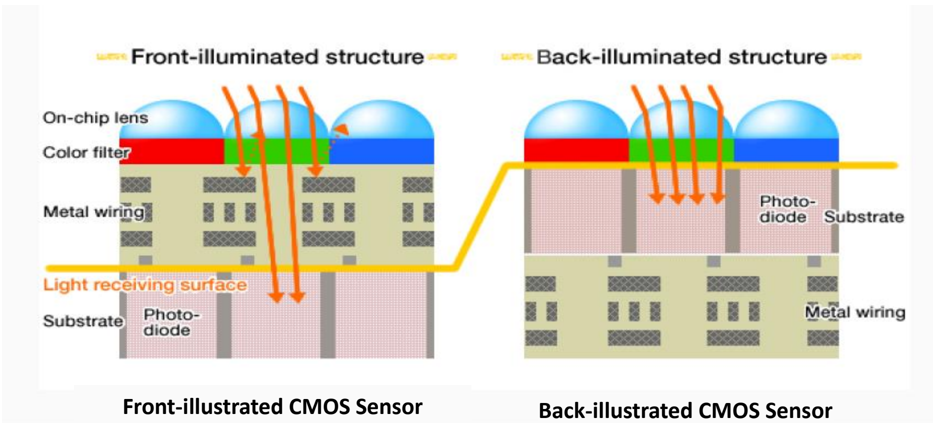


Figure 3 Back-illustrated CMOS Technology and Front-illustrated CMOS Technology

2.2 Starlight Lens

2.2.1 Super Large Aperture

As we all know, a lens determines the amount of flux, which is an extremely important indicator of IPCs. Use Zemx to simulate an optical path that shows the change of the aperture of an optical system. It can be seen that if the aperture gets smaller, the light energy that can enter becomes less. That is, the aperture changes in proportion to the flux of a lens. The larger the flux of a lens is, the more light enters the photosensitive element, which yields better imaging effect. UNV IPCs use super large-aperture lenses, which can achieve images with less noise, more brightness and more details.

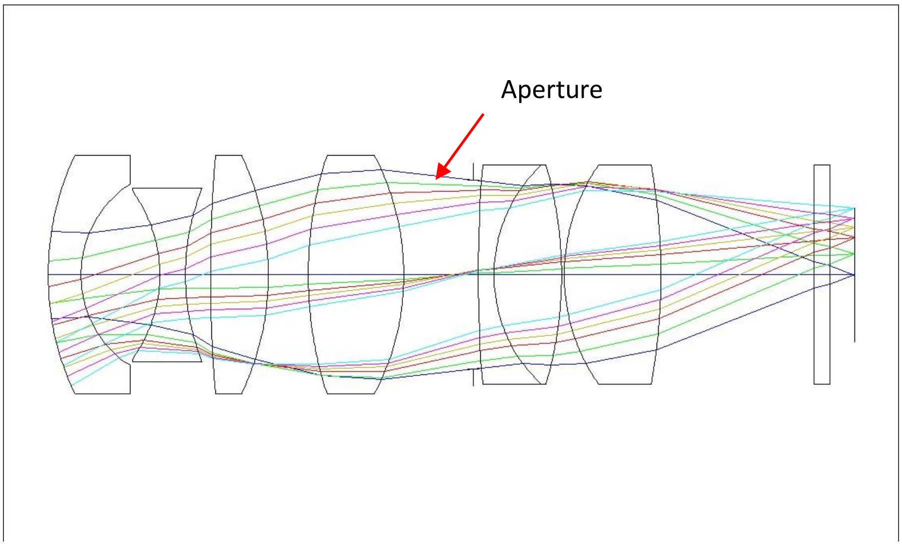


Figure 4 Optical System Before Aperture Decreases

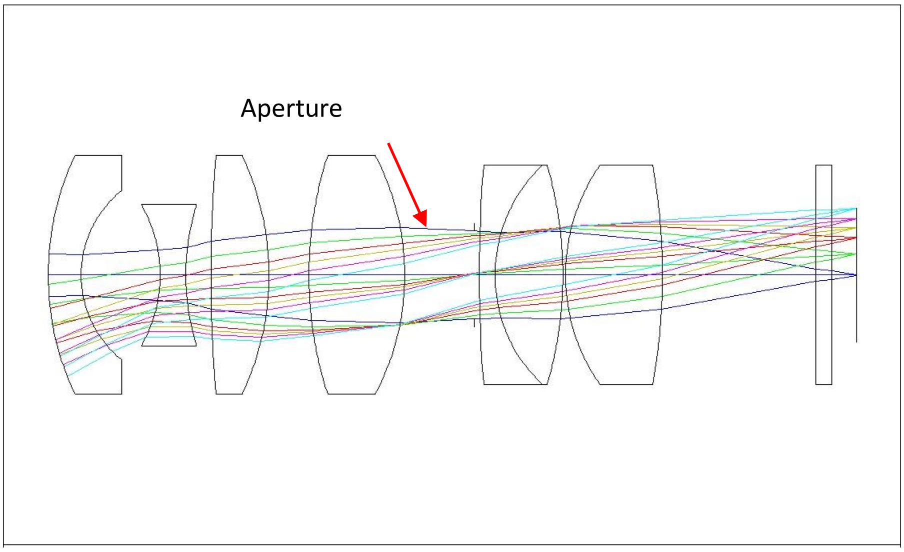


Figure 5 Optical System After Aperture Decreases

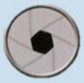
FX	F2.2	F1.6	F1.2
Schematic			
Brightness	395.7	593.4	1140.2
Effect			

Figure 6 Lenses with Different Apertures

2.2.2 Constant Large Aperture

For ordinary zooming products, the aperture will change according to the focal length. When the lens focuses on a long distance, the focal length increases and the aperture becomes smaller. The UNV zooming IPCs are equipped with lenses having a constant large aperture, making constant large aperture possible. When the focal length changes, the images can remain bright.

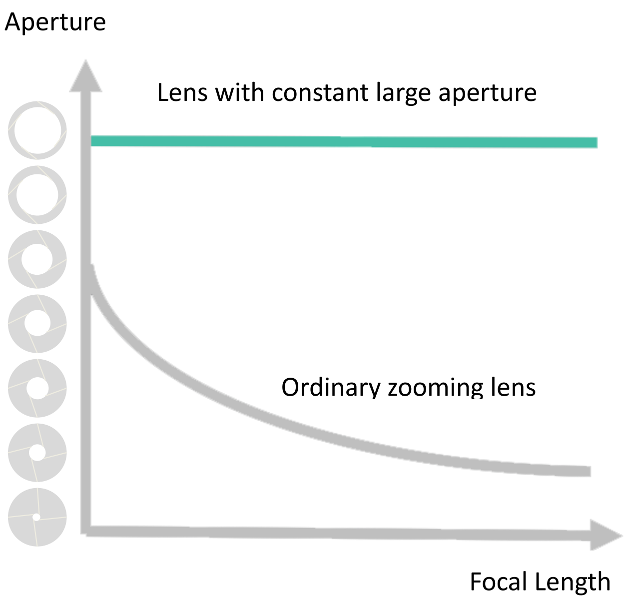


Figure 7 Aperture Change of Lenses with Different Focal Lengths

2.2.3 High-Transmittance Lens

The IPC lens is not a simple lens, but is essentially composed of multiple lenses. When light shines onto the lenses, not all of the light can pass through the lenses and finally form the image on the sensors. UNV special lenses have flux that is at least 15% higher than that of ordinary lenses. In low-illumination environment, the flux of UNV lenses is increased by 36% compared with that of ordinary lenses. When more light forms the image on the sensors, the image is brighter. Under the same illumination conditions, UNV lenses boast higher light transmittance and brighter images.

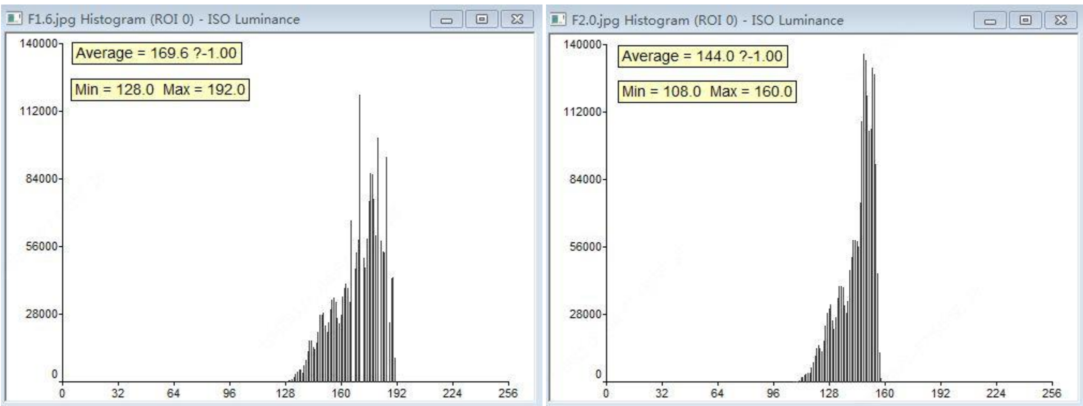


Figure 8 Measured Flux of UNV Lens (Left) and Ordinary Lens (Right)

2.2.4 Super High Imaging Uniformity

Ideally, the image formed on a sensor by light transmitted through a lens should be uniform and clear.

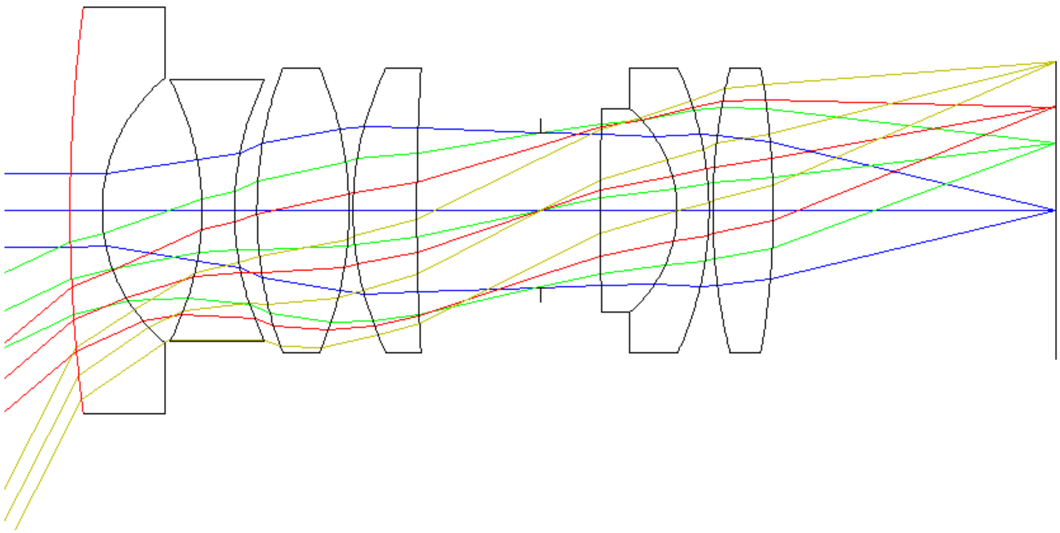


Figure 9 Optical Path of a 3.6mm Lens

In practice, the lens resolution may not be up to standard, resulting in uneven imaging because of problems such as lens installation tilting, poor fusion of lens, oversize thickness of lens, and too large outer diameter of lens. In addition, poor assembly can lead to tilt optical axis of the optical system. That is, the optical axis of the lens is not perpendicular to the effective imaging surface of the sensor, resulting in a blurry corner or half of the image.

Simply speaking, the optical axis of the lens does not coincide with the vertical direction of the sensor's photosensitive surface. These problems will impair corner definition of the image. Uneven imaging will seriously affect the image effect, especially in low-illumination environment.

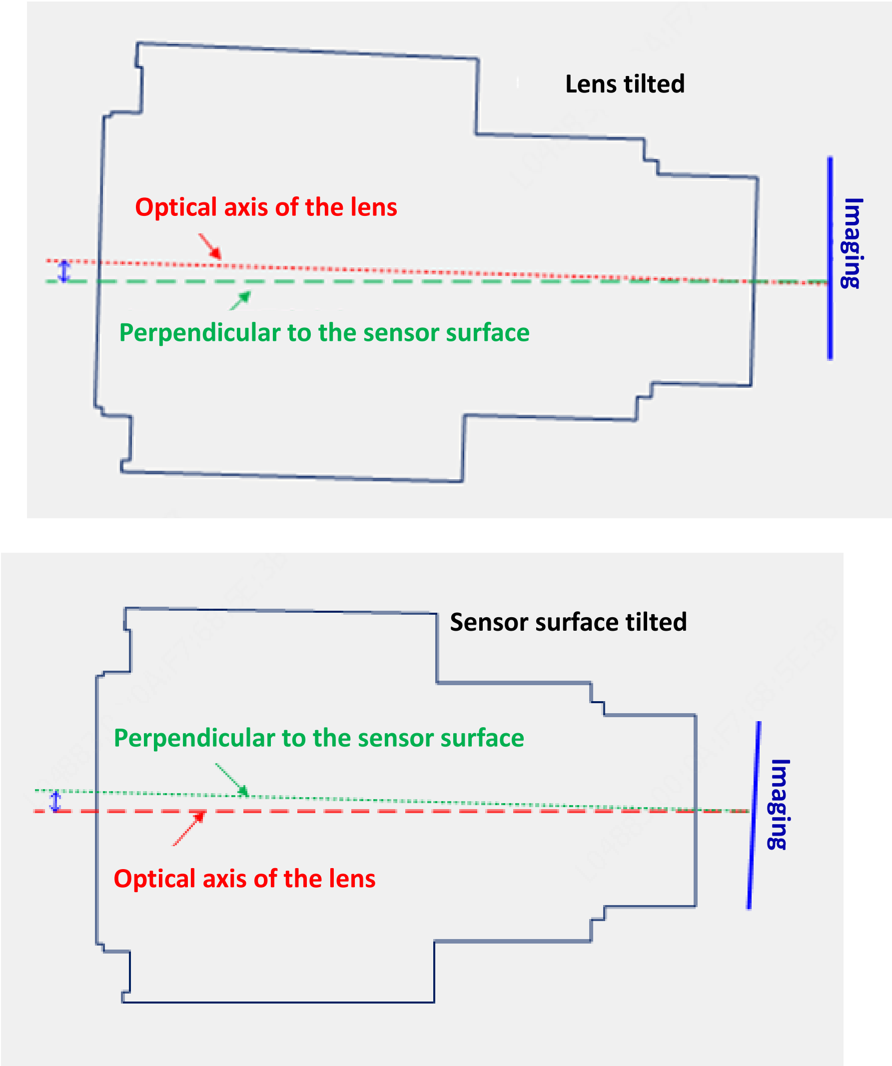


Figure 10 Optical Axis Tilted

Based on the root causes of image unevenness, UNV LightHunter IPCs analyze factors that cause optical axis tilting, optimize the optical axis of the lens, accurately adjust the perpendicularity of the lens base, and optimize the flatness of the sensor board to achieve resolution uniformity of the overall image by technical innovation.

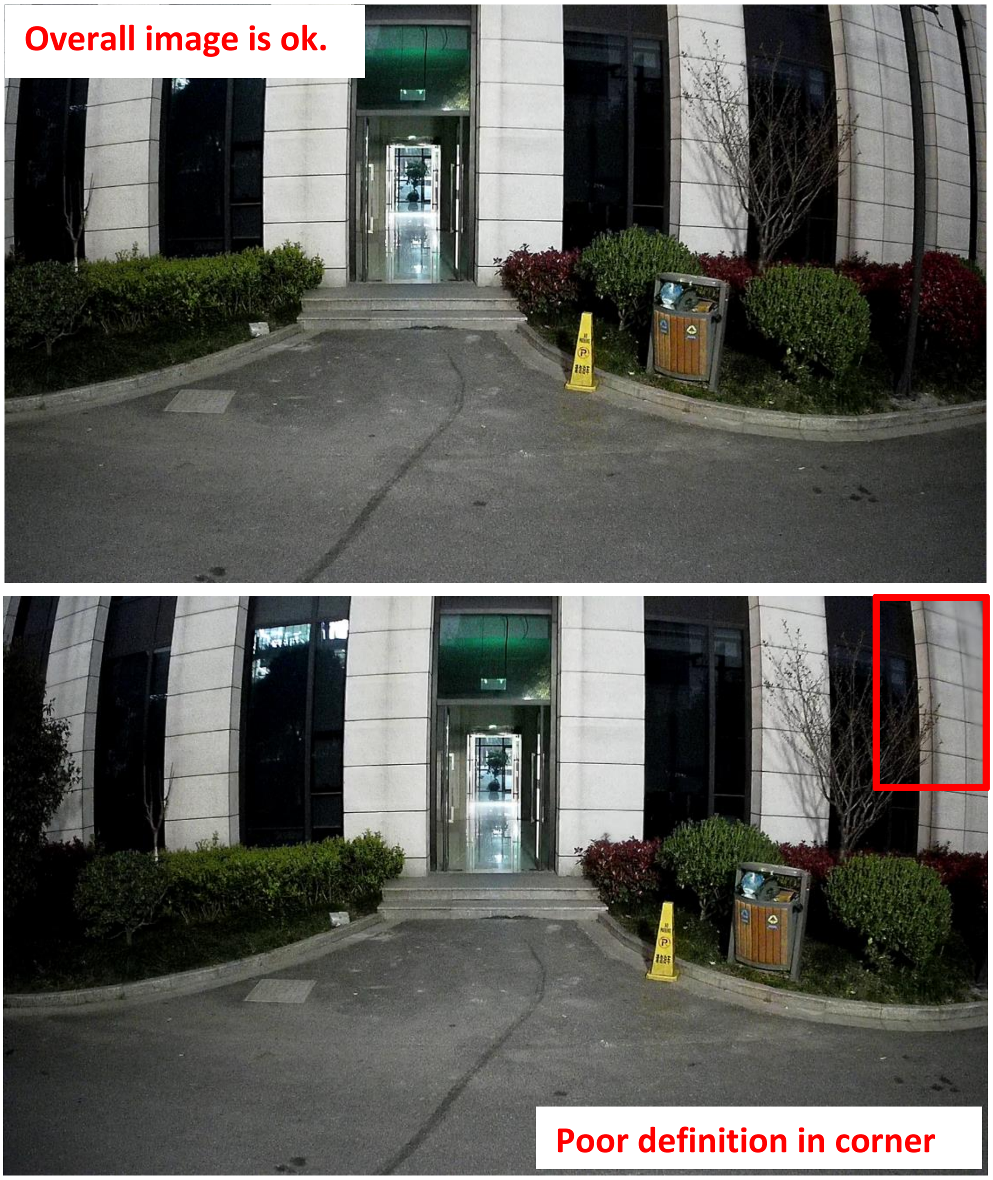


Figure 11 Image Uniformity

2.2.5 Anti-Reflection Coating

Generally, IPC lenses are made of glass or plastic. If they are not specially processed, the lens surface will reflect about 5% of the incident light. If the incident light is strong, the light will be reflected multiple times by other lenses inside the IPC, resulting in flare. The main reason of flare is that in the target area, there is a light source that is obviously brighter than the surrounding environment.

Figure 12 Flare

To solve this problem, Uniview applies an anti-reflection (AR) coating to lenses using the SMC technology. The AR coating improves the transmittance by reducing the reflectivity. Ordinary glass has a unilateral reflectivity about 4% and a total spectral reflectivity about 8% in the visible light range. If a high-quality glass is processed on one side or both sides, its reflectivity is reduced to less than 1% compared with ordinary glass. With the light loss reduced, flare and glare are effectively suppressed. The AR coating also helps improve definition and transparency of images.

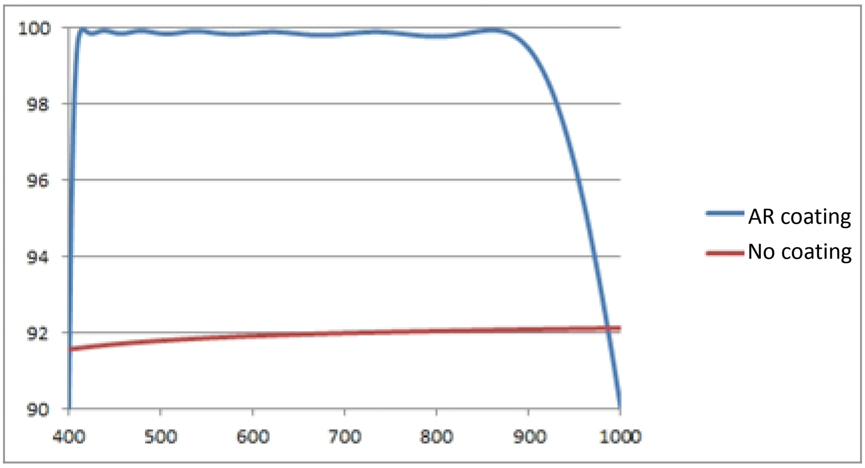


Figure 13 Transmittance Before and After AR Coating

2.3 U-ISP Image Processing Technology

2.3.1 Multidimensional Noise Reduction

UNV new-generation time domain noise reduction (TDNR) algorithm and multidimensional sharpness enhancement (MDSE) algorithm improve image definition and brightness, enabling mobile objects to be clear in low-illumination environment and effectively reducing blur during object moving to ensure that the image is restored to the true scene.

1. TDNR algorithm

The TDNR technology is a noise reduction method based on motion compensation. For the monitoring system, 25fps means that 25 pictures are generated in one second. For a moving object, the content of two adjacent frames does not have great displacement in the monitoring range. That is, adjacent frames have self similarity.

The similarity between the image blocks of the current frame and the image blocks of the previous frame in the same position is calculated to find out the most similar image blocks. Then, the average weight is finally determined according to the similarity of the most similar image blocks and the noise characteristic of the sensor, thereby smoothing the image blocks or pixels of the current frame and suppressing noise.

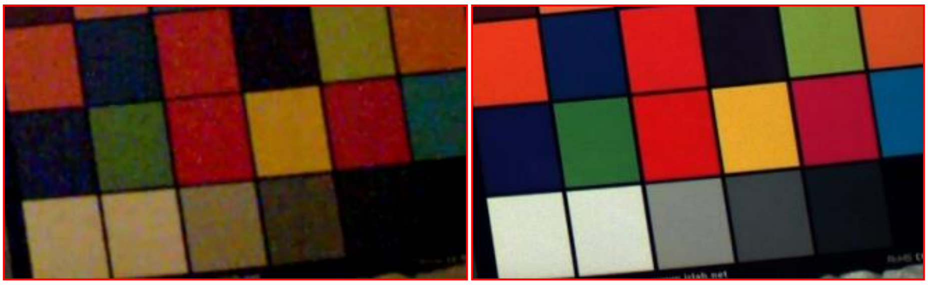


Figure 14 Noise: Ordinary IPC (Left) vs. UNV LightHunter (Right)

2. MDSE algorithm

Adjust the sharpenD and sharpenUD values to sharpen the directional edges and the non-directional detail texture. Adjust the SharpenEdge value to control the sharpening intensity within a reasonable range. Finally, adjust the EdgeSmoothThr and EdgeSmoothSlope values to suppress the edge burrs and make the image clearer.

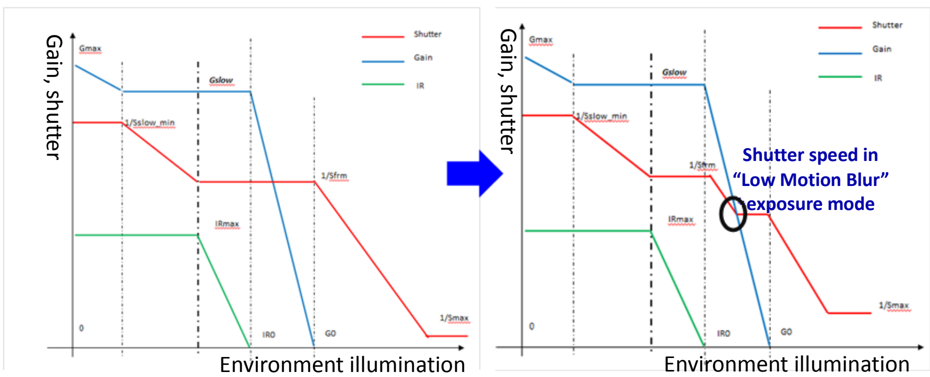
Figure 15 Sharpness: Ordinary IPC (Left) vs. UNV LightHunter (Right)

3. Low-blur technology

On the basis of the original automatic exposure, add an exposure curve, keep the shutter speed at 1/100 under a specified gain, and set corresponding shutter thresholds for shutter switching.

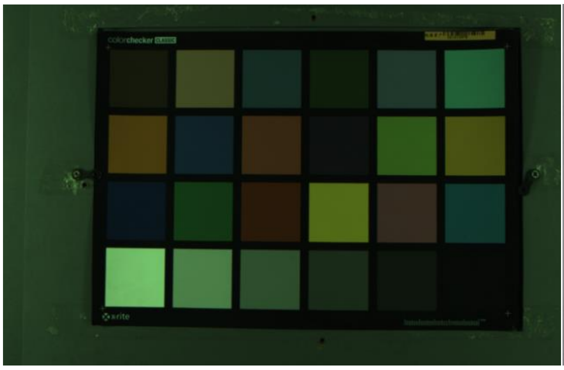
If the shutter speed is 1/100, set two thresholds to control the shutter switching point: Gmax*65% and Gmax*55%. If the shutter speed is faster than 1/100, set three thresholds to control the shutter switching point: Gmax*75%, Gmax*65%, and Gmax*55%.

By combining the previous thresholds with the image characteristics of different sensors, debug to include specific low-blur parameters.



2.3.2 Color Restoration

In low-illumination environment, IPCs cannot obtain enough color information, which results in color distortion. UNV IPCs analyze live view based on the intelligent image recognition algorithm, and adjust gain and other image parameters to achieve color restoration.

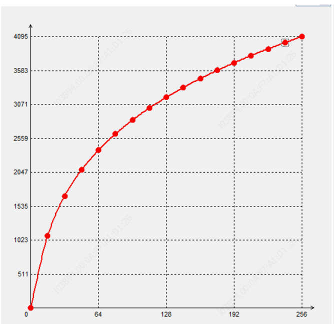


Color Distortion

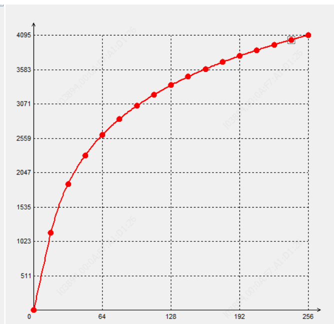
Color Restoration

2.3.3 Intelligent Gamma Adaption

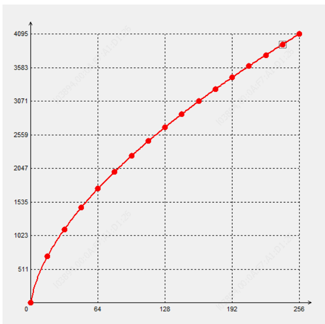
Ordinary IPC sensors have linear I/O during photoelectric signal transmission, but human eye's perception of light is nonlinear. UNV LightHunter IPCs obtain image signals that are similar to those perceived by human eyes through non-linear adjustment of the Gamma curve. Moreover, with the smart Gamma adaption technology, UNV IPCs intelligently adjust the Gamma curve to adapt to different illumination parameters, and smoothly switch to a Gamma curve (from the Gamma curve library) that best fits the current scene, so that they can get more image details in low-illumination environment.



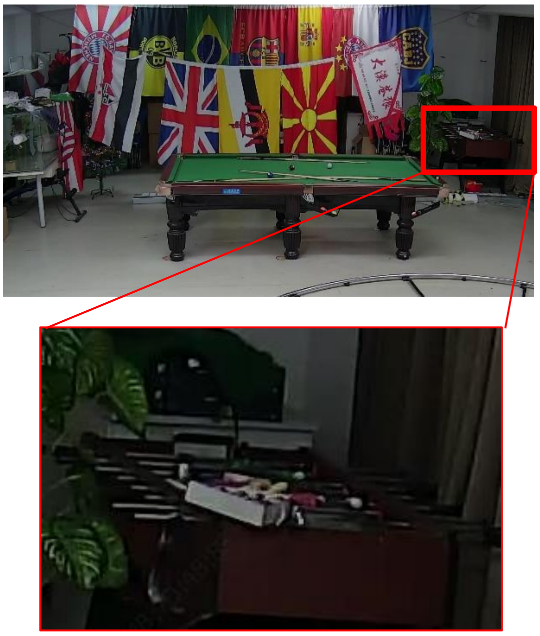
Gamma A



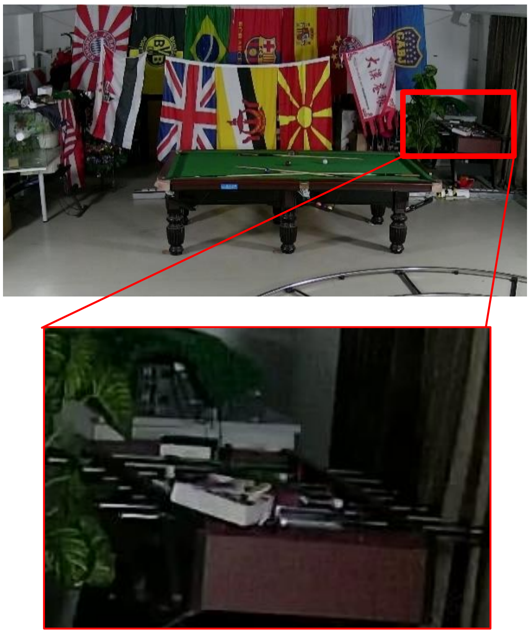
Gamma B



Gamma C



Scene 1: Adapt to Gamma A

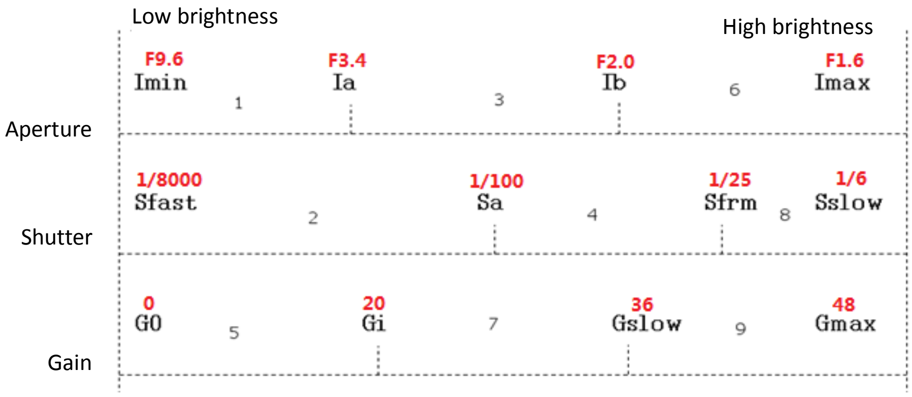


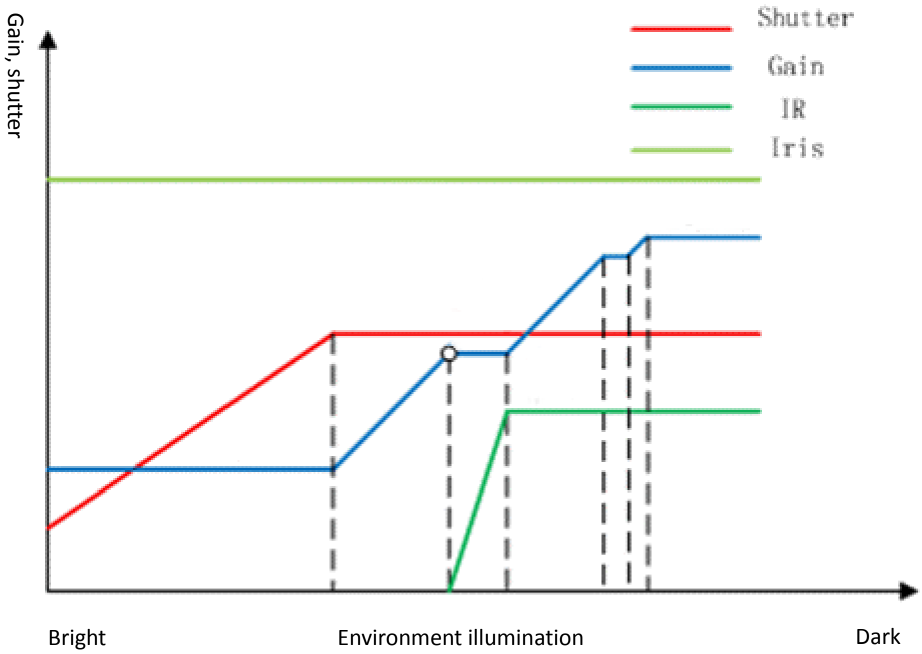
Scene 2: Adapt to Gamma B

Scene 3: Adapt to Gamma C

2.3.4 Intelligent Exposure Policy

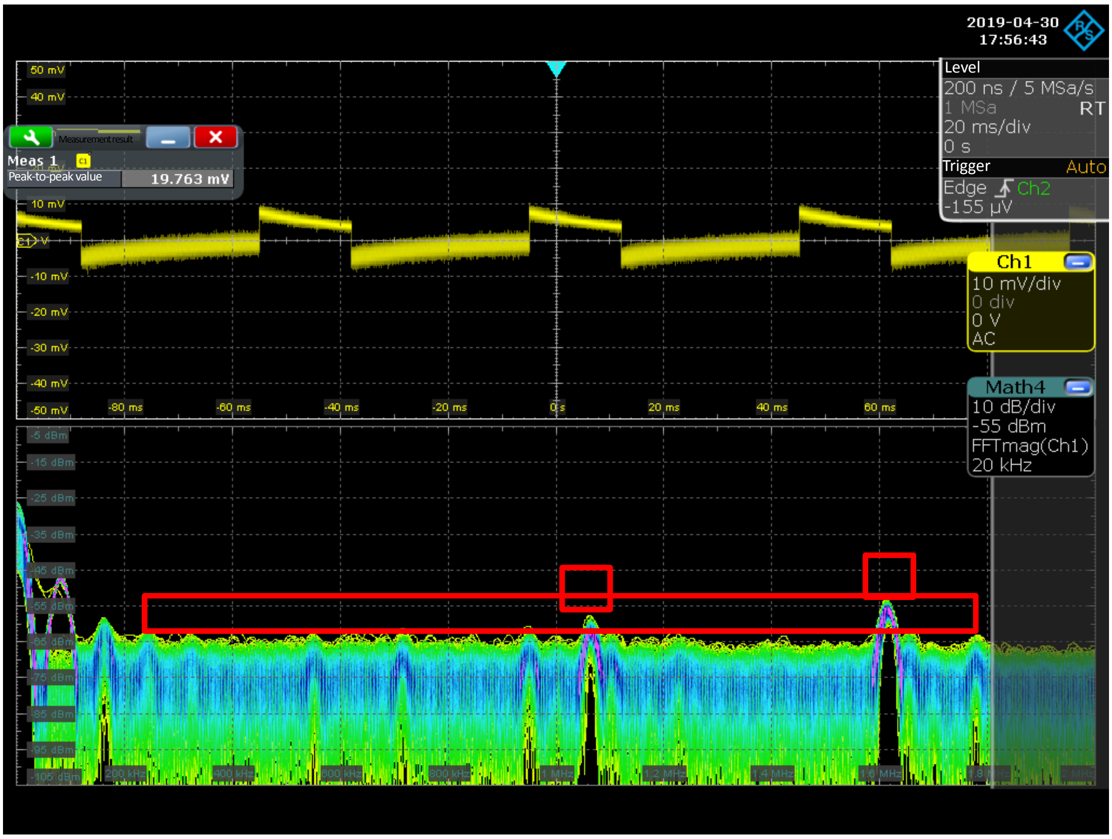
Exposure is an important factor that affects image quality, especially in low-illumination environment. Many parameters affect exposure, including shutter, aperture, and gain. According to the UNV intelligent exposure policy, sensor a/d gain and dsp dgain parameters are adapted accurately to different shutter parameters based on different illumination conditions to ensure image brightness and minimize the impact on image quality.



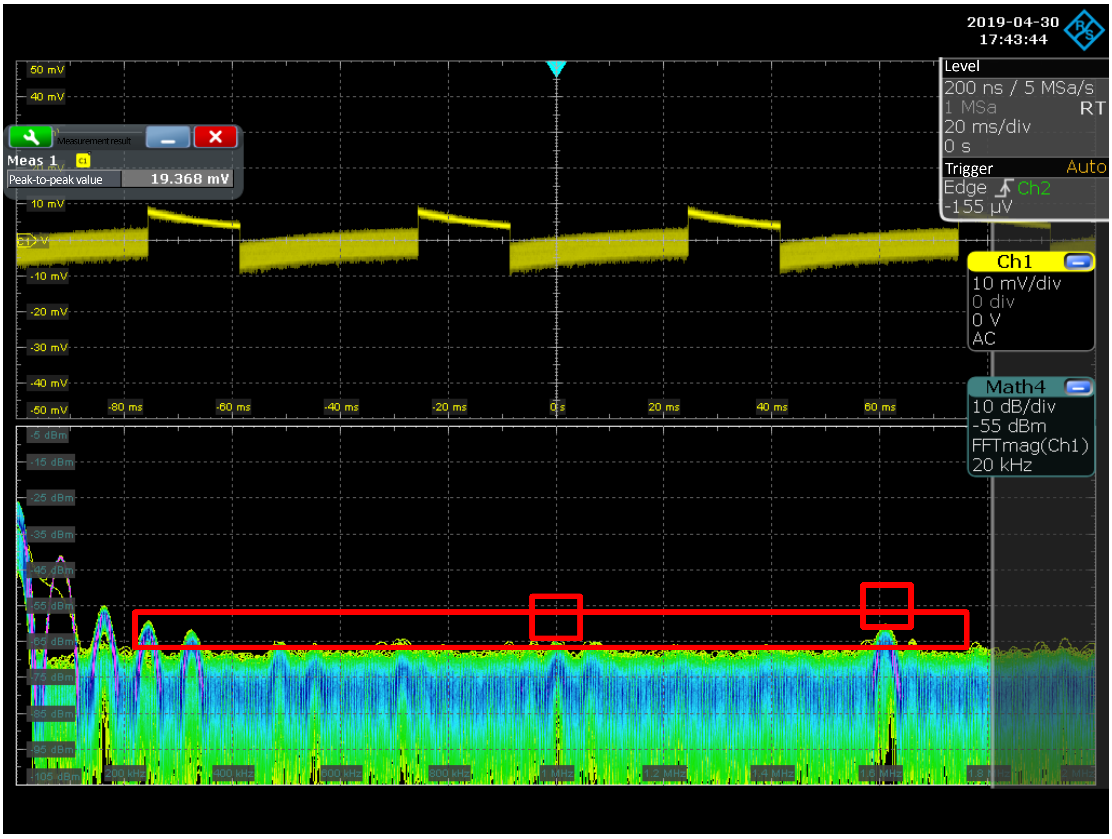


2.4 Circuit Noise Reduction

UNV IPCs also use the low dropout regulator (LDO) noise suppression technology. According to this technology, a resistor is serialized to a benchmarking voltage, and a capacitor is added to constitute a first-order low-pass filter of the benchmarking voltage. With this technology, the power noise on sensors is suppressed in normal environment, and noiseless image signals are obtained in low-noise environment. This technology also avoids analog/digital noise interference by reducing the impact of random noise.



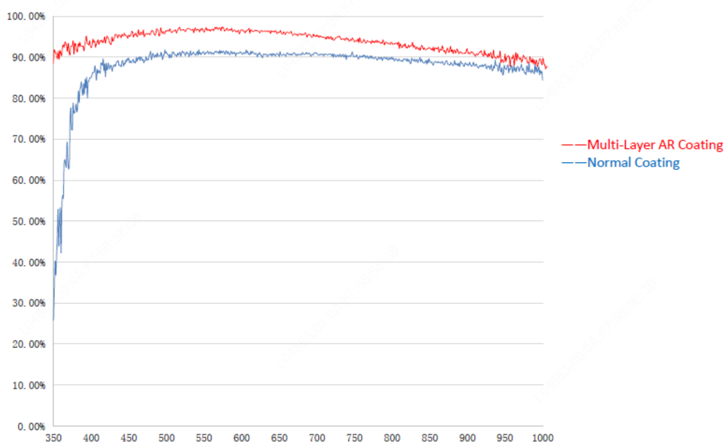
Before Noise Reduction



After Noise Reduction

2.5 High-Transmittance Cover

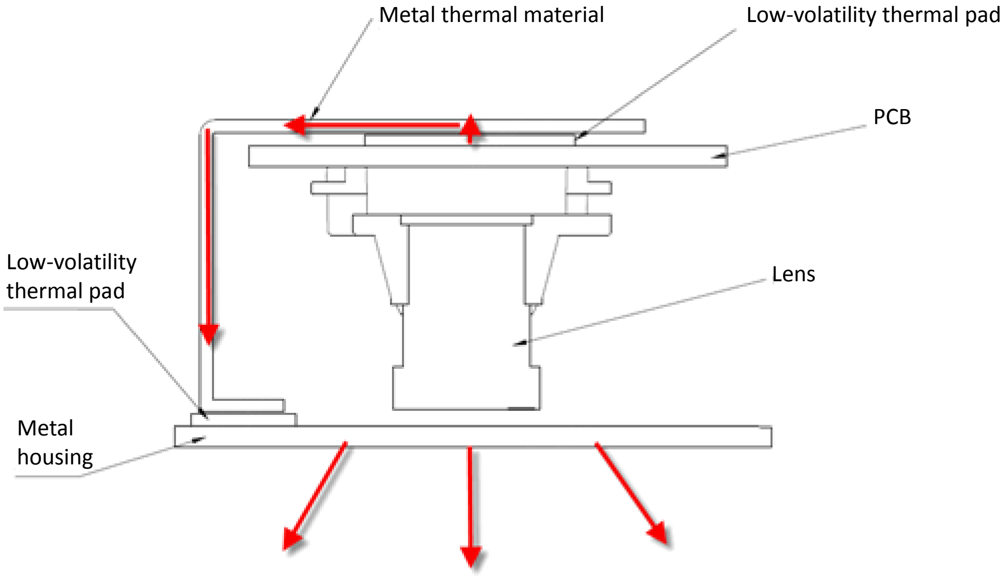
Except for the high transmittance lens, the front transparent glass of UNV IPSs also adopts high transmittance materials. Irrespective of the changes of illumination, LightHunter remains a high transmittance to ensure images of higher quality. In low-illumination environment, a stable and high transmittance can ensure a bright image.



Horizontal axis: wavelength; vertical axis: transmittance

2.6 Unique Cooling Structure of Sensor

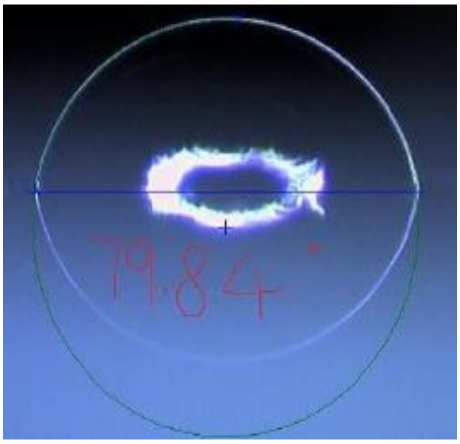
Sensor temperature significantly affects image quality. When the sensor temperature is increased excessively, the image noise is increased as well, which affects the night vision of IPCs. To obtain high image quality, Uniview uses integrated cooling structure for sensors, which delivers IPC heat to the front glass surface die cast through the low-volatility thermal pad to directly dissipate the heat. This structure improves the sensor temperature lowering by 7°C, which effectively reduces image noise caused by sensor temperature rise and ensures the night vision of IPCs.



2.7 Airtight Design

In outdoor rainy environment, the IPC glass window easily gets attached by water droplets, affecting the screen, and the water vapor easily enters the IPC, causing the window to fog. UNV LightHunter IPCs are made of materials imported from Switzerland and adopt a design scheme that effectively suppresses moisture in the hardware structure. Bolts are designed outside the waterproof ring to prevent the water vapor from entering the IPCs through the bolts and avoid the dome housing from fogging. The unique hardware structure design of UNV IPCs allows a large contact angle of water droplets to the glass window, ensuring that the water droplets drop easily.

LightHunter Contact Angle (114.35°)
of Water Droplet



Ordinary IPC Contact Angle (79.84°)
of Water Droplet

3. Actual Application and Effect

The LightHunter technology has been applied to all forms of UNV IPCs, meeting the monitoring requirements of customers for high quality image effects in low-illumination environment. The UNV LightHunter series IPCs can be used in schools, plazas, parking lots, shopping malls, airports, hotels, hospitals or any low-illumination scenes that customers need.

Scene 1: Park

Photos Taken with iPhone X [Left] and LightHunter Camera [Right]

Scene 2: Street

Photos Taken with iPhone X [Left] and LightHunter Camera [Right]

Scene 3: Shopping Mall

Photos Taken with iPhone X [Left] and LightHunter Camera [Right]

4. Summary

In terms of hardware, UNV LightHunter IPCs enhance the brightness of the images in low-illumination environment by increasing the sensor target surface, sensor photosensibility, lens aperture and transmittance and optimizing the hardware structure. In terms of software, UNV LightHunter IPCs guarantee image quality in low-illumination environment by using the intelligent U-ISP technology. With the support of both the software and hardware technologies, UNV LightHunter IPCs are the most competitive products to meet the monitoring requirement in low-illumination environment.