

WHITE PAPER

In search of better visibility

i-PRO visibility enhancement technologies



Table of contents

1. Introduction	3
2. Environmental factors against visibility	3
3. i-PRO's approach to better visibility	4
4. Camera visibility improvement technologies	6
5. Visibility Enhancement Software	12
6. Conclusion	14



1. Introduction

Nature has given severe challenges to video surveillance. While indoor lighting may have a not-so-wide dynamic range, natural light such as direct sunlight causes difficult lighting conditions. Adverse weather conditions such as snow and rain may also cause poor visibility. In low visibility, it is difficult for security personnel to identify suspicious objects and movements, or to monitor road traffic conditions and rail infrastructure. But the great need exists for reliable surveillance and remote monitoring in these challenging conditions.

Based on over fifty years of experience in the video surveillance industry, i-PRO has developed a series of leading-edge technologies that delivers clear images even in these challenging conditions. This document presents an overview of i-PRO's visibility enhancement technologies which provide better video surveillance.

2. Environmental factors against visibility

Many natural scenes have complex lighting conditions such as bright daylight, hazy twilight, the dark of night, high contrast scenes where there are very bright and very dark areas, and backlight situations typically where a person is in front of a bright entrance. Due to the lack of dynamic range of camera's image sensor, visibility is reduced in high contrast scenes, backlight situations and poor lighting conditions..

Weather affects the image quality in outdoor surveillances. Droplets on the dome cover and condensation inside the housing may reduce image quality. Falling snow and rain greatly reduce visibility, because snowflakes and droplets in the air obscure targets to be observed and reduce contrast by scattering the light caused by reflection on them. Fog, mist, haze, smoke, dust and sandstorms, which are composed of smaller droplets or particles than snow and rain, have an impact on visibility, making images white and blurred by scattering light.

3. i-PRO's approach to better visibility

i-PRO provides two types of solutions for better visibility; one is a suite of software and hardware technologies incorporated in the cameras. Another one is the software which runs on a PC where a large computing power is required.

3.1 Camera visibility improvement technologies

It is crucial that cameras deliver clear images at any time. It makes not only surveillance more reliable, effective and efficient but also surveillance system more flexible, scalable and cost-effective, eliminating the need for image processing on each server, monitor and recorder.

i-PRO cameras incorporate a suite of advanced software and hardware technologies as well as a high-sensitive image sensor to provide excellent image quality. Some examples; Rain-wash coating improves the visibility in rainy weather by hydrophilic coating on the dome cover. Built-in dehumidification unit prevents condensation inside the housing. A suite of real-time image processing technologies such as Super Dynamic, noise reductions and fog compensation result in better visibility. The details are described in the next chapter.

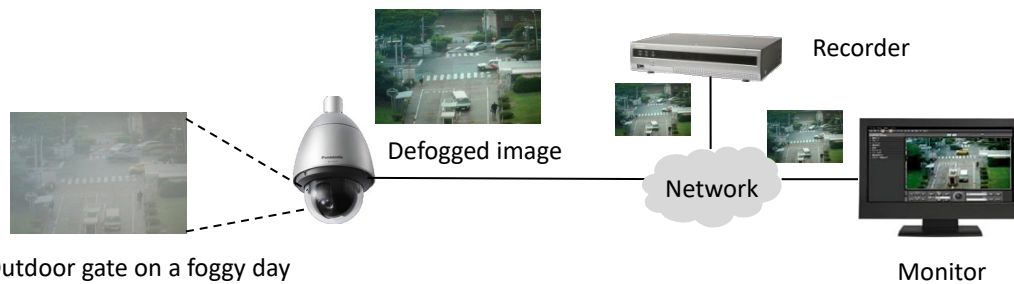


Figure 1: Example of visibility improvement on the camera. Images are defogged on the camera and distributed to the monitor and recorder.

3.2. Visibility Enhancement Software

Snowflakes in the air obscure objects but it is possible to see objects through a certain degree of snow. Because snowflakes are moving, a camera can capture the object behind snowflakes little by little. By picking up small fractions of the object from a series of images and putting together into one picture, the object becomes visible to the human eye.

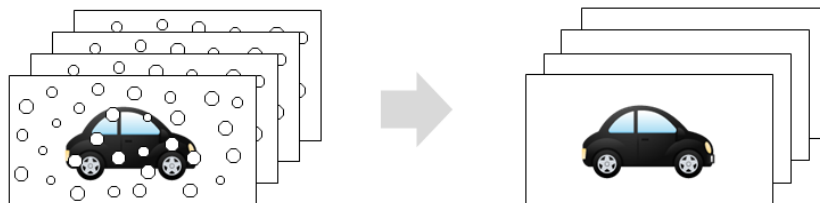


Figure 2: Above Illustration shows a concept of i-PRO Visibility Enhancement Software. A car behind snowflakes becomes visible by piling fractions from a series of images.

i-PRO

Combining GPU-accelerated computing and new high-speed image processing algorithms, i-PRO has developed Visibility Enhancement Software. Applied to live and recorded video streams captured in poor visibility conditions, i-PRO Visibility Enhancement Software delivers clear moving images on a real-time basis without losing important details such as color, contrast and movements.

i-PRO Visibility Enhancement Software is provided as easy-to-use extension software of the WV-ASM200 i-Pro Management Software.



Figure 3: System configuration example of i-PRO Visibility Enhancement Software.

What is GPU-accelerated computing?

GPU-accelerated computing is a cost-effective technology to accelerate scientific and engineering applications. A graphics processing unit (GPU) has thousands of cores to process parallel workloads simultaneously, while a CPU has some. GPU-accelerated computing offers high-speed computing by offloading CPU-intensive portions of the application to the GPU. From a user's perspective, applications simply run significantly faster.

4. Camera visibility improvement technologies

This chapter describes the major software and hardware technologies of i-PRO cameras to deliver better visibility and image quality.

4.1 Enhanced Super Dynamic / Super Dynamic

There are many difficult lighting conditions in video surveillance. One typical challenging situation is high contrast scene where there are very bright and dark areas. Super Dynamic enables clear identification in both bright and dark areas in high contrast scenes. It is one of key technologies of i-PRO cameras because high contrast scenes are commonly found in video surveillance application. Super Dynamic captures multiple images with short and long exposures. The short exposure captures the bright areas well and the long exposure captures the dark areas well. Super Dynamic combines them into one frame and results in clear images.

Enhanced Super Dynamic is a latest Super Dynamic technology that delivers a wider dynamic range of 133dB. Variable exposure and shutter speed control is introduced to capture both bright and dark areas more clearly.

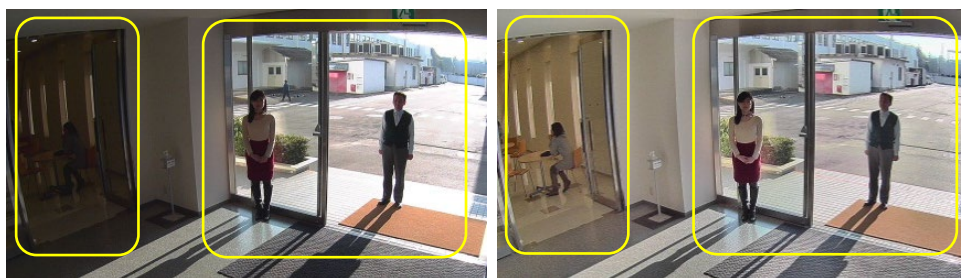


Figure 4: Entrance in backlight situation. At left, two persons are buried in black. At right, Enhanced Super Dynamic is on. Two persons at the entrance and one person at the left table can be seen clearly.

4.2 Adaptive Black Stretch (ABS)

It is hard to see into a dark area through the camera. Adaptive Black Stretch (ABS) enables clear identification of people and objects in the dark areas by compensating the signal level automatically. ABS is also incorporated in Enhanced Super Dynamic.

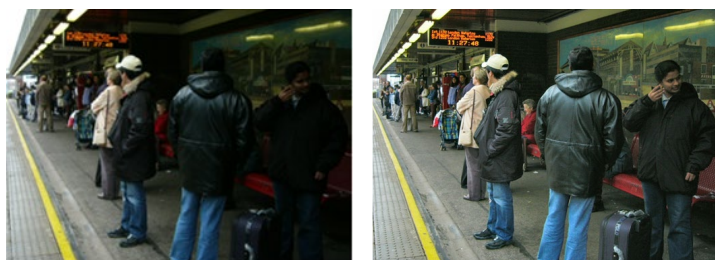


Figure 5: Bus stop. At left, ABS is off. At right, ABS is on and persons and objects in the dark area are seen clearly.

4.3 Face Super Dynamic

It is hard to identify a person who is in front of a bright place such as entrance or window. Combining Super Dynamic and face detection technology, Face Super Dynamic enables clear and easy identification of the person in backlight situation.



Figure 6: Person in front of a bright window. At left, the face cannot be identified. At right, Face Super Dynamic is on and his face is identifiable.

4.4 Multi-process Noise Reduction (MNR) / Digital Noise Reduction (DNR)

As the gain level is increased to amplify the video signal in poor light conditions, it causes a grainy video. With the high-sensitivity image sensor, Multi-process Noise Reduction (MNR) and/or Digital Noise Reduction (DNR) deliver clear color image, reducing the visual noise in low lighting conditions.



Figure 7: Shed during the night. The Full HD picture was taken with illumination of 0.04lux in the absence of nearby light. Noise is removed from the image.

4.5 Super Chroma Compensation (SCC)

The color of images is discolored in poor lighting conditions, because built-in infrared (IR) cut filter is removed to increase light sensitivity. Super Chroma Compensation (SCC) recovers the original color of objects by digital image processing.

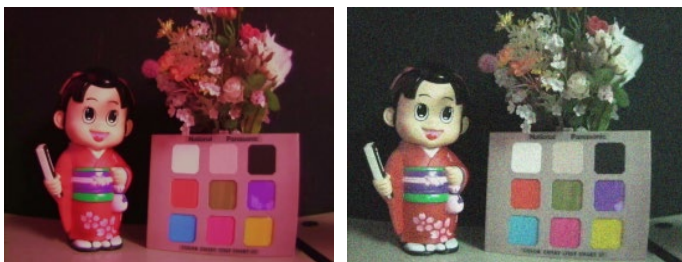


Figure 8: At left, built-in IR cut filter is removed and image is discolored in poor lighting condition. At right, the original color is recovered by Super Chroma Compensation (SCC).

4.6 Full HD / HD at 60fps

Combining Full HD 1080p / HD 720p resolution and 60fps high frame rate, the latest i-PRO network cameras enable easy and clear identification of rapid moving objects such as people moving chips and cards in casino, and a vehicle plate on the road.



Figure 9: Roulette table.

4.7 Fog compensation

Fog compensation is a digital image processing on the camera, which delivers clear images in the conditions such as fog, haze, smoke, smog, dust and sandstorms..

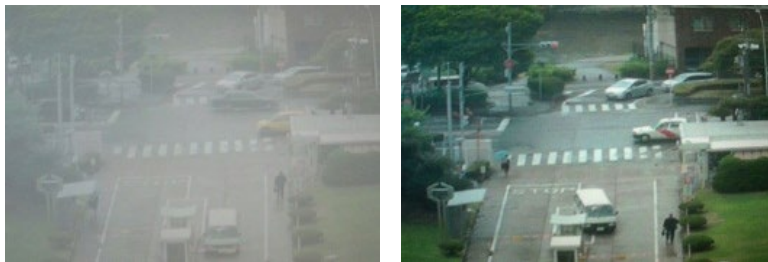


Figure 10: Outdoor gate on a foggy day. The picture on the left is taken on a foggy day with the Fog compensation off. The picture on the right is the same scene taken with the Fog compensation on and visibility is improved.

4.8 High Light Compensation (HLC)

Strong lights like headlight reduce visibility in low light scenes. High Light Compensation (HLC) enables clear identification in the areas next to bright spots, compensating for brightness overpowered by excessive light.



Figure 11: Vehicle front. At left, HLC is off. At left, High Light Compensation (HLC) suppresses excessive light and vehicle plate can be seen.

4.9 Smart DoF

Depth of field (DoF) is the distance between the nearest and farthest objects in a scene that appear acceptably sharp in an image. Video surveillance requires wide DoF to capture both near

and far objects clearly, while usual photographs use shallow DoF to emphasize a particular subject in the scene. Smart DoF keeps wide DoF, optimizing fine iris opening and focus.



Figure 12: Example of Smart DoF. Nearby cards and distant buildings are captured clearly.

4.10 Auto Back Focus (ABF)

Every time the camera changes the mode between day and night, it gets slightly out of focus with or without the IR-cut filter. Auto Back Focus (ABF) keeps fine focus all the day, adjusting precise image sensor position automatically and promptly. ABF also streamlines field installation and maintenance works, enabling remote focus adjustment.



Figure 13: At left, before running ABF. At right, focus is adjusted by ABF.

4.11 Lens Distortion Compensation (LDC)

With a rapid market penetration of Full HD / HD cameras that can capture the larger areas than traditional cameras, wide angle of view lenses are getting popular. Barrel distortion appears in wide-angle lens. The distorted images may affect not only visibility but also the recognition rate of Intelligent Video (IV) such as face recognition. Lens Distortion Compensation (LDC) recovers clear images by digital image processing.

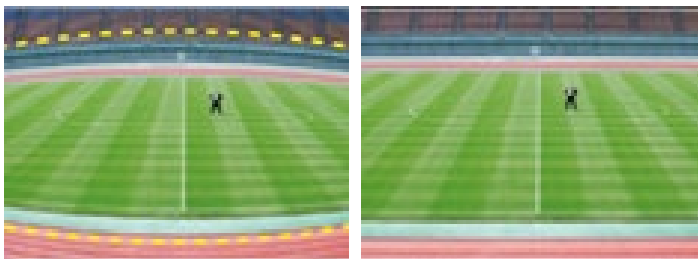


Figure 14: Stadium. At left, the image captured with wide-angle lens is distorted. At right, barrel distortion is removed by Lens Distortion Compensation (LDC).

4.12 Intelligent Resolution technology

With the Intelligent Resolution technology, the latest i-PRO network cameras deliver clear 3 Mega-pixel images. Three areas – outlines, detailed texture areas and soft gradation areas – are automatically detected. Apart from the uniform enhancement of sharpness, the innovative technology Intelligent Resolution precisely performs signal processing pixel by pixel in the most effective way according to the area. As a result, images are naturally clear and crisp.



Figure 15: Cropped images with and without Intelligent Resolution technology. At right, the details are produced clearly by Intelligent Resolution Technology.

4.13 Auto Image Stabilizer

Auto Image Stabilizer is an electronic image stabilizer which reduces the negative impact brought by vibrations and swings caused by trailers, trains, machinery, strong winds and storms.



Figure 16: Free-way. At left, the image is blurred by vibration from the road. At right, Auto Image Stabilizer is on and eliminates the vibration effects.

4.14 Rain-wash coating

Water droplets on the dome cover reduce visibility, distorting light by lens effect. The hydrophilic Rain-wash coating improves visibility in rainy weather, by sheeting water off instead of forming droplets that scatter light.



Figure 17: Airport on a rainy day. The left half of the dome cover is coated with Rain-Wash coating and the image is clear. For comparison, the right half is not coated.

4.15 Built-in dehumidification unit

As well as droplets described above, condensation inside the dome of the camera reduces visibility. Built-in electric anti-humidity unit keeps the camera dry inside and prevents condensation on the cover and lens. This electrolysis-based technology is safe and green because heaters and fans are not used.

4.16 Auto Eye lid Mechanism (AEM)

With the conventional PTZ dome camera, the image becomes blurred when the PTZ camera tilted above the horizontal position due to the small curvature difference between the lower spherical part and upper cylindrical part of the dome. Auto Eyelid Mechanism (AEM) keeps the image clear even above horizontal viewing angle. As the PTZ camera tilts upward, a built-in light shield cuts the unwanted light accordingly and results in clear images..

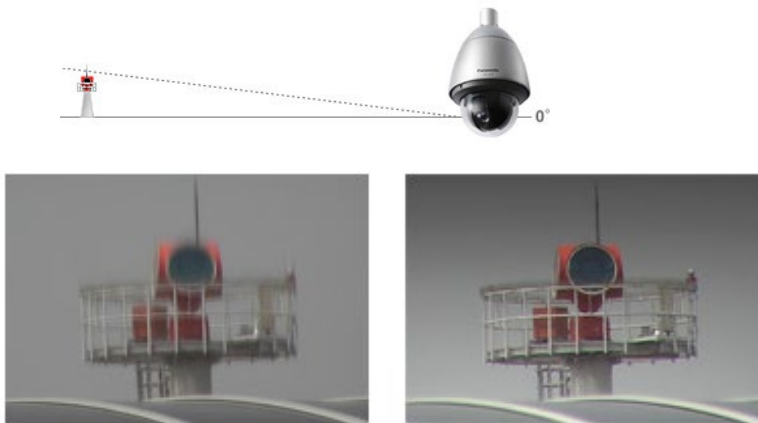


Figure 18: Control tower at the airport. The control tower is positioned higher than the camera installed on the ground level. At left, the image was captured without AEM. At right, AEM was working and the image is clear.

4.17 Built-in infrared (IR) LED

Infrared illumination is an option for low light or complete dark conditions. Some i-PRO cameras have built-in infrared (IR) LED designed to illuminate full view evenly without diffused reflection on the dome cover.



Figure 19: Built-in infrared (IR) camera captures clear images in the dark.

5. Visibility Enhancement Software

With a large processing power of GPU computing and the sophisticated image processing software, i-PRO Visibility Enhancement Software improves the quality of images taken in lower visibility conditions such as snow, heavy rain, thicker fog and others. i-PRO Visibility Enhancement Software also works well for difficult lighting conditions. Applied to live or recorded video streams, it produces clear moving images in real time.

Compared to other technologies like infrared (IR) and/or thermal cameras that capture objects in black and white, i-PRO Visibility Enhancement Software keeps details such as color, contrast and background, which helps security personnel grasp the situation quickly. It is ideal for outdoor video surveillance and remote monitoring where clear images are required for a safe and smooth operation, such as public, perimeter and parking lots surveillance and road, rail, harbor and airport traffic monitoring and others.

5.1 On a snowy and rainy day

The example below demonstrates the effectiveness of i-PRO Visibility Enhancement Software against snowy weather. The picture on the left was taken on a snowy day. Objects are barely seen in the picture due to the heavy snow. The picture on the right is the same scene that is processed through i-PRO Visibility Enhancement Software. Snow disappears. The vehicles, road surface condition, the green signal and persons on the left shoulder can be seen clearly.



Figure 20: Road on a snowy day. At left, there is almost zero visibility due to heavy snow. At right, the visibility is greatly improved by i-PRO Visibility Enhancement Software.

5.2 On a foggy day

i-PRO Visibility Enhancement Software improves the visibility that is made blurred by thick fog, mist, haze, smoke, dust and sandstorms. By using more sophisticated image processing with a large computing power than the camera, it delivers clear images in a thick fog.

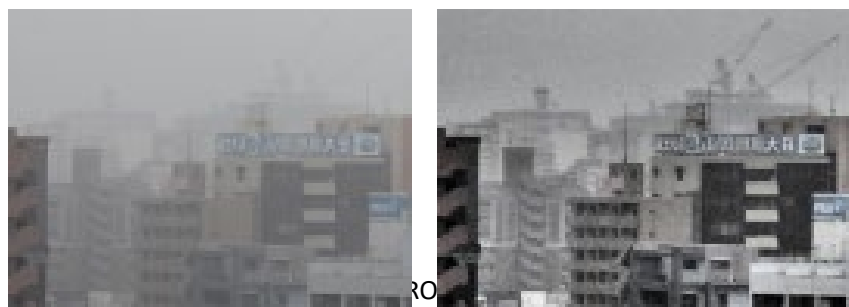


Figure 21: Buildings on a foggy day. At left, thick fog reduces visibility. At right, the image is processed through i-PRO Visibility Enhancement Software. The visibility is improved and the distant objects like cranes become visible.

5.3 In difficult lighting conditions

i-PRO Visibility Enhancement Software enables clear and easy identification in difficult lighting conditions such as high contrast scenes and low lighting conditions. By using proprietary tonal correction and multi-frame noise reduction with a large computing power, it produces photo-realistic images.



Figure 22: Garage on a sunny day.

Top: The image was taken on a sunny day without any image compensation. Details inside the garage are lost.



Middle: The top image was compensated by a conventional image correction. While inside the garage becomes visible, the bright area at the bottom part is white out under the sun light.



Bottom: The top image is processed through i-PRO Visibility Enhancement Software. The objects inside the garage, the car and ground surface condition are identified clearly.

(Note: The vehicle plates in the pictures are masked to protect privacy.)



6. Conclusion

As described in this document, i-PRO provides comprehensive visibility enhancement technologies to deliver clear images in various challenging conditions. Each technology has a different advantage. Please choose suitable features for your needs and make use of them with proper settings to deliver good performance.

We hope this document has been helpful in getting more understanding why i-PRO image quality is superior. For more information about i-PRO video surveillance cameras and solutions, please visit us at <https://i-pro.com/global/en/surveillance>



About i-PRO Co., Ltd

i-PRO offers everything from development and manufacturing to sales, implementation and maintenance. By leveraging the full capabilities of this comprehensive enterprise to resolve customer problems and provide countermeasures, the new company is able to reinforce customer competitiveness while developing and expanding customer potential.

Our system proposals are based on our vast accumulation of image processing and communication technologies, backed by manufacturing knowhow, a versatile product range and IP expertise



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