

Smart Coding Technology

i-PRO Video surveillance systems

Vol.2



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1. Introduction

Advancements in video surveillance techniques since the launch of IP cameras have seen many technological advances that have delivered increased resolution and improved picture quality through better lenses, sensor and image processing technology. These advancements are capable of bringing much needed improvements in evidential image quality and enable the user to realize the investment made in CCTV through deliverable results in terms of clear identification.

Delivering these advancements requires additional design thinking in terms of total bit rate throughput. Typically higher resolutions FHD & 4K require much greater bandwidths that impact on the design and cost of both the network to stream high definition images across and the recording hard drive capacity needed to store them on. System designers now not only need to think in terms of the angle of view or depth of field that a camera needs to produce but also to think of the content within the camera image in terms of what is useful and what is not. For example streaming and recording scenes in high definition of empty streets devoid of movement, people or cars, or the skyline creates lots of useless image data that requires lots of bandwidth to stream and store.

i-PRO have now developed a cost viable solution to the high definition bandwidth problem by enabling important content to stream as high definition whilst economizing or eliminating on unimportant content in an image. This technology is called Smart coding and its employment reduces the total cost of ownership and makes the investment in high definition within the reach of a much wider section of the video surveillance marketplace.



2. i-PRO's Smart Coding Technology

Smart Coding is a license free feature available on *i-PRO and i-PRO Extreme cameras. Total bit rate throughput can be reduced by combining the two main technologies that make up the Smart Coding innovation;

1. Technology that assigns high resolution data to important content, such as people or cars
2. Technology to reduce noise generated in low-illumination environments or at night therefore eliminating the streaming of noise seen as movement in current compression algorithms.

As we are eliminating the unnecessary streaming or high resolution data even greater results in overall bit rate throughput can be saved by combining Smart Coding with i-PRO high-resolution 4K surveillance cameras.

i-PRO's Smart Coding Technology is based on the coding of the moving video standard, as such special modules and the like are not needed for display or playback by a client who is employing this technology.

The two technologies that make up the Smart Coding innovation are made of several elements that are described as follows;

3. Technology to assign data only to subjects to be monitored

Bit rate is sufficiently assigned to subject matter that is important, such as people or cars and therefore needs to be streamed and recorded as high definition video. However, so-called background elements such as walls and roads are not so important therefore as content does not really need to be as sharp, so lower or no bit rate is assigned to it. Overall the total bit rate that needs to be streamed and recorded is reduced. This technology uses various techniques to accomplish the overall reduction in throughput as follows;

3.1. GOP Control

The video stream is comprised of I-frame data encoded closed in the screen (as still image) and P-frame data where the difference from the previous frame is encoded. If the refresh cycle is set to 1 second (the default setting for i-PRO cameras) at a frame rate of 30 fps, stream data is generated where 29 P-frames follow after one I-frame. The data from this I-frame to the next I-frame is called Group of Picture (GOP).

To play back stream data generated in this way, decoding must be done in order from the I-frame. For that reason, the I-frame is also called the reference frame. If the refresh interval (interval between I-frames) is long, much decoding must be performed until playing back the end frame of that GOP.

I-frames encode the entire screen, so the volume of data is large. P-frames encode the difference from the previous frame, so the volume of data becomes smaller.

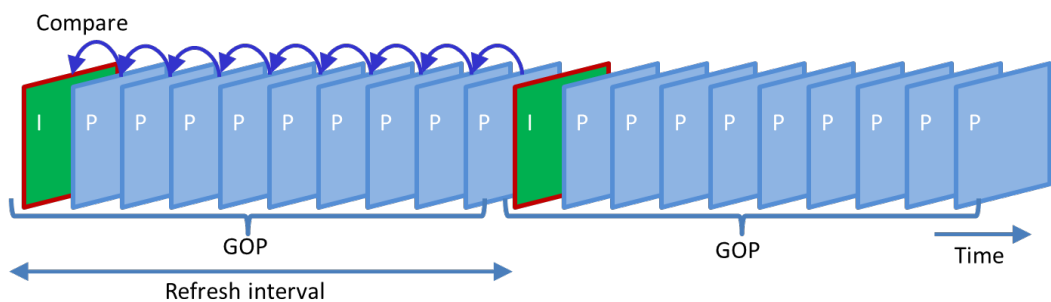


Figure 1 : The image of video stream

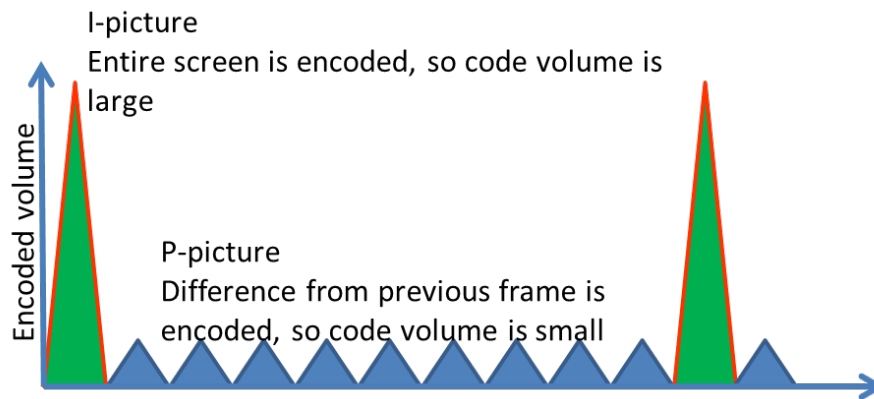


Figure 2 : The encoded volume of I-picture and P-picture

The GOP Control function detects motion of subjects and makes the interval between I-frames shorter if there is motion or longer if there is no motion. By making the interval longer in scenes with no motion, the number of I-frames with large data volume can be reduced, greatly reducing the total bit rate. And in scenes with motion, the interval is made shorter to secure accessibility to scenes the user wants to view.



Figure 3 : The difference of I-frame insertion interval

i-PRO H.265 cameras have been given an Advanced mode in addition to conventional GOP control described on the previous page.

The reference frame structure in Advanced mode is shown in **Figure 4**

Advanced mode utilizes the concept of long term prediction frames. Its reference frame structure consist of I-frames, P-frames, which reference two frames (an I-frame and the previous P-frame), and key frames (P#30,#60,), which reference the first I-frame(IDR) in the GOP.

Figure 4 shows the reference relationship at 30 fps with an I-frame interval of 60 sec and key frame interval of 1 sec.

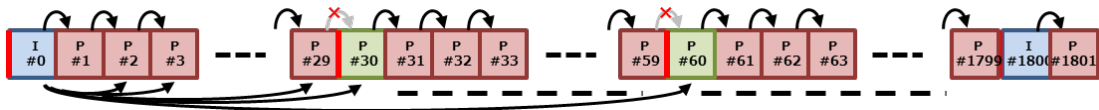


Figure 4 ; reference frame structure of Advanced mode

If there are no key frames in the GOP, decoding needs to be done sequentially from the I-frame at the head of the GOP. However, key frames can be decoded using just the I-frame. For example, if key frames are present in the GOP, #61 can be displayed by decoding just IDR#0, P#60, and P#61. Additionally, by inserting key frames, random accessibility can be secured.

The Advanced mode improves prediction efficiency by using two reference P-frames and reduces the bit rate by expanding the I-frame interval whilst maintaining random accessibility.

3.2. Auto-VIQS Control

Auto-VIQS (Variable Image Quality on Specified area) Control can automatically determine areas with and without motion and therefore reduces the data volume of those without motion. In the example below Auto-VIQS has realized two areas of importance that have a lot of movement (seen in red) and one area of little or no movement (seen in yellow).

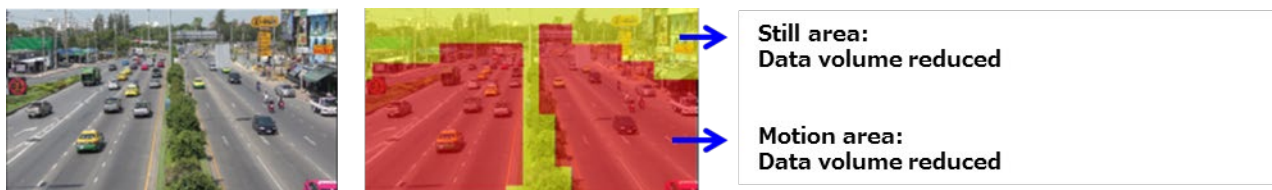


Figure 5 : Left: Original image. Right: The image is an example of separate a still area and an area with motion.

3.3. Smart Facial Coding

Smart Facial Coding reduces bit rate by detecting the face and motion areas and keeping the face area at high image quality, slightly reducing high-frequency components of the motion areas, and reducing high-frequency components of other still areas.



Figure 6 : Smart Facial Coding explanatory diagram

Smart Facial Coding and Auto-VIQS can be selected independent of GOP control on H.265 cameras.

4. Noise Reduction Technology for i-PRO H.264 cameras

Noise from image sensors at night or in other low-illumination environments cause unnecessary data volume as noise is seen as movement with current compression technologies. The data created rises in volume with higher resolution cameras like 4K that are often less effective at low light and therefore create more noise.

i-PRO have created two technologies to provide a more effective response to noise generated which when employed can reduce data volume by 20% in comparison with conventional camera noise reduction techniques. These two technologies are explained below;

4.1. 3D-MNR

3D-Multi-process Noise Reduction (3D-MNR) analyzes differences in signal level and reduces grainy noise generated in low-illumination environments to achieve a low bit rate. Noise generation patterns can be estimated and predicted by individual luminance level using i-PRO's own noise reduction algorithm. Noise generated when increasing gain to secure brightness in video is reduced by individual pixel accurately and in fine detail.

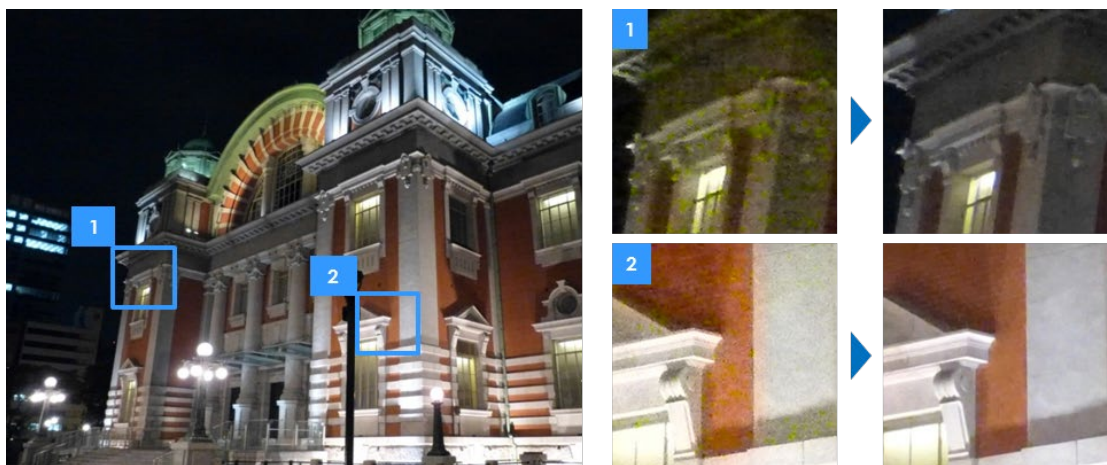


Figure 7 : The image diagrams for the description of 3D-MNR

First, noise detection is performed with high precision by creating statistics for the difference of the signal level of the surrounding pixels by luminance level, deciding the threshold, and estimating a noise model in advance. Pixels with a signal level lower than the threshold are averaged with the surrounding pixels to reduce noise. A Bayes mathematical estimation is then performed on the estimated noise model and the noise model that shifts in the time axis

direction. If the patterns are similar, they are reduced as noise; if they differ, the afterimage is minimized as motion.

Up to approx. 25% of data can be reduced by this function

4.2. FDF

Frequency Divided Filter (FDF) analyzes frequency and reduces fine noise that is generated at slightly low illuminance to achieve low bit rate. Images are divided into multiple bands, and an optimum coring filter for each is applied to enable noise to be reduced while leaving edge components.

Up to approx. 25% of data can be reduced by this function

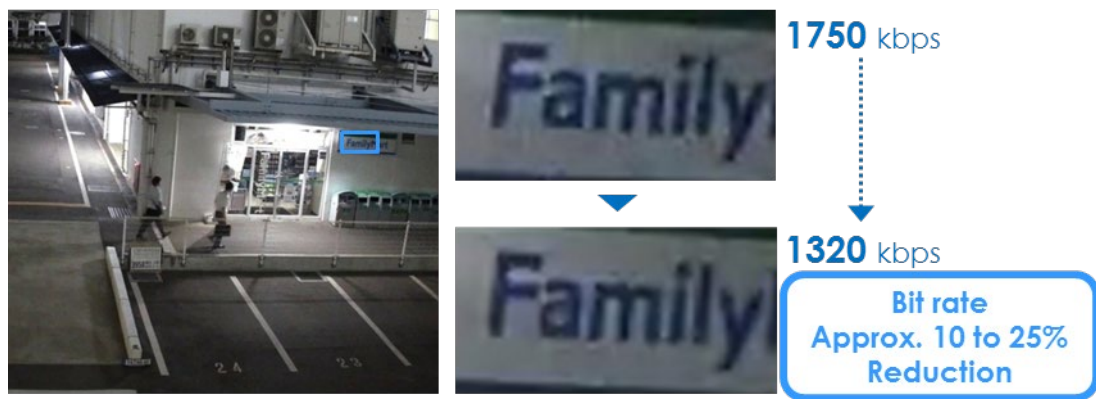


Figure 8 : The image diagrams for the description of FDF

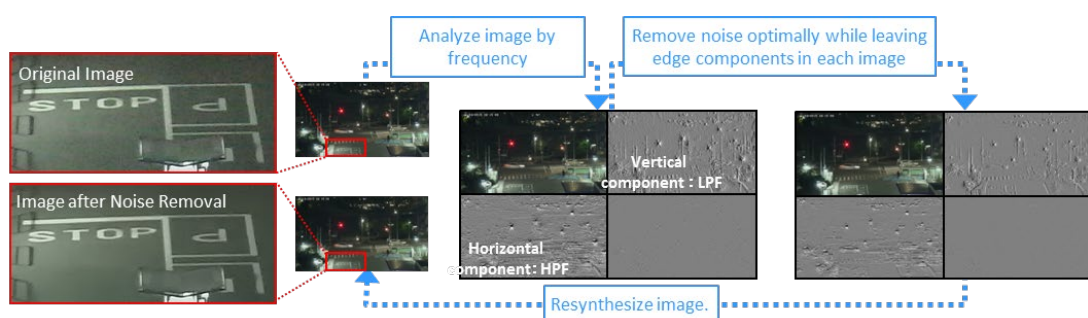
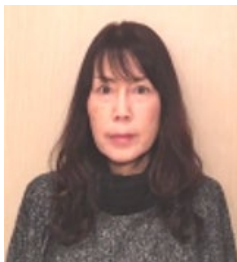


Figure 9 : The outline flow of FDF processing



Conclusion

i-PRO's Smart Coding technology is technology to reduce video surveillance system costs. It concentrates data volume into that for important scenes and areas, and it reduces data volumes for scenes and areas without motion as well as reduces noise in low-illuminance situations, enabling data volume to be reduced.



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