Smart H.264+

Smart codec, Lower bit rate, Less storage

White Paper by Dahua Technology

Release 1.0

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Dahua Smart H.264+ Codec

1   Introduction

Smart H.264+ is not a new technology, but an optimized implementation of H.264.

Smart H.264+ technology is a collection of intelligent encoding algorithms developed by Dahua technology based on H.264. To meet the characteristics of video surveillance, Smart264+ adopts some key video encoding techniques and these techniques can be flexibly add/delete or combined according to different applications and products. Smart H.264+ codec can effectively enhance video encoding efficiency according to the characteristics of different surveillance environments; furthermore, it can greatly reduce transmission bit rate, storage capacity thus to improve the overall system CAPEX/OPEX.

2   Background

Typical video surveillance needs to record the video for 24/7 and it consumes huge storage. With the surveillance operators pursuing/moving to HD, the surveillance video of high resolution and large bit rate has become one of the main challenges. It further adds the storage and transmission cost, and increases the whole cost of the surveillance system. Smart H.264+ is to address this issue in a smart way.

To resolve these issues, the surveillance industry players are constantly investing technologies and innovations to reduce the surveillance system cost. On the one hand, following the latest encoding standard (including MPEG4,H.264,H.265 and etc.), the manufacturers are constantly upgrading and improving their product line so that their products can support the latest technologies and high efficiency encoding standards.   Usually this target can be realized via the hardware development and it may take long time till the development and maturity level of the hardware eco-system. On the other hand, since H.264/AVC encoding standard

are widely used in the surveillance products, how to improve the compression rate with software upgrade based on current H.264 encoding standard is one of the new development in the industry.

Comparing with other video files, typical surveillance video file has the following characteristics:

- During the specified period, the background of the surveillance video is static, or has minor motions.

- In the surveillance video, most of the time the video is static and the moving object/motion appears at the certain periods.

- The surveillance environments usually need 7/24 recording, the noise is generally high, and especially at night the noise is extremely high.

- Operators are usually only interested in the moving object in the surveillance video.

3   Key Technologies

Smart H.264+ technology is a collection of intelligent encoding algorithms. It includes many key techniques of the encoding technology. Dahua newly developed Smart H.264+ includes the following three key aspects:

- Advanced bit rate control algorithm;

- Video encoding based on the video contents analytics (including dynamic ROI, dynamic GOP, flexible reference frame structure);

- Noise suppression technology.

3.1   Scene Adaptive Encoding Strategy

The surveillance scene is not fixed. According to the JND model (just noticeable Difference Model), the human vision perception about an object is different. For example, the human vision perception about indoor objects is more sensitive than outdoor objects. To adopt differentiated encoding strategy according to different scene can effectively reduce human vision redundancy, thus to improve the encoding

efficiency. For example, 4M bite rate with indoor objects will have similar human vision presentation with 1-2M for outdoor objects.

Scene adaptive encoding strategy is to implement differentiated strategy based on smart scene analysis which includes the analysis of light/noise/motion conditions and enjoinments. The Scene adaptive encoding strategy can not only guarantee the human vision perception of the surveillance scene but also improve the encoding efficiency.

3.2   Video Encoding Based on Video Analytics

3.2.1   Dynamic ROI

Generally speaking, surveillance operators are only interested in the moving object in the surveillance video and have less interest in the background area.   With this background in mind, Smart H.264+ implements the strategy of separating the moving objects from the background automatically according to the motion in the video scene through video analytics technology.   After separation, Smart H.264+ adopts different compression level according to different ROI.   For example, lift the compression level for background area and lower the compression level for moving objects. For surveillance video, since the moving object only appears in the specified period and lasts short time, Smart H.264+ can remarkably enhance compression efficiency.
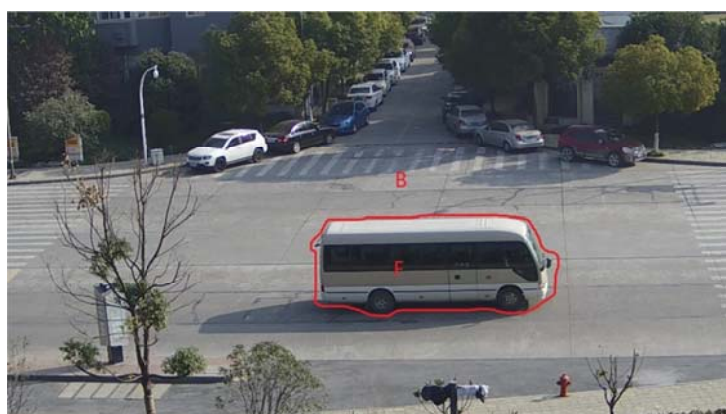

Figure 1

As show in figure 1, Red box is the moving object marked as F, and the other area is the background scene marked as B. Normally only the moving object (F) is the main interested area and the image quality need to be guaranteed. Following differentiated encoding strategy described in figure 2 can be adopted to improve the overall performance: quality of moving object F need to be guaranteed and quality of background area B can be lowered down, thus to reduce the bit rate of background area and as a result to lower the overall system transmission bit rate.
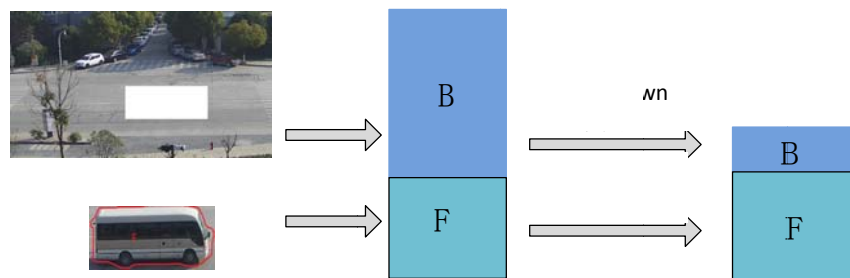

Figure 2   Compression strategy of interested area and background

3.2.2   Dynamic GOP

In the video bit stream, the frame size of I-frame is usually times of the P-frame size in order to guarantee the video quality.   The I-frame has much bigger storage load in the video bit streams comparing with P-frame. Since typical surveillance video is static or has minor changes for majority of the time, smart H.264+ adopts the strategy of dynamic GOP and only inserts I-frame when there are big changes and additional I-frame is necessary. The length of GOP can be adapted dynamically according to the real application in surveillance video. With the dynamic GOP structure (D-GOP) to reduce I-frame amount in the bit stream, the compression efficiency can be improved effectively.
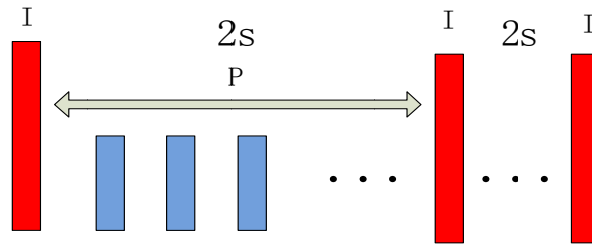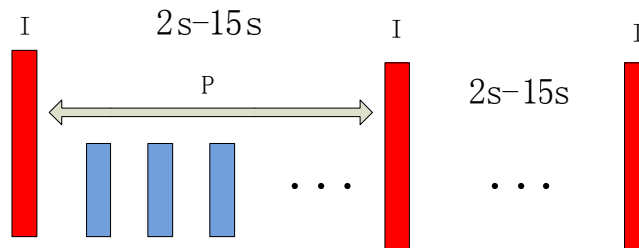
Figure 3 Fixed GOP

Figure 4 Dynamic GOP

Described in figure 3, typical surveillance system implements fixed GOP which means the interval between 2 I-frames is fixed, generally set as 2 seconds. Keep in mind that In surveillance video, most of the time the video is static and the moving object/motion appears at the certain periods, to enlarge the GOP could effectively reduce the amount of I-frame in set time period. Only when the motions/moving objects appears, I-frame will then be inserted to ensure the video quality according to the real surveillance scene which is called dynamic GOP. Described in figure 4, reducing the amount of I-frame can reduce the overall system transmission bit rate.
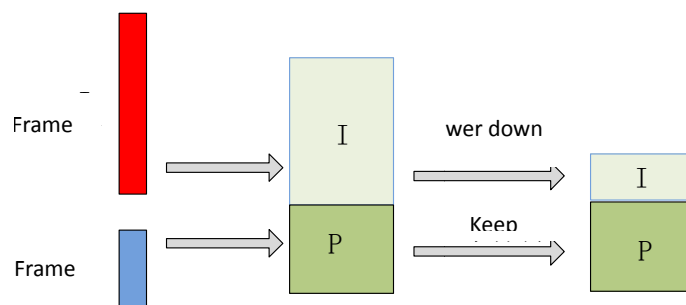

Figure 5 Bitrate

3.3 Flexible Reference Frame Structure

To reduce the bit rate and guarantee encoding video quality, comparing with the

single frame reference structure of standard H.264, Smart H.264+ adds more flexible reference frame structure. It adopts dual-frame reference and virtual I-frame technique.
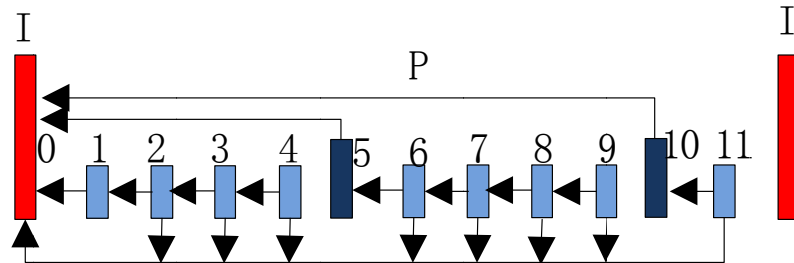

Figure 6 Dynamic GOP

(1) Dual-frame reference technique

For ordinary surveillance video encoding, it only takes single frame (I-frame or previous frame) as reference frame. For dual-frame reference technique, two reference frames will be taken for referencing purpose. Besides referencing the previous frame, it takes IDR as reference frame too. In the above figure, the 2nd P-frame references both the IDR (frame 0) and the 1st P-frame. In the motion scene, comparing with the single frame reference, the dual-reference structure can find better reference block for the shielding background zone of the moving object. It can enhance the accuracy of the evaluation and raise the compression efficiency.

(2) Virtual I frame technique

Generally, only I-frame can realize the random add/insert function. The virtual I-frame technique implementation ensures the P-frame can appoint the previous IDR as the only reference frame (In the above figure, the 5th P-frame can only reference the 0th IDR) so that it can be added/inserted whenever necessary instead of relying on the previous P-frame to decode.

3.4   Noise Suppression

The noise of the surveillance video is usually high when the application area is

uncertain and the light condition is poor. The noise can not only affect the video quality, but consume more encoding bit rate as well. It is necessary to control the noise and implement better controlling strategy for video encoding. The traditional noise reduction strategy is generally to take the video scene as a whole and intense noise reduction techniques can delete some video details during noise reduction. It is hard to find the balance between these two factors in traditional noise reduction techniques. Based on the video analytics technology, the Smart H.264+ technology generally separates/distinguish the motion area from the background area and adopts different noise reduction levels for motion and background area (see figure 7). In this way, it can not only reduce the noise, but also guarantee the ROI video quality. Especially for the high noise environment such as surveillance scene at night, it can greatly improve the encoding bit rate.
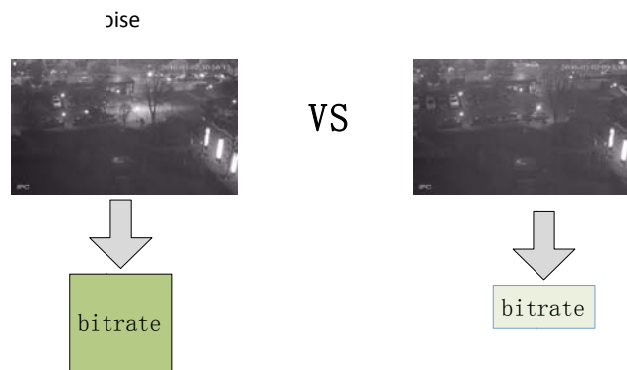

Figure 7 Noise suppression

4   Encoding Efficiency Test

Following table shows real test result of Encoding efficiency with Smart H.264+ enabled comparing with Smart H.264+ disabled.
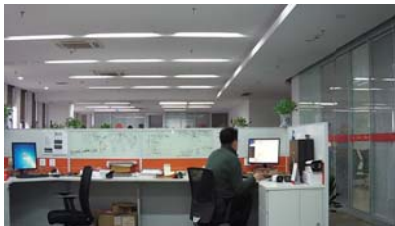
Scene	Light condition	Movements	Bit rate reduction
Indoor	Low light	static	95%
	Low light	movements	88%
Indoor	Bright	static	92%
	Bright	movements	65%
Outdoor	Low light	static	91%
	Low light	movements	75%
Outdoor	Bright	static	85%
	Bright	movements	60%

Figure 8 Encoding efficiency table

The above figures are based on real test conditions and the bit rate reduction may vary depending on the light and movement conditions and details of the scene.

5   Applications Areas

Smart H.264+ is a collection of intelligent encoding algorithms and contains many encoding techniques. To ensure that it can be widely used in various products across different platforms, the key techniques can be add/delete or combined flexibly according to the real application with different products or platforms. For different motion surveillance environments, Smart H.264+ can generally enhance the

compression rate.   Generally speaking, the improvement rate of compression efficiency is high if the contents in the surveillance scene are simple and the moving objects amount is small. Since Smart H.264+ is developed based on the H.264/AVC standard, the Smart H.264+ encoding compression rate is as good as the general H.264/AVC encoding even in extreme environment.

Smart H.264+ technology is developed based on the H.264/AVC standard.   Most existing hardware and software can play its bit streams. To enjoy better playback experience, the decoder is able to support Smart H.264+ bit streams with minor modifications required.

Smart H.264+ refers to a collection of intelligent encoding algorithms. It is not in any way a new video encoding standard but an optimized implementation of the H.264. Many techniques of Smart H.264+ are beyond the video encoding standard framework which ensures that Smart H.264+ technology does not conflict with the H.265 encoding standard. Or the other hand, its key techniques even can be applied to the H.265.

6   Conclusion

Based on current H.264 video encoding standard, Smart H.264+ adopts some available video encoding techniques, and integrates these key techniques with Dahua advanced video contents analytics technologies. It effectively improves video encoding efficiency while guarantee video quality at the same time. The Smart H.264+ technology does not require the hardware upgrade or replacement, but a firmware upgrade which can greatly enhance the product features without adding additional cost.

About Dahua Technology

Dahua Technology is a world-leading video surveillance solution provider. Our company enjoys the world's second largest market share according to the IMS 2015 report. We believe in investing and building strong R&D capabilities for new technology and innovation. The company invests more than 10% of sales revenue in R&D every year. Dahua technology has more than 4000 professionals in R&D team, who are dedicated to provide cutting edge products and solutions for our valuable customers. The company has 592 patents in total till end of 2005 and advocates opens to share or license its technical know-how with global partners.

Dahua's product portfolio includes: Advanced Video Surveillance Products/Solutions and related Software, Access Control, VDP, Alarm, Intelligent Building Management Systems and Intelligent Traffic Management System etc.

Dahua's products are widely used in banking, public security, energy infrastructure, telecommunication, intelligent-building and intelligent-transportation etc. Many significant projects have been installed with Dahua's solutions including: The Sanxia Hydropower Plant, Six-Country Summit, Beijing Olympic Venues, APEC, Shanghai World Expo, UNESCO site in Italy and London Underground Subway as well as many others.