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H.265+ Takes Video Surveillance to the 4K Era

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H.265+ Technical Article

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H.265+ Introduction and Background

Recently, ultra-high-definition surveillance cameras introduced 4K resolution to the security industry. However, 4K resolution has yet to achieve wide application, mainly because of the tremendous bandwidth and data storage requirements. Limiting the bitrate of an ultra-HD video feed while retaining a high-quality, 4K-image remains the biggest problem—a problem whose solution will decide the fate of ultra-HD surveillance video. Video transmission balances image quality, transmission capabilities, and data requirements—i.e., how much information and how it's handled. Therefore, image transmission optimization lies in advancements in video compression technology.

Until now, H.264 compression has been the industry-standard codec. When the H.264 codec found wide use, Hikvision developed its own compatible algorithm to go the next step, calling it “H.264+”. The next iteration in this codec lineage—H.265—presently stands at the cusp of widespread adoption. And once again, Hikvision has already pushed this compression technology to a new level. H.265+ employs an intelligent algorithm whose encoding technology stems from the H.265/High Efficiency Video Coding (HEVC) standard.

H.265+ optimizes the existing codec most strikingly where specific criteria are met in a surveillance video feed. This criteria consists of: 1.) a stable background where information rarely changes; 2.) a primary focus on the objects moving across that stagnant scene; 3.) a substantial period of time where a scene's moving objects appear only occasionally; and 4.) 24-hour non-stop surveillance where visual noise has a relatively large impact on image quality. In this type of environment, field-tests show H.265+ radically decreases the required bitrate of the ultra-high-definition surveillance video by up to 67% over H.265, thereby reducing required bandwidth and storage. Bitrate reduction means cost reduction for consumers, as well as increased efficiency, stability, and reliability of all the hardware in a given surveillance system. Here's how it works.

Three Keys: Encoding, Noise, and Bitrates

With ultra-HD resolutions and higher efficiency transmission as the two primary objectives, H.265+ improves the compression ratio based on three key technologies: 1.) predictive encoding technology based on a background or reference frame, 2.) digital noise suppression technology, and 3.) long-term bitrate control technology.

Predictive Encoding

Predictive encoding can be divided into “Inter-frame prediction,” creating a prediction model from one or more previously encoded video frames, and “Intra-frame prediction,” where the samples of a macroblock (processing unit) are predicted by using only information of previously transmitted macroblocks of the same frame. With inter-frame prediction, bitrate can be reduced by compressing only the difference in rates between a reference frame and any other frame. This reference frame—usually the background of a scene—will contain few if any moving objects. Fortunately, in most security surveillance, the background remains stagnant.

Scenario: In a traffic intersection field-test, three unique frames are analyzed from a video feed. The first frame is the empty intersection (T0), the second two (T1 and T2) include a moving object—in this case, an automobile. The first image gets encoded as the reference frame; thereafter, reference frame data no longer needs to be sent or stored with every frame. This liberates the VMS to follow moving vehicles only, since new data (bits) will not be required for each frame capturing the background. The requirement for bits, bandwidth, and storage immediately drop. In the case where a strictly empty background or reference frame cannot be captured, the alternative is to encode two or more frames that might include a moving object. Intelligent software can fill in spaces that are vacated by those moving objects with similar information found in the immediately surrounding space. Thus, bitrate usage can be lowered while guaranteeing normal playback for the user.

Noise Suppression

In order to guarantee a high image quality of moving objects, the encoding module also encodes the visual noise in the scene. However, using the predictive encoding methods mentioned above, the H.265+ intelligent analysis algorithm distinguishes between the background image and moving objects so that each can be encoded with different encoding strategies.

A background image is encoded with high compression in order to suppress noise and applies data to new or moving objects. Since data transmission is limited, the overall bitrate dips substantially when compared against conventional video compression.

Long-Term Bitrate Control

Hikvision has introduced a concept it calls “Long-Term Average Bitrate” to make full use of a data from a video feed. Long-Term Average Bitrate calculates the rates over a specified time period (usually 24 hours). With the average bitrate control, the camera can assign higher bitrates to busier hours while reducing it during idle hours—e.g., midnight to 6 AM outdoors, or 8 PM to 7 AM in an office. In the case of a constant bitrate mode for H.265 encoding, the bitrate varies slightly but stays near the predefined maximum bitrate value. Using H.265+, average bitrate can be as low as half of the maximum bitrate. Image quality can still be optimized since the H.265+ technology makes full use of every bit.

In variable bitrate mode, the instant bitrate varies according to a scene's activity, while the image quality remains steady. Employing H.265+, the bitrate change can take two courses: 1.) if the configured average bitrate value is limited, H.265+ encoding can provide a better image quality within the limited bitrate; and 2.) if the configured average bitrate value is high for the scene being monitored, the actual average bitrate—the actual amount of data used—can be lower than the predefined value, lowering the total data storage requirement.

Real-World 24-Hour Testing

A bitrate-reduction test was conducted, based on cameras featuring 1080p resolution at 25 fps. The scene was a small café under video surveillance feed for a 24-hour period.

Instant Bitrate Comparison between Two Scenes

Testing the same scene—a busy café—at different times of day, showed that the rate difference between codecs appears less significant as the number of moving objects in the scene increases. Nevertheless, the numbers are still remarkable. The average bitrate between H.264 and Hikvision's H.265+ decreased by a substantial 83%. The rate between the standard H.265 and Hikvision's H.265+ codec decreased by 67%—a smaller difference, but nonetheless significant when applied to real-world surveillance systems.

24-Hour File Size in Different Scenes

In discreet, 24-hour file size comparison of two different scenes, drastic reductions were plain to see. Scene one was a café, where the H.264 codec yielded an average of 22.7 GB, and H.265 yielded 11.8 GB, on average. Remarkably, Hikvision's H.265+ averaged only 3.9 GB. Scene two was a traffic intersection. Here, the 24-hour file size comparison yielded similar results. H.264 averaged 36.4 GB, H.265 averaged 21.1 GB, and H.265+ averaged the lowest bitrate again at only 7.5 GB.

Here are in those numbers in percentages. In the café monitoring scenario, the rate of the 24-hour file size between H.265 and Hikvision H.265+ decreased by 66.4%, while the rate between H.264 and Hikvision H.265+ decreased by a substantial 82.5%. For the traffic intersection monitoring, the rate of the 24-hour file size between H.265 and Hikvision H.265+ decreased by 64.5%, while the rate between H.264 and Hikvision H.265+ decreased by 79.4%.

Benefits: Improved Bandwidth, Storage, Imaging, & VCAs

First, H.265+ makes the best use of every bit, so HD and ultra-HD resolutions looks as clear, sharp, and focused as possible. Also, as H.265+ improves image transmission, target objects will have more pixels so the use of VCAs will arguably become more precise, more accurate. Next, a network utilizing H.265+ has more bandwidth available at any given time. More bandwidth means better system functioning all around. In real terms, on a 20 Mb broadband network, the H.264 codec can accommodate five cameras. H.265 doubles that, carrying the load of 10 cameras. But H.265+ doubles even that, accommodating 20 or more cameras on the single network. Therefore, H.265+ will be the best choice for users expanding an installation and moving to 4K at the same time.

What's more, users reduce costs and other resources involved in storing video-feed data. Here's another scenario: when eight 2-Megapixel cameras are connected to a network, and a storage device holds five 5-Terrabyte hard drives, recording capacities vary significantly. A system running on H.264 will hit its storage ceiling in about two weeks. H.265 will do a bit better, filling up after about one month. Hikvision's H.265+, however, will continue recording—up to about two full months. When considering these results on a monthly or annual basis for budgeting expenses and hardware allocations, H.265+ reduces expenditures all around. While the jump to H.265+ might be slow initially, the benefits will prove advantageous far into the future.

Applications are Everywhere

The applications here extend at least as wide as those of any previous codec. However, under conditions like an unstable network or limited bandwidth, or where customers are required to store data for extended periods of time, H.265+ will be most profoundly effective. Furthermore, this codec can be integrated into comprehensive security solutions for specific functions—4K, Panoramic, and explosion-proof cameras, ultra-low light products, and anti-corrosion products are a few examples.

As with any new technological improvement, industry-wide upgrading from current or legacy standards requires investing time and resources. For H.265, migration is accelerating, primarily in newly designed systems since upgrading existing H.264 systems only increases expenditure. H.265 will become more desirable to system integrators and end-users since its decreased bitrates yield high-definition resolutions and images come through more clearly. Added to that, target objects can be isolated and enlarged with more clarity, and more accurate VCAs can be employed.

Summary

Hikvision's H.265+ codec optimizes the H.265/HEVC encoding technology, meeting its compression standards and operating with the vast majority of hardware and software designed to employ H.265. With H.265+, video quality remains virtually the same as that of H.265/HEVC while radically reducing transmission bandwidth and data storage capacity requirements. The H.265+ codec will serve to widen the application of ultra-HD resolutions in video surveillance, such as 8 MP and 12 MP devices. Wherever applied, this new codec will cut storage costs, make the fullest use of surveillance video investments, and broaden the use of 4K and ultra-HD security video.

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