

Dahua AI Coding Technology

Clearer Target, Lower Bitrate

White Paper by Dahua Technology



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1 Foreword

With the fast building of safe cities and smart cities in recent years, the demand of video surveillance sites has an exponential increase, resulting in an explosive growth in video data storage. Thus, both network bandwidth and storage space are at risk of becoming bottlenecks. The rapid technology development of image sensor, optical component and embedded image processing in camera, is making the resolution and frame rate of video encoding become much higher, and the required storage space much bigger.

Transmitting video efficiently in the limited network bandwidth and storing as many effective videos as possible in the expensive storage space has become a growing concern, because this relates to the bandwidth cost and the storage cost that it brings in the process of increasing sites.

2 Existing Technologies and Solutions in the Industry

The most direct way to resolve the problem of limited bandwidth and high storage cost is to accelerate the development of bandwidth and storage space as well as the upgrading of video encoding standard, but other problems arise:

- (1) The stability and high cost of network bandwidth are always the pain point for users.
- (2) The development of HDD storage technology is much slower than the explosive increase in video data growth.
- (3) Video encoding standards (e.g., H.264/H.265/H.266, SVAC1/SVAC2, AVS1/AVS2/AVS3, VP8/VP9) are designed to compress video data as much as possible while ensuring the video quality, but their development cycles are long and may involve many patent fees.

In addition, manufacturers are also using technologies such as dynamic GOP (Group of Pictures), dynamic ROI (Region of Interest) as dynamic frame rate to reduce the video data quantity. These technologies are optimized for variable bitrate, and they have some drawbacks.

- (1) Dynamic GOP technology saves bitrate by reducing the number of I frames through increasing the interval between two adjacent I frames, but it makes the random access of video stream worse, and leads to inflexibility in some typical applications (e.g., fast forward, fast backward) which could affect user experience.
- (2) Dynamic ROI technology generally improves the ROI encoding quality, resulting in an increase in the overall bitrates instead of a decrease.
- (3) Dynamic frame rate technology adjusts video frame rate dynamically and is obviously not feasible for application scenarios which have strict requirements for real-time monitoring and frame rate. Therefore, it is not well received by the average customers.

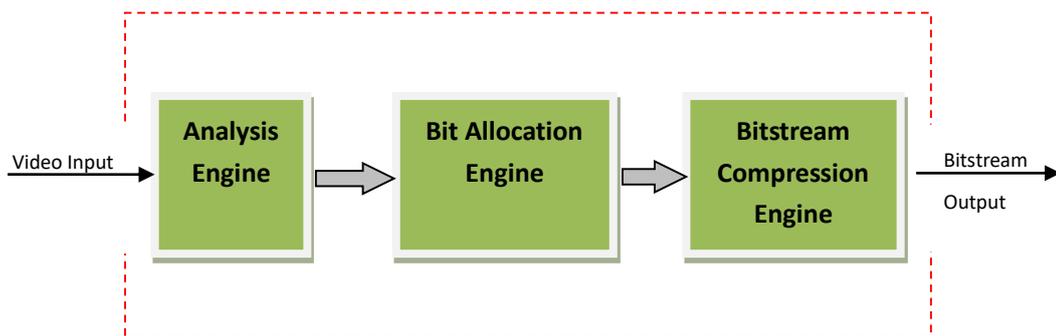
3 Dahua AI Coding Technology

Dahua AI Coding is introduced in the context, aiming to improve compression efficiency with limited bandwidth and storage space on the basis of existing video encoding standard.

3.1 Dahua AI Coding Technical Framework

Dahua AI Coding technology mainly includes three engines: Analysis engine, bit allocation engine and bitstream compression engine. See Figure 1.

Figure 1 Dahua AI Coding technical framework



■ Analysis Engine

It is mainly used to judge and analyze the scene (such as judging whether it is day or night, clear day or rainy day, snow or fog), and output the user's region of interest and the motion state analysis of the target, all of which are used to guide the bit allocation engine.

■ Bit Allocation Engine

Bit is the unit of data quantity, and the more bits are allocated, the more encoded data quantity and the higher image quality. According to the result of the analysis engine, the bit allocation engine can accurately assign bits to the optimum place in the video, for example, if the analysis engine analyzes an area with a human or vehicle that the user is very concerned about and other areas that the user is not concerned about, the bit allocation engine will allocate more bits to the human or vehicle area, and allocate fewer bits to other areas. In the common security scenario, the unconcerned area is much larger than that of the concerned area, so this feature can not only ensure the quality of user concerned area, but also save the overall bitrates.

■ Bitstream Compression Engine

The engine uses the best configurations of existing encoders to compress bitstream according to the result of bit allocation engine.

The analysis engine outputs the analysis result in real time and guides the bit allocation engine, and uses the compression engine with the best configurations to compress bitstream, and then

outputs the high-quality compressed bitstream that meets user's requirements. The three engines work together and cooperate with each other, to output high-quality standard compressed bitstream by reasonably and efficiently removing time-domain redundancy, spatial redundancy and human-eye-sense redundancy.

3.2 Principle of Removing Time Domain/Spatial Redundancy

Surveillance video consists of consecutive frames which contain large time-domain redundancy between two adjacent frames (there are large scale of similar or identical areas in two consecutive frames, which are useless data in time sequence, that is, redundant data); in addition, there are large scale of continuous areas (such as sky and road) in the monitoring video, and the data in these areas is almost identical or similar, resulting in spatial redundancy in the same picture.

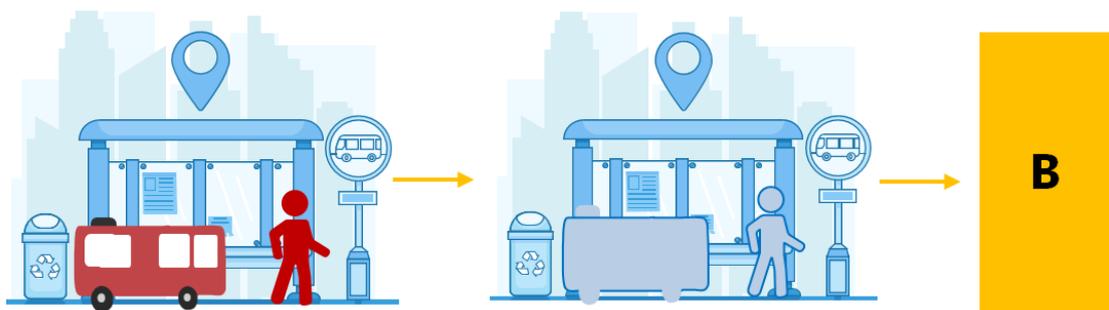
During the development of video encoding standards, block-based hybrid encoding technology continuously deepens the depth of image blocks and enlarges the predicted direction, to improve the compression efficiency for high-resolution images. On the basis of this encoding method, Dahua AI Coding technology makes a more thorough and reasonable analysis of the correlation between frames and between images by the analysis engine; and then the bit allocation engine stably allocates bit to the optimum places, removing time-domain/spatial redundancy more greatly and reasonably while keeping the image quality and bitrate at a good level.

3.3 Principle of Removing Human-Eye-Sense Redundancy

Users generally pay more attention to the focused area, and ignore the image quality of unfocused areas, which is due to the visual masking effect of human eyes. Therefore, image quality drop of unfocused areas is almost unable to be perceived by human eyes.

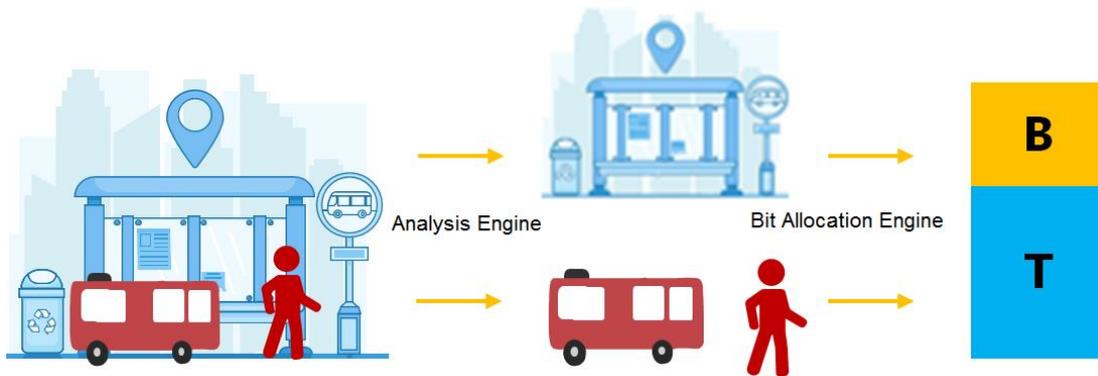
Figure 2 shows the image with Dahua AI Coding technology disabled. The encoder does not distinguish between vehicle, human and background, and all the elements in the image are encoded as an entire element.

Figure 2 Dahua AI Coding disabled



Dahua AI Coding technology ensures the quality of user-focused target or area, and meanwhile reduces the quality of unfocused area on a certain level. See Figure 3.

Figure 3 Dahua AI Coding enabled



As shown in Figure 3 above, the user's region of interest is output by the analysis engine. The engine separates key targets such as human and vehicle from other areas, and marks them as T, and then marks the remaining areas as background B. Since users usually focus on the image quality of the key target T, the bit allocation engine gives priority to ensuring the image quality of T (the bit consumption in encoding is increased), and meanwhile reduces the quality of B on a certain level (reduces its bit consumption) , so as to reduce the overall bitrates without affecting user's viewing effect.

3.4 Advantages and Effects of Dahua AI Coding Technology

On the basis of integrating the compression effect of the original video encoding standard in time domain and spatial domain, Dahua AI Coding technology adopts the independently developed algorithm to further reduce the video data quantity. This technical solution does not depend on hardware, so users only need to upgrade the firmware as long as their devices support this technology. And because it is a secondary development solution based on existing coding standard protocols, users do not need to worry about the compatibility with other decoders.

Dahua XVR products use fixed-bitrate AI Coding technology which features small bitrate fluctuations, to reduce overall bitrates and maintain/enhance the video quality of key areas. For example, in the case of 4MP and 30 fps fixed-bitrate video surveillance without AI Coding, we recommend you use 4M bitrate; and after Dahua AI Coding is enabled, we recommend you use 2M bitrate.

Figure 4 and Figure 5 show the use of fixed-bitrate encoding technology. Compared with the traditional fixed-bitrate encoding, the AI Coding reduces the bitrate by half while keeping the image quality of key areas stable.

Figure 4 Fixed-bitrate without AI Coding, 2560*1440, 4M bitrate



Figure 5 Fixed-bitrate with AI Coding, 2560*1440, 2M bitrate



4 Summary

Dahua AI Coding is suitable for many dynamic scenarios, especially when bandwidth and storage costs are limited but the client wants to see more details of the target. The bitstream is stable because the AI Coding is optimized on the basis of fixed-bitstream, which makes AI Coding has more advantages over compatibility with third-party encoding platforms. Compared with the Smart H. 265+ encoding technology which Dahua is also promoting, smart codec is more suitable for large scenes, especially for static scenes where it can achieve a larger proportion of compression. All series of XVR-I2 integrates both Dahua AI Coding and H.264+/H.265+ encoding,

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allowing customers to choose the appropriate encoding as needed according to the actual use scenario.

Dahua AI Coding technology is an independently developed solution that is based on existing video encoding standards, reducing video bitstream according to the distinctiveness of security monitoring scenarios. It can effectively reduce the video transmission data quantity, network bandwidth occupation and storage space consumption, and significantly alleviate the contradiction between explosive growth of video surveillance sites, video data quantity and the slow development of the network and insufficient storage space, helping build safe cities and smart cities.

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.