Real-Time Transcoding and Advanced Encryption for 360 CCTV Streaming

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요 약

Recently, according to the rapid development of surveillance information, closed-circuit television (CCTV) has become an indispensable component in security systems. A lot of advanced technologies of encryption and compression are implementing to improve the performance and security levels of the CCTV system. Especially, 360 video CCTV streaming is promising for surveillance without blind areas. However, compared to previous systems, 360 CCTV requires large bandwidth and low latency. Therefore, it requires more efficiently effort to improve the CCTV system performance. In order to meet the demands of 360 CCTV streaming, transcoding is an essential process to enhance the current CCTV system. Moreover, encryption algorithm is also an important priority in security system. In this paper, we propose a real-time transcoding solution in combination with the ARIA and AES algorithms. Experimental results prove that the proposed method has achieved around 195% speed up transcoding compared to FFMPEG libx265 method. Furthermore, the proposed system can handle multiple transcoding sessions simultaneously at high performance for both live 360 CCTV system and existing CCTV system.

1. Introduction

Nowadays, CCTV is widely deployed in the video surveillance systems and video analysis is a key factor to provide intelligent services. To adapt the necessity of digital CCTV video analytic, enhancing quality of service (QoS) of video is one indispensable element. Especially, the existing CCTV system cannot provide high-resolution Ultra-HD, or hard deploy efficient video codec High Efficiency Video Coding (HEVC) [1]. The video transcoding is necessary to adapt the various requirements of CCTV systems.

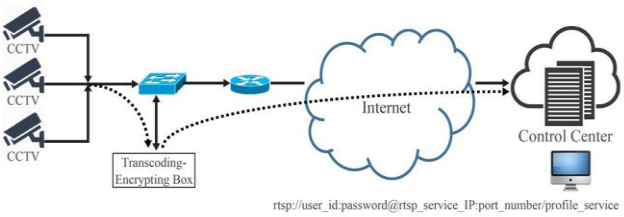

Figure 1. Conceptual architecture of live CCTV System with real-time transcoding.

Compared to the H.264 Advanced Video Coding (AVC) [2], the HEVC video encoding has achieved approximately twice the compression [3] [4]. Due to a large amount of existing video content encoded by H.264/AVC codec, transcoding H.264/AVC to HEVC is very necessity. Thus, an efficient HEVC transcoder is helpful to upgrade the AVC CCTV system at the lowest cost. However, the computational complexity of H.265/HEVC coding was very high compared to the H.264 standard. This leads to it too hard for implementation a real-time high-quality HEVC encoder software in multimedia encoding systems.

To implement the security feature for CCTV system, the encryption method can be implemented at the Network Abstract Layer (NAL) unit level to affect all NAL units of HEVC bitstream file. The performance of the encoder is not significant as it will increase the complexity of the encoder and the transcoder. Therefore, in this paper, we propose a transcoding method for multi-cores platforms. Moreover, the proposed system encrypts the Video Parameter Set (VPS), Sequence Parameter Set (SPS) and Picture Parameter Set (PPS) NAL units of the HEVC bitstream during transcoding process to reduce the computational complexity. The experimental results proved that the proposed system provided significant speed corresponding to a bit rate for H.264 to HEVC real-time transcoding. The conceptual architecture of the proposed system including various CCTV cameras is illustrated in Figure 1.

2. Real-Time Transcoding and Encryption

Video transcoder study can be reviewed in [5]. Regarding the transcoding, there are some concepts commonly discussed in multimedia area such as transcoding codec (for example: MPEG-2 video source to H.264/AVC video and AAC audio, AVC to HEVC etc.), trans-rating bitrate (4 Mbps to 2 Mbps, etc.) or trans-sizing the resolution (3840x 2160 to 1920x1080 etc.). Commonly, transcoding is the combination or one of them of all the above methods. The video conversion requires intensive computational power, so transcoding often requires acceleration capabilities of CPUs/GPU.

and videos as perceived by humans. We performed the comparison for both 1080p and Ultra-HD videos. All WS-PSNR of Y, U and V channels are higher than 38 dB. These values confirmed that the quality of 360 videos at client are reasonable to feel fully immersed in 360 videos.

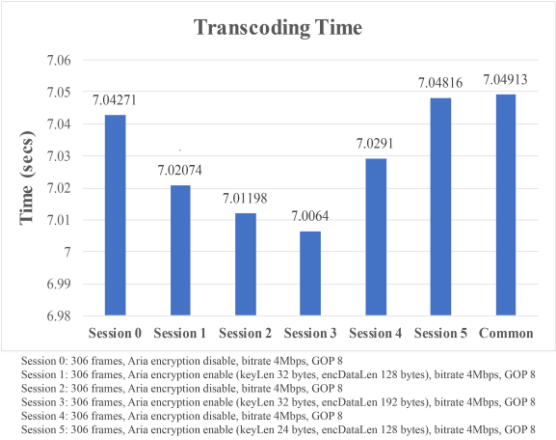

Figure 4. AVC-HEVC: Six 1080p sessions.

Table 1. 360 Video Transcoding Comparison.

Test_sequence	x265	Proposed
DrivingInCity 1080p	20.78s(14.48 fps)	7.03s(42.8 fps)
GasLamp 1080p	22.12s(13.56 fps)	8.45s(35.5 fps)
Harbor 1080p	22.45s(13.37 fps)	8.58s(34.9 fps)

Table 2. The WS-PSNR Comparison

Test sequence	WS-PSNR Y channel	WS-PSNR U channel	WS-PSNR V channel
*DrivingInCity*_1080p	39.36	45.14	44.52
DrivingInCity Ultra HD	38.68	45.33	44.63
*GasLamp*_1080p	41.47	46.74	46.08
GasLamp Ultra-HD	42.19	47.34	46.61

Table 3. Processing time comparison between ARIA and AES algorithms.

Test sequences	ARIA total time	ARIA time	AES total time	AES time
ParkScene_240 Frames 25FPS	5.596s (42.88 fps)	3.16%	5.07s (47.33 fps)	2.82%
Kimono_240 Frames 25FPS	5.61s (42.7 fps)	2.53%	5.39s (44.5 fps)	2.07%
Basketball_240 Frames 25FPS	11.89s (42.05 fps)	2.28%	11.55s (43.29 fps)	1.14%

In order to perform the encryption efficiency, the proposed system was taken experiments with both AES and ARIA algorithms. The result proved that the AES algorithm can provide the encryption speed up to 33.4 times when compared to the ARIA algorithm. As shown in Table 3 AES encryption process can reduce the total processing time around 10% when compared to the ARIA algorithm. The percentage time of AES encryption over the total time will be more and smaller when the CCTV video duration time increasing. The ARIA encryption gives the result in the same way with higher percentage than AES encryption. Finally, we can conclude that AES encryption is one of the best choices to secure live video streaming.

4. Conclusion

The development of 360 video technology is promising to motivate the development of current CCTV systems. In the scope of this paper, we proposed the transcoding and encryption method for real-time CCTV video streaming. The proposed system optimized real-time transcoding AVC-HEVC and ARIA/AES encryption for two Ultra-HD sessions and six 1080p sessions with speeds of 33.6 FPS and 36.4 FPS, respectively. In the future, we will apply cubemap projection extensively into 360 cameras to improve the quality of input CCTV video. Regarding encryption, applying cryptographic attack and plaintext attack are planning to take testing the secured ability of the proposed system.

Acknowledgement

이 논문은 2018 년도 정부(과학기술정보통신부)의 재원으로 정보통신기술진흥센터의 지원을 받아 수행된 연구임 (No.2018-0-00765, 6DoF 지원 초고화질 몰입형 비디오의 압축 및 전송 핵심 기술 개발).

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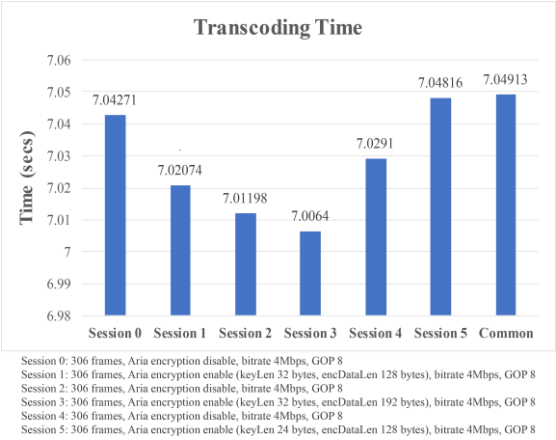

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