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Efficient Ultrasound Video Streaming using HEVC

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Abstract

This work investigates the feasibility of using High Efficiency Video Coding (HEVC) to stream ultra-sound scan video over mobile networks. HEVC is designed to efficiently encode and decode high volume video to achieve a significant bit-rate saving while preserving the video quality. Even though HEVC is capable of encoding and decoding movies, the efficient usage of HEVC specifically for ultra-sound scan video streaming is not investigated thoroughly. In response, we investigate the feasibility of using HEVC to encode a full-high-definition abdominal ultrasound scan video in order to efficiently stream across a mobile network and decode in the receiver at an acceptable quality. Ultra-sound scan videos are encoded at different quantization parameters to produce video sequences at different bit-rates. These video sequences are transmitted across a mobile network and the received video is evaluated quantitatively and qualitatively. Initial results of the experiment are presented in this paper. These results indicate that at least 6 Mbps of bandwidth is required in order to transmit a full-high-definition ultrasound scan video at an acceptable quality. Hence, the PSNR(Peak Signal to Noise Ratio) of the received video sequence should be at least 50. These results also raise the requirement to develop more efficient HEVC schemes and transmission techniques to facilitate real time ultra-sound scan video streaming over mobile networks in advanced telemedicine applications.

Keywords: *ultra-sound scan video streaming, HEVC, telemedicine*

1.INTRODUCTION

High Efficiency Video Coding (HEVC) is designed in such a way to facilitate the efficient storage and transmission of high volume video. Additional features of HEVC provide up to 50% bit-rate saving compared to its preceding video coding standard H.264/MPEG-4 AVC[1]. However, optimizing HEVC for ultra-sound scan video transmission has not been investigated thoroughly. In response, this work investigates the feasibility of ultra-sound scan high definition video streaming over a mobile network. It is envisaged that this study will pave the path to develop complicated medical imaging procedures such as ultra-sound scanning to be performed remotely.

The rest of this paper is organized as follows. Section 2 presents the methodology followed to obtain the initial results that are presented in section 3. Conclusions and possible future research directions are summarized in Section 4.

2.METHODOLOGY

A human abdomen ultrasound video sequence of resolution 1920×1080 in yuv format with frame rate of 25 fps is encoded using HM 16.0 reference software. The resolution is not reduced in order to maintain the clarity of the transmitted video and enhance the viewing experience through modern smart phones and tablets. The first 20 frames of the ultra-sound scan video sequence is encoded at various quantization parameter (QP) values i.e. QP = 34, 36, 38, 40, 42, 44, 46, 48 and 50 to obtain video sequences at different bit-rates, as indicated in Fig. 1. The 20th frame of the original and each of the encoded videos are demonstrated in Fig. 2. The resultant HEVC videos are transmitted across a simulated mobile network. We consider a network with zero packet losses, no packet jitter and unlimited bandwidth to obtain the initial results that come under the scope of this paper.

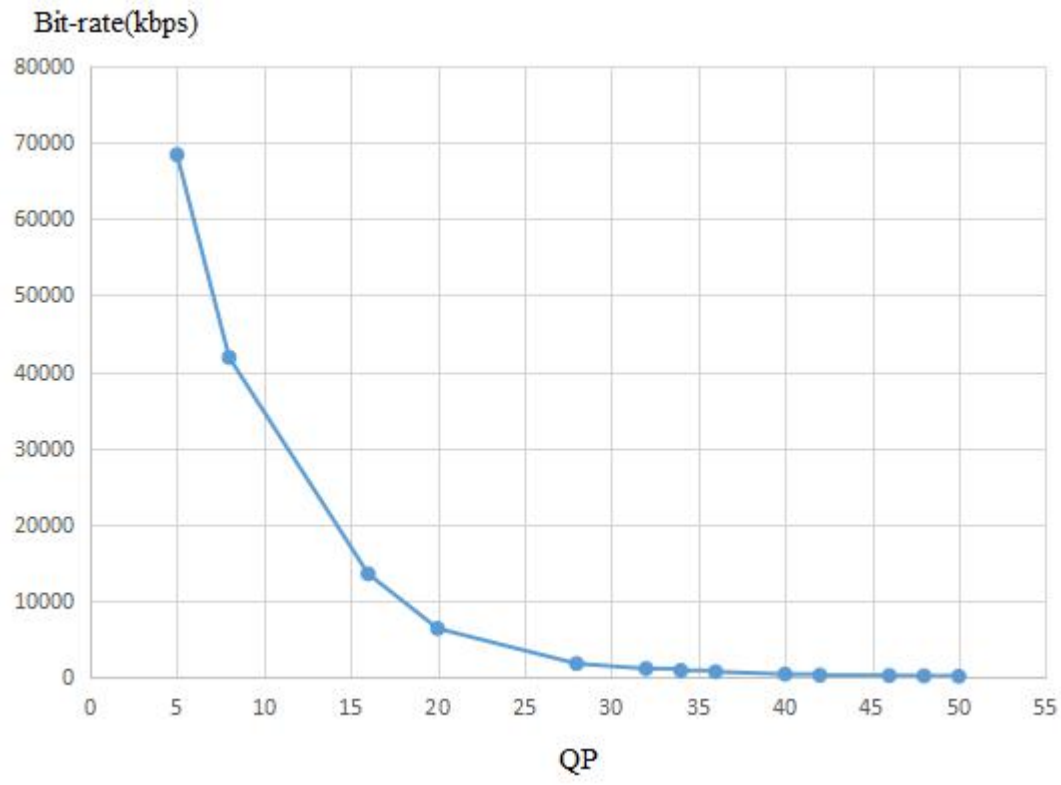

Fig. 1 Bit-rate variation when encoding the video at different QP values

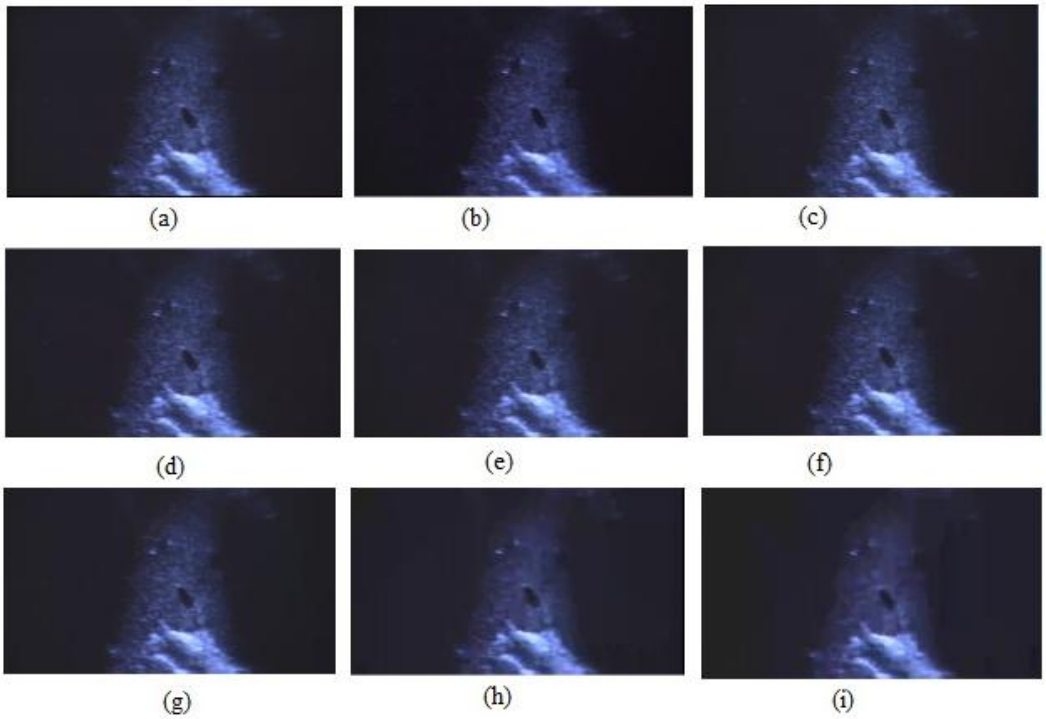

Fig.2 20th frame of the original and encoded videos at various Quantization Parameter to compare the video quality (a) Original video (b) QP=08 (c) QP=16 (d)QP=20 (e) QP=28 (f) QP=32 (g) QP=36 (h) QP=42 (i) QP=50
Video source: https://www.videvo.net/video/ultrasound-screen-2/3300/

Received video sequences are evaluated quantitatively and qualitatively. Quantitative evaluations consider the peak signal-to-noise ratio (PSNR) of the received video sequence. Qualitative evaluations are performed through subjective tests performed for a number of six imaging researchers and obtaining the mean opinion score (MOS) on the quality of the received sequences.

3.PRELIMINARY RESULTS AND DISCUSSIONS

Preliminary results obtained through the experiment and an analysis of the results are presented in this section.

Fig. 3 presents the PSNR variation of received video sequences along with their bit-rates. The qualitative evaluation results, as presented in Fig. 4, which indicates the MOS variation against bit-rate, indicates that at least 6Mbps of uninterrupted bandwidth is required to transmit the ultrasound video at an acceptable video quality. In addition, Fig. 5 indicates that the PSNR value of the received video sequence should exceed 50 in order to produce an acceptable ultra-sound scan video at the receiver.

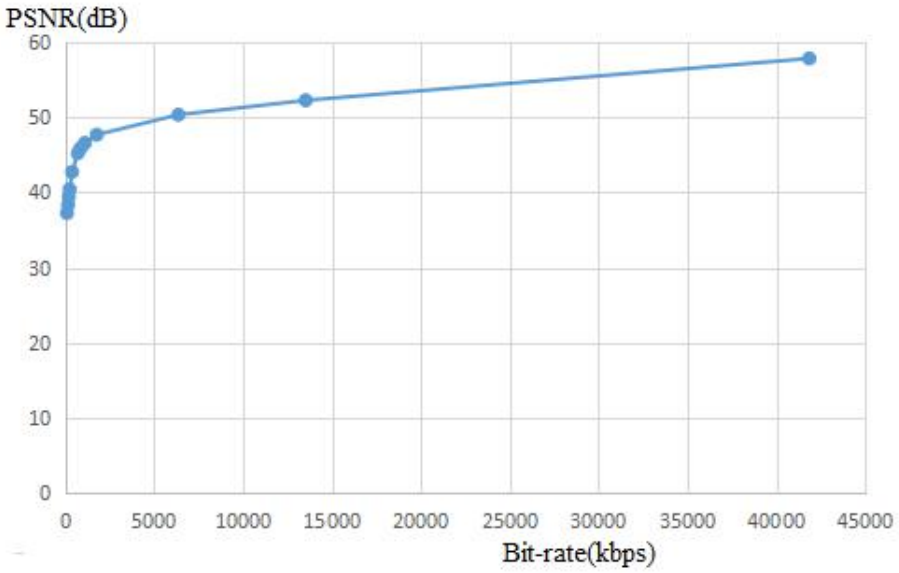

Fig. 3 PSNR of the received video vs encoded bit-rate

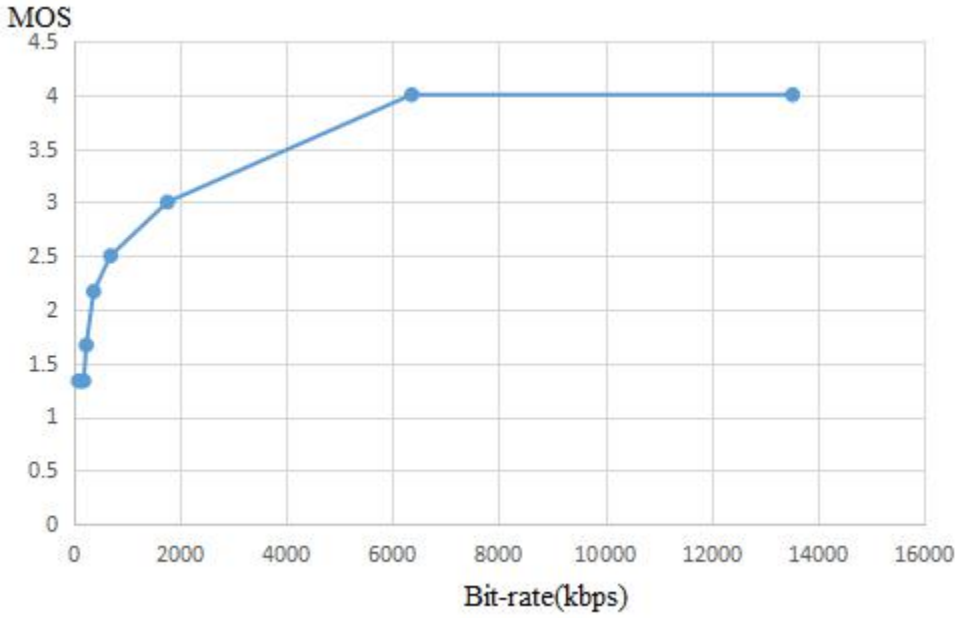

Fig. 4 MOS of the received video vs. encoded bit-rate

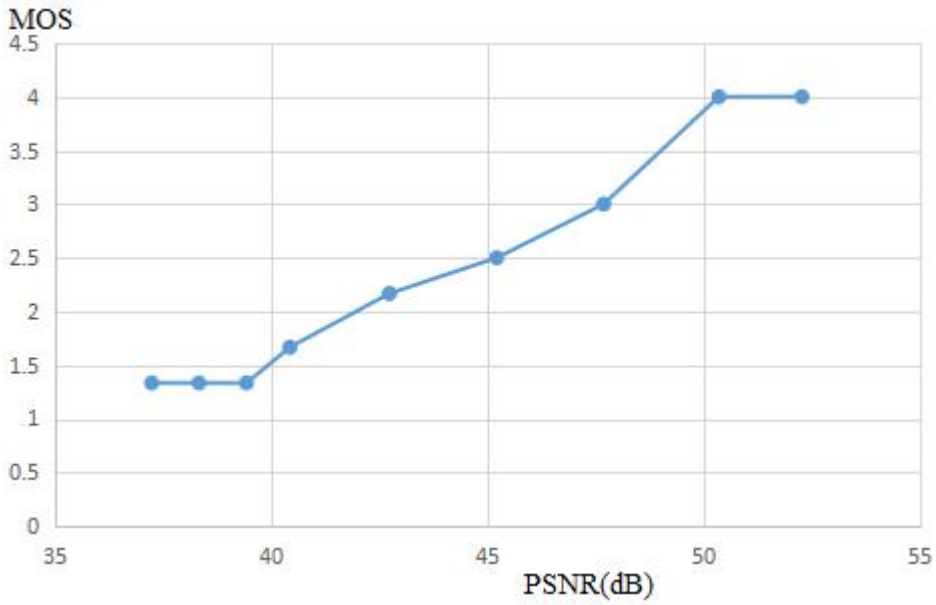

Fig. 5: MOS vs PSNR of the received video sequence

It should be noted that having an un-interrupted bandwidth of 6Mbps is technically possible with state-of-the-art mobile communication networks. However, this bandwidth requirement is a luxury when it comes to the mobile network resources available at remote locations. This paves the path to investigate not only more efficient encoding techniques but also more bandwidth efficient techniques to transmit video across mobile networks.

4.CONCLUSION AND FUTURE WORK

This paper presents an initial evaluation of using High Efficiency Video Coding (HEVC) for telemedicine applications. Experimental results indicate that it is technically possible to use HEVC as it is for ultra-sound scan video streaming across mobile networks. However, the observed bandwidth requirement is a luxury considering mobile networks and connectivity options in remote locations. This study paves the path to investigate bandwidth efficient encoding and transmission techniques to facilitate future telemedicine applications such as remote ultra-sound scanning and diagnosis over mobile networks.

5. REFERENCES

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