Human Mobile-Device Interaction on HEVC and H.264 Subjective Evaluation for Video Use in Mobile Environment

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***Abstract*-- High Efficiency Video Coding (HEVC) is the next coding standard that is being finalized by ITU's Joint Collaborative Team on Video Coding (JCT-VC). This paper compares the H.264/AVC, current coding standard, and HEVC (aka H.265) in mobile compute environments. In this study, the focus, within the mobile compute environment, are smart phones. The major smart phone elements are smaller screen size, which is typically 3.5 inches diagonal to 5.0 inches diagonal for high end smart phones and typical cellular network bandwidth, which is typically 3G or faster. There is compelling subjective test feedback that indicates human device interaction focused on user's experience is very similar between HEVC and H.264 encoding standards for mobile environment screen size and higher cellphone bandwidth (such as 400kbps constant bit rate). This suggests the benefits of HEVC over H.264 in mobile environment are not as clear.**

I. INTRODUCTION

The mobile compute environment has evolved rapidly in the last few years and smart phones have penetrated the consumer market extensively. Display technologies, in the mobile environment market space, have benefited from strong design investment by smart phone manufacturers and significant research and development by liquid crystal display (LCD) manufacturers. This has enabled the mobile LCDs to improve steadily in performance, such as: (a) resolution, (b) power consumption, (c) viewing angles, and other aspects.

The evolution of encoding methods from H.264 to HEVC targets mainly larger screen displays, which are described as 10.4 inch and above, with the main beneficiary being the broadcast industry. However, HEVC is expected to provide compression gains over H.264 in the mobile environment. However, the significance of these gains in mobile devices has to be evaluated to determine whether the additional gains are perceivable by end users on mobile device displays. This study will provide guidance on user experience for the targeted bitrate.

The economic incentive for mobile industry to adopt HEVC may not be a strong motivator when considering user experience with encoding method for a given bitrate. This will allow this market segment to leverage existing H.264 infrastructure and allow HEVC standard to mature some more before adopting. This will reduce early adoption risk with little risk to reduced consumer experience.

II. METHODS

Mobile encoding method recommendations, within this study, revolved around recommendations from Brightcove and Apple that are widely adopted by content providers. Smart phone display performance has progressed significantly and cellular network bandwidth has improved in recent years. These events have led to the use of higher quality resolutions and bitrates for mobile environments. The higher resolution and bitrate will eventually be common for consumer-grade mobile products in the near future. For Brightcove, "Higher quality and resolution" [1] which lists resolution for 640x360 (16:9) at 400kbps. For Apple HTTP Live Streaming [2] recommendations are listed in Table 2-1 (Encoder settings for iPhone, iPod touch, iPad, and Apple TV, 16:9 aspect ratio) were used for test direction. A combination of WiFi resolution (640x360) and higher bandwidth cellular (400 kbps) were selected. Basically, the display technology progress strongly dictated the WiFi resolution (640x360) over the high end cellular resolution (480x224), as currently observed by popular mobile phones with resolutions up to 1280x720 for 5.0" diagonal screen sizes.

The encoder implementations used for the comparison are H.264/AVC Software Coordination version: JM18.3 [3] and High Efficiency Video Coding (HEVC) version HM 6.0[4]. H.264 was configured to closely mimic HEVC coding (based on HM-like configurations available in JM 18.3). The benefit is to reduce the variability between the two video encoding protocols.

Video test sequences chosen are the 30fps HEVC test sequences used in HEVC standards development. The video test sequence files are scaled and cropped to 640x360 resolutions. A total of 5 sequences are in the experiment pool. These are: (a) Flowervase, (b) Keiba, (c) People on Street, (d) Race Horses, and (e) Traffic.

III. EXPERIMENTS

The 640x360 video test sequences were encoded for various quality levels. For H.264, the QP encoded was for QP 27-51. For HEVC, the QP encoded was for QP24-51. For objective comparison the PSNR(Y) was chosen.

Video sequences were shown on a 4.3" LCD with 480x272 resolution. The observer is approximately 12" to 18" from the display and viewing angle is approximately 10 degree above normal as shown in figure 1.

Seven observers participated in the test. The observers are 18 to 50 years of age. All observers are in good health. Corrective lenses were used during the test, if the lenses were prescribed.

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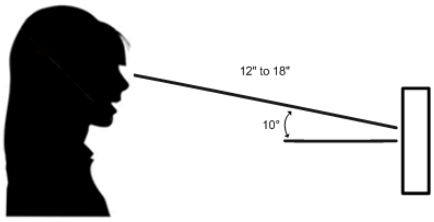

Fig. 1. Observer to LCD viewing definition

For subjective comparison, the H.264 and HEVC quality sequence closest to 400kbps bitrate was chosen. The impaired sequences test methods were configured as described by Oelbaum[5]. Comparisons between both impaired video sequences are in accordance with Double-stimulus impairment scale (DSIS) as defined by ITU-R BT.500-13[6]. Variant II was used for presentation structure of test material. This allows the user two viewings of each video sequence (reference and impaired) before subjective grading. Also, video sequence was shown randomly in order to reduce observer bias. Grade scores are on a scale from 1 to 5. Grade of "one" is poor (very annoying) and "five" is excellent (imperceptible) as defined by ITU-R BT.500-13.

IV. RESULTS

"Keiba" test sequence results yielded PSNR(Y) is about 1.5dB better than H.264. However, the subject results indicate subjective performance is about the same. Actually, H.264 was shown to perform better by one observer. The next two figures show test results on "Keiba" test sequence.

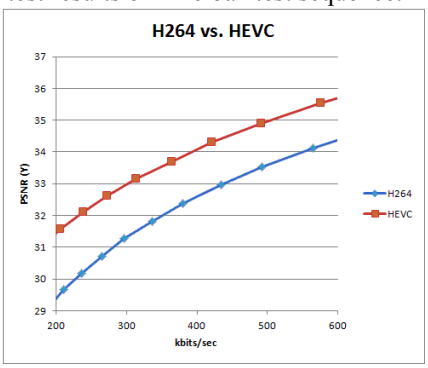

Fig. 2. Keiba PSNR(Y) data. HEVC performed approximately 1.5dB better than H264.

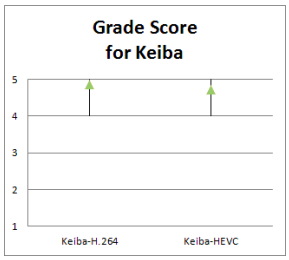

Fig. 3. Keiba subjective data. H.264 performed, as well as, HEVC performance. Chart shows minimum to maximum grade range and average.

"People On Street" test sequence yielded PSNR(Y) is about 0.5dB better than H.264. The subject results indicate subjective performance is about the same.

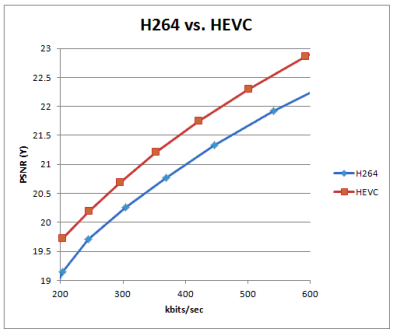

Fig. 4. PeopleOnStreet PSNR(Y) data. HEVC performed approximately 0.5dB better over H264.

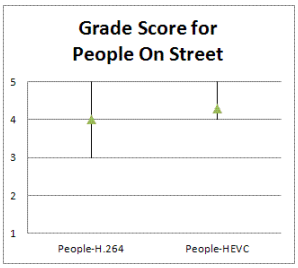

Fig. 5. PeopleOnStreet subjective data. H.264 performed, as well as, HEVC performance. Chart shows minimum to maximum grade range and average.

Subjective results showed 90% grade scores ratings of "5" or "4", which indicates the observer feedback is "imperceptible" or "perceptible, but not annoying", respectively. The observer feedback is the impaired video sequence is acceptable for the mobile (i.e. smaller screen) environment.

V. CONCLUSION

For the mobile conditions performed in the study, which is 4.3" screen size and 400kbps constant bit rate, the user (i.e. observer) experience is not severely affected when comparing H.264 and HEVC impaired video sequences. Observations show both encoding methods are adequate in the mobile environment.

VI. REFERENCES

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