Screen Content Coding in Recently Developed Video Coding Standards

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Date: 1 December 2020
Time: 09:00-12:00

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Xiaozhong Xu has been a Principal Researcher and Manager of Multimedia Standards at Tencent Media Lab, Palo Alto, CA, USA, since 2017. He was with MediaTek USA Inc., San Jose, CA, USA as a Senior Staff Engineer and Department Manager of Multimedia Technology Development, from 2013 to 2017. Prior to that, he worked for Zenverge (acquired by NXP in 2014), a semiconductor company focusing on multi-channel video transcoding ASIC design, from 2011 to 2013. He also held technical positions at Thomson Corporate Research (now Technicolor) and Mitsubishi Electric Research Laboratories. His research interest lies in the general area of multimedia, including video and image coding, processing and transmission. He has been an active participant in video coding standardization activities for over fifteen years. He has successfully contributed to various standards including H.264/AVC and its extensions, AVS1 and AVS3 (China), HEVC and its extensions, MPEG-5 EVC and the most recent H.266/VVC standard. He served as a core experiment (CE) coordinator and a key technical contributor for screen content coding developments in various video coding standards (HEVC, VVC, EVC and AVS3). Xiaozhong Xu received the B.S. and Ph.D. degrees from Tsinghua University, Beijing China in electronics engineering, and the MS degree from Polytechnic school of engineering, New York University, NY, USA, in electrical and computer engineering.

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Shan Liu received the B.Eng. degree in electronic engineering from Tsinghua University, the M.S. and Ph.D. degrees in electrical engineering from the University of Southern California, respectively. She is now a Tencent Distinguished Scientist and General Manager of Tencent Media Lab. She was formerly Director of Media Technology Division at MediaTek USA. She was also formerly with MERL, Sony Electronics and Sony Computer Entertainment America (now Sony Interactive Entertainment). She has been actively contributing to international standards since the last decade and served co-Editor of HEVC SCC and the emerging VVC. She has numerous technical contributions adopted into various standards, such as HEVC, VVC, OMAF, DASH and PCC, etc. She also directly contributed to and led the development effort of products which have served hundreds of millions of users. Dr. Liu holds more than 150 granted US and global patents and has published more than 80 journal and conference papers. She was in the committee of Industrial Relationship of IEEE Signal Processing Society (2014-2015) and is on the Editorial Board of IEEE Transactions on Circuits and Systems for Video Technology (2018-2021). She was
the VP of Industrial Relations and Development of Asia-Pacific Signal and Information Processing Association (2016-2017) and was named APSIPA Industrial Distinguished Leader in 2018. She was appointed Vice Chair of IEEE Data Compression Standards Committee in 2019. Her research interests include audio-visual, high volume, immersive and emerging media compression, intelligence, transport, and systems.

Abstract

In the recently years, screen content video including computer generated text, graphics and animations, have drawn more attention than ever, as many related applications become very popular. However, conventional video codecs are typically designed to handle the camera-captured, natural video. Screen content video on the other hand, exhibits distinct signal characteristics and varied levels of the human’s visual sensitivity to distortions. To address the need for efficient coding of such contents, a number of coding tools have been specifically developed and achieved great advances in terms of coding efficiency.

The importance of screen content applications is well addressed by the fact that all of the recently developed video coding standards have included screen content coding (SCC) features. Nevertheless, the inclusion considerations of SCC tools in these standards are quite different. Each standard typically adopts only a subset of the known tools. Further, for one particular coding tool, when adopted in more than one standard, its technical features may various quite a lot from one standard to another.

All these caused confusions to both researchers who want to further explore SCC on top of the state-of-the-art and engineers who want to choose a codec particularly suitable for their targeted products. Information of SCC technologies in general and specific tool designs in these standards are of great interest. This tutorial provides an overview and comparative study of screen content coding (SCC) technologies across a few recently developed video coding standards, namely HEVC SCC, VVC, AVS3, AV1 and EVC. In addition to the technical introduction, discussions on the performance and design/implementation complication aspects of the SCC tools are followed up, aiming to provide a detailed and comprehensive report. The overall performances of these standards are also compared in the context of SCC. The SCC tools in discussion are listed as follows:

Screen content coding specific technologies:

- Intra block copy (IBC)
- Palette mode coding (PLT)
- Transform Skip Residue Coding (TSRC)
- Block based differential pulse code modulation (BDPCM)
- Intra string copy (ISC)
- Deblocking filter (DBK)

Screen content coding related technologies:

- Integer motion vector difference (IMVD)
- Intra subblock partitioning (ISP)
- Geometrical partition blending off (GPBO)
- Adaptive Color Transform (ACT)
- Hash based motion estimation (HashME)