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OMAF VIEWPORT-DEPENDENT VR VIDEO STREAMING USING HEVC TILES

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Enabler for High Quality 360° VR Video

MPEG's ongoing work on Omnidirectional MediA Format (OMAF) aims at standardizing storage and delivery formats for VR video content by the end of this year. One of the most promising techniques for streaming the 360° VR video considered in OMAF is viewport-dependent streaming based on HEVC tiles.

Tiles allows to maximize the visual quality within the viewport on mobile and tethered devices compared to conventional viewport-independent approaches. This technique reduces video bitrates and decoder requirements by adaptively mixing video resolutions within a single video stream. Using Tile-Based DASH Streaming high video quality in the current viewport is maintained while lower resolution outside is streamed outside the viewport in a viewport-dependent manner. The video stream adapts to the current user viewport on-the-fly without heavy transcoding or storing of a large number of pre-rendered viewports on server side. With Tile-Based DASH Streaming, individual tiles are offered to the client, which selects a configuration suitable to his viewport orientation and throughput budget. Hardware video decoder usage allows for energy efficient playback and maximum runtimes of mobile devices.

Challenges

Ultra-high-resolution within the user viewport is required to achieve full immersion in VR video applications. Covering the full 360° video would easily lead to multiple times UHD resolution. Such large amount of data poses a major challenge to the

whole chain of state-of-the-art video streaming, especially to mobile devices with constrained resources. The throughput required for streaming of 360° video over the public Internet cannot be provided for many users. Furthermore, most VR relevant devices such as mobile phones contain hardware video decoders that are tailored to conventional FullHD and 4K resolution services.

Conventional adaptive HTTP streaming in a single resolution does not provide satisfactory QoE under such circumstances. Therefore, new means for adaptivity in terms of video bitrate and viewport resolution are required to enable high quality 360° video services.

Viewport-dependent video streaming based on HEVC tiles

Fraunhofer HHI's viewport-dependent streaming technique based on HEVC tiles overcomes the challenges of ultra-high resolution content in context of limited bandwidth and decoder capabilities often found on mobile devices. In a conventional service design, the whole 360° VR video content is streamed at a single resolution. Such an approach sacrifices video quality in the actual user viewport for pixels that are not even presented to the user most of the time. Another viewport-dependent approach is to offer per-user or per-viewport orientation streams, which does not scale well as it comes at significant costs for storage, caching and encoding.

Using Tile-Based streaming, a tailored video stream for each user can be easily generated on-the-fly without intensive processing on the server or client side. Video content outside the users current viewport is transmitted in low quality or resolution which allows a more efficient throughput and decoder utilization.

Furthermore, Fraunhofer HHI's Tile-Based solution enables usage of a single hardware video decoder on mobile end devices, since the required subset of tiles can be aggregated into a single HEVC compliant bitstream using ISO Base Media File Format (ISOBMFF) extractors.

Complete streaming solutions can be implemented based on well-established standard families such as ISOBMFF and MPEG-DASH, which are extended by OMAF to allow Tile-Based streaming for 360° VR video.

Technical Background

- Lightweight merging of HEVC tiles using ISOBMFF extractors
- Mixing of qualities and resolutions in one end user video stream
- Single hardware video decoder for energy efficient playback
- Tile Based DASH Streaming with short buffer sizes to allow for responsive adaptation

Benefits

- High video quality in user viewport
- Increased quality for given decoder level capabilities
- On-the-fly viewport adaptation without transcoding
- Per-user or per-orientation encoding is not required
- Streaming bitrate and storage footprint reduction
- Fully compliant to HEVC, MPEG DASH, MPEG ISOBMFF, and MPEG-I Part 2 (OMAF)