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Influencing factors on quality of experience for multiview video (MVV) services

ITU-T G-series Recommendations – Supplement 73

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Supplement 73 to ITU-T G-series Recommendations

Influencing factors on quality of experience for multiview video (MVV) services

Summary

Supplement 73 to ITU-T G-series Recommendations classifies multiview video (MVV) services and identifies the key factors for the quality of experience (QoE) of MVV.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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1 Scope

The multiview video (MVV) service is a video service that obtains video streams from different perspectives from multiple cameras, allowing users to view video from various aspects by selecting one of multiple viewpoints. Compared with single-view video, this service can provide users with a better sense of on-site participation. Due to the realization of large-capacity access networks represented by 5G, MVV services have become popular. Compared with previous single-view video services, the MVV service puts forward a new set of requirements for QoE assessment. This Supplement discusses MVV QoE in 5G networks.

This Supplement categorizes and summarizes the factors that affect user-perceived experience of MVV service, with the intention to help identify methodologies for assessing MVV quality. Considering the factors affecting MVV QoE, a suggested scheme for MVV QoE assessment is proposed.

2 References

[ITU-T P.10] Recommendation ITU-T P.10/G.100 (2017). *Vocabulary for performance, quality of service and quality of experience*.

3 Definitions

3.1 Terms defined elsewhere

This Supplement uses the following terms defined elsewhere:

3.1.1 QoE [ITU-T P.10]: The degree of delight or annoyance of the user of an application or service [b-Qualinet].

3.1.2 QoE influencing factors [ITU-T P.10]: Include the type and characteristics of the application or service, context of use, the user's expectations with respect to the application or service and their fulfilment, the user's cultural background, socio-economic issues, psychological profiles, emotional state of the user, and other factors whose number will likely expand with further research.

3.2 Terms defined in this Supplement

This Supplement defines the following terms:

3.2.1 bullet time: A visual effect or visual impression of detaching the time and space of a camera from those of its visible subject, allowing high speed movements such as the flight path of individual bullets to be seen by the audience, sometimes referred to as time-slice photography.

3.2.2 video gallery: An extension of multiscreen viewing scenes that displays panoramic video in a tiled manner so that users can display the full picture of the game in a panorama. The input controller can select the video window to display the full picture.

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

AVC Advanced Video Coding

FOV	Field of View
FPS	Frame Per Second
HD	High Definition
HEVC	High Efficiency Video Coding
MVC	Multiview Video Coding
MVV	Multiview Video
PPD	Pixels Per Degree
SD	Standard Definition
UHD	Ultra-High Definition
VOD	Video on Demand

5 Conventions

Within the scope of this Supplement, MVV services include services with traditional functions (VOD, video live, playback, etc.) and services with special effects (bullet time, free viewpoint, etc). People using and experiencing these MVV services are referred to as users or players.

6 MVV service overview

Multiview video (MVV) service is a video service that obtains video streams of different perspectives from multiple cameras and allows users to view video from various aspects by selecting one of multiple viewpoints. As [b-Boyce] states, in 360° video, the viewer's perspective of the video content is as if the viewer were in the centre of a sphere, looking out, with all content at the same distance away from the viewer to the sphere's surface. Unlike 360° video, in MVV, the viewer may change orientation to select which portion of the sphere's surface can be seen. The traditional MVV services provide users with multiview video in the form of picture-in-picture or tiled video from multiple cameras. In recent years, new-generation MVV services have emerged, such as bullet time services and free viewing services. These new-generation MVV services use multiple cameras to provide users with video information of the entire surface in all directions during program production and broadcasting, so that users can find their desired viewpoint and the best viewing position by rotating and switching the orientation.

The traditional MVV service is captured by multiple cameras from multiple aspects at the same time. On the screen, it provides users with different perspectives through picture-in-picture, multiscreen viewing, mosaic channels and so on. In traditional cable TV and IPTV services, it is mainly used to enhance the viewing experience of live channels.

The bullet time service uses computer-aided photography technology to simulate the effects of speed changes, such as enhanced slow motion, static time and so on. It is an intelligent system based on multiple cameras, which can realize effects such as enhanced slow motion and static time, by simulating variable speed. It is a depth enhanced simulation of variable-speed action and performance which can be found in films, broadcast advertisements and real time graphics within video games and other special media.

The free viewing service uses cameras installed around the site to collect all angle information of the same object or scene in real time and transmit it to local or cloud servers in real time. Users can watch the video through the terminal and choose the viewpoint freely.

5G technology enables multigigabit upload speeds and seamless transmission when moving at high speeds. For UHD live broadcast of MVV, there are many cameras to upload UHD videos to a backend system. 4K broadcasting requires a transmission bandwidth of 60-75 Mbit/s, while 8K video requires a transmission bandwidth of 100 Mbit/s. Therefore, 5G networks can guarantee the uploading quality of UHD videos.

7 MVV QoE key influencing factors

As [b-Qualinet] recommends, the factor of MVV QoE can be categorized in the following groups: human influencing factors, system influencing factors and context influencing factors. Compared with a typical video service, some key system influencing factors that are particular to MVV are listed below.

7.1 Video quality key factors

7.1.1 Video codec related

Video codecs are used to compress original scene data from a raw format. Traditional video codecs (e.g., AVC, HEVC), may be used for the MVV service. The multiview extension of AVC is known as multiview video coding (MVC), and a successor to AVC is high efficiency video coding (HEVC). A more efficient video encoder can provide users with better experiences.

7.1.2 Video resolution

Due to the limited field of view (FOV) of MVV, part of the video will not be displayed on the screen. Therefore, it is recommended that pixels per degree (PPD) be used to represent the resolution of MVV. The larger the PPD, the higher the definition of the MVV. When the PPD reaches 60 (the limit of the human retina), the viewing definition is the highest. It is recommended that the PPD of an SD video is about 11, and the PPD of an HD video is about 20.

7.1.3 Video frame rate

Frame rate is the frequency at which images are displayed continuously. The higher the frame rate, the better the smoothness. It is recommended that the minimum frame rate be 30 frames per second (FPS) for MVV.

7.1.4 Video bit rate

Video bit rate represents the number of video stream bits transmitted per unit time. The higher the video bit rate, the clearer the video image and the higher the image quality.

7.1.5 Time delay

The time delay includes playback delay, switching delay and so on. A shorter time delay can provide users with better experiences.

7.1.6 Video initial buffer time

The video initial buffer time is the duration between the user's click to play the video and the first video frame displaying in the screen. A shorter initial buffer time can provide users with better experiences.

7.1.7 Video stall

The number of video stalling events, sum of the length of video stalling events and average interval between video stalling events of MVV will affect the quality of user experience.

7.1.8 Video mosaic

The number of mosaic events, sum of the length of mosaic events, average mosaic area ratio and average interval between mosaic events of MVV will affect the quality of user experience.

7.1.9 Frame skipping

The number of frame-skipping events, sum of the length of frame skipping events and average interval between frame skipping events of MVV will affect the quality of user experience.

7.2 Audio quality key factors

7.2.1 Audio content related

The frequency and channels of audio in MVV service will affect audio quality. The microphone collects the detailed sound of the scene and the background sound of the environment. The sound collected by the microphone can be mixed with the comment sound of the scene to form a mixed comment sound. The audio supports multiple channels.

7.2.2 Audio codec related

Audio codecs are used to compress original scene data from a raw format. Traditional audio codecs may be used for MVV service. A more efficient audio encoder can provide users with better experiences.

7.2.3 Audio stall

The number of audio stalling events, sum of the length of audio stalling events and average interval between audio stalling events of MVV will affect the quality of user experience.

7.3 Terminal display key factors

7.3.1 Time-shift

Time-shift operation includes fast-forward, fast-rewind, double-speed play and drag play. The MVV player should support synchronous time-shift for all videos in multiscreen view service.

7.3.2 Playback

The MVV player should support the function of recording and playback for video gallery service and free viewpoint service.

7.3.3 'Wonderful moment'

The MVV player should be able to click the time-slice list to replay a 'wonderful moment' in the process of VOD/live broadcast.

7.4 Interacting key factors

There are several multiview scenarios; three typical multiview scenarios are listed below.

7.4.1 Multiscreen view interaction

In multiscreen play mode (see Figure 1), a user with a touch screen can click a small window video to switch the small window video to the big window video, and a user with a remote control can select a small window video and press OK on the remote control to switch the small window video to the big window video.

Figure 1 – Multiscreen view

A client with a touch screen can double click the big window to play it in full-screen mode, and click the big window to call up the play control menu or the play control bar to conduct time-shift operation (fast-forward and fast-rewind function, double-speed play or drag play, etc.).

A client with a remote control can press the OK button to switch the big window to full-screen mode, and press the up and down key to call up the play control menu or the play control bar to conduct time-shift operation (fast-forward and fast-rewind function, double-speed play or drag play, etc.).

The synchronized time-shift function makes all videos synchronously time-shifted during time-shift operation.

The bandwidth consumption issue is a challenging issue in multiscreen view. The big window requires high-definition resolution to make the user feel that they have a clearer view. The multiscreen view service requires a small delay so that the user can smoothly change the window.

7.4.2 Video gallery interacting

In the video gallery mode (see Figure 2), a user with a touch screen can swipe left and right to select the video to be played, while a user with a remote control can press the left and right keys to select the video to be played. During the selection process, all videos will be played continuously.

Figure 2 – Video gallery

After the selection operation stops, the gallery's position will stop moving and the images will be played continuously.

For clients with a touch screen, double clicking a play window switches to the full-screen play state of the stream, and double clicking again returns from the full-screen mode to gallery mode.

For clients with a remote control, when the focus is on a play window of the video gallery, the play control menu can be called up to select full-screen play mode for the stream, and pressing the back key returns from full-screen mode to gallery mode.

The video gallery service has similar requirements to the multiscreen view service. The bandwidth consumption issue is a challenging issue in the video gallery service. Video gallery service requires a small delay so that the user can smoothly change the window.

7.4.3 Free viewpoint interacting

Figure 3 shows a free viewpoint video.

Figure 3 – Free viewpoint video

When the user slides left or right in the play window or presses the left or right key of the remote control, the viewpoint can be automatically and smoothly switched, and the shorter the response time for switching, the better.

Double clicking the screen or pressing the OK key on the remote control calls up the play control menu or the play control bar to conduct time-shift operation (fast-forward and fast-rewind function, double-speed play or drag play, etc.). During the time-shift operation, the viewpoint remains unchanged.

Clicking the "Bullet Time" button or selecting "Bullet Time" with the remote control enters the bullet time mode, and pressing the back key returns from bullet time mode to normal play mode.

The bandwidth consumption issue is challenging for free viewpoint view. Free viewpoint view requires stringent delay so that the user can smoothly change the viewpoints when watching. Additionally, the immersive experience of "being there" is an important factor in free viewpoint view.

Bibliography

[b-Boyce] Boyce, J.M., et al. (2021), *MPEG Immersive Video Coding Standard*, Proceedings of the IEEE, Vol. 109, No. 9, 1521-1536.

[b-Qualinet] *Qualinet White Paper on Definitions of Quality of Experience* (2013), Output from the fifth Qualinet meeting, Novi Sad, March 12.
http://www.qualinet.eu/index.php?option=com_content&view=article&id=45&Itemid=52

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