Video Adaptation Concept for Universal Access

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Universal Access

The phenomenal rise in the multimedia content available to an increasing number of users, who intend to consume it at different locations with different presentation preferences, using a plethora of devices and through heterogeneous networks, have resulted in a complex dilemma for universal access to the multimedia content.

Universal access is the vision of accessing multimedia content with a certain amount of user experience regardless of any constraints (e.g., terminal capabilities, network condition, etc.) (Mao et al., 2019; Calvalho et al., 2004). There exist two main concepts, namely Universal Multimedia Access (UMA) (Rong et al., 2006; Vetro et al., 2003) and Universal Multimedia Experience (UME) which follow this vision (Pereira et al., 2003).

UMA

Video content can be viewed on a variety of devices such as laptops, tablets, TVs, etc. These devices use ubiquitous network connections with different characteristics to obtain the content. Moreover, the owners of these devices have various preferences. The amount of video content is increasing enormously day by day. Interoperability problem occurs within this complex landscape comprised by rich multimedia content, diverse devices with varying capabilities, diverse user preferences, etc.

The notion of UMA concept relies on allowing users to seamlessly access any content, using any device, through any network, at any time, and from anywhere. Thus, UMA is mainly focused on the negotiation between the usage environment constraints (i.e., network and terminal capabilities) and the vast quantities of content meeting these constraints for allowing this seamless access (Mao et al., 2019; Waltl et al. 2009; Jain 2004). Figure 1 shows the concept of UMA.

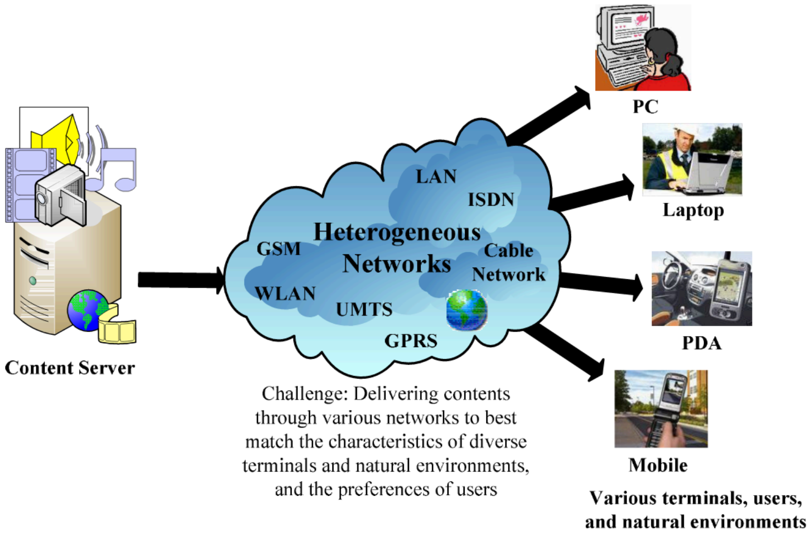

Figure 1. The Concept of UMA

UME

The context associated directly with the user her/himself (e.g., user's activities, habits, etc.) is the dominant driving force in the UME concept to provide the best possible multimedia experience to users. UME has been thought as the future of universal access to information since the theme of universal access has been shifted from a device-centric approach (i.e., the UMA concept) to a user-centric approach (Waltl et al., 2009).

Figure 2 presents the switch on the focus of universal access from UMA to UME. Adaptation is the most important process to provide the best possible video representations accommodating various constraints (e.g., terminal and network characteristics) as well as user preferences in both UMA and UME (Mao et al., 2019; Waltl et al. 2009; Jain 2004).

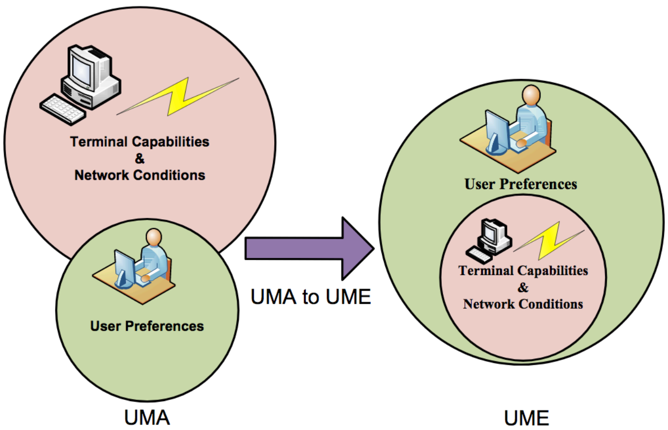

Figure 2. The Concept of UME

Video Adaptation Techniques

There are a number of video adaptation techniques which can be classified into three categories considering the processing technologies, the way the adaptation performed, and the level of adaptation operations executed (Mao et al., 2019; Waltl et al. 2009; Jain 2004).

Video Adaptation Techniques Based on Processing Technologies

Video adaptation techniques are split into three categories depending on the processing technologies used in the adaptation, namely: Scalable Video Coding (SVC) based adaptation, transcoding, and transmoding.

- SVC-Based Adaptation:

Adapting a compressed video stream into different spatial resolutions, temporal and quality levels using the support of SVC is offered by SVC based adaptation. This adaptation technology is performed by removing part(s) of a scalable video stream to satisfy a set of constraints (Nur Yilmaz, 2021; Kofler et al., 2008; Shen et al., 2006; Pan et al., 2008).

- Transcoding:

Transcoding is the process of manipulating or converting data from one format into another one. There are three major types of transcoding techniques existing in the literature: heterogeneous transcoding, which is based on format change (e.g., Motion Picture Experts Group-2 (MPEG-2) to MPEG-4), homogeneous transcoding, which relies on modification (e.g., temporal, spatial, quality etc.), and information insertion transcoding (e.g., editing, error resilience, etc.) (Kim et al. 2005).

- Transmoding:

Transforming multimedia content with one modality into another multimedia content having another modality (e.g., video to images, image to text, etc.) is called transmoding. Transmoding can also be identified as cross-modality transcoding (Baltazar et al. 2006).

Video Adaptation Techniques Based on the Way the Adaptation is Performed

The video adaptation techniques are divided into two categories when taking into account the way the adaptation is performed (Bijur et al., 2021; Martinez et al., 2005).

- Static (Off-line) Adaptation:

With the static adaptation technique, multiple versions of the same content are created at authoring time and the best variation satisfying a specific usage constraint (e.g., terminal capabilities, user preferences, etc.) is selected at runtime. Static adaptation technique is quick since the adaptation is only performed by selecting content from a set of content versions and sending the adapted content to the receiver. However, it has a disadvantage that it requires high storage capacity because different content versions should be pre-prepared and stored at the server (Bijur et al. 2021; Sofolleous et al., 2008).

- Dynamic (On-line) Adaptation:

Due to the dynamic behaviors of the terminals and network, it is required to process and adapt the multimedia content dynamically. This way of adaptation technique can be identified as real time adaptation, and is needed for the cases where various devices exist, and require on-the-fly adaptation of the accessed content. Dynamic adaptation can be performed at any location that has enough processing power. The processing power required for the on-line adaptation is higher compared to that for the off-line adaptation because of the dynamic adaptation operations (Bijur et al., 2021; Hutter et al., 2005).

Adaptation Techniques Based on the Level of Adaptation Operations

According to the levels of adaptation operations, the adaptation techniques are divided into three categories, namely: signal level adaptation, semantic level adaptation, and structural level adaptation (Bijur et al., 2021;Valdes et al., 2006).

- Signal Level Adaptation:

Signal level adaptation technique relies on using media signals (e.g., video, audio, etc.) during adaptation operations. Bit rate transcoding and spatial resolution reduction are some examples for signal level adaptation (Bijur et al., 2021; Nur Yilmaz, 2021).

- Semantic Level Adaptation:

This technique is based on rendering important events (e.g., scoring points in basketball videos, breaking news in broadcast programs, etc.) in video contents by summarization. These important events are defined by the content providers or user preferences (Bijur et al., 2021; Chang et al., 2003).

- Structural Level Adaptation:

Structural level adaptation is based on utilizing the relations of structural elements in a video content, which arise due to event occurrence orders, camera control patterns, etc. Mosaicking, which is converting video sequences captured by continuous camera into panoramic views is an interesting technique utilized in structural level adaptation. While mosaicking, the pixels in the background of different image frames are aligned together considering pixel correspondence and camera motions (e.g., pan, zoom, etc.). The pixels belong to the foreground moving objects are detected and they are placed on the top of the mosaicked background pixels (Bijur et al., 2021; Martinez et al., 2004).

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