Sensory Experience for Videos on the Web

Markus Waltl, Benjamin Rainer, Christian Timmerer and Hermann Hellwagner
Institute of Information Technology (ITEC)
Alpen-Adria-Universität Klagenfurt
Klagenfurt, Austria
{*firstname.lastname*}@itec.uni-klu.ac.at

Abstract—**More and more multimedia content is becoming available via the World Wide Web (WWW). These contents stimulate only senses like hearing or vision. Recently, it has been proposed to stimulate also other senses while consuming multimedia content, through so-called sensory effects. These sensory effects aim at enhancing the user's viewing experience by providing effects such as light, wind, vibration, etc. These effects are represented as Sensory Effect Metadata (SEM) which is associated to multimedia content and is rendered on devices like fans, lamps, or vibration chairs. In this paper, we present a plug-in for Web browsers which is able to render such sensory effects provided via Web content, and we describe a demonstrator that uses this plug-in to control an amBX system.**

Keywords-Quality of Experience; Sensory Experience; MPEG-V; Web Browser Plug-in; World Wide Web

I. INTRODUCTION

Multimedia content (i.e., combinations of text, images, audio, and video) has become omnipresent in our life. Each day we consume dozens of multimedia assets when reading electronic newspaper, listening to Internet radio, and watching digital television (TV). In 2008 W3C established a strategy that video should become more prominent on the Web [1]. A major contribution towards this goal is the HTML5 video tag [2]. HTML5 provides means for playing videos within a Web site without the need for an additional player such as Flash or QuickTime. Furthermore, Internet platforms are already implementing recommended technologies, e.g., YouTube started supporting High Definition (HD) some time ago and recently started to offer services beyond HD in the so-called Ultra-HD format (i.e., resolutions of 4k (4096 x 3112) and beyond).

Another dimension that recently gained popularity is 3D graphics which is already supported on the Web. The technical foundation for supporting 3D video on the Web is already in place [3]. Furthermore, devices providing additional effects (e.g., lights) are already emerging and well received [4].

The work presented in this paper goes one step further by enriching multimedia content with additional effects (i.e., light, vibration and wind) in the context of the World Wide Web (WWW). To achieve this, we present a Web browser plug-in which supports these so-called sensory effects.

The remainder of this paper is organized as follows. Section II presents related work in the area of sensory effects and multimedia. Section III introduces the Web browser plug-in which we developed to enhance the user experience for multimedia content on the Web. Section IV describes our demonstration utilizing the browser plug-in. Our conclusions and future work items are presented in Section V.

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II. RELATED WORK

During the past years the new research area of sensory information has been introduced. This area comprises research on ambient illumination [4], olfaction [5] or combinations of various sensory effects (e.g., vibration and light) [6]. Additionally, ISO/IEC MPEG has recently approved a standard called MPEG-V – Media Context and Control [7] which resulted in various research efforts [8]-[11]. In [8] and [9] we have performed formal subjective quality assessments in order to investigate the benefit of sensory effects under different circumstances (e.g., genres, bitrates). The results presented in [8] indicated that sensory effects are enhancing the quality of experience for genres like action or documentary, but they are annoying for the news genre. The observations described in [9] denote that sensory effects can increase the perceived video quality, i.e., video bitrates can be reduced without influencing the viewing experience of the user when additional effects are being added.

Choi et al. [10] presents a framework for Single Media Multiple Devices (SMMD) media services which support sensory effects. Furthermore, the paper presents an authoring tool for generating SMMD media files accompanied by sensory effects. In [11] a short overview of the different parts of the aforementioned MPEG-V standard is given. The description of each part is based on a 4-D broadcasting scenario, i.e., a video broadcast is accompanied by sensory effects which enhance the user's Quality of Experience.

Since the WWW gains more and more importance, we have implemented a Web browser plug-in which is capable of rendering sensory effects [12]. In its first version, we have focused on ambient light effects that can be automatically extracted from the video content without the need for additional metadata. In [12] we investigated the benefit of Web videos enriched with ambient light effects in the context of the Web. Furthermore, as the color information is extracted directly from the video frame, we investigated the influence on the subjective quality when skipping pixels, entire rows, and frames for calculating the information to control the ambient lights. The results of these two assessments are that ambient light enhances the user experience in the context of the WWW.

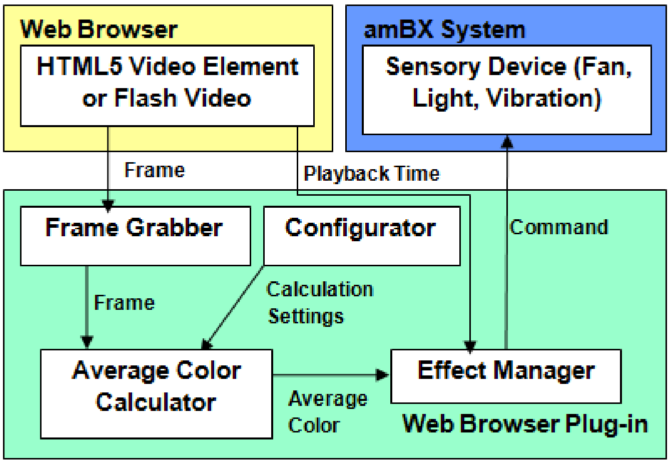

Figure 1. Architecture of the Web Browser Plug-in.

Furthermore, the results obtained indicated that if performance issues arise, entire frames should be skipped first as this only influences the transition of the color and does not influence the quality of the viewing experience. If pixels or entire rows of pixels are skipped, this can lead to colors which do not match the content displayed on the screen and thus, annoy the user.

III. Web Browser Plug-in

Our Web browser plug-in provides a communication component between the Web browser (e.g., Mozilla Firefox) and the amBX system [13] used in our experiments. The amBX system consists of two fans, a wrist rumbler, two sound speakers and a subwoofer, two front lights, and a wall washer.

Fig. 1 illustrates the architecture of the Web browser plug-in. The aim of this plug-in is to enhance the user experience in the context of the World Wide Web. It is able to extract color information from Web videos and render the color on the amBX lights synchronized to the content. Therefore, the plug-in retrieves the video frames either from Flash content or the HTML5 video tag by using the implemented *Frame Grabber*. Moreover, the plug-in is able to load and parse so-called Sensory Effect Metadata (SEM) descriptions which are specified in MPEG-V – Media Context and Control – Part 3: Sensory Information [14]. The SEM description contains information about sensory effects such as wind and vibration which are rendered on the amBX fans and wrist rumbler respectively.

The plug-in provides a *Configurator* which allows setting different color calculation options by means of a configuration dialog during initialization. The plug-in can be configured w.r.t. whether and how many video frames, rows, or pixels within a row should be skipped in order to increase the performance of the color calculation. For extracting the color information, the plug-in uses the retrieved video frame according to the given configuration in order to control the amBX system via commands through the corresponding SDK. The settings for the color calculation can also be used to change the frequency of color transitions. By default, the *Frame Grabber* retrieves approximately 33 frames/s. Based on the frame skip value, the frame grabber decides whether the current video frame should be skipped or not. For example, if

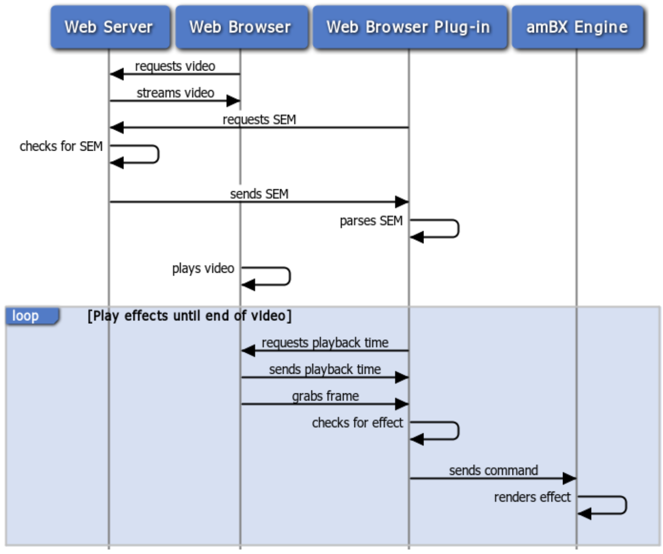

Figure 2. Process Diagram of the Web Browser Plug-in.

we take only every third frame for the average color calculation, light colors will change every 100 ms instead of every 33 ms. If the current video frame is not skipped, the frame grabber forwards the configuration information and the video frame to the *Average Color Calculator*. The color calculator splits the current video frame into different parts which correspond to the setup of the lights of the amBX system (i.e., lights on the left, center-back, center-middle, center-right, and right). For each of the parts, the average color is calculated and the result is forwarded to the *Effect Manager* which activates the corresponding lights of the amBX system.

For the other sensory effects, i.e., vibration and wind, the Web browser plug-in uses the information from the SEM description. The effect manager parses the SEM description, provided as an URL, before the content is being displayed. For the synchronization of the effects with the actual content, the Web browser plug-in uses the time information received from the video player. Fig. 2 illustrates the process described above as a sequence diagram.

Since the Web browser plug-in performs frame grabbing on the currently played video content, an increase of CPU load by around 50% to 90% can be observed (tested on a Pentium D 2.8 GHz, 1 GB RAM, ATI Radeon HD2400 Pro with Mozilla Firefox 5 and the Shockwave Flash 10.3 plug-in). This results in playback artifacts for 720p and higher resolutions if the used system does not provide enough processing power. It has to be mentioned that the performance can be drastically increased if the Web browser uses GPU-based video rendering. This decreases the CPU load to 30% to 50% (tested on the same system but with an ATI Radeon HD5450) and prevents video artifacts.

IV. Demonstrator

This section presents our demonstrator for the Web browser plug-in. The demonstrator consists of a number of Web videos offered by a Flash player (i.e., JWPlayer [15]). The aforementioned plug-in retrieves the video frames from the

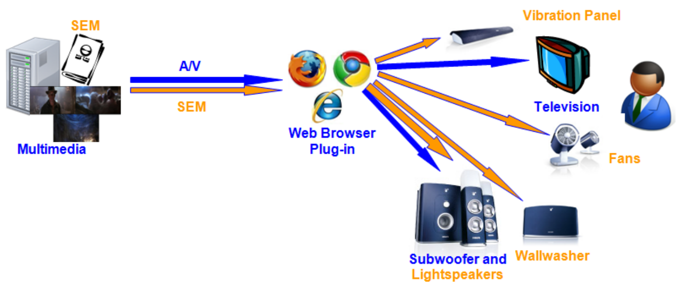

Figure 3. Schematic View of the Demonstrator.

player and renders the average color on the amBX system. Furthermore, the plug-in requests available SEM descriptions and activates the fans and vibration panel of the amBX system in correspondence to the shown content.

Fig. 3 presents a schematic view of the demonstrator. A single server provides the video content and SEM description. The Web browser plug-in uses the information stored in the SEM description to control the amBX system. For providing light effects it retrieves the currently displayed video frame and displays the average color on the amBX lights. The video content is displayed regularly on a computer/TV screen. An example of the demonstrator is shown in Fig. 4.

V. Conclusion and Future Work

In this work, we have presented a Web browser plug-in which offers the possibility to enhance the user experience by sensory effects in the context of the WWW. The conducted subjective quality assessments [12] indicate that sensory effects (i.e., light effects) can improve the user experience providing a sensory experience for multimedia on the Web. Furthermore, the demonstrator presented in this paper gives an overview of the currently available technology and standards for providing a unique, worthwhile, and enhanced user experience in the Web.

Future work includes providing a comprehensive data set of multimedia content annotated with sensory effects. Additionally, we are building a live test-bed for evaluating sensory effects (i.e., wind, vibration and light) on a large scale. The live test-bed will provide us with the possibility to engage a large number of users in the tests and, thus, will allow us to provide a more general conclusion on the results presented in this work and in our previous evaluations.

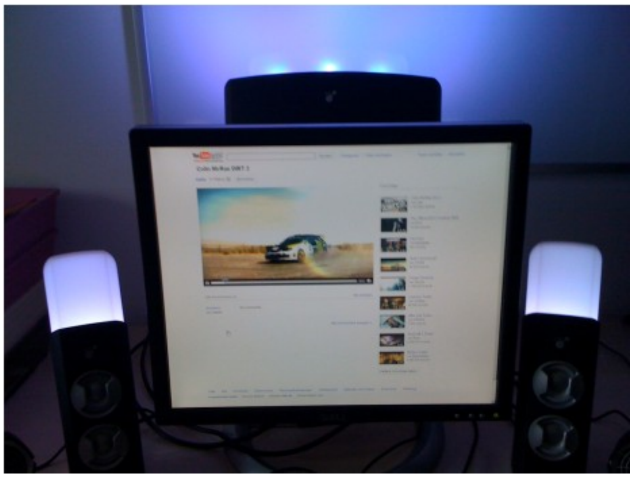

Figure 4. Example of the Demonstrator.

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