Immersive Future Media Technologies: From 3D Video to Sensory Experiences

Christian Timmerer
Klagenfurt University
Universitätsstraße 65-67
A-9020 Klagenfurt
+43 (463) 2700 3621
christian.timmerer@itec.uni-klu.ac.at

Karsten Müller
Fraunhofer/Heinrich-Hertz-Institut
Einsteinufer 37
D-10587 Berlin
+49 (30) 31002-225
kmueller@hhi.de

ABSTRACT
In this tutorial we present immersive future media technologies ranging from 3D video to sensory experiences. The former targets stereo and multi-view video technologies whereas the latter aims at stimulating other senses than vision or audition enabling an advanced user experiences through sensory effects.

Categories and Subject Descriptors
H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems – *Evaluation/methodology*.

General Terms
Measurement, Experimentation, Human Factors, Standardization.

Keywords
Immersive Media, 3D Video, Stereo Video, Multi-view Video, Sensory Effects, MPEG-V, Quality of Experience.

1. INTRODUCTION
The past decade has witnessed a significant increase in the research efforts around the Quality of Experience (QoE), e.g., [1], which is generally referred to as a human-centric paradigm for the Quality of a Service (QoS) as perceived by the (end) user. Previous research has identified various dimensions in the area of QoE [2] while others work toward a theoretical framework [3]. One dimension recently gained momentum is 3D video [4] which aims for an increased immersive user experience [5]. Another dimension aims at going beyond 3D and promises advanced user experience through sensory effects [8][9]. We will briefly outline both dimensions presenting means for immersive future media technologies. Hence, this tutorial is organized in two parts.

The first part addresses issues related to 3D video coding technologies ranging from stereo-video systems – currently being commercialized – to more flexible 3D video systems, i.e., multi-view systems independent of the number of views. The second part of the tutorial covers yet another (new) dimension of the QoE, which we think, will go beyond current and emerging 3D technologies. In particular, we argue that the consumption of multimedia resources may stimulate also other senses than vision or audition, e.g., olfaction, mechanoreception, equilibrio-ception, or thermoception which shall lead to an enhanced, unique user experience. Therefore, the multimedia resources are enriched with additional metadata describing so-called sensory effects that are rendered on sensory devices like fans, vibration chairs, lamps, perfumer, etc.

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2. 3D VIDEO: STEREO AND MULTI-VIEW VIDEO TECHNOLOGY
3D related media technologies (e.g., [6][7]) have recently developed from pure research-oriented work towards applications and products. 3D content is now being produced on a wider scale and first 3D applications have been standardized, such as multi-view video coding for 3D Blu Ray disks. This development was only possible due to joined international research and development work on all stages of the 3D media chain from data capturing via transmission and coding to multi-view displays with different application areas for digital cinema, home entertainment and mobile services.

This part of the tutorial starts with an overview on 3D in the form of stereo video based systems, which are currently being commercialized. For this, stereo formats and associated coding are introduced. However, the available systems mostly require stereo glasses for multiple users. Here, recent developments in display technology led to glasses-free multi-view displays. For such displays, the current stereo solutions need to be extended. Therefore, current activities in 3D video are introduced. These 3D solutions will develop a generic 3D video format with color and supplementary geometry data, e.g. depth maps, and associated coding and rendering technology for any multi-view display, independent of the number of views. As such technology is also developed in international consortia, the most prominent, like the 3D@HOME consortium, the EU 3D, Immersive, Interactive Media Cluster and the 3D video activities in ISO-MPEG are introduced.

3. ADVANCED USER EXPERIENCE THROUGH SENSORY EFFECTS
This part of the tutorial addresses a novel approach for increasing the user experience – beyond 3D – through sensory effects which is referred to as sensory experience. The motivation behind our work is that the consumption of multimedia assets may stimulate also other senses than vision or audition, e.g., olfaction, mechanoreception, equilibrioception, or thermoception that shall lead to an enhanced, unique user experience [8][9]. This could be achieved by annotating the media resources with metadata providing so-called sensory effects that steer appropriate devices capable of rendering these effects (e.g., fans, vibration chairs, ambient lights, perfumer, water sprayers, fog machines, etc.). In

particular, the metadata format for describing such sensory effects, i.e., Sensory Effect Description Language (SEDL), will be defined by ISO/MPEG as part of the MPEG-V standard.

In particular, we will review the concepts and details of the forthcoming MPEG-V standard enabling advanced user experiences through sensory effects. We will further present our prototype architecture for the generation, transport, decoding and use of sensory effects. As this covers a completely new dimension of the QoE, this calls for a scientific framework to capture, measure, quantify, judge, and explain the user experience. Therefore, we will present details and results of a series of formal subjective quality assessments which confirm that the concept of sensory effects is a vital tool for enhancing the user experience. However, this novel approach will not only be addressed theoretically but also by means of concrete use case scenarios and comprehensive examples. Additionally, these concepts will be demonstrated by prototype software implementations.

4. BIOGRAPHY OF PRESENTERS

Karsten Müller received the Dipl.-Ing. and Dr.-Ing. degree from the Technical University of Berlin, Germany, in 1997 and 2006 respectively. In 1996 he joined the Heinrich-Hertz-Institute (HHI) Berlin, Image Processing Department, were he is a project coordinator for European projects in the field of 3D media technology. His research interests include motion and disparity estimation, 3D media representation and coding, 3D graphics-based scene reconstruction with multi-texture surfaces, and 3D metadata and content description. Further information can be found at http://iphome.hhi.de/mueller/.

Christian Timmerer received his M.Sc. (Dipl.-Ing.) in January 2003 and his Ph.D. (Dr.techn.) in June 2006 (for research on the adaptation of scalable multimedia content in streaming and constraint environments) both from the Klagenfurt University. He joined the Klagenfurt University in 1999 and is currently a Assistant Professor (Ass.-Prof.) at the Department of Information Technology (ITEC) – Multimedia Communication Group. His research interests include the transport of multimedia content, multimedia adaptation in constrained and streaming environments, distributed multimedia adaptation, and QoS/QoE. Further information can be found at http://research.timmerer.com.

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