

PERCEVAL - A Norwegian Project on Perceptual and Cognitive Evaluation Techniques for Audiovisual Systems

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Introduction

Today, few methodologies and software exists to assess the complex effects of human audiovisual quality perception. Especially the combination of multi-modal perception, in which audio and video stimuli interact, is largely unexplored. Current objective and subjective assessment methodologies approach the problem mainly from a technical perspective, considering frame rates, spatial resolution and distortion artifacts. The perceptual and cognitive side of quality experience is thereby frequently ignored. Most methods also require a controlled laboratory environment, restrict stimulus duration to a few seconds, and demand full attention from assessors. This makes them inadequate for long-term evaluation of user sensations in real application scenarios where perceptual, affective and cognitive factors are of paramount importance.

In response, PERCEVAL [1] aims to develop a novel approach to multi-modal quality assessment for audiovisual systems by considering cognitive, perceptual and affective quality attributes. We approach the challenges with an interdisciplinary research team, consisting of researchers from cognitive psychology, sensory analysis of food, and multimedia technology. Although this research may be relevant for many multi-modal applications, we focus on two key scenarios, the World Opera project, and scalable video coding.

This contribution discusses the project with a focus on the World Opera project and introduces the difficulties found in the World Opera scenario.

The World Opera Scenario

In the World Opera project, the participating opera houses and partners “provide a worldwide platform for exploring tradition and innovation in opera as a diverse artform in multiple formats” [2]. From a technical point of view, this means that the World Opera project explores the possibilities of networked performances of a distributed opera, with artists interacting across continents in a live performance situation. In this scenario, quality perception has multiple facets: On the one hand, it is expected that the quality of audio-visual information transmission and display will determine the expressiveness, interaction, and performance of the artists on stage. Although the technical parameters describing such a setup are well defined, relatively little is known about the

impact of these parameters upon an artistic performance. For example, Chafe et al. have published on the effect of time delays on ensemble accuracy [3], and Olmos et al. have explored the role of latency and orchestra placement on the networked performance of a distributed opera [4]. On the other hand, enabling the artists to perform satisfactorily does not necessarily provide the spectators, i.e. the public present in one of the participating opera houses or in a third location, with a decent quality experience. Rather, the impact of novel technologies as applied by the World Opera project upon the opera goer, and specifically on his quality perception in terms of an overall quality of experience, is largely unexplored. Not surprisingly, many of the questions that arise cannot be answered today, because there are no methodologies available that would allow an evaluation of perceived quality in such a scenario.

Among the questions unanswered are those relating to multi-modal perception, annoyance, and information loss. The three central questions in the PERCEVAL project are: When do users become aware of low audiovisual quality under the assumption that no direct reference exists? When do users become annoyed by poor quality? And, when is information actually lost due to poor quality? Answering these questions is challenging, because annoyance and information loss are affective and cognitive attributes. They can not yet be measured directly like physical quantities or objective metrics. Moreover, they vary between individuals, contexts, and application purposes. However, annoyance thresholds can help to identify soft limits at which people are likely to reject acceptance of a technology, while information loss depicts critical limits at which a technology fails.

For the World Opera scenario to be successful, PERCEVAL will need to provide answers to several more challenging questions: How will artists and audiences perceive and react to mixed-reality performances? What are the important quality factors, and where are the limits at which opera goers become annoyed of technology in general and poor quality in particular? Which factors must be considered in the World Opera design to avoid the risk of spectators refusing the technology? There are even more specific questions for the World Opera: When do two out-of-sync video displays render a mixed reality performance meaningless? Can audio help to regain comprehension? What are the limits of synchrony in multi-modal settings with multiple video displays?

PERCEVAL aims to find answers to these questions by designing, applying, and verifying novel perceptual assessment methodologies, which could prove beneficial for

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other areas of audiovisual media as well.

Perceived Quality - Human Perception

Research in the PERCEVAL project follows an empirical and interdisciplinary approach involving sensory analysis and statistics researchers at Nofima Mat AS [5], cognitive psychology researchers from the Institute of Psychology at the University of Oslo [6], and multimedia technology researchers at the Centre for Quantifiable Quality of Service in Communication Systems [7] and Simula Research Laboratory [8]. By joining researchers with these very different backgrounds, we hope to gain deeper insights into the mechanisms of human audiovisual perception. At the same time, this will stimulate the development of novel experimental and statistical methodologies, extending the well-known rating-scale and comparison based ITU recommendations in the field of audiovisual quality perception.

In a first step, PERCEVAL will apply sensory analysis methodologies with the use of a trained sensory panel [9]. Such methodologies are useful to describe and measure quality characteristics of products in an easy and relevant language. Mapping techniques can then be used to relate sensory data to consumer preference. Sensory analysis plays a crucial role for product development and quality control of food, an area in which it has been applied for a long time [10]. PERCEVAL will apply these principles to the field of audiovisual technology in order to find attributes that describe user satisfaction regarding overall quality, annoyance, and information loss due to poor quality as described above.

PERCEVAL also includes cognitive psychology to help understand the mechanisms of interaction between auditory and visual stimuli. These interactions are assumed to play a crucial role in the design of cross-modal objective metrics based on mono-modal (auditory or visual only) ones [11]. Cognitive psychology will further help to define the limits of cognitive and affective impressions, like information loss and annoyance, and provide input for the design of appropriate assessment methodologies. At the same time, psychology will also provide insights into the effects of quality perception over extended periods of time, i.e. durations of several minutes up to hours, which will later guide the development of low-attention and long-term assessment procedures.

Project Outline

The PERCEVAL project had its kick-off meeting in late Q3 2009 and is scheduled to terminate in Q4 2012. Its six work packages are separated into topics from multiple disciplines:

- WP1: Sensory analysis and preference mapping
- WP2: Mono-modal quality assessment
- WP3: Cognitive study of multi-modal perception, annoyance, and information loss
- WP4: Multi-modal assessment method design

- WP5: Robustness analysis and method validation
- WP6: Objective metric design and validation

So far, work on the first three work packages has started by looking into the relevant attributes that determine an overall quality perception in the World Opera scenario. First results are expected in Q2 2010, when data from user preference assessments will be mapped to data coming from sensory profiling experiments. This way, we expect to find out which attributes are associated with users' perception of low quality, which attributes are drivers of annoyance, and which attributes describe factors responsible for information loss.

Literatur

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