

THE ROLE OF AUDIOVISUAL QUALITY IN MOBILE TELEVISION

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ABSTRACT

Audiovisual quality is an important factor in acceptance and success of new mobile services such as mobile television. The produced quality is always a combination of the development of content and service providers, as well as handset manufacturers. The end result is perceived as a unity by the end users. Audiovisual quality effects consumers' technology acceptance and adoption of new products. The quality requirements vary between different consumer groups, their needs for contents and usage contexts. The perception of quality is a combination of sensorial, cognitive, emotional and social factors. In this paper, we present how the presented quality factors and requirements can be applied in different levels of subjective quality research. The proposed model sets a framework for testing the complete set of user acceptance criteria of mobile TV audiovisual quality experience.

1. AUDIOVISUAL QUALITY IN MOBILE TELEVISION PRODUCTS AND NEW TECHNOLOGY ACCEPTANCE

Mobile devices and mobility set special technical requirements for mobile television and video presentation (e.g low bitrate, framerate, screen size and battery life time). The overall quality of mobile television is created as a sum of technologies developed by different players in the field. The players in the field have been described as the mobile value chain by Funk 2004[4]: Content owner, producer and provider, together with the service provider deliver the content to the user. In addition, the handset manufacturer plays a key role by providing the user interface, including the output devices for the end user to experience the content. User's experience and perception of quality is built on the combination of content production (content quality, objective quality, coding), service providing (transmission quality) and handset design and

implementation (design, application interaction, display quality). The success of the resulting product depends on how well these factors together support the overall experience.

Audiovisual quality is a factor in the broader picture of technology acceptance. The technology acceptance model TAM [2] models users' acceptance of technology as combination of perceived ease of use, perceived usefulness and intention to use, which leads to usage behaviour. Venkatesh and Davis [20] have extended this model by describing factors affecting perceived usefulness in which output quality presents one set of factors [10]. Kaasinen (1995) has developed the model further to Technology Acceptance Model for Mobile Services and emphasises the importance of trust and perceived ease of adoption [10]. Audiovisual quality can be seen as one such output quality factor which affects users' trust towards a system, and finally the willingness to use the new technology. TAM, with its extensions, illustrates the complexity of how consumers finally adopt a new technology product. Quality levels of the factors listed above (in Section 1) play key roles, however, the final acceptance is a result of a broader picture. To be able to develop acceptable mobile TV product quality, the total effects of the quality factors to the experienced quality need to be investigated.

2. FROM PERCEIVED QUALITY TO EXPERIENCED QUALITY

Experience of quality consists of integrated set of perceptions combining low-level sensorial and high-level cognitive processes including emotional and social viewpoints. Experience of quality can be defined as overall degree in excellence of how the system fills the requirements based on perceptual processes. In video and audio quality research, perceptual quality is mostly related to noticeable factors handled in low-level sensorial processing (e.g. brightness, color, motion, pitch, loudness, timbre). The necessary part of the experience of quality is the high-level cognitive

processes as a part of perceptual processes. They are needed to unified audiovisual processing, object recognition, knowledge directed interpretation under attention and action [6]. For example, knowledge bases on individual schemas representing reality in human mind mediated with emotions and attitudes as social factors [3]. In the wide view, the quality refers to the ability to fulfill the requirements of all experience factors (low-level sensorial, high-level cognitive including emotional and social factors) included in perceptual processes.

An umbrella perspective to experience of quality is missing in the field of audiovisual quality research. Traditionally one-dimensional satisfaction represents the experience of quality in television quality research focusing on sensorial level of quality [15]. Recently more detailed descriptions are presented with a concept of Quality of Perception (QoP) [5] that combines subjective satisfaction and cognitive information assimilation into one experience of quality. Further more, Pereira [16] has introduced the layered model of quality of experience including sensation, perception and emotions. According to Pereira in sensorial layer, for example bitrates, spatial and temporal resolution can be measured. Perceptual layer focuses on presenting the material “what and where” cognitively efficient way and emotional layer gives ideas from color temperature to content adaptation and changes of modalities. All these three dimensions are at least needed to take into account while talking about the experience of quality.

In the current stage of the audiovisual quality research, the quality of experience factors can be listed mostly based on traditional psychology. However, the challenges for the future are in identifying the most important quality experience factors, in finding the relations between them and finally in exploring the proper combinations of research methods to measure the quality of experience. In these well-defined measurements, the acceptance is the lowest level of experienced quality. Experience of quality and its measurements are strongly related to consumer or user groups, contents and usage contexts.

3. THE QUALITY REQUIREMENTS OF MOBILE TV FOR CONSUMPTION, CONTENT AND CONTEXT

Consumers - Mobile television is expected to become a mass broadcasted service. Mobile terminals are becoming standard personal appliances in the developed countries and a broad part of the population can be expected to be target consumers of the mobile TV as ubiquitous service. The adoption of a new service will start from the innovators and early adopters [18], but

will spread to the mainstream population later in the new technology diffusion process. According to Moore (2002), ease of use of new technology innovation is a key requirement in crossing the chasm between the early adopters and early mainstream [13].

There are connections between the audiovisual quality and consumer or user groups. Our earlier studies on subjective assessment on audiovisual quality indicate that innovators and early adopters are more optimistic in their evaluations than other consumers. In addition, it appeared that the older the participant, the lower the quality requirements (with the sample aged 18-65 years). The tightest quality requirements arose from the young participants (18-25 years) [7]. It can be expected that the audiovisual quality requirements vary between the consumer and user groups. In these requirements contents and contexts can set their own characteristics.

Content - Popular television contents are expected to become popular also in mobile television. Objectives in different type of genre consumption are to become informed and/or entertained [1]. According to study of Södergård et al. [19] the most popular contents in a mobile television would be informational news, entertaining sport and different type of television series. Compared to traditional television the mobile television content consumption is expected to relatively short less than 10 minutes and also the different narration type may needed for mobile television presentation [19].

In quality evaluations, there are some interesting connections between the quality and contents. In subjective experiments, it is widely reported that the results were strongly content dependant. The same phenomenon is also reported when the popular television contents is used in subjective quality evaluation for mobile devices [11][9]. For example, the audio-video bitrate ratio is very content sensitive [9]. In the usage of television contents the evaluations are affected by participants’ interests and knowledge of the content. The quality requirements are tighter for the recognized content and lower for the interesting content [8]. The use of popular television in subjective testing seems to reflect the phenomena appearing in the real usage.

Context - Context of use is a main concept in user-centered design of technical systems and it comprises the characteristics of users, users’ tasks, technical equipment, and physical and social environments [14]. The most common usage contexts of mobile TV are typically public transport vehicles, home and work place [12]. The mobile contexts are inherently heterogeneous and in the design process, usage contexts are hard to fully predefine.

When connecting the usage context to the audiovisual quality there is neither any publications

from this topic nor conducting subjective quality evaluation tests in the real usage. It can be expected that the quality requirements will vary according to the context. A scenario can be drawn about news listening and watching. In the bus stop, audio material can be preferred. In contrast, during the bus trip watching the audiovisual content can be managed and after leaving the bus the audio becomes again more preferred. Simultaneous tasks may have an effect on the quality requirements in different usage contents.

The consumer or user needs, content types and usage contexts set the own characteristics to product quality requirements. In general, their potential is not taken into account in as high level as it could be. In the next section, we propose a framework for combining the experience of quality factors to consumer needs, content types and usage contents. The goal is to introduce a new perspective on audiovisual quality acceptance measurements during different phases of product development.

4. IMPLICATIONS TO AUDIOVISUAL QUALITY MEASUREMENTS FOR MOBILE TV

Implications to audiovisual quality measures for mobile television lie in how to take into account quality factors in the different stages of subjective testing in order to investigate the acceptance level as early as possible in product development. The subjective testing stages can be divided into three levels: psychophysical assessment, quality optimization assessments and usability testing (adapted from [17]). From the product development point of view, the emphasis is put on the two latest stages (see Figure 1).

Usability tests require the highest degree of product readiness. It can mean high level of requirements for all components of the product e.g. wireless connections, user interfaces and contents. In addition, in usability testing stage, potential users, contents and usage contexts can be known in detail. Also the test measurements and tasks can cover different experience factors such as cognitive, emotional and social factors and some tests can be conducted as field trials.

Quality optimization assessment is also a part of typical testing in product development even though the degree of the product readiness is not as high as in the usability tests. The quality optimization measurements in mobile television can for example focus on compression optimization (audio-video bitrate optimization) or different features of transmission optimization. Even though the product readiness is lower than in usability testing the part of the typical features of usability testing can already be applied. The benefits of applying the features of usability testing are to cover the consumer or user, content and context quality requirements as early as possible. On the other hand more versatile research methods can be utilized to measure multidimensional experience of quality instead of plain satisfaction or sensorial measurements. The main point is to reach the acceptance quality level as early as possible in product development.

Psychophysical assessments mainly focus on testing sensorial phenomena. The tested factors can be for example brightness, color, motion, pitch, loudness, timbre. Mostly this research is not bound directly to product development.

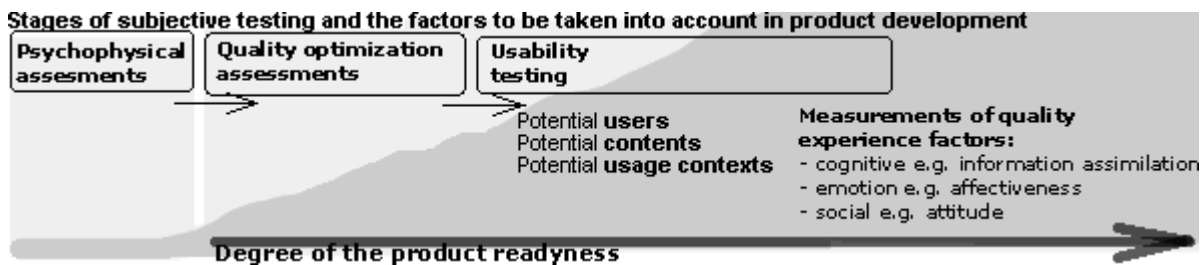


Figure 1. Stages in subjective testing and factors consider in the testing for product development purposes

4.1 The practical implications for user, content and context selection for the subjective testing in quality optimization assessment

The potential user selection can be taken into account in careful sample selection for the subjective tests. According to the previous research technology attitude and age can be strong indicators in this [7].

Potential content selection can focus on usage of contents of particular application field as stimuli material. In content selection, in addition to potential and popularity it is equally to select the final stimuli representing the things to be measured (e.g. spatial details, temporal motion and length of the stimuli). In potential content selection for mobile TV, we suggest the usage of normal television materials instead of available video quality clip libraries. Also the length of potential consumption times can be taken into account as well as possible. Potential content selection may tightly depend on potential user selection.

Potential usage contexts can be used at least parallel to laboratory environment in audiovisual quality tests. Before more knowledge is gained from this field it can be advised to do the parallel tests. Another reason is in research methods. Short contextual studies may need partly qualitative research approach and traditionally laboratory research is focused on quantitative measurements. The real usage context selection may tightly depend on users and contents.

4.2 The practical implications for quality of experience measurements for the subjective testing

Quality of experience factors can be categorized in many different ways. In Figure 1 it is divided to cognitive, including sensory and perceptual, emotional and social factors. More important than categorizing the factors according to psychological naming is to examine the most important factors related to different user groups, contents and usage contexts. As the first step, this naming research will require understandable qualitative or quantifying qualitative research approach.

After understanding the factors and their relations, the definition of quality is stated and it can be measured. The goal in understanding the role of quality factors is to state the model and constants to the equation that describes the quality of experience (hypothetical example e.g. $QoE = x * Cognitive + y * Emotional + z * Social$). The second step is to select the proper research methods combinations to measure the quality of experience in the conditions where some of the factors are manipulated.

Examples of different research methods related to cognitive, emotional and social factors are:

Cognitive: Information recall measurements in which the sets of questions are presented to the subjects to ask the most necessary points of the content. e.g. How many cars were in the content? What was the result of the match?

Eye-tracking can be used to view the regions of interests in the contents (e.g. bug, texts, faces).

Emotional: Questions e.g. How pleasing/ (un)comfortable / entertaining was watching the last content?

Social: Attitude measurements towards contents and contexts, studies about the effect of context.

The feasibility of quality of experience factor modeling and measurements depends on the level generalizability. It can be expected that such a model is dependant on the user groups and content (and context) instead of a global model for subjective experiments. When considering the objective metric construction, the model might be the high level model that applies to the sensorial models. In summary, the primary aim of the experience of quality model and quality measurements in to the model is to capture a holistic quality approach and then set the experimental research method combinations to capture it.

5. SUMMARY

This paper presented a holistic approach to audiovisual quality and quality factors in the acceptance of new mobile television services. In the acceptance of new products as mobile TV, perceived usefulness e.g. in terms of output quality is one of the influencing factor. In this paper the short overview to ideas from perceptual quality and quality of experience was given to support the integrated view. Related to mobile television and quality requirements, the effects of consumer-user groups, contents and contexts were discussed. In addition, the current stage of the knowledge of experience of quality was evaluated and future work was suggested. As a practical implication we presented the framework suggesting that the experience factors measurements connected to consumer-user groups, contents and contexts could be taken in to account efficiently in early stages of subjective assessments.

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