Defining the Viewing Conditions in the Home Environment and its Influences

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Abstract

This work describes the activities towards the definition of modern TV viewing environments and possible changes over time from a standardization point of view compared to the real usage in the living room. Up to now, standards are available in order to recommend the ideal viewing environment for different viewing conditions including TV system, usage purpose and kind of visualization (e.g. 2D vs. 3D) for subjective assessment of quality in laboratory environments. In order to define these and similar factors for the therein differentiated home environment a study was conducted investigating the collection of data which is relevant for future evaluation purposes. The results show, that different profiles might be detectable concerning room conditions but not concerning the illumination and ambient light conditions deriving from a small-scale field examination. Based on this, we would like to discuss the process of defining the home environment and its influence including ambient light conditions.

Index Terms: viewing environment, TV, user experience, standards

Introduction and Background

In order to get reliable and comparable cross-researcher evaluation results of studies in the home environment, it is important to consider the influence of the TV viewing environment and its definitions in standards. This importance derived within the question on device calibration which interferes with the environment by nature. In order to allow comparable cross studies and to investigate single influencing factors without excluding the real usage environment we want to know more about the real conditions of the home environment. Thus, changes of general viewing conditions for subjective assessments in home environments concerning new usage habits and trends need to be considered. Figure 1 visualizes exemplarily a home environment profile based on the information of interior equipment.

Recommendations (e.g. [1], [2]) defined the basic information and necessary factors for the laboratory viewing conditions in order to ensure comparable evaluation results. This includes the reconcilement of preferred viewing distance, illumination, and respective calibration of the used TV system in order to detect critical quality influencing factors. There are suggestions available concerning the definition of home environment as well. However, in order to conduct compare able tests, we assume a more detailed definition of the home environment is mandatory [3]. This includes a possible differentiation into different profiles for different user and usage habits, for example in the living room (see Figure 1).

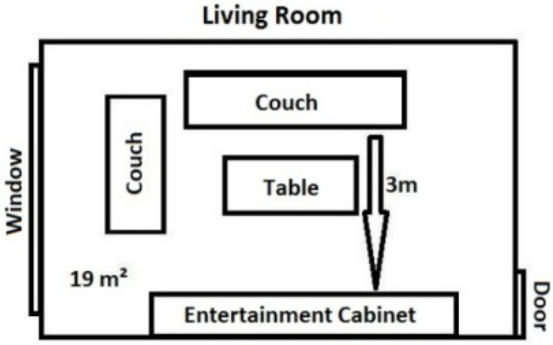

Figure 1: *Approach of a home environment profile*

This work shows results of a field examination and asks for future activities towards home environment definition. New trends like second screen usage, 3D-TV devices, as well as smart home functionalities may shape this viewing environment completely. Studies considering these further forms of influences defining the viewing conditions are provided by Abreu, Almeida, Teles, and Reis [4]. Herein, the focus lies on the viewer behaviors and practices in the changing television environment.

A cross-lab study by Li et al. on preference of experience in 3DTV investigated the influence from display technology and test environment towards quality rating [5]. In this case, as well as by a study provided by Pinson et al. [6] a significant influence by the viewing environment on quality assessment was neglected. However, defined viewing conditions in the home environment focusing on research questions within cross-lab studies which need a more detailed description of the considered viewing environment allowing a detailed description of influencing variables may be useful. Experiments asking for sublimation of influencing factors and degrees of freedom may profit thereof. Furthermore, on viewing conditions within the home environment based pre-sets or special viewer profiles considering detected influences may be useful in the future for applications within more complex and differentiated viewing conditions.

In view of this fact, we collect more information about the viewing conditions in the home environment. Therefore, the used method is described in the next section, followed by results and an extensive discussion.

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Method

To define the home environment conditions and in order to define profiles for standardized viewing conditions we gathered data about relevant influencing factors. Additionally to the preferred viewing distance (PVD), following factors based on already introduced standards ([1], [2]) are collected during an individual prime time which is defined as the time of the day when the test participants usually use their TV:

- Luminance of inactive screen to peak
- Luminance of the screen when black and room dark
- Maximum observation angle relative to the normal
- Screen size and satisfaction to PVD rules
- Environmental illuminance on the screen in lux

Therefore, different approaches to collect the information have been considered.

Due to equipment necessary to measure the lightning conditions in the home environment household visits seemed to be most adequate. The household visits allow a controlled collection of viewing angle and illumination measurements additionally to the information about the PVD, changes over time including a demonstration by the user.

In order to collect the required luminance data using black, white and usual TV content as suggested in [1] and [2] pre-prepared test patterns (i.e. PLUDGE from IQ quick test) were used. Therefore, a DVD was produced containing a within Adobe Premiere CS6 produced black and white color mask as well as test material in SDTV- and two different HDTV- variants in order to meet the households requirements based on available equipment. The test material shows a trailer of "House of Flying Daggers" as presented on a VIDEO-Test DVD in 2005 provided by a video journal in Germany (see also Figure 2). Additionally, a USB device containing this test data and a DVD-Player (Sony DVP-NS310) allowed measurements in any case. The illumination was measured with a lux meter (Minolta, T-10). Therefore, and concerning candela (cd) and lux calculations the DIN norm on basics and criteria for the requirements on illumination [7] was considered. A folding meter stick was used for viewing distance and viewing angle measurements.

Figure 2: *Test patterns in presented order of used DVD*

The situation was a strictly structured interview situation and contained questions asking for demographic data, TV device related information, illumination related and room related information.

Parts of the collected data were presented in [8]. Within the second study, the users also were asked to draw their living room and indicate their viewing conditions within the sketch. As a result of this, additional data was collected which is presented together here.

Results

In sum, data sets from 66 participants (34 men, 32 women) with the average age of 38.5 were collected. 28 of the participants were students, 27 employed persons, one self-employed, and nine were retired persons. In the following the amount of different kinds of TV devices used in visited households are presented:

- Cathode ray tube (CRT, 4:3): 18
- Plasma (16:9): 4
- Liquid Crystal Display (LCD, 16:9): 29
- Light-emitting diode (LED, 16:9): 3
- LED 3D (16:9): 4
- PC Monitor (LCD, 16:10): 7
- Laptop (16:10): 1

Out of the collected data sets following average values are presented in Table 1. Herein, available recommendations (see: [1] and [2]) are presented in addition for comparison.

Table 1. *Different TV devices used in visited households*

Condition	**Average value**	**Recommendation**
Room size	19.7 m²	Not available
Viewing distance	2.5 m	PVD
Screen size	~32"	
Ambient light conditions	10.2 lx	Not available
Peak luminance	Not available	200 cd/m²
Environmental illuminance on the screen	8.37 lux	200 lux, or ≤ 20 lux to detect distortions [6]
Ratio of luminance of inactive screen to peak luminance	LCD, Laptop & PC: < 0.02, Plasma: > 0.02, CRT: not available	≤ 0.02
Observation angle relative to normal	horizontal 30°, vertical 15°	Max. 30° (horizontal)

However, detailed view on the overall collected data set shows a wide spread collection of data and using average results is problematic. Considering this, after further data analysis it is not possible to create valid clusters concerning TV device usage correlated with a viewing environment setting or other correlations out of collected information including the different sketches and drawings of the viewing environment by the test participants. Therefore, the amount of data collected is still too less and too wide spread.

However, using suggested methodological approach for a bigger amount of data may allow more detailed conclusions. Thereof, any potential clusters may be made after collecting more information. For example, if the existing trends are confirmed.

These trends may lead towards in the following exemplarily described viewer profiles:

A) Elderly, either alone or in pairs in front of the TV in a rather traditional way (i.e. PVD is met) without lightning or only with a small background light somewhere in the room. There are nearly no or very seldom settings changed provided by the TV besides volume and channel settings.

B) A single viewer context in front of the laptop or other mobile devices by rather young users, not paying too much attention to the background light and illumination as well as the PVD rules.

C) Early adopters, either alone or in pairs in front of the TV. Paying attention to the most convenient lightning (either everything dark or adequate background illumination), as well as to different settings provided by the modern TV device.

D) A multi viewer context in front of the TV in the living room by families considering a cozy background light and/or even using a TV with automatic background lightning. Based on the room situation, the PVD is intended. Settings provided by the TV are sometimes changed, if ever, or only at the beginning of device usage. Second screens are used (e.g. tablets or mobiles) for further information gathering or in order to see other contents. In any case, the viewing positioning is in front of the TV, although it may vary vertically and horizontally. Within 3D usage, persons tend to reduce the distance to the display in order to get a better immersion.

These are exemplary descriptions for possible user profiles. They could be complemented under usage of the sketch drawn by the different participants. Having enough data collected, these viewer profiles may be described more detailed and allow a more exact definition of the viewing environment influencing factors similar to the description(s) for the laboratory in standards. This might be interesting for evaluation purposes as well as for the definition of TV device pre-settings.

Discussion of Results

Generally speaking, the amount of data sets collected is not enough to define valid different home environment profiles. Additionally, as seen within up to now collected data, modern viewing environments (e.g. using other displays than LCD or CRT, as well as using other PVD instead of in front of the traditional TV) were not yet very wide spread. However, what we have until now is a basis for further discussion and we also see trends:

Deriving from presented evaluation activities we can summarize that the biggest influence within the viewing environment in the living room is the ambient light conditions. Effectively, these conditions are different from living room to living room and therefore it is hard to standardize this information. Every person has other preferences and therefore uses different ways of lightning for TV consumption and we were not able to find several groups using the same or similar ways of lightning.

The viewing position plays a less important role to the user and is similar to the room size easier to capture and to group. These rely on age and income. Room size and technical equipment rise for example with income. The kind of viewing device change based on financial possibilities and preferences. Therefore, we assume referring to collected data, that students use rather a CRT or laptop whereas elderly prefer modern devices supporting the handling of their listening and viewing handicap. However, this observation was already confirmed in former studies and bigger field trials (e.g. [9]).

Considering new trends like second screen devices, the variation of screen sizes, or mobile visualization devices used in different usage environments as described for example by Abreu et al. [4], leads to further degrees of influences concerning a standardized home environment and leads towards the assumption that more devices and variations lead to more influences leading to an heteroscedasticity (i.e. growing distribution). Recently published studies asking for influences based on different devices used or different (home) usage environments show, that for subjective testing with naïves it does not have that much influence on evaluation results compared to studies conducted within the laboratory (see [5], [6], and [10]). However, in some cases it still might be interesting how to define the home environment or several kinds of home environments. For example, in order to answer research questions considering the home environment and having the need of a good defined evaluation environment. Perhaps in a next step, the definition of thresholds or recommended value areas could be defined rather than average values.

Therefore, we belief that household visits or methods near to household visits (e.g. especially therefore defined Probing [11] or a good enough defined graphical user interface used together with crowd sourcing [12]) in order to collect a huge amount of data are useful.

As this study was conducted in one western country only, it is hard to predict how results would be in other cultural areas. Research shows, that there are severe differences within usage habits and viewing conditions in the home environment, especially depending on the amount of users per one device. van der Kamp, Withagen, and de Wit [13] for example examine cultural differences of Judd illusion between Europeans and East Asians. Herein it is about a special illusion case. However, interesting visual perception differences are outlined. This has to be investigated further when it comes to viewer profile definition.

Summary and Outlook

This work shows the results from a structured field examination in order to define profiles on general viewing conditions in the home environment. It is shown, that different profiles could be envisaged concerning room conditions but not concerning the illumination and ambient light conditions. This is, only for traditional 2D TV consumption in the living room excluding new trends in the home environment like second screen usage (e.g. [14]) and 3D. In the workshop, we would like to address the question whether it is useful to have a detailed definition of the home environment for comparable subjective quality assessment as well as for personalized new interactive TV applications using illumination information and how the process of defining the home environment should therefore look like.

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