



Impact of user emotion and video content on video Quality of Experience

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Abstract

The measurement of Quality of Experience is largely assessed using the Mean Opinion Score (MOS) that has been defined in telecommunication domain. It is known that MOS measurement focuses on system influencing factors, and strives to filter-out human, contextual and content factors. However, the emerging conceptualization of QoE gives attention to non-functional factors. These factors are known to play a central role in user experience and still largely unexplored in context of Quality of Experience (QoE) and User Experience (User Experience).

This paper analyses the impact of human emotion and video content on the measured QoE. The emotional state of subjects is evaluated after and before each visualized video sequence. A statistical analysis is realized in order to identify the importance of emotion state and video content type in shaping QoE.

Index Terms: Video Quality of Experience, subjective tests, emotion, video content.

1. Introduction

The video content represents today a predominant portion of media delivered over the Internet. Every day people watch hundreds of millions of hours on social networks, such as Twitter, Google+, Facebook, etc. This yields new forms of interaction with video contents, where users may play the role of a producer and/or a consumer of video content. In this context two different concepts appeared. The first concept takes into account the degrees of satisfaction of the users [1], namely Quality of Experience (QoE). The second concept take into account the person's perception and response that results from the use of a product, a system or a service [2], i.e. User experience (UX). The segregation of QoE and UX was ambiguous and confusing [3]. However, QoE/UX can be considered as a shift from QoS to usability concept; the usability concept is used in HCI (Human Computer Interaction) discipline. The usability evaluations take into account the user's profile. Therefore, it can be considered as more human oriented. In this context, some proposed work claimed that a good/bad QoE evaluation is related to positive/negative emotions [7]. Some other claimed that a stimulus, i.e. Multimedia content may cause an emotion at the recipient due to its meaning [12].

The scope of this paper consists on giving a response to these prominent questions: Is it true or false that a good / bad content evaluation is linked to positive/negative emotions? Is it true that a stimulus may cause an emotion at the recipient?

The response to these questions will be based on a comparative study that considers a subjective QoE assessment, for different video content.

This paper is organized as follow. Section 2, presents our motivation and the related work. Section 3 presents our methodology in the subjective assessment. This section describes the user's profiles, the video content and the assessment process. Section 4 presents and discusses our finding. This section is based on a statistical analysis. The last section, i.e. section 5, concludes this paper.

2. Motivation and related work

The domain of QoE has been increasingly influenced by UX field [3]. Human emotion plays a central role in this field, which is mainly explored by HCI specialist. Nevertheless, this fact concern the QoE field, because a stimulus, i.e. video, may evoke an emotion at the consumer, due to its meaning or its content; and this may affect the assessment of other technical parameters. Therefore, it is substantial for a video QoE researcher to know what stimuli, i.e. video content, can be considered as emotionally relevant, or even better, measure its emotional connotation to take it into account in its analysis.

With regard to related work in this context, we enumerate different proposal. In the field of video QoE, the work in [4] presented a subjective study in which the authors has shown the impact of contextual factors, video content, equipment and applications QoS metrics. They didn't study the impact of human emotion on video QoE.

[5] realized an extensive analysis of the video QoE in the context of 3G network. The authors considered objectives and subjective metrics, related to video characteristics and to the emotional state of the participant. In this work the authors showed that QoE is affected by QoS parameters, contextual, and emotional factors. In the paper, the authors did not specify the content type used in their work.

In [8], a subjective video assessment study in mobile environment take into account human emotion. The authors considered different subjective metrics related to the participant psychology, i.e. enjoyment, engagement and satisfaction. They concluded that sensory experience is a significant factor for enjoyment and engagement. The disadvantage of this work is the absence of the MOS's variation according to each emotional state.

The work in [9] explores the relation between affective aspects and the overall perceived video quality. Different metrics were used in this work: MOS, emotional state metrics, (e.g. Joy, surprise, interest, content likeability) and physiological metrics, such as EEG, gaze tracing and facial expression. The authors concluded that traditional QoE measurement need to be extended with affective state related measurement.

The work in [10] presents a study based on a questionnaire-generated and on EEG feedback from test

subject, in the context of an assessment session of different type of audiovisual content. The authors concluded that there is a significant difference in the importance and in the evaluation of perceptual, viewer and clip-related dimensions, depending on the clip that were used. The experiment has shown, also, that using additional feedback data can increase the validity of the measured Quality of Experience. In this work, the authors used several emotion metrics, for 3 video content classes: Football, cartoon and action movie. The same authors of this paper, proposed another work in [11]. They claimed that the user's associations, requirement and expectation depend on the visualized content. The strength of this paper consists on considering different content class.

Nonetheless, the shortcoming of most of these works [6-11] consists on: (1) the absence of a description of the used multimedia content, i.e. content type, and video duration; (2) The absence of MOS's variation for different video content and for different emotional state. Moreover, none of the previous work has discussed if there is a correlation between the emotional state before and after watching a multimedia content.

Therefore, this paper presents and discusses the impact of human emotion on video Quality of Experience, measured through the MOS, for different content class, i.e. funny, soccer, films and documentary. This work considers the emotional state before and after subjective tests. It debates also the relation between these emotional states.

Table 1 : Pre /Post Questionnaire form

	1	2	3	4	5
Metric's name					

3. Subjective QoE assessment process

In this study, we followed general recommendation for subjective as defined by ITU-R Rec. BT.500-13 and ITU-T Rec. P.910[2] , and we used the Mean Opinion Score (MOS) for the assessment of video quality. The different subjective tests were done in laboratory. The laboratory has low artificial daylight condition. A 17'' Plasma screen size were used to display content. Audio was played over headphones. The viewing distances were set according to the comfort of each participant. Before and after watching video clip, the participants answer to a printed paper questionnaire.

We considered 72 participants, with an average age of 25 years. In order to minimize the testing periods and maximize the number of viewers; different participants have done the tests at the same time and in different places. In this study, each individual participated in three session tests, in different days.

With regard to the multimedia content, we used different MPEG-4 video sequences combined with AAC audio codec with a resolution of (1280x768). We considered 11 emotional metrics and four different content classes: funny, soccer, documentary, and films. The video length was equal to 5 minutes. The different video sequences are available in [13].

With regard to emotional metrics, we used those proposed and used in [5]. In this work, we divided these metrics, in two groups: a pre-questionnaire and a post-questionnaire.

The general assessment process was divided into three different steps:

3.1. Pre-Questionnaire

A pre-questionnaire was given to the participant in order to know their emotional state before the subjective test, using 7 metrics: *Happy, Not Frustrated, Relaxed, Not Bored, Curious, Not Doing other Staff and Distracted*. The participant rate their feeling using a five-point Likert scale, which range from 1, for "Not at all", 3 for "Neutral", 5 for "Extremely", as proposed in [5].

3.2. Main Evaluation

After rating their emotional state the users were asked to assess a video sequence. We used 4 metrics: *Mean Opinion Score (MOS)*, which vary from 1 to 5; and video characteristic metrics: *Content, Picture Quality, and Sound Quality*. These metrics use five scales: Excellent, good, acceptable, bad and very bad. We used 4 content classes: funny (C1), documentary (C2), soccer (C3) and films (C4). Each content class was evaluated by 18 participants.

3.3. Post-Questionnaire

After visualizing the multimedia content, the users rate 4 metrics: *Not disappointed, Rich experience, No time waste and Enjoyed*. These metrics try to determine the emotional state of the participant after visualizing the video content.

Table 1 presents the Pre/Post questionnaire used to assess the different emotional metrics. It was composed by 7 and 4 metrics, respectively, for the pre-questionnaire and the post-questionnaire.

4. Results and discussion

In this part of the paper we will present and discuss our finding. After collecting the resulting output, a statics analysis was done, in order to know if the video characteristics and emotional state and their impact on general video quality, measured with the MOS. As described in the previous section, we considered 4 metrics, related to the video characteristics, and 11 metrics, related to the emotional state of the different participant. In this statistical analysis two different steps were followed. First of all, we considered the reliability's analysis of the obtained results; second, we used of the Principal Component Analysis in order to minimize the number of metrics. The next section gives a description of these steps, and presents the variation of the Mean Opinion Score (MOS), for different content class and for the different emotional metrics, that were retained in the statistical analysis.

4.1. Statistical Analysis

4.1.1. Reliability of the results

In order to know the reliability of the results, two statics tests were used: Cronbach alpha and Kaiser-Meyer-Olkin (KMO) [5] [10]. The different retained items, with regard to the video characteristics are *Content, Picture Quality and Sound Quality*. For these metrics: KMO=0.7; Cronbach alpha=70%; p=0.000. The Different retained metrics related to the emotional state are: *Happy, Relaxed, Not bored, Not disappointed, Rich experience and Enjoyed*. For these metrics KMO=0.705; Cronbach alpha=70%; p=0.000.

4.1.2. Principal Component Analysis

In our statistics analysis, we used the Principal Component Analysis (PCA). We used the PCA analysis with Varimax Rotation, on both set of items, as in [5] and [10].

With regard to the video quality aspect, only one PC were extracted, namely Video Characteristic (VC). It explain more than 63,67% of the total variance of the original items. It is composed by *Content*, *Picture Quality*, and *Sound Quality*.

With regards to the emotional aspect, two principal components were extracted. The first PC is composed by 3 metrics: *Happy*, *Relaxed*, *Not Bored*. These metrics were presented to the participant before starting the assessment of the video clips. Therefore, the name affected to this principal component is Emotional State Before Subjective Test (ESBST). The second principal component is composed by three metrics: *Not Disappointed*, *Rich Experience*, and *Enjoyed*. These metrics were presented to the different participant after the assessment of the video clip. Therefore, the name affected to this PC is Emotional State After Subjective Test (ESAST).

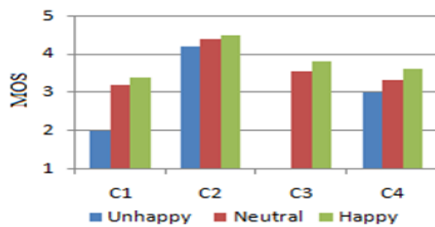


Figure 1: Average MOS obtained for "Happy"

The Pearson's correlation r and the statistical significance p of each principal component with the Mean Opinion Score (MOS) have been also considered. With regard to the video characteristics (VC) there is an important correlation with the Mean Opinion Score ($r=0.72$). This correlation is statistically significant ($p=0.000$). There is a medium correlation between the MOS and the Emotional State After Subjective Test (ESAST), $r=0.35$. This correlation is statistically significant ($p=0.003$). With regard to the Emotional State Before Subjective Test (ESBST), there is a small correlation ($r=-0.08$). This correlation is not significant at 5% ($p=0.45>0.05$). These results show that general video quality is influenced by the video characteristics. Moreover, the emotional state after subjective test of the different participant is influenced by the visualized content. These two statements are statistically significant at 5%.

4.1.3. Variation of the Mean Opinion Score

Aside from the statistical analysis, we considered also the variation of the MOS, for the different content class, i.e. funny (C1), documentary (C2), soccer (C3), and films (C4), for the retained emotional metrics.

- Variation of the MOS for the emotional metrics used before subjective tests

The different metrics that were retained are: *Happy*, *Relaxed* and *Not Bored*.

With regard to "Happy" metric, Figure 1, shows that highest average values of the MOS ($MV=4.5$; $SD=0.5$) were obtained for the funny content, for the happiest participant, i.e. they rated 4 and 5 this metric. For the soccer content class (C3), there are no participants who were unhappy. This content class

rank the second, for the happiest participant ($MV=3.81$; $SD=0.87$). With regard to "Relaxed" metric, the different ratings are almost coequal. Highest values of the MOS were obtained for funny content, i.e. C2 ($MV=4.66$; $SD=0.51$) and films, i.e. C4. These values of MOS we obtained for "Not Relaxed" persons. This result may be explained by the fact, that the different participants were not relaxed and were stressed, in the beginning of assessment session.



Figure 2: Average MOS obtained for "Enjoyed"

The last metric that were retained, according to the statistical analysis, is "Not Bored". The obtained results show that highest values of the MOS were obtained for the second content class ($MV=4.75$; $SD=0.5$) and the third content class ($MV=4$; $SD=1$), for *Bored* participant. The lowest values of the MOS were obtained for "Not bored" participants, for the first (C1) ($MV=3.45$; $SD=0.96$) and the fourth content (C4) ($MV=3.5$; $SD=1$). According to these results, we can see that a positive emotional state, before subjective test, can lead to positive subjective assessment, i.e. highest values of the MOS, according to "Happy" metric. This score depends, also, on the class content, funny, documentary, soccer, and films. However, the correlation between Emotional State Before Subjective Tests (ESBST) and Video Characteristics (VC) was equal to -0.187 and $p\text{-value}>0.05$. According to these values, the statement above is not statistically significant at 5%.

- Variation of the MOS for the emotional metrics used after subjective tests

Concerning the second category of emotional metrics, only three metrics were retained after the statistical analysis.

The first metric was "Enjoyed", Figure 2 presents the variation of the MOS for different content class. This figure shows that highest value of the MOS was obtained for participant, who rated with 4 or 5 this metric. It shows also, that the highest values were obtained for the second content class, ($MV=4.71$; $SD=0.48$).

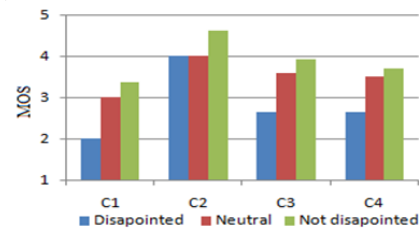


Figure 3: Average MOS obtained for "Not Disappointed"

For the second considered metric, "Not Disappointed", the obtained results are presented in Figure 3. This figure shows that the participants, who were *Not Disappointed* after the subjective test, rated the visualized video with a highest MOS's values, among the different content class. The value obtained for the third (C3) ($MV=3.92$; $SD=0.73$) and fourth (C4) ($MV=3.7$; $SD=0.94$) content class are almost co-equal.

The highest values of the MOS were obtained for the second content class, i.e. funny (MV=4.62; SD=0.51).

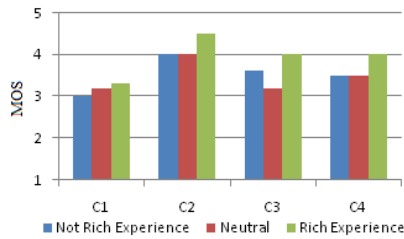


Figure 4: Average MOS obtained for "Rich Experience"

With regard to the last emotional metric, i.e. *Rich Experience*, the participant who declared that the visualizing the video content was a rich experience, have rated the video sequences with a high Mean Opinion Score (MOS), for the different content class. The highest value was obtained for the second content class composed by funny video (MV=4.55; SD=0.52), Figure 4. The value obtained for the third content class (C3) (MV=4; SD=0.85) and fourth content class (C4) (MV=4; SD=0.75) were co-equal. From the different figures and results presented above, we can conclude that emotional state after subjective test is affected by the positive/negative experience. This means that if the video sequence pleased to the participant, this will lead to a positive emotional state (*Rich Experience*, *Not Disappointed*, and *Enjoyed*) after the subjective test. This state depends on the visualized content. The correlation r between emotional state after subjective test (*ESAST*) and video characteristics (*VC*) was equal to 0.31 and p -value = 0.007. This correlation is statistically significant. This finding confirms the statement of [12], which states that a multimedia content may cause an emotion at the recipient due to its meaning.

4.1.4. Relation between emotional state before subjective tests and after subjective tests

In this section, we will discuss another finding, related to emotional state after and before subjective tests and their impact on the Mean Opinion Score.

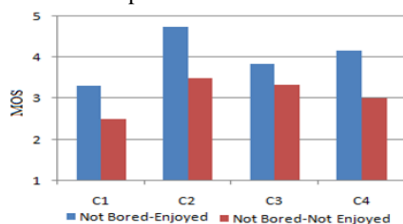


Figure 5: Average MOS obtained for Not Bored/Enjoyed-Not Enjoyed

Figure 5 presents the variation of the MOS for different content class, for a specific category of participant. These participant were *Not Bored* before the subjective tests, but after visualizing the video sequences, they rate either (1-2) or (4-5) the metric *Enjoy*. The first group of value refers to: *Not Enjoy* whereas the second group refers to *Enjoy*. This figure shows that participant that were *Not Bored* and *Not Enjoyed* have got lowest value of the MOS. In the same context, we observed the same finding for participants who were *Happy* before subjective test, but after subjective test they were

Disappointed. Lowest values were obtained for these participants (MV=2; SD=0.57). The obtained correlation r between these two metrics: *Happy* and *Not Disappointed* was equal to 0.37 and p =0.001.

From this we can state that video sequences may change the emotional state of a participant from a positive state (*Not Bored/Happy*) to a negative one (*Not Enjoy/Disappointed*).

We considered also another category of participant, i.e. *Bored* participant; they rate by 1 and 2 the above metric, but after visualizing the video sequences, either they *Enjoy* or did *Not Enjoy* the video content. We observed that the participant who were *Bored* and *Enjoyed* visualizing the video, have got highest value of the MOS, for 3 content classes. Highest value were obtained for the second content class (MV= 4.5; SD=0.57) and for the third content class. The correlation r between these metrics, i.e. *Not Bored* and *Enjoyed* was equal to 0.4, and p =0.008. Therefore the statement above is statistically significant. From this we can state that watching a video content may change the emotional state from negative state (*Bored*) to a positive one (*Enjoyed*).

Therefore, we can state that a positive/negative emotional state may be changed to a positive or a negative emotional state, depending on the watched video content. This finding confirms the statement of [12] that assumes: a multimedia content may give rise to an emotion on the recipient.

5. Conclusion

This work consists on studying the impact of the emotional state and video content on the perceived video QoE. The assessment process realized was followed by a statistical analysis. Two prominent statements were pronounced in the literature: Is it true or false that a good / bad content evaluation is linked to positive/negative emotions? Is it true or false that a stimulus may cause an emotion at the recipient?

With regard to the first question, the correlation between the Mean Opinion Score and the emotional state before subjective test (*ESBST*) was very low and statistically not significant at 5%. Therefore, a bad/good evaluation is not linked to a positive/negative emotion, according to our work.

With regard to the second question, that states that a stimulus may cause an emotion to the recipient [12]. We have proven through our statistical analysis that a positive/negative emotional state before subjective test may be changed to a positive/negative emotional state after a subjective test, depending on the visualized content. These statements give a response to this prominent question and confirm the statement of [12]. We considered also, in this paper, the variation of the Mean Opinion Score. According to these results, the second content class, i.e. funny films, scores better compared to the other content class. We observed that the emotional state, after subjective tests depend on the visualized content. The correlation between emotional state after subjective test and the Mean Opinion Score was statistically significant.

Our finding must be followed by other researches, which consider some other content class, such as cartoon, romantic film, news and music. The consideration of some other metrics that assess the emotional state of the different participant before or after subjective tests is also an important issue. The presentation of these metrics to the participant, can be also reconsidered; through the use of a web application, instead the use of paper. As future work, we will work on these issues and we will consider some others factors that impact the video Quality of Experience.

6. References

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