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Influence of Gender and Viewing Frequency on Quality of Experience

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***Abstract*—Some of the most important aspects for content creators and service providers are the content appeal and the time consumed by the end users on a particular application or service. Gender and age can influence the Quality of Experience (QoE) ratings of multimedia based on the nature of the shown content, yet few studies have quantized this notion. In this paper, we zoom in on the influence of gender on user ratings in a video QoE study (N=89) with packet loss as the main system influence factor. We have analyzed the impact of gender on QoE subjective ratings both as a standalone influence factor and in coherence of temporal traits like the frequency of watching online content. We have observed significant trends to highlight the importance of systematically checking and reporting on the impact of basic human factors, such as gender in relation to quality perception with respect to different types of content.**

***Index Terms*—QoE, Human Factors, User Diversity, Machine Learning**

I. Introduction

While the already major share of video and multimedia traffic as part of the global internet traffic is forecasted to continue its increase in the years to come [1], service and content providers face the challenge of meeting their users' expectations and of enabling positive experiences in increasingly multi-device, blended context, and multi-user settings. Keys to attract users, trigger adoption and foster sustained use are found in the understanding of what influences users' and diverse user segments' Quality of Experience (QoE) [2], and translating such insights into strategies that enable good experiences. Indeed, the use of applications and services never happens in a vacuum and neither does "the user" exist. In the literature, the term Influence Factor (IF), defined as *'Any characteristic of a user, system, service, application, or context whose actual state or setting may have influence on the Quality of Experience for the user'* [3], [4] is used to capture this reality.

Whereas there has traditionally been a lot of focus on the impact of system-related factors on users' QoE with a range of applications, the role of non-technical factors is – despite the fact that they receive growing attention – still not as thoroughly understood nor systematically addressed. Even though a limited set of user characteristics is usually presented in the sample description of a study, there seems to be no systematic practice for reporting on the potential impact or confounding role of some of these basic descriptors on the dependent measures used in QoE studies [5]. In addition, the majority of QoE studies are designed and conducted from a developed country-point of view. However, the context is in many ways very different in developing countries, which is under-reflected in the current understanding of influence factors on QoE for various application domains.

In this paper, we therefore zoom in on the influence of gender on user ratings in a video QoE study (N=89) with packet loss as the main system influence factor under investigation. The study was designed for and conducted in a developing country.

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II. Background and Related Work

Reiter et al. [4] have discussed that users might not be aware of the influence factors that affect their liking or disliking of a content. The physical, mental or current social state of a user may impact her behavior and corresponding decisions. Thus human based influence factors such as user mood, motivation or attention have a tendency to influence the QoE. They have also discussed the user frequency of using a system or a service as a temporal aspect that can influence the user perception.

Zhu et al. [6] have analyzed the social and human-related factors with diverse parameters like video content, user enjoyment, gender and cultural background. They observed that men get more involved in videos but did not find significant influence of gender on other QoE aspects. The research was extended [7] by collecting information like age, gender, video watching frequency, etc. in both controlled (laboratory-based quality ratings) and real-time online study (using an open source application). The latter confirmed the finding that men were more involved with the content than women.

Murray et al. [8] have observed the effect of gender and age on perceived visual quality with olfactory context. They have observed that women are overall more sensitive to smell.

In a previous study, we have observed a minor impact of user delight on MOS by the subjects [9]. In the perspective of Human IFs, we have observed a tendency of lack of focus as the typical assessments take 35-40 minutes by playing short-length video clips in a loop based on System IFs. Moreover, the temporal factors that the subjects who were used to

TABLE I
VIDEO SPECIFICATION FOR STREAMING AND SUBJECTIVE EVALUATION

Parameters	H.264/AVC
Streaming Software	VLC Media Player
Frame Rate	25 fps
Duration	10 s, News 11 s
Profile	Main
Resolution	352×288

watching online videos regularly were more critical in giving quality ratings to the stimuli.

III. EXPERIMENTAL SETUP

A within-group experiment with 3 content types and 7 packet loss conditions as independent factors was conducted. The technical specification of the videos is available in Table I. Due to the low Internet speeds in third-world countries, we have selected the lowest resolution QVGA that is available for both high and low end smart phones. As the focus of our study is on the validity of subjective quality assessment and corresponding MOS, we have chosen seven packet loss scenarios ranging from 0.1% to 10% for streaming videos. There was no delay or jitter associated with these videos during the experiment resulting in output of a total of 21 videos streamed over the experimental test-bed, which is composed of a Linux based system with the Netem traffic shaper for introducing packet losses [10]. Video streams were encoded by H.264/AVC using the VLC media player over RTP/UDP/IP.

The videos were shown to the users in randomized order in line with the guidelines given in ITU-R BT.500 regarding viewing distance and display characteristics. A training session was conducted before every assessment, and users were provided with both verbal and written instructions. The user ratings for video quality were obtained using the Single-Stimulus method on a 5-point Absolute Category Rating (ACR) scale with a total assessment time of around 10-12 minutes.

IV. RESULTS AND DISCUSSION

The results from the subjective assessment are available in the Table II. A total of 96 participants rated the test media out of which seven outliers were identified and subsequently removed. Out of the remaining 89 subjects, 61 males and 28 females participated in terms of gender classification with a mean age of 21.61 and mode 21. The subjects are bachelor students of Information Technology with far less enrollment of female students, strongly limiting the possibilities to have a balanced sample size in terms of gender. In general, we have observed that the majority of videos start to show the freeze effect at a packet loss percentage of 1% or higher. Almost, all the videos at 5% or more packet loss have shown significant effects of smearing, blur, jerkiness and grey screen effects.

A. Impact of Gender on quality ratings

The impact of gender on quality ratings is shown in the Figure 1. A difference in standard MOS and gender-based MOS can be observed, but apart from the Football video, the confidence intervals overlap for the majority of the results. We have calculated one-way ANOVA with $\alpha = 0.05$ and found *Football* videos at 0.1%, 0.3% and 0.7% packet loss ratio to have a *p*-value (significance) of less than a or close to 0.05. Apart from Football, the *Foreman* video at 10% packet loss has a *p* value of 0.013. These results correlate with the observation that for low packet loss level for *Football*, the effect of gender on average MOS is statistically significant for the delight towards the shown content. On the contrary, for more neutral content, i.e. Foreman and News, the subjects have rated the stimuli solely based on quality.

B. Multivariate Analysis

In order to analyse the effect of gender with respect to frequency of watching online content, we have performed a Multivariate Analysis of Variance (MANOVA) test with gender and frequency as fixed factor, and different packet loss ratios as dependent variables. The results of the test are shown in Table III. The results regarding gender influence are statistically significant for *Foreman*, *Football* and combination of all videos with same significance value for both Wilks' Lambda and Pillai's Trace. There is a trend that subjects from both genders who watch online videos on daily basis are more critical towards quality with a mean difference of approximately 0.2 in MOS as compared to non-daily viewers.

C. Analysis by M5P Machine Learning

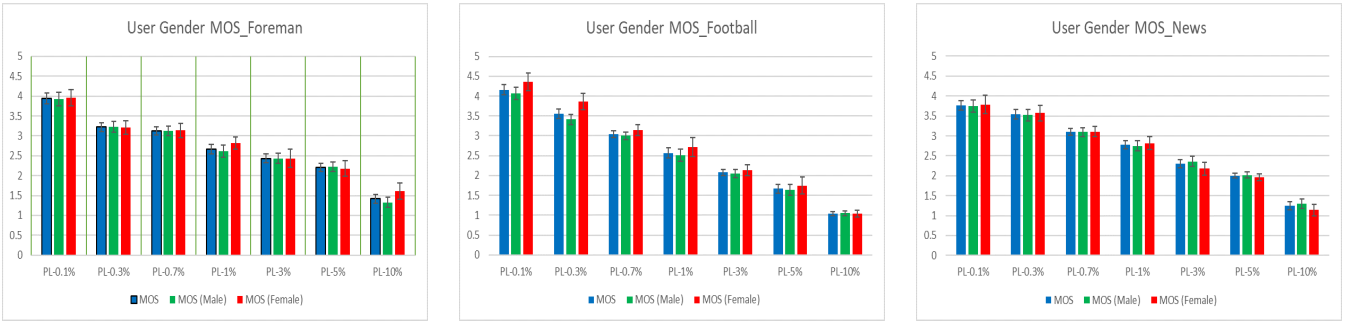
We use the machine learning algorithm M5P [11] to reconfirm above observations. M5P constructs model trees with local linear models of the kind $y_i = a_i + \sum_j b_{i,j} x_j$, which identifies different subspace of different sensitivities [12] of the outcome (user rating) as functions of the features as shown in Table IV. As usual for M5P, we applied a full training set and 10-fold cross validation [11], [12].

We first examine the impact of gender on the ratings in case of the football video, cf. Section IV.A. The modeling results are shown in Table V. We obtained a correlation coefficient of 0.9049. The gender feature has positive weights, which together with the definition shown in Table IV implies that ratings by females tend to be higher than those of males. This holds in particular for low loss rates (below 2%), where a difference in the order of 0.3 MOS units is indicated, which is visible in Table II. As expected, the loss rate has negative weights, meaning that a growing loss rate decreases the user ratings.

Similar results are obtained for the impact of the frequency in case of the football video, where we observe $b_{1,2} = -0.1817$ and $b_{2,2} = -0.0063$ and a correlation coefficient of 0.9015. Obviously, the effect of daily watching is negative and in the order of -0.2 MOS units for small loss rates, which confirms the observation at the end of Section IV.B. In both cases, the discriminating effects of gender and loss decrease significantly for higher loss rates, visible from decreased weights and in agreement with Table II.

TABLE II
MOS WITH 95% CONFIDENCE INTERVALS

Video		Foreman							
		Users	MOS_PL 0.1%	MOS_PL 0.3%	MOS_PL 0.7%	MOS_PL 1%	MOS_PL 3%	MOS_PL 5%	MOS_PL 10%
	All	89	3.94 ± 0.13	3.22 ± 0.11	3.13 ± 0.10	2.67 ± 0.12	2.43 ± 0.11	2.21 ± 0.10	1.42 ± 0.11
Gender	Male	61	3.93 ± 0.17	3.23 ± 0.14	3.13 ± 0.12	2.67 ± 0.15	2.43 ± 0.13	2.23 ± 0.12	1.33 ± 0.13
	Female	28	3.96 ± 0.20	3.21 ± 0.17	3.14 ± 0.18	2.82 ± 0.16	2.43 ± 0.23	2.18 ± 0.19	1.61 ± 0.20
Watching Frequency	Daily	52	4.02 ± 0.17	3.27 ± 0.15	3.21 ± 0.12	2.71 ± 0.16	2.48 ± 0.15	2.21 ± 0.13	1.46 ± 0.15
	Not-Daily	37	3.84 ± 0.19	3.16 ± 0.15	3.03 ± 0.17	2.62 ± 0.17	2.35 ± 0.18	2.22 ± 0.16	1.35 ± 0.17
Video		Football							
		Users	MOS_PL 0.1%	MOS_PL 0.3%	MOS_PL 0.7%	MOS_PL 1%	MOS_PL 3%	MOS_PL 5%	MOS_PL 10%
	All	89	4.16 ± 0.13	3.55 ± 0.12	3.14 ± 0.08	2.57 ± 0.13	2.08 ± 0.08	1.67 ± 0.11	1.04 ± 0.05
Gender	Male	61	4.07 ± 0.15	3.41 ± 0.13	3.00 ± 0.10	2.51 ± 0.15	2.05 ± 0.10	1.64 ± 0.14	1.05 ± 0.06
	Female	28	4.36 ± 0.22	3.86 ± 0.21	3.14 ± 0.14	2.71 ± 0.24	2.14 ± 0.14	1.75 ± 0.21	1.04 ± 0.08
Watching Frequency	Daily	52	4.06 ± 0.14	3.42 ± 0.15	2.98 ± 0.07	2.56 ± 0.17	2.08 ± 0.11	1.65 ± 0.15	1.02 ± 0.04
	Not-Daily	37	4.30 ± 0.23	3.73 ± 0.17	3.14 ± 0.17	2.59 ± 0.19	2.08 ± 0.13	1.70 ± 0.18	1.08 ± 0.10
Video		News							
		Users	MOS_PL 0.1%	MOS_PL 0.3%	MOS_PL 0.7%	MOS_PL 1%	MOS_PL 3%	MOS_PL 5%	MOS_PL 10%
	All	89	3.76 ± 0.12	3.54 ± 0.12	3.10 ± 0.08	2.78 ± 0.10	2.30 ± 0.10	2.00 ± 0.06	1.25 ± 0.10
Gender	Male	61	3.75 ± 0.15	3.52 ± 0.14	3.10 ± 0.11	2.75 ± 0.13	2.36 ± 0.13	2.02 ± 0.08	1.30 ± 0.12
	Female	28	3.79 ± 0.23	3.57 ± 0.20	3.11 ± 0.13	2.82 ± 0.16	2.18 ± 0.16	1.96 ± 0.08	1.14 ± 0.14
Watching Frequency	Daily	52	3.75 ± 0.16	3.52 ± 0.16	3.10 ± 0.10	2.73 ± 0.13	2.29 ± 0.13	1.96 ± 0.08	1.33 ± 0.14
	Not-Daily	37	3.78 ± 0.20	3.57 ± 0.17	3.11 ± 0.14	2.84 ± 0.17	2.32 ± 0.16	2.05 ± 0.08	1.14 ± 0.12



(a) Foreman (b) Football (c) News

Fig. 1. MOS with 95% confidence intervals with respect to gender.

TABLE III
RESULTS OF TWO-FACTOR MIXED MANOVA

Influence Factor	Videos	Significance
Gender	Foreman	.011
	Football	.037
	News	.427
	All	.036

TABLE IV
FEATURES USED BY THE M5P.

Feature	Description	Type	Values
x_1	gender	binary	1: female; 0: male
x_2	frequency	binary	1: daily; 0: non-daily
x_3	loss rate	decimal	percentage

TABLE V
M5P MODEL TREE CAPTURING GENDER AND LOSS RATE (FOR THE FOOTBALL VIDEO), WITHOUT CONSIDERING THE FREQUENCY ($b_{i,2} := 0$)

i	Rule	a_i	$b_{i,1}$	$b_{i,3}$
1	$x_2 \leq 2$	4.0856	**0.2686**	-1.6064
2	$x_2 > 2$	2.4758	**0.0815**	-0.1484

V. CONCLUSION

In this paper, we have analyzed the significance of gender to affect the subjective quality ratings based on the user related factors in dependency of the content shown. We have observed that based upon the interest towards the contents of online videos, male participants were more critical during evaluation of the quality aspects as compared to their female counterparts. This trend is statistically significant in low packet loss ratios, but with the degradation of shown stimulus quality equal or above 1% packet loss ratio, the difference becomes minimal. In addition, daily users were critical in their ratings until the packet loss ratio is around 3% as compared to non-daily viewers. The multivariate analysis further supports the correlated effect of gender and viewing frequency on system factors. These results therefore highlight the importance of focusing more extensively and systematically on the combined impact of various influence factors on QoE.

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