Exploring Gender Differences in eXtended Reality (XR)

Marta Orduna, Pablo Pérez, Ester González-Sosa
XR Lab, Nokia
Spain

Figure 1: Base scenarios that are considered in the exploration of gender differences in XR experiences.

ABSTRACT
Extended reality technology is generating greater interest every day, assuming it as one of the communication platforms of the next decades. However, this work presents the lack of diversity in terms of gender of the participants who evaluate the technology (often students from STEM careers) and reported in datasets used to train and develop machine learning algorithms. Therefore, it warns of the gap that, as a consequence, will appear in the acceptance of the technology in underrepresented populations. Additionally, this work summarizes lessons learned exploring gender differences in extended reality experiences.

KEYWORDS
Quality of Experience (QoE), eXtended Reality (XR), Immersive Communications, Diversity

1 INTRODUCTION
Nowadays, eXtended Reality (XR) is one of the most interesting technologies in areas such as education, health or industry. A great advance has been the 360-degree video captured by omnidirectional cameras that cover the 360-degrees of the scene. Users typically visualize this type of real-world video through a Head Mounted Display (HMD). They only visualize a small area of the scene, called viewpoint, which changes with the movement of the head of the users, allowing the exploration of the whole scene [12]. This technology provides new social and interaction environments for teleconferencing, remote collaboration or teleoperation purposes.

The main motivation of this work is that immersive communications might be useful in daily activities when the XR technology becomes established. For this, it is important to evaluate the factors that influence Quality of Experience (QoE). The factors are divided into three categories: human (vision and hearing, simulator sickness, immersion, and expectations and expertise), system (content, network conditions, and encoding parameters), and context (physical, temporal, social, and task context) factors [15]. Based on this, our research is focused on the analysis of technical and what we called socioemotional aspects, related to the psychological effects induced in users, such as presence or empathy [13].

2 RELATED WORK
The assessment of technical and socioemotional aspects in the XR paradigm is a great challenge. However, this is not the only challenge addressed since there are works in the literature focused on experiments without taking into account the diversity of the participants. For example, the methodologies used in the literature with traditional content [12], which are used as a basis to study this new technology, do not always provide data about the gender of the sample of participants. Furthermore, more recent databases of 360-degree videos at the content level (i.e., recordings with women in the scene) or at the perceptual level (i.e., questionnaires with the associated ratings) are unbalanced [1]. First, this is a problem for the conclusions obtained when analyzing the evaluations. Second, these databases are often used to implement machine learning algorithms to model, for example, the behavior, spatial navigation patterns or movements, or visual attention of users [10]. If the databases used to train and develop these algorithms do not consider gender diversity, there will be no guarantee of their correct operation.

Some works in the literature analyze gender differences in Simulator Sickness (SS) which involves symptoms similar to those of motion-induced sickness due to elements of visual display and visuo-vestibular interaction [9]. Grassini et al. [5] present an exhaustive review of that. Their review classified the articles taking...
into account: the types of the HMD, the locomotion, and the content. In addition, they note that only male and female genders are considered. However, in a significant part of the literature, only the data of one gender is reported [2, 11]. Some of the main findings are the influence of gender in the adaptation of the HMD, in the discomfort, or in the perception of specific XR environments [14].

Studies carried out in universities commonly collect students as participants for their subjective assessments. Here there is a first bias in relation to age and a second, in relation to gender. Although there has been an increase in the gender diversity in STEM careers, the samples are still unbalanced and therefore females and other genders are underrepresented. Likewise, Himmelsbach et al. [7] reveals that there is a great lack of diversity in the authorship and research area dedicated to QoE. Along these ideas, it is necessary to investigate the factors that make technology, in this case XR, not equally attractive for all genders. The implementations and the offered QoE should be validated analyzing the gender differences to guarantee that they are inclusive [6]. Without taking into account all this analysis, XR technology cannot be a reality in society.

3 WORK APPROACH

Figure 1 presents our base scenarios. On the left side, the scenario is an immersive communication between locals, who are around a 360-degree camera and travelers, who attend the meeting using the HMD [8, 13]. As can be observed, the 360-degree video is transmitted in real-time and the audio is bidirectional. On the right side, the scenario presents an interactive immersive experience [3] where participants walk through the virtual environment that is an active volcano crater. The scenarios are chosen to represent two fundamental areas of XR technology: immersive communications based on 360-degree videos (a realistic environment) and interaction and movement through the virtual environment applying different body representations (virtual hands, video pass-through with color-based full-body segmentation, and video pass-through with deep learning full-body segmentation).

The poster that we will present considers some of the insights obtained in previous experiments related to these two base scenarios [3, 4, 13], but focusing on them from the point of view of gender differences. In fact, this way of approaching the research results of independent experiments allows us to learn taking into account: a) different populations (i.e., beyond the university population), b) different socioemotional aspects (i.e., presence or embodiment), and c) different roles, such as remote or local participants.

4 CONCLUSIONS

We summarize the lessons learned and the open questions to take into account in the next steps. Regarding populations that evaluate technology and participate in XR experiences, we discuss about how to reach a sample that goes beyond the university, investing time and resources, and its impact on research. We highlight the problem of gender imbalance of students at STEM universities, who are the students closest to most of the experiments carried out in XR environments. In relation to perception, we find socioemotional aspects more influential for one gender than for others. They are often shared in semi-structured interviews and help find an explanation for the results. This also opens a new aspect in relation to confounding factors: perception may vary depending on personal experiences (for example, experience with video games), so these experiences in which there is also a gender bias should be an aspect collected along with gender. Finally, the experience and interaction is different if the participant acts as a local or traveler, emphasizing the importance of conducting balanced studies on both sides of the communication.

ACKNOWLEDGMENTS

This work has been supported by project TSI-064200-2022-009 (INCLUVERSIO 5G) funded by program UNICO I+D 5G-6G 2022 of the Spanish Government within the framework of the Recovery, Transformation and Resilience Plan.

REFERENCES