Challenges Using Head-Mounted Displays In Shared and Social Spaces

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ABSTRACT

Everyday mobile usage of AR and VR Head-Mounted Displays (HMDs) is becoming a feasible consumer reality. The current research agenda for HMDs has a strong focus on technological impediments (e.g. latency, field of view, locomotion, tracking, input) as well as perceptual aspect (e.g. distance compression, vergence-accomodation). However, this ignores significant challenges in the usage and acceptability of HMDs in shared, social and public spaces. This workshop will explore these key challenges of HMD usage in shared, social contexts; methods for tackling the virtual isolation of the

Figure 1: Typical scenarios of HMD usage in (a) Shared and Social Spaces such as (b) a symmetric co-located shared theatre experience [17] (c) transportation [10, 24] and (d) asymmetric co-located experiences [7].

VR/AR user and the exclusion of collocated others; the design of shared experiences in shared spaces; and the ethical implications of appropriating the environment and those within it.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; **Mixed / augmented reality**; **Virtual reality**; *Field studies*; Interaction paradigms.

KEYWORDS

Head-Mounted Displays; Virtual Reality; Mixed Reality; Augmented Reality; Social Acceptability.

INTRODUCTION

Self-contained mobile Augmented and Virtual Reality HMDs (AR/VR) are increasingly being used for entertainment and productivity across a variety of contexts. These contexts span from private usage in the home, to public [10, 24, 35] and shared spaces [7, 8, 22]. This adoption is motivated by the capability of VR HMDs to invoke sensations of presence, and AR HMDs to seamlessly integrate virtual elements into the real world. Current HMD research has predominantly focused on fundamental, necessary technical problems e.g. solving locomotion in VR [3, 26], or providing robust tracking for AR [40]. However, if we are to assume that HMD adoption is likely to increase in the coming years, then we must begin to also consider a new emergent set of research challenges [6, 21, 22]. This new set of challenges is a result of the complex shared and social environments in which these HMDs will inevitably be used (see Figure 1).

One of the new and unique aspects of these shared and social spaces are the co-presence of other users that may or may not be involved in the same AR/VR experience. These "human factors" are something that were defined within the field of context-aware computing and were also one of the big challenges when personal computers left the lab and became part of our social lives in the form of smart phones [34]. One of the big differences with HMDs is that they are inherently designed for only one user and lead to isolation of the wearer and exclusion of everyone in the surrounding [8]. AR and VR users are ensconced in private (albeit shareable through software) virtual experiences, effectively isolated in their own personal *"techno-cocoon"* [5].

Whilst this choice to ignore or block out one's surrounding may seem similar to current smartphone usage [32], there are key differences. Smartphone usage is overt, and distinguishable by those around

you. With smartphones, an element of peripheral awareness is maintained, and catching a user's attention is not infeasible; with VR HMDs, there is no obvious means by which an outsider can reasonably approach and interrupt the user. AR HMDs do not have this extreme isolation, but still exclude people in the environment and impede the ability to share experiences without actually sharing the HMD. Therefore, these VR and AR HMDs are likely to play a greater role in putting up a barrier between ourselves and the real world. To see acceptance and adoption, the design of head worn devices needs to take into account the challenges arising from public usage even more than existing, established technologies.

We posit that HMDs should better support social awareness, such that future VR and AR experiences can optionally be inclusive of collocated others and of the shared, social environment in which they are used. In this way, we can avoid the proliferation of technology that might contribute to an increasing sense of being together yet alone. This workshop is intended to further discussion regarding the challenges and potential new design space of shared, public usage of HMDs, and aims to derive a set of problems that will work as a basis for a new research agenda on *Head-Mounted Displays in Public/Social Spaces*.

BACKGROUND

In recent years AR and VR research started to increase inside of the HCI community (see Fig. 2), starting to explore the technology from a strong usability perspective [23]. One of the major directions is the exploration of social acceptance of the technology [9, 14, 35]. However, we argue that social acceptance is only one of the upcoming issues that have to be addressed to help with a larger user adoption.

One large stream of research focuses on exploring and implementing systems that support collaborative experiences in co-located scenarios [1, 4, 11, 16, 17, 19, 28, 31, 33], in remote scenarios [25, 29, 36] or looking at solitary users in shared spaces [13, 15, 16, 21, 22, 33]. This direction of research shows a strong emphasis on supporting shared experiences and increasing collaboration between users. These shared spaces also create further challenges such as exploring the willingness of users to try HMDs in public [22] and how to facilitate and manage engagement with others that share these spaces [21, 23, 27].

More recently, researchers have further proposed VR systems for asymmetric collaboration scenarios using either projection [7, 12] or modified VR HMDs with displays [2, 8, 20, 30]. This line of research highlights one of the upcoming issues that HMDs have in general, the exclusion of everyone inside the environment without the technology leading to an isolated experience for the wearer. The variety and diversity of prior work in this field shows the interest of the community and hints at the potential to create a more structured research agenda for HMD usage in shared and social spaces.

	2018	2017	2016	2015	2014	2013
Augmented Reality	21	12	5	7	5	2
Virtual Reality	46	26	9	9	0	0
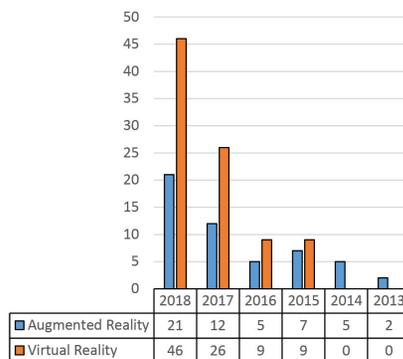
Figure 2: Number of publications at CHI for the last 6 years, containing the keywords 'Augmented Reality' and 'Virtual Reality' either in the title or abstract.

Workshop Topics

Social Acceptability of HMD Usage How are AR/VR HMD users perceived by collocated others? How does this vary by location (home, park, coffee shop etc.) and relation to others (local residents, intimacy groups, strangers etc.)? How comfortable are HMD users in wearing headsets and occluding reality in shared, social spaces [13, 35]?

Tackling Isolation and Exclusion How can we facilitate peripheral awareness of those in the surrounding environment [23] and enable asymmetric interactions with non-HMD users [7, 8]. And how can we use this awareness to protect AR/VR HMD users from potential abuses by others, facilitating safe, social interactions in public spaces?

Shared Experiences in Shared Spaces How can we encourage engaging, shared social VR [25] and Mixed Reality [4, 7] experiences in public spaces, both symmetric/asymmetric in awareness and synchronous/asynchronous in time? Is the public space merely a multi-sensory backdrop for Mixed Reality experiences, or can a deeper engagement with these spaces be fostered [31]?

Ethical Implications of Public Mixed Reality With sophisticated AR/VR HMDs having the capability to actively incorporate and appropriate the environment, and those within it, for virtual experiences and entertainment, the ethical use of these capabilities must be considered [18, 37]. From unwitting participation in others experiences, to manipulating the appearance of others (e.g. exploiting the proteus effect to boost confidence [39], to altogether more sinister appropriations [38]), our capability to dynamically shape and alter our environment will introduce new ethical dilemmas for AR/VR HMDs.

Participants and Expected Interest

AR and VR HMDs have seen significant investment and interest from both the research community and major hardware and software companies (e.g. Google, HTC/Valve, Facebook/Oculus, Magic Leap etc.).

The low cost of the technology an easy development tools (e.g. Unity Engine, Unreal Engine) resulted in a diverse group of developers coming from fields other than computer science such as art, design and psychology. Therefore, we welcome all fields of interest – e.g. art, psychology, sociology, computer science, HCI/UX –, including those working on "traditional" technological approaches and new researchers that are only starting to explore the field. We expect that participants from these different fields of expertise will add significantly to the outcome of the workshop, with interdisciplinary discussion revealing new research perspectives.

PRE-WORKSHOP PLANS

We will distribute a CFP in all relevant communities, announcing the CFP on popular mailing lists (e.g. ACM, CHI-announcements) and social media (e.g. Twitter, Facebook). We will also directly contact researchers and practitioners who are likely to be interested in the workshop and write to relevant institutions and research labs. Papers will be reviewed and selected using a juried process managed by the workshop organisers.

Our website will be located at https://www.medien.ifi.lmu.de/socialhmd/ and will act as a portal both for this and future workshops. We will host all the accepted position papers on the workshop website before the workshop takes place.

CALL FOR PARTICIPATION

Everyday mobile usage of Head-Mounted Displays (AR and VR) is becoming a feasible consumer reality. The current research agenda for these devices has a strong focus on technological impediments (e.g. locomotion, tracking, input devices). This ignores significant challenges in the usage and perception of HMDs in shared and social spaces where HMD users are co-located with non-HMD users and are likely to be observed while interacting.

We invite academics, artists, designers and practitioners to create a common understanding of upcoming challenges and derive a research agenda for this new topic. In this CHI 2019 workshop, we will focus on group work in which we will experience and discuss challenges of HMDs in shared and social spaces.

*** Important Dates ***
Submission Deadline: February 1st, 2019

Workshop Structure The workshop is planned to last one day. During the morning, two keynotes will motivate the topics of the workshop and participants will have an opportunity to present their work and form interest groups around the workshop topics. The afternoon will focus on a group discussion around different technologies (AR and VR HMDs) and several public and social scenarios. The conference organisers will provide all the hardware for the discussion (e.g. Microsoft HoloLens, Oculus GO, Epson Moverio, Samsung GearVR)

Time Schedule

Early Bird Coffee & Prep (08:00 - 9:30)
Introduction & Welcome (09:00 - 9:30)
Keynote: Ken Perlin (9:30 - 10:00)
Keynote: Frank Steinicke (10:00 - 10:30)
Coffee (10:30-10:45)
Lighting Talks (10:45 - 12:15) Participants will present short talks covering their research to gain familiarity with all workshop participants.
Coffee (12:15-12:30)
Discussion (12:30-14:00) Discussion of public and social scenarios

Notification: February 28th, 2019

We invite submissions of position papers: 4 pages in SIGCHI Extended Abstract format (references excluded) of work within the scope of challenges and opportunities for HMDs in shared and social spaces. Each participant will have 5 minutes for a oral presentation of his/her work.

Relevent topics include, but are not limited to:

- Social Acceptability of HMD Usage
- Tackling Isolation and Exclusion
- Shared Experiences in Shared Spaces
- Ethical Implications of Public Mixed Reality

Participants will be selected according to the suitability of their research to contribute to the workshop outcome or the relevance of their workshop position paper. Please note that at least one author of each accepted position paper must attend the workshop. All workshop participants must register for both the workshop and for at least one day of the conference. For more information and submitting your contributions, please visit: https://www.medien.ifi.lmu.de/socialhmd/

EXPECTED OUTCOMES

- Establish a community of researchers and practitioners interested in addressing the challenges of HMD use in shared and social spaces
- Outline the current challenges and barriers impeding the widespread adoption of HMD use in shared and social spaces based on hands-on usage and group discussions
- Disseminate the results of the workshop to a wider community through the publication of a fieldwork report and a special issue in a journal such as ToCHI or PUC.

POST-WORKSHOP PLANS

We will invite participants to contribute to a paper based on the hands-on session and group discussion. The paper will outline the identified research challenges and all the materials collected will be available through the workshop website. Based on this paper, we plan to outline a special issue for a journal (e.g. ToCHI) and invite participants to submit an extended version of their workshop papers.

Based on the workshop outcome and defined next steps for future research, the organisers commit themselves to foster collaboration and support the participants in the planned work, e.g., by providing a communication platform.

ORGANISERS

This workshop will be organised by an interdisciplinary team of researchers and artists all of which are currently actively working in the field of *Head-Mounted Displays In Shared and Social Spaces*.

Jan Gugenheimer (http://www.gugenheimer.com) is a research associate at Ulm University working in the fields of mobile/nomadic virtual reality and asymmetric co-located interaction for VR HMDs. His research explores how HMDs can be designed to be more inclusive for non-HMD users and enable the HMD user to break out of the isolation the technology is currently imposing.

Christian Mai (http://www.medien.ifi.lmu.de/team/christian.mai) is a research associate from the LMU Munich. In his work he addresses the challenges appearing with the introduction of fully immersive HMDs into everyday contexts. The goal of his work is to understand the problemspace arising and offer solutions suitable for everyday use.

Mark McGill (www.markmcgill.co.uk) is a research associate in the School of Computing Science at the University of Glasgow. His research has explored augmented virtuality, shared at-a-distance VR experiences, VR locomotion and passenger usage of VR/AR headsets in-transit, with an emphasis on overcoming the key usability impediments.

Julie R. Williamson (www.juliericowilliamson.com) is a lecturer in human computer interaction in the School of Computing Science at the University of Glasgow. Her research focuses on interaction in public spaces, including non-planar displays, virtual reality, and tangible interfaces. She is an expert in public evaluation and research on social acceptability of novel technologies.

Frank Steinicke (https://www.inf.uni-hamburg.de/en/inst/ab/hci/people/steinicke.html) is a professor for Human-Computer Interaction at the Department of Informatics at the University of Hamburg. His research is driven by understanding the human perceptual, cognitive and motor abilities and limitations in order to reform the interaction as well as the experience in computer-mediated realities

Ken Perlin (https://mrl.nyu.edu/~perlin) is a professor in the Department of Computer Science at New York University, where he directs the Future Reality Lab. His research interests include socially shared virtual and augmented reality, computer graphics and animation, user interfaces and education. He is hoping to help build a better world where our computer-augmented interactions will be more like Harry Potter meets Harold and the Purple Crayon.

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