

Research Methodologies across the Physical - Virtual Reality Spectrum

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ABSTRACT

Over the last couple of years, there has been a big push toward making immersive and mixed technologies available to the general public. Yet, designing for these new technologies is challenging, as users need to position virtual objects in 3D space. The current state-of-the-art technologies used to access these virtual environments (e.g., Head-mount displays (HMD)s also presents additional challenges for designers when considering depth perception issues that affect user precision. Moreover, these challenges are exacerbated when designers consider accessibility needs of special populations. To make new immersive and mixed technologies more accessible, we propose a tutorial at UbiComp / ISWC 2023 to discuss design strategies, research methodologies, and implementation practices with special populations using technologies across the physical-virtual reality spectrum. In this tutorial participants will learn how to make these technologies more accessible by (1) teaching students of the tutorial how to design, prototype, and evaluate these technologies using empirical research. We aim to (2) bring together researchers, practitioners, and students who are interested in making immersive and mixed technologies more accessible and (3) identify common problems when designing new user interfaces.

CCS CONCEPTS

• **Human-centered computing** → **Mixed / augmented reality; Virtual reality.**

KEYWORDS

Empathy, Accessibility, Virtual Reality, Mixed Reality; Special Populations; Methodology

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1 INTRODUCTION

When designing, Human-Computer Interaction (HCI) Researchers and User Experience (UX) practitioners will take a user-centric [1] approach to creating new applications. However, often these approaches cater to the typical population. Literature has demonstrated that special populations have specific needs when using new technology [2]. These needs must be considered when designing new user interfaces, or there is a risk of excluding them from accessing this technology. For example, blind users using virtual reality (VR) need a way to identify the position of objects in the virtual environment [7, 11]. Users with motor-control accessibility needs also require special controllers to play games [4, 15]. Moreover, users with over- or under-sensitivities like autistic individuals might need different system or device features [6] The growing access and sophisticated design of these tools may lead to a more significant change in Ubiquitous-computing (UbiComp) design by including and allowing individuals with different abilities to use and benefit from this type of technology. The tutorial's will help participants address these challenges when designing new user interfaces for special populations across novel immersive and mixed technologies. We also aim to bring together designers, developers, practitioners, students, and researchers working on accessibility technologies across the physical-virtual reality spectrum to discuss strategies for designing considering accessibility.

The proposed tutorial focuses on designing applications for special populations for novel immersive and mixed technologies across the physical-virtual reality spectrum, e.g., Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). We believe the topic is timely and relevant due to the more recent publication trend towards accessibility, wellness, health, and medicine. Thus, we believe this tutorial will interest the participants of UbiComp, as these technologies are used to create pervasive and ubiquitous computing. ISWC participants will also benefit from participating in this tutorial, as they will better understand special populations' requirements when designing new applications for wearable technologies.

As such, we propose a tutorial to discuss research methodologies and design practices when designing UbiComp technologies for special populations. The need for inclusive and accessible design is important for all users but can be especially important to users facing additional challenges. We will focus on answering methodology questions like - 'how to do research in this space?', 'what methods are best employed for the current research vectors?', and 'What considerations do we make for each special population?'. Finally, answering these questions will impact the community as they will help to build a common ground between individuals working on

the same topic. Moreover, we aim to use this tutorial to create relationships between researchers, students, industry, and practitioners working in the area.

1.1 Special Populations

By ‘special populations’, we refer to any grouping of people which require special considerations when designing for or with (e.g., geographical area, accessibility considerations, socio-economic group, neurodivergence, mental and physical health). For example, when designing for sensitive topics that carry stigma (e.g., physical health, mental health, sexuality) it is important to consider the environment in which we present the information creating a safe space for conversation within the parameters of the application [16]. Moreover, the evaluation of interventions for mental health for vulnerable populations requires additional thought [12]. Considerations for groups of individuals dealing with stressful situations can also be an area of research. For example, work examine the information handover of families coping with having a family member in palliative care [5]. Often adding extra modalities for interaction can be helpful for expanding usability of basic application types for people with accessibility needs. For example, Moffatt et al. explores adding sound and enhanced visuals to planners to further benefit people with aphasia [9]. Exploring technologies along the physical-virtual reality continuum provides opportunities to approach problems from new directions. For example, work in the space of VR is exploring desensitization of combat-related Post-Traumatic Stress Disorder (PTSD) [10]. Lizbeth Escobedo et al. [6] explored the use of AR interactive system for children with autism to enhance their therapies. Dr. Escobedo found that AR is an interesting technology for the autism population as it mixes real and virtual information that can help them to generalize learning and the form of objects, supporting children’s real-life situations.

In this tutorial, we do not focus on a specific special population, as we believe there are common methodological challenges that need to be taught, for instance, ‘how to design and run user studies with these populations?’ or ‘how to be respectful when working with them?’.

1.2 Immersive Technologies

In this tutorial, we do not focus on a specific technology, but in all the interfaces for immersive and mixed technologies as we believe there are common challenges when designing them like how to simplify the operations, how to create novel input technologies, and how to provide more feedback to the user. When discussing novel, immersive and mixed technologies, we refer to new technologies across the physical-virtual reality continuum [8], including VR, AR, MR, but also large displays and CAVE environments. When designing for these technologies, additional considerations must be made when exploring implementations mixing states of digital and physical design. For example, these technology typically require users to be able to control objects using a 6 degrees of freedom (DOF) device, which pose higher cognitive and sensorimotor demands for eye-hand coordination than screen based technologies [13]. Users also need to know the position of virtual objects in space that do not provide haptic feedback. For example, Dr. Barrera Machuca et al. have studied the effect of the depth perception issues on

interaction [3], which is an issue that affect all technologies that use stereo displays to render 3D content.

2 TUTORIAL

To allow for conversation and cross-pollination of ideas, we propose the presented tutorial for academics, industry members, practitioners, and students to contribute to the discussion and learn about new methodologies for designing within the physical-virtual reality continuum with special populations. Our tutorial is designed to be a safe, playful and inclusive space to encourage participants to explore the topics and connect for future collaborations.

2.1 Participants

This is an open tutorial, but we will encourage participants to demonstrate their interest in participating in the tutorial by contributing a single slide summary of their profile and research for the madness [1 slide]. The submissions will be presented in the 2-minute madness and facilitate networking. We expect to have maximum 20 registered participants. We also expect to have an additional 10 walk-in participants.

2.2 Prior Knowledge

Participants of this tutorial don’t need to have prior knowledge.

3 PRE-TUTORIAL ACTIVITIES

Participants will prepare a single slide for madness introductions.

4 TUTORIAL ACTIVITIES

The presented proposal is a half-day tutorial that aims to teach the basics of designing and developing immersive technologies for special populations. We also aim to build relationships between individuals interested in the same topics and provide a place to start the discussion. Therefore, our main activities are related to teaching specific topics, networking and exchanging ideas about possible collaborations. Below is the planned schedule. All times are tentative as the duration of most activities depend on the number of participants:

Time	Activity
8:50 am	Registration
9:15 am	Opening notes
9:30 am	Madness introductions
10:30 pm	Learning and Lectures
12 pm	Burning Questions
12:30 pm	Lunch

Times can be adjusted to fit morning or afternoon session start.

4.1 Madness introductions

As part of the tutorial attendance, we will ask each participant to provide one slide summarizing their short bio. Each participant will have 2 minutes of madness to present. We will create a fun environment with timers and count down music. The idea is to be aware of possible collaborations with each other. This activity will happen from 9:30 am to 10:30 am.

4.2 Learning and Lectures

Within the tutorial, we will have mini-lectures from experts in the areas. Each talk will be aimed at teaching a subset of research theories, prototype design, ethics, methods, and analysis techniques that are specific to research in this area. Using the participant's position papers, we will point to relevant examples based on the research interests of the course's students.

4.2.1 Introduction and Prototype Design. Dr. Mayra Barrera Machuca will begin with an overview of the concepts and technologies. We will cover the basics of the technologies and explain their differences. This part of the tutorial will also explain the devices needed to develop Virtual and Mixed Reality applications, including going over the basics of libraries and game engines.

4.2.2 Methodology and Ethics. Dr. Lizbeth Escobedo will teach understanding on the specifics of working with special populations using MR. What considerations should be made for each specialized group targeted within the empirical research. She will also review equitable research practice and ethical conduct.

4.2.3 Evaluation of the Results. After learning the technological and theoretical underpinning of the area, we will then do a deep dive into the methodologies and research analysis techniques in the area. We will cover statistics design in correspondence to the research questions given within the first two mini-lectures for continuity and to help participants see the application of the statistical calculation. We will do an example that is qualitative and discuss exploratory studies and how they enrich the area. Finally, we will cover analysis with heat mapping and location based data specific to this area.

4.3 Burning Questions

We aim to create a playful and fun environment for our participants. We would like the tutorial to feel inclusive, and be a safe environment to share ideas. In this activity, participants will be given a piece of paper where they will write 'the **one** burning question' that has brought them to the tutorial. We hope writing the question will remind participants of their motivations for joining, and inspire increased attention. Once the question has been written participants will be instructed to enter their question into an deflated balloon. The participants will then inflate their balloons. All balloons will be thrown around the room to randomize questions and hide the identify of the question author. Following, all participants will be instructed to catch one balloon, pop the balloon, read the question, and encourage discussion of the answer [14].

4.4 Lunch

The committee will organize a lunch break as a group by making a reservation. Despite the reservation, participants will be responsible for purchasing their own lunches. We plan to go to a traditional Mexican restaurant near the conference centre to also share the local culture. We endeavour to pick a location that can accommodate a student budget. This restaurant will be chosen by Dr. Escobedo and Dr. Barrera Machuca, who are from Mexico. Over lunch we encourage networking and discussions with each other.

5 POST-TUTORIAL ACTIVITIES

Post-tutorial we will send a summary of the lectures and learning materials. In addition, we will also ask participants if they would be comfortable distributing their emails to facilitate and support connections made through the tutorial.

6 TUTORIAL ORGANIZERS

To lead this tutorial, we present an intersection of skills across design environments (e.g., MR, VR, Large Displays). Additionally, we also apply to multiple application areas e.g., novel user interfaces for VR and AR, Games for Mental Health Education, HCI, and assistive technology for neurodivergent children across the Autism Spectrum Disorder (ASD).

6.1 Rina R. Wehbe (she/her)

Rina R. Wehbe is an assistant professor, Faculty of Computer Science, Dalhousie University, Canada. Dr. Wehbe's research is in Games 4 Change, using MR games for education regarding physical, mental health and wellness. Wehbe's work believes that teaching empathy to encourage pro-social behaviour and community support. Wehbe has supported conferences as co-chair for ACM CHI Social Media (2018-2020), Globalization, Diversity, Inclusion and Allyship (2021), and Allyship (2022). Wehbe has also held past positions as an organizing member in other ACM conferences. She has received funding from National Science and Engineering Research Council (NSERC) Discovery Grant (DG).

6.2 Mayra Donaji Barrera Machuca (she/her)

Dr. Barrera Machuca is an Assistant Professor at the Faculty of Computer Science at Dalhousie University in Halifax, Canada. Her current research areas include using multimodal interactions for 3D sketching and understanding human performance with virtual objects. She also proposes new user interfaces that improve the accuracy of people working inside virtual environments. She also researches the challenges the HCI Latin American community faces. Dr. Barrera Machuca's work has generated considerable interest in the community, including winning the 2021 VGTC Virtual Reality Best Dissertation Award and the Dalhousie Belong Grant. Dr. Barrera Machuca's work has been funded with multiple grants like the NSERC Discovery Grant and Dalhousie University VIPRIIS grant.

6.3 Lizbeth Escobedo (she/her)

Dr. Escobedo researches to understand the models of interaction of people with technology and their environment, to develop, implement and evaluate the impact of ubiquitous technology that mainly helps people in vulnerable situations, and their families and caregivers, thus raising their quality of life. She has explored technology as augmented reality, wearables, mobiles, tangibles, among others for children with autism and other vulnerable populations. She has received funding from agencies in Mexico and USA including CONACYT and NSF. Her interdisciplinary and multidisciplinary research work encompasses areas such as psychology, education, medicine, social science, design, among others. She has been collaborating with both academic and private industry. Dr. Escobedo is part of the Amexihc's (Mexican association of Human-Computer interaction) board of directors and the SIGCHI Mexican chapter. She

has been chair of the Mexihc conference, part of the group of chairs of conferences (e.g., Ubicomp, ASSETS, CLIHC, ENC, Pervasive Health), and organized workshops as WUC (Workshop Ubiquitous Computing Uniting the Californias).

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