Experiencing the World through Imperfect Lenses: An Autoethnography of Living in Mixed Reality

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Figure 1: The primary author living with a video see-through capable Meta Quest 3 [59] on a typical day. From left to right: interacting with the device using pinch gestures in public spaces, doing sports while following a Youtube tutorial, shopping and reading the label through the see-through camera, and wearing the headset while on the go.

ABSTRACT

Mixed reality (MR) technologies are evolving to become more portable, incorporating video see-through capabilities, which enable a shift from stationary to mobile use. This development allows MR headsets to be used in various everyday contexts, including eating, travelling, and exercising. Before MR technologies reshape how we live and seamlessly integrate into our daily activities, we must understand the lived experiences of using MR in our personal lives and their influences and implications on our day-to-day activities. This paper presents an autoethnographic study that adopts an exploratory first-person perspective to uncover challenges and opportunities within this intimate context. We present the experiences and challenges of living in mixed reality, including on-the-go scenarios and social interactions. Our findings reveal issues such as social and ethical concerns and offer lessons learned to inform the design of future interactive systems for mobile mixed reality.

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CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**; **Interactive systems and tools**.

KEYWORDS

mixed reality, autoethnography, first-person methods, everyday life usage

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1 INTRODUCTION & MOTIVATION

Mixed reality (MR) technologies bring many exciting and unique possibilities, for example, enabling heads-up computing [103], supporting multi-tasking [30], and providing information in-situ and altering realities [9]. In daily contexts such as cooking [45], subtle-gesture interactions enable users to watch YouTube tutorials without needing to clean their hands to interact with a physical screen. This capability extends to other use cases, including live translation [53], eating [63], navigating [56], and shopping [88]. MR-enabled natural interactions are more human-centered and comfortable, allowing users to integrate computing seamlessly into their context without the limitations of a small display. With the advancement of MR technologies, MR headsets are becoming increasingly mobile and ubiquitous as they become more compact and lightweight [70]. Recent innovations in video see-through technologies [79] have expanded possibilities beyond traditional stationary setups, enabling interactions with digital content while engaging in real-world activities across diverse environments.

Early adopters and tech enthusiasts have demonstrated the versatility of these headsets, such as Apple Vision Pro [38] and Meta Quest 3, using them in various settings such as supermarkets [92], flights [61], cooking [91], and even skateboarding [13]. Moreover, integrated social features like the Eyesight feature [37] from Apple Vision Pro, which displays the user's eyes on an external screen, make embedding MR headsets into everyday activities feel more natural, including social contexts. By living with these technologies and incorporating them into daily life, early adopters reveal both the opportunities and challenges MR technologies present across various aspects of life. These include increased navigational difficulties due to reduced visual perception through the camera, social discomfort stemming from bystanders' reactions, ergonomic challenges with the hardware, and positive engagement through enhanced productivity and immersive experiences.

Despite the growing interest in video see-through mixed reality headsets, a lack of structured understanding regarding the lived experiences of using these devices in natural, everyday activities remains. Addressing their potential pitfalls and risks is crucial before MR technologies can be seamlessly integrated into daily life. Key areas that warrant further exploration include the impact of MR on daily activities, real-world social interactions (as opposed to controlled lab settings), and its use in mobile, on-the-go scenarios. Therefore, we formulate our research questions as follows:

RQ1: What are the lived experiences of using MR technologies in daily life?
RQ2: What lessons can these experiences offer to inform the design and development of future MR technologies?
RQ3: What are the broader implications of integrating MR technologies into everyday life?

To explore the lived experiences associated with video see-through MR headsets, we conducted an autoethnographic study documenting the primary author's first-person account of living with the Meta Quest 3 headset over two months. The study was co-designed and analysed collaboratively by both authors, combining lived experience with critical reflection on the recorded data. Through an autoethnographic lens, we examined the nuanced and situated experiences of living with mixed reality on a daily basis. The first author (hereafter referred to as "I") used the headset during most of my everyday activities, recording my emotional responses, encountered challenges, and social interactions in various settings. Initially, there was a sense of excitement; however, the results revealed a range of complexities, including frustrations and disappointments in navigating daily tasks with immature and imperfect MR technologies, and the digital distractions they introduce to social interactions. These challenges led to feelings of isolation, disconnection from my surroundings, and various reactions from others. This study illuminated unexpected emotional responses and changes in my behaviour and relationships. The intricacies uncovered in this work offer valuable insights for the DIS community, providing a deeper understanding of the experience of living with MR and offering lessons learned for designing future MR technologies and applications.

2 RELATED WORK

Our study is situated within the context of living with a state-of-the-art video see-through headset in everyday life, particularly in public spaces, mobile contexts, and social interactions. The unique nature of this device enables seamless transitions between physical, augmented, and virtual realities, supporting applications across both MR and VR. This section reviews relevant literature on our close relationship with immersive technologies and their integration into everyday contexts, focusing on user experiences with AR/VR applications and the broader social implications of them.

2.1 Situated HMD Applications in Everyday Contexts

Research in HCI has explored various applications and use cases where people use head-mounted displays (HMDs) to support everyday living activities. For example, researchers found that people sleep with headsets on to combat loneliness before falling asleep [100], or use see-through HMDs while playing the piano [72] to enhance their training through real-time visual cues displayed on the instrument. During yoga practice, Jo et al. [40] use FlowAR to continuously blend instructional content directly into the learners' view, regardless of the direction they are facing, thus enabling smoother execution of complex exercises. Additionally, users can wear an HMD while working to access customised working environments that improve productivity [48]. Other applications include ARpenSki [55], which provides real-time visual feedback for learning skiing, Lifelog-MR [1], which captures and archives life experiences anytime and anywhere, and systems that support reading while navigating with an HMD [105] or assist with fear management in sport climbing [80]. These examples demonstrate that immersive applications are increasingly being developed to enhance everyday life, supporting physical, cognitive, and emotional activities through the use of HMDs.

2.2 User Experience with Video See-Through MR Headsets

Modern MR headsets increasingly rely on video see-through technologies, where users view their surroundings through stereoscopic, high-resolution video displayed in real-time on the headset's screens [7, 11]. These technologies enable indoor and outdoor use, potentially changing how MR can be integrated into daily life. Although recent advancements have improved headset performance, limitations remain. Souza et al. [18] highlighted device quality and cybersickness as significant obstacles to the widespread adoption of video see-through HMDs. While these headsets offer realistic colour representation and superior reading performance, they are more prone to issues when used in motion rather than stationary settings. Extended use can also result in discomfort and symptoms of cybersickness [84].

While video see-through MR headsets have made great technological advances, challenges remain. Further research is needed to fully understand their practical integration into everyday life. Our research bridges this gap by exploring lived experiences beyond controlled lab settings, highlighting how these technologies are actually used and felt in real-world contexts.

2.3 Social Implications of MR in Public Spaces

Existing research has examined the social implications of mixed reality technologies in public spaces, with a focus on social acceptability, bystander interactions, and their influence on social behaviour. Schwind et al. [81] found that mobile VR headsets were perceived as less socially acceptable, particularly in contexts where social interaction with others was expected, such as in a room with guests or a public café. Gugenheimer et al. [31] further highlighted the problem of bystander exclusion, where using MR devices in public can leave non-users feeling excluded. Additionally, users themselves also risk isolating themselves in their own personal "techno-cocoon", becoming detached from their surroundings despite being physically present [95].

To mitigate negative user experiences, FaceDisplay [34] was developed to enhance bystanders' social experience by displaying a representation of the user's face on an outward-facing screen. Li et al. [47] proposed SeatmateVR, which provides proxemic cues for nearby bystanders to improve users' awareness of others while immersed in MR environments.

Beyond the immediate social context, research has also addressed the broader societal implications of pervasive MR technologies. As head-mounted displays become "always-on" computing devices that overlay content directly into our visual field, they introduce ethical concerns related to altered perceptions of reality. O'Hagan et al. [67] describe how MR enables dynamic manipulation of environments, potentially reshaping how users perceive people, places, and media. Moreover, public use of MR raises critical concerns about privacy and surveillance, particularly when such technologies are becoming mobile and can be used in shared public spaces [32].

2.4 Autoethnography in HCI

Autoethnography research [19] is an approach that intertwines personal experiences with academic inquiry and is adopted from ethnographic research, offering a unique and insightful perspective for exploring the deeply personal and contextual aspects of technology use. A recent literature review conducted by Kaltenhauser et al. [42] elaborates on how autoethnography methods are adopted by numerous works within the human-computer interaction (HCI) community. For example, Gamboa [25] reported her year-long documentation of the interaction between her family and robots and drones, surfacing issues and opportunities of design for child-drone interaction. Mueller and Pell [62] used an autoethnographic approach to explore HCI perspectives on an adventure during an expedition to Mount Everest. They reflected on the impact of two earthquakes during the journey and identified various dimensions and roles for adventure technologies. Homewood [35] presented an 18-month autoethnographic study using a Fitbit to manage Long COVID symptoms by doing less, proposing new design considerations for managing chronic illness. Gamboa [26] presented an autoethnographic illustrated portfolio of her pregnancy, focusing on socio-technical entanglements and promoting better design of technologies used during pregnancy and childbirth. These studies provide critical reflections on personal experiences with technologies, deepening our understanding of the intricate relationships between humans and technologies, and demonstrating the value of such methods, which could benefit the DIS community.

3 METHODOLOGY

In this study, we employed an autoethnographic approach, where the subjective experiences of the first author informed the data collection, analysis, and outcomes. The following sections will employ a first-person perspective to convey the methods and results and clarify where the other researcher contributed, such as in data analysis. Autoethnography provides a means to capture nuanced, subjective details, including first-hand accounts from HCI researchers [66], deeper insights into lived experiences [27], and perspectives from marginalised groups [85], which are often missed by traditional methods. This methodology is particularly valuable when studying how emerging technologies integrate into daily life, encompassing personal emotions, social dynamics, and intimate moments, insights that can inform the design of more empathetic and inclusive technologies.

3.1 Methodological Fit

Our choice of autoethnography was motivated by several factors: (1) the need to capture personal, lived experiences of mixed reality in everyday life; (2) the ability to offer reflections and nuanced details that are difficult to obtain through third-person methods; (3) the opportunity to present long-term (2-month) study results that allowed time for both technology acclimation and novelty effects to diminish; and (4) the practical consideration of limited user pool accessibility due to the intrusive nature of the study. Similar to other autoethnographic studies conducted in unique settings, such as an expedition to Mount Everest during two earthquakes [62] or the lived experience of childbirth [26], our work required collecting data on MR experiences while engaging continuously and deeply in everyday activities. This required usage in personal and social scenarios (e.g., eating or socialising), which could understandably cause discomfort for participants. This differs from typical VR usage, primarily in gaming or lab settings and does not require use in extended contexts. Moreover, the ergonomics of current MR headsets present limitations for extended use, including neck fatigue due to the weight of the goggle, eye strain, and nausea caused by cybersickness.

3.2 Positionality of the Authors

Growing up as an Asian female in a major Asian city, I witnessed firsthand how rapidly technologies can change our lives. The adoption of new technologies was remarkably quick in my environment. I remember how mobile payments became ubiquitous almost overnight, reshaping how we handled daily transactions. Moving to Europe for my master's and Ph.D. studies in HCI opened my eyes to different perspectives on technology. Here, I began to consider the potential negative consequences of technological advancements. Privacy protection and ethical considerations became important aspects of my work and daily life. I have gained hands-on experience through research and practice in the XR space, having designed, developed, and evaluated several XR applications. I also actively follow developments in XR hardware and software, staying current with trends and technologies. The second author is a European academic with extensive experience in HCI and serves as the supervisor of the first author's doctoral research. He contributed to the study's design, the data analysis, and the framing of the paper.

3.3 Procedure & Protocol

The primary data source of the autoethnography study was a research diary kept over two months from February to March 2024. During this time, I aimed to incorporate the Meta Quest 3 headset [59] into as many aspects of my daily routine as possible. Considering ethical study design and ensuring my well-being, I did not wear the headset continuously 24/7. However, I documented both its use and the moments when I felt compelled to remove it due to issues such as cybersickness or social discomfort. I structured my sessions based on my daily schedule. For example, on a typical day, I would wear the headset before commuting by bus to the office. I sometimes connect the headset to my laptop during office hours and work in VR, though not always, as VR work has both advantages and drawbacks. During breaks, such as lunch, I would wear the headset while visiting the supermarket or socialising with colleagues. After work, I would continue wearing the headset during activities like working out, attending seminars, or socialising, unless the headset significantly impacted the activity or caused discomfort, particularly during more physically or socially demanding interactions (e.g., skiing or exam meetings).

Like Homewood et al. [35], I initially used a voice memo app on my smartphone to document my thoughts, emotions, and experiences — partly because the headset only supports video recording and does not allow for voice memos. However, I gradually shifted to writing diary entries, as managing an additional device while wearing the headset and remaining attentive to my surroundings became overwhelming. This transition highlighted the practical challenges of documenting autoethnographic data while living with MR technologies. Tasks such as unlocking my phone, inputting the password (made difficult by the distortion of the phone's display through the MR lenses), and finding the voice memo app, which had previously been straightforward, became cumbersome and energy-consuming. To address this, I eventually set a physical shortcut button on my phone to quickly trigger the voice memo app. However, multitasking — managing the recording, maintaining personal safety while on the move, and observing my MR experiences — often left me exhausted. As a result, I shifted to writing diary entries on my laptop at the beginning of March, after two full days at a community event where I had engaged intensively with others. This change allowed me to focus more deeply on the experience itself and dedicate time to recalling past events, resulting in narratives with contexts and reflection. These entries were much longer, often several hundred words, and provided detailed insights compared to the fragmented recordings from the voice memos. Before transitioning to writing on my laptop, I also experimented with the Journal app [2] to take diary notes, particularly when I feel awkward speaking in crowded spaces. The voice memos, totalling 69 pieces, were transcribed using WhisperX [49], along with 12 diary entries from both my phone and laptop. This resulted in a total of approximately 10,349 words.

There's an ongoing debate in autoethnography about a better documentation method. While field voice memos capture immediate, intuitive reactions and reduce the risk of forgetting details, they can also distract from observing the current experience. On the other hand, dedicated diary writing allows for more reflective storytelling, incorporating connections with other experiences that may not have been immediately noticeable during the event. However, this method risks distorting the memory through personal bias and can lead to certain details being forgotten.

Given my goal of documenting lived experiences with MR technologies, I recorded all aspects of my daily activities, including my observations, user experience, and reactions from others. The data were collected in various settings such as public transport (buses, trains, subways), supermarkets, cafeterias, malls, gyms, lecture halls, offices, airports, and public events, providing various contexts for analysis.

3.4 Methodological Limitations

Autoethnography has its limitations. As both the researcher and the participant, it can be challenging to avoid influencing one's own behaviour during the research. For instance, I sometimes persisted in uncomfortable situations to continue the study, which may not accurately reflect real-world behaviour. Generalisability is also a concern, and it is worth noting that a collaborative autoethnography could offer broader reflexivity — an approach that may be considered in future work. However, this limitation can be mitigated by involving two researchers in the analysis, thereby expanding perspectives and reducing individual bias. Additionally, my experiences align with those observed in videos by YouTube influencers, suggesting that these reactions are widely resonant and shared among a broader audience.

3.5 Data Analysis and Reporting

Aligned with Gamboa et al. [25], the Critical Incident Technique (CIT) [23] was applied to identify diary moments that significantly shaped my emotional and behavioural responses to using mixed reality. Employing CIT allowed for a structured focus on meaningful and disruptive moments. These critical incidents included, for example, situations where I had to stop using the headset due to physical or social discomfort and emotional turning points that marked shifts in my engagement.

A reflexive thematic analysis [10] was then conducted on the critical incidents, identifying four themes: (1) *my body and imperfect technologies*, (2) *frictions, frustrations, and struggles*, (3) *moments of isolation and disconnection*, and (4) *curiosity, distrust, and uncertainty of others*. These themes progress from personal experiences to interactions with others. To deepen the analysis, the first and second authors held a five-hour discussion, reflected on and validated the analysis. In the following, we report the results combining thematic analysis, interpretation of lived experiences, and engagement with related work [83], ensuring a self-reflective and contextually grounded narrative.

4 RESULTS

This section presents four critical aspects of MR experiences derived from the analysis of critical incidents. The results are organised into

Figure 2: a) The primary author engaging in a conversation with colleagues; b) socialising with friends; c) observing the steps while boarding a train; both d) and e) attracting attention in public spaces.

two parts: (1) first-person narrative results, including direct field note quotes and summarised experiences to avoid narrative fatigue in cases where similar experiences recur, and (2) sense-making and lessons learned from these experiences. The four themes are elaborated below:

First, the ergonomic challenges and safety issues associated with MR are examined. This analysis will highlight the challenges and potential risks that users may encounter, particularly those familiar from short-term VR or MR sessions. We aim to provide a comprehensive overview of how these technological constraints and safety concerns influence UX and overall satisfaction, emphasising the need for improved solutions to enhance MR environments.

Next, we will address the frictions and frustrations experienced during MR usage in concrete everyday scenarios, focusing on the discrepancies between the real-life experiences and the mixed reality experience. This section will underscore users' difficulties when doing various tasks, especially while moving or in on-the-go scenarios, and will explore how these mismatches impact effective interaction and usability. By examining these issues, we seek to identify specific areas where the integration of real and virtual experiences can be improved.

Third, a personal reflection on the dimensions of connections with others and the surroundings will be presented, including the feelings of disconnection and loneliness that emerged throughout the study. This introspective examination will delve into user's subjective experiences, providing insight into how MR can affect their sense of social connection and emotional well-being. By reflecting on these emotional impacts, we aim to highlight the broader implications of MR technologies on user's mental and social health during long-term use and to suggest ways to address these concerns in future MR developments.

Finally, we will explore the social interactions influenced by MR environments. This section will assess how MR technologies mediate social engagement and communication among users, including the dynamics of virtual and augmented social interactions. By analysing how MR influences the quality and nature of social interactions, we seek to understand how MR enhances or detracts from user's ability to connect with others. This examination will also consider the implications for social relationships and community-building within MR contexts, highlighting areas for improvement to foster more meaningful and effective social exchanges.

4.1 My Body and the Imperfect Technologies

Starting from the internal perspective — the immediate physical sensation of an artificial component mounted on my body and the perception of the world through the lenses of a camera — feels like a constant reminder of the imperfections of the technologies I am using. This awareness quickly turns into concerns of safety and physical discomfort, caused by the field of view (FOV), weight imbalances, software design and unstable system.

4.1.1 ***Peripheral Peril.*** Due to the limited peripheral vision, I frequently found myself in situations where I was unaware of objects or people until they were almost directly beside me. I bumped into people countless times, but one particularly nerve-wracking incident involved a near accident with a bicycle. This moment occurred as I stood on the zebra crossing under the green light, ready to cross the street without noticing any approaching vehicles. As I stepped forward, a bicycle flew past me, mere inches from collision — something I would have noticed without the headset. The headset's restricted FOV required me to adopt cautious behaviours, such as frequent head rotations, to compensate for the reduced visibility, which increased cognitive load.

Lessons Learned: This incident highlights several critical implications: (1) limited peripheral vision not only caused delayed reactions but induced a heightened sense of caution in public spaces [76]; (2) the compensatory behaviors (like frequent head rotations) introduce additional cognitive load that could lead to mental fatigue during extended use; (3) the safety risks are particularly acute in dynamic environments where rapid spatial awareness is crucial, such as street crossings or crowded spaces - notably, these risks have led to safety warnings from transportation authorities regarding MR headsets use while driving [65]; and (4) these limitations suggest that future MR designs need to consider how to better integrate peripheral awareness, perhaps through augmented visual cues [102], sound warning [8], or haptic feedback.

4.1.2 ***Disembodied Walking.*** Without peripheral vision in mixed reality, I frequently experienced movement and spatial awareness difficulties. *"With the headset, I lose this natural sensory input and have trouble perceiving my immediate ground (within 2-3 meters). Although I consciously avoided looking down to prevent excessive strain on my neck and corrected my posture promptly, I still received feedback that I constantly looked downward, as if checking my feet."* To avoid feeling uncertain, I prepared to avoid obstacles proactively. When obstacles entered my blind spot, I checked the ground more often, especially when navigating uneven terrain, such as moving downstairs.

Lessons Learned: This experience reveals that (1) the loss of peripheral vision disrupts our embodied experience [24], affecting the natural way we perceive and interact with our body and surrounding space; (2) the absence of subtle visual cues forces users to develop compensatory behaviours (like frequent downward glances) that can lead to poor posture and physical strain; (3) these adaptations suggest a conflict between maintaining natural movement patterns and ensuring safety while using MR; and (4) this incident suggests that MR designs need to consider alternative ways to provide awareness of the surrounding and embodied experiences.

4.1.3 ***Physical Strains.*** When used in the gym, the weight factor is particularly important for physical comfort [99]. Compared to common head-worn earphones used during training, which typically weigh around 270 grams, with some even reaching 400 grams, the 515-gram Quest 3 [59] *"feels somewhat acceptable and manageable for certain limited exercises like squats, boxing, cycling, and yoga. However, since the headset is front-loaded, it strains the neck more than head-worn earphones, especially when performing gestures like lowering the head."* Despite being suitable for certain activities mentioned previously, the headset is not ideal for dynamic movements such as squat jumps, jumping jacks, or burpees due to its instability during rapid motions. Adjustable straps that enhance stability, balance, and comfort are available online, but I did not test them for sports. While the headset does present ergonomic challenges, it provides better physical comfort than a smartphone for following workout videos. *"Instead of having to lower my head to view a small screen, I could maintain a natural posture by positioning the large video interface at eye level,"* aligns with the notion of heads-up computing [103]. This setup felt comparable to facing a real trainer in a studio, which significantly increased my immersion and engagement.

Lessons Learned: As the headset is only ergonomic for upright exercises that maintain a natural head position, it highlights the need for improved headset designs that fit into high-dynamic sports. Particularly crucial are better weight distribution and customisable fits to enhance physical comfort across users with varying body sizes and genders. This need is underscored by research from Stanney et al. [86], who found that a substantially greater proportion of females could not achieve a good fit and experienced cybersickness with VR headsets. However, this incident also points to MR's great potential in enhancing exercise experiences, such as having eye-level video tutorials or AR smart trainers [97], supporting multitasking while working out, in-situ gesture correction [101], etc.

4.1.4 ***Obstructed Vision.*** *"On my way to the train platform, I grabbed the headset, intending to consume video or music content. However, after putting on the headset, I realised that I couldn't switch to see-through mode with a double tap before I could unlock the screen, leaving me trapped in VR. Being in VR while moving through a large crowd was far too dangerous, especially with many passengers exiting the train towards me. I needed to be aware of people both in front of and behind me. Additionally, using mid-air hand gestures to accurately target the unlock button proved trickier while moving rapidly. It was a perilous situation — surrounded by a crowd, on the move, and completely cut off from reality."*

Lessons Learned: (1) current MR devices still present significant friction in basic operations - the process of wearing, adjusting, and unlocking is far more cumbersome than using other mobile devices, such as answering a phone call, especially while on the go; (2) these challenges point to the gap between current MR interfaces and the vision of truly ubiquitous XR [41], where computers seamlessly mediate reality, perhaps in devices as lightweight as normal glasses, or eventually in form factors as natural as contact lenses; (3) as mid-air gestures become more challenging in mobile contexts, there is a need for alternative and context-aware input/unlocking solutions. Current industry developments, such as smart rings as input devices [20], Meta's wristband [21], and Magic Leap's Iris Unlock [50], represent steps toward addressing these challenges through biometric authentication and behaviour-based methods.

Digital Overlays. Despite the pass-through video feature, digital overlays often present their risks. Virtual artefacts, such as persistent controller contours and frequent pop-up notifications, can obstruct the user's real-world view, creating additional hazards. These obstructions force users to remain constantly vigilant of their surroundings, further complicating navigation in complex environments like subway stations.

Lessons Learned: (1) There is a need to redesign notifications and digital overlays to minimise visual obstruction of the real world, such as by adjusting the transparency and placement of digital overlays [73]; (2) the system should be context-aware in placing virtual artefacts, potentially adapting based on the user's environment (e.g., reducing overlays in crowded or complex spaces, or enhancing obstacle visibility through contextual highlighting [104]).

4.1.5 ***Dimmed Sensing.*** The camera's limited capabilities, such as limited dynamic range, low definition, and low-light noise, reduced my perception of the world, affecting text readability and making me feel partially cut off from my surroundings, leading to a sense of isolation. Once, *"during a bus trip, the camera's limited dynamic range made the text on the bus display with a white background appear overly bright and illegible. It felt like seeing the world without wearing eyeglasses, reducing the perceived information. I continued the study because I was familiar with the area and could navigate without reading the text."* This would not have been possible in an unfamiliar environment. For example, during my trip to Paris, *"I experienced strong uncertainty and reduced confidence. The text was blurry due to the camera's low definition, and without sufficient navigation information, I couldn't rely on my local knowledge to find my way."* The inability to read critical information in an unfamiliar setting heightened my sense of disorientation and isolation. Additionally, I encountered frequent LED screen flickering due to refresh rate mismatches between the camera and displays, further compromising text readability.

The reading issue extended beyond street signs, shop displays, and digital screens, affecting my ability to see faces and recognise people at night as well. *"Due to the camera's strong low-light noise, I found it difficult to see people's faces clearly as I navigated the campus. This created a constant worry that I might miss seeing people I know, reducing my social connection and adding to my sense of isolation."*

Lessons Learned: Future MR devices must prioritise camera quality that matches or exceeds human visual capabilities, particularly in challenging lighting conditions and text-heavy environments ranging from digital displays to street signage.

4.1.6 ***Crash***. I experienced two crashes of the see-through video under extreme conditions. One crash occurred in an extremely dark situation. *"I was navigating the mountains at night, with very few street lights, and visibility was incredibly low. The camera's limited dynamic range made the world appear even darker than it actually was. Suddenly, I received a notification that the environment was too dark for hand tracking, and then the display went completely black, cutting off my view of reality entirely. I was forced to take off the headset at that moment, feeling both disoriented and shocked."*

Another alarming moment occurred during intense movements while navigating down the mountain. *"The see-through video glitched quite often while on the go, depending on my speed and vertical movements. At one point, the screen flashed black briefly, but I continued using it because I was in the middle of this study. Suddenly, the screen went completely black again for two full seconds. I realised it was too dangerous to continue wearing, as I could miss a step at any moment. Abruptly stopping to wait for the screen to clear was equally risky, as people following closely behind could collide with me, potentially causing an accident."* The uncertainty and safety concerns made it a tense and unsettling experience.

Lessons Learned: These moments highlight the critical physical safety implications, like illustrated by Costello et al. [15]. The see-through camera's limitations in low-light environments and during rapid movements create serious safety hazards, especially when users rely on the headset for real-world navigation. At this stage, the device is still unstable in covering all critical situations, such as navigating dark environments or steep terrain. We see many early adopters reported riding bicycles or e-scooters on mountain roads or busy city streets, where there are high levels of motion and unpredictability. In one reported case, a cyclist experienced a system crash followed by a real-world crash on a mountain road [75], demonstrating the need for more resilient designs. The technical failures could lead to distrust or panic, particularly in hazardous moments. The design of MR systems should prioritise safety, ensuring real-world awareness, especially if we envision ubiquitous computing extending to outdoor scenarios.

4.2 Frictions, Frustrations and Freakiness: My Journey of Struggles

Beyond my physical experiences, I engaged with and explored my environment through various contexts facilitated by my headset. Here, I share these emotional experiences across different activities and settings, especially those fundamental to my life, such as eating, travelling, shopping, etc.

4.2.1 ***On the Go***.

Street Multitasking. *"That was an overwhelming moment. I had just finished shopping, standing on a busy street with my hands completely full, needing to interact with the headset. Unfortunately, hand tracking was not functioning."* (I later discovered that if hand tracking fails, I can use the volume button and eye tracking to make selections.) So at that moment, I needed the controller. *"Managing several extra devices, such as my phone and the controller, increased complexity and limited my multitasking ability — contradicting the vision of heads-up computing using natural gestures."* Despite the promise of natural hand interactions, I repeatedly relied on controllers to handle emergencies, forcing me to carry the controller with me at all times as a backup input method.

Lessons Learned: In scenarios where a fallback is needed — such as hand tracking bugs, challenging lighting conditions, or when hand gestures are impractical — a smart ring or smartwatch could serve as an alternative input method for quick actions like starting an app or unlock the screen, as discussed in Section 4.1.4. This approach reduces the reliance on holding or searching for additional controllers. Furthermore, the hidden fallback feature of using the volume button for input was poorly communicated, leaving many users struggling to reboot the device or seeking help in online forums, indicating missed opportunities to improve the onboarding process.

Another frustrating moment came when *"I tried to play YouTube videos while walking — just listening to the audio should have been enough. I left the screen in place and moved away, but constant pop-up notifications warned me that I was too far away, stopping the videoplay and disrupting the experience. To fix this, I tried 'holding' the video with me by continuously holding the pinch gesture. However, the headset still detected my distance from the original location, triggering the same safety notification, which stopped the holding process and made me 'drop' the video. Even after I reduced the notification frequency in the settings, the interruptions were still annoying. I had to keep returning to the spot where the video was 'lost'. From an outside perspective, I must have looked ridiculous — pinching the whole time and constantly turning around to 'retrieve' my video."*

Lessons Learned: While Meta has updated travel mode [58], it is designed specifically for seated situations within vehicles, and doesn't account for pedestrian use. Although designing for walking requires careful consideration of safety, the system could implement smarter solutions for mobile multitasking. This could include a 'follow-me' window feature for safe indoor spaces like homes, or context-aware warning notifications that adjust based on environmental safety (e.g., reducing interruptions in safe squares with minimal obstacles and traffic).

Regarding **phone use on the go**, *"due to motion-induced distortion, my phone shakes wildly and appears completely twisted, almost like a big strip. Depending on the speed of movement, my ability to perform tasks varies. For example, while I can't clearly see the exact position of buttons during rapid walking, I can estimate and uncertainly try to start the app I need. However, it is impossible to read the screen on the bus, making the phone entirely unusable."* Additionally, the headset made me more cautious while on the move. For example, *"when seeing a yellow traffic light, I would usually cross the road because there was enough time. However, with the headset on, I often felt it was too risky and would choose to wait, even though the timing* *was still sufficient."* This reduction in confidence also highlights the imperfections of the technologies.

While **ascending stairs**, the see-through video exhibited increased wobbliness compared to walking on level ground. This wobbling effect might be attributed to head tracking being optimised for horizontal rather than vertical movements. Nonetheless, navigating stairs remained manageable, and the wobbling did not significantly impact my perception of stair height due to the slow pace of movement.

Public Transportation. *"I felt eye fatigue as I tried to read the text on the bus screen through the headset. The text was hard to read — shaky, surrounded by flickering white lines, and distorted. When I glanced outside, it was just as bad due to the strong motion distortion — the trees appeared to jump and sway unnaturally, and everything else felt disorienting." "During my train journey, the track had many curves, causing the train to experience lateral acceleration to the left or right. I wanted to watch a YouTube video, so I opened the Browser app. However, whenever the train took a curve and experienced sideways acceleration, I noticed that my user interface would always float away, because the system loses stable reference points."* Later, I wanted to meditate in VR, so I started an immersive app. However, many VR apps require the guardian system [60], and similarly, my guardian system drifted away with the train's movements. I then received a notification that I was outside the guardian system and needed to set up a new one. Since the system thought I was outside the boundaries, it automatically blended reality into the headset display for safety. Meanwhile, my meditation app kept running, and the constant switching between see-through reality and VR became a frustrating experience.

<u>Lessons Learned:</u> Vehicle motion is the most significant factor impacting the stability of spatial tracking, requiring optimisation for each mode of transportation. According to Meta's update, they specifically tuned their algorithms to account for the motion of a plane, ensuring a stable and consistent experience in Travel Mode — even when looking out the window [58]. This aligns with reports from numerous vloggers, indicating that aviation use cases show more promise, although acceleration during takeoff and landing still poses challenges [90]. This highlights the need for additional mode-specific optimisations in spatial tracking, such as for trains or even cars. Compared to Meta, the Apple Vision Pro's travel mode [3] reportedly offers more robust solutions, as noted by user feedback [6].

Travel. During my trip to Paris, my uncertainty grew significantly due to the unfamiliar environment. *"The first challenge came at the subway checkout point when my ticket couldn't be read, and the warning message was in French. It was stressful because I felt like I was blocking the exit while people hurried past. Asking for help in a place where many people didn't speak English, while also wearing a distracting headset, could make communication feel even more difficult. That was the moment I decided to take it off."*

After that, I walked for 30 minutes to explore Paris physically and through the MR headset. *"When I passed a puddle, I couldn't tell how deep it was — this struggle with depth perception happened several times with reflective surfaces like water. As night fell and the streetlights illuminated the city, I was struck by the beauty of the Louvre. At that moment, I took off the headset to fully enjoy the view with my own eyes, rather than through the low-fidelity lenses."*

<u>Lessons Learned:</u> The MR device creates additional barriers to social interaction. Its presence can reduce users' motivation to engage with others or fully experience new environments, as it adds a layer of social complexity to already stressful situations. This experience also made me reflect on the environments in which we wish to fully immerse ourselves and what use cases are truly suitable for mobile mixed reality. In monotonous settings, such as train travel, we might prefer to engage with the digital world, consuming content like movies or games. However, in scenarios where direct interaction with the real world is key, such as connecting with people or exploring a beautiful city, fully experiencing the environment without the barriers will be a better option than being imposed by imperfect lenses.

Navigating the Mountains. Motion-induced depth distortion was prevalent during movement, particularly while navigating mountainous terrain or using public transportation. This distortion caused objects' perceived size and distance in the see-through video to differ from their real-world counterparts. As I moved, the video feed frequently shifted erratically, leading to a disorienting effect and an increased likelihood of motion sickness [98]. A notable instance of motion sickness occurred while hiking past a brewery, where shaky video and the olfactory stimulus triggered a wave of nausea.

At night, the see-through video was filled with low-light noise, resulting in blurriness that impeded the ability to discern faces or read street signs. The limited dynamic range of the headset further darkened the environment. A notification indicated that the environment was too dim for hand tracking.

<u>Lessons Learned:</u> The dimmed sensing presents not merely technical but also navigational, emotional, and social challenges, as discussed in Section 4.1.5, which poses risks of disconnecting from real life and inducing a sense of loneliness.

4.2.2 ***Shopping***. Viewing the world through the 4-megapixel Quest 3 [59] lenses significantly reduces the amount of detail compared to the human eye, which has a resolution of around 576 megapixels [44]. This lower resolution presents challenges, especially in high-information-density environments like shopping. Normally, we can gather information like price, product name, and appearance at a glance. However, the observation process becomes fragmented into multiple steps when using the headset. *"I needed to move closer to products, carefully scanning for the price tags, and sometimes even searching for out-of-view information. In addition to decreased visual clarity, the see-through cameras capture the scene with lower colour contrast, and reflective materials, such as metal, add further recognition challenges. The reduced visual fidelity makes it harder for information to 'pop' into focus naturally, requiring a more active effort to grasp important details. The increased cognitive effort required to gather basic information can lead to difficulty in decision-making. Tasks like choosing bed linen became a complex challenge — I needed to find information about size, price, material, and select a design or colour. All this became so energy-draining and overwhelming that I had to remove the headset to relieve the mental load."*

<u>Lessons Learned:</u> (1) the reduced visual fidelity disrupts natural bottom-up attention processes, where salient features like

colour, size, or contrast would normally automatically capture attention [39]; (2) this disruption forces users to rely more heavily on top-down, goal-directed attention processes, requiring conscious effort to search for specific information that would typically "pop out" naturally [96]; (3) the shift from automatic/bottom-up to deliberate/top-down processing significantly increases cognitive load, as users must actively maintain search goals and systematically scan for information rather than letting salient features guide their attention; and (4) these findings suggest that future MR devices need to either match natural visual fidelity, or develop intelligent visual enhancement systems that e.g. highlight relevant information [17] or filter out non-essential details [89], thereby supporting natural bottom-up attention processes and reducing cognitive load.

4.2.3 ***Eating***. Eating is a fundamental and enjoyable part of life. Colour plays an important role in our food consumption, influencing our perception of its deliciousness. Additionally, colour is crucial for food recognition. Unlike objects such as furniture, which can be identified by shape, cooked food often relies on colour for identification. However, viewing food through a headset camera can alter our colour perception, as it is affected by the ambient light conditions. In the cafeteria, I struggled to recognise and select food, leading to greater effort and more frustration. For example, *"I frequently had to bend down to closely observe the food while selecting it. Viewing through the headset made the world appear darker, with less colour contrast and a grainy texture, often leading to mistakes. On one occasion, I thought I was choosing glass noodles, but it turned out to be sliced cabbage. The most disappointing aspect was that the altered colour made the food look less appetising. I tried eating with the headset on, but it added difficulty as I had to avoid touching it while eating. My behaviour became less natural and more cautious. Drinking water was particularly challenging because the glass would touch the headset, and the vertical rotation of my head would quickly reach its maximum angle, preventing me from drinking more. After a while, I decided to remove the headset to enjoy the food with the vibrant colours and enhance my overall dining experience."*

4.3 Moments of Isolation and Broken Connections

This section switches perspectives and focuses on moments when I communicated with others, built bridges between myself and the surrounding world, and felt isolation and loneliness. These broken experiences left me feeling cut off, unplugged, and disconnected from my environment.

4.3.1 ***Fear of Disengagement***. *"During a train journey with a friend, who had consented to let me briefly experience using the headset in the train and take notes. However, after many chaotic and stressful moments living in MR, I completely forgot she sat beside me. After a super long time on the ride, I finally remembered her presence. I was shocked and embarrassed to realise that we hadn't exchanged a single word or had any social interaction throughout the entire journey."*

Lessons Learned: This experience highlights how MR can create unintentional social barriers. Combining immersive UI, blocked peripheral vision, and absorbed attention creates a semi-closed environment that reduces environmental awareness [29]. This isolation effect parallels historical practices, such as how newspapers were once used to create private spaces in public settings. While this isolation can support positive applications, e.g. focused work and flow states [16, 78], it can potentially be misused to avoid social interactions. These findings highlight the importance of developing social awareness features and appropriate interruption mechanisms to maintain connection with their physical social environment while using MR. Possible considerations could include: (1) recognising bystanders' interaction intentions, ranging from approaching attention, casual greetings to urgent behaviours; (2) graduated notification systems that adapt to social context and urgency - from subtle cues for nearby friends to prominent interruptions when being approached [47]; and (3) context-aware transition mechanisms that help users smoothly balance task immersion with social engagement [28].

4.3.2 ***Social Blind Spot***. The limited peripheral vision caused not only safety concerns mentioned in Section 4.1.1 but also social blind spots. A particularly striking incident occurred when a bystander approached from behind. *"I believed it was a one-on-one interaction until another voice chimed in. When I slightly shifted my head, I was astonished to realise we were actually a group of three, standing in a triangle formation. We had been chatting for about 10 minutes, and I hadn't noticed the presence of the third person at all."* This oversight was embarrassing and disappointing, as it demonstrated my failure to adhere to the social norm of balancing attention among all participants. I regretted it and hoped that the third person didn't feel left out.

The feeling of isolation reappeared when attempting to connect to Wi-Fi in a public area. The extensive user interface felt like a barrier, obstructing my view of people in front of me. Usually, social cues are picked up through peripheral vision or direct observation, but the headset's UI overlay and restricted peripheral vision left me feeling isolated in a cubicle. Similarly, *"the lack of feedback from my environment, especially on a crowded street where I was trapped in VR and unable to unlock my screen, felt like being a car stalled in the middle of moving traffic, unable to restart the engine."*

4.4 Curiosity, Uncertainty, and Adaptability from Others

This section focuses on the feedback I received from others, capturing their feelings and reactions through various encounters and discussions. Many people were curious about what I saw and what I was doing. Countless times, I noticed people staring at me. Many greeted, waved at me or reached out to discuss my experience, and one even requested that I take off the headset to see my face. I also observed that people exhibited less regulated behaviour [71], openly talking about me and the headset in public spaces where I could hear the conversation. This was especially noticeable in groups; when one person pointed out the "weird" individual, the entire group would start reacting, with some people even secretly taking pictures of me without asking.

4.4.1 ***Altered Reality***. *"The most frequent question I was asked was, 'What do you see?' My usual response was, 'I see reality — or more exactly, an altered reality.' I had a light-hearted conversation with a ticket inspector on a train. I mentioned that it was getting dark,* *making the reality appear pixelated through the headset. He laughed and said, 'I must look 20 years younger without my wrinkles being visible.' I replied, 'Well, I could always add a beauty filter to the video feed.' This sparked another interaction that felt more like a 'Black Mirror' moment when someone suggested adding an overlay to avoid seeing them altogether."*

Lessons Learned: Reality manipulation through MR presents both opportunities and challenges: on one hand, it enables beneficial applications like beautification filters [9] (changing clothes, makeup, or facial features) and diminished reality for focused shopping experiences [88] (removing visual distractions); on the other hand, these same capabilities raise ethical concerns about consent, privacy, and social interaction - particularly when they could be exploited for commercial gain through dark patterns [43], such as selectively altering or removing information that influences consumer decisions. Moreover, widespread adoption of reality manipulation could lead to 'reality bubbles,' [69] where individuals experience different versions of the same physical space, potentially fragmenting shared experiences and undermining the concept of objective reality.

4.4.2 ***Black Box***. The opaque nature of MR headsets creates a significant communication barrier by covering the eyes. Crucial social cues become invisible to others - they cannot see where I'm looking, gauge my emotional reactions, or read subtle expressions of interest or understanding. This creates a "black box" effect where my engagement remains uncertain to others, leading some to question whether I was genuinely present in conversations or multitasking behind the headset. For example, *"during a date while wearing the headset, my companion didn't seem surprised, as he had just watched videos about Apple Vision Pro. However, he mentioned that if we were going to have a deep conversation, the headset would become a disturbing factor. He could suspect that I might be multitasking since he couldn't see what I was doing behind the headset or where my attention was. 'It could happen that someone is watching a video or playing games while conversing,' he said. 'Or, I could have an AI that prompts me with real-time responses to support the conversation.' I replied."* I received a similar concern from a colleague as well. *"She felt uncertain about whether I was fully engaged in our conversation, even though I looked at her occasionally to show that I was paying attention. She shared that it felt like talking to someone who might be playing with their smartphone."*

Lessons Learned: This indicates that the lack of shared reality in MR settings can cause misalignments in communication, leading to distrust, disengagement, and a breakdown of social connection. One approach proposed by Gugenheimer et al. [33] could bridge the gap between the asymmetry of the digital and physical worlds. Their shared reality solution avoids excluding bystanders by enabling non-headset users to participate in the virtual experience. Another solution proposed by Gugenheimer et al. [34] involves mirroring the inner display directly onto the outer display, allowing non-MR users to transparently observe the activities of MR users.

This eye-covering nature of the headset and the lack of transparency also caused behaviour changes. *"While I was sitting in a lecture room, a researcher approached me and mentioned that the headset influenced his behaviour, making him more cautious instead of acting naturally, even though I wasn't filming anyone. He explained that, typically, people can pick up on cues and sense when someone is observing them, which helps them become more mindful and regulate their behaviour. However, with this cue blocked by the headset, he couldn't tell if he was being observed, leading to a constant need to regulate behaviours. This resulted in feelings of discomfort, unease, and a sense of intransparency, even creepiness."* Additionally, he questioned whether the EyeSight [37] feature of Apple Vision Pro addresses intransparency. EyeSight shows an animation to indicate to others that users may be unable to see them using MR or VR apps. However, it can not indicate whether the user is observing reality or not. Furthermore, the design of EyeSight may not be well communicated without reading the documentation.

Additionally, the MR headsets create identity barriers that can affect future connections - when people haven't seen your complete face, they may struggle to recognise you in subsequent interactions. Meeting someone for the first time, the obscurity of my facial features due to the headset led to a lack of transparency in appearance. While I could see her face clearly, I remained half-anonymised, leaving her uncertain about my true appearance.

Lessons Learned: The black box has entailed three layers of transparency: identity transparency, social transparency (no social cues), and behavioural transparency (potential multitasking). It conceals my expressions and distorts the dynamics of human interactions.

In other situations where feedback mechanisms are cut off, social cues and other non-verbal cues are blocked, which can lead to stressful feelings. While visiting a business booth, I asked someone to walk me through their product while I kept the headset on the entire time. She felt exhausted by the single-directional communication. It was like pitching to someone on Zoom with their camera off, missing non-verbal cues that indicate engagement, understanding, and emotional reactions.

4.4.3 ***Social Acceptance: Is That the Future? Cyborg!*** *"Even though the headset cut off direct eye contact, people could still associate it with a human face. Some interpreted the two cameras as eyes and the middle one as a nose, and integrated these features into my face as a whole. This perception made them feel like they were talking to someone whose face wasn't largely covered, but rather replaced with machine eyes, allowing for eye contact."* This phenomenon reflects the theory of face pareidolia [106], where humans naturally ascribe facial features to non-human objects. This association helped enhance the natural feeling and social acceptance of the headset. However, this constructed face still appeared unusual, creating an impression of interacting with a hybrid entity of human and machine. Not everyone perceived it this way; some individuals were unsure where to direct their gaze, often focusing on my mouth, which did not enhance the illusion of eye contact.

Social acceptance varies by community as well. *"At a community summit with artists, designers, and developers, I felt less out of place and 'weird' wearing the headset, and individuals were more generally more open to 'weird' technologies here. One attendee remarked, 'Is that the future?' as I navigated the venue with the headset. At the Tesla robot booth, while I was taking a photo of Optimus [14], a person requested to take a picture of me with the robot. He thought it looked harmonious — a 'cyborg' human alongside a humanoid robot — representing the coexistence of machine and human elements."*

Lessons Learned: People are adaptable and have the ability to accept new, emerging things quickly, as evidenced by how swiftly they adjusted to socialising with masks during the pandemic. This adaptability raises an interesting question: once headsets become ubiquitous (with cheaper prices and killer apps), could people rapidly accept them with reduced social weirdness, just like we accepted headphones and masks? Or, perhaps not, given the fundamental difference that headsets cover the eyes, potentially impacting social interactions more significantly?

5 DISCUSSION

This section presents design concepts informed by the lessons learned and challenges encountered through the lived experience. We propose the ideas of *Full Reality Mode, Peripheral UI,* and *Four Layers of Context-Awareness for Mixed Reality*. We then reflect on the potential risks associated with the deeper integration of MR technologies into daily life, exploring broader societal implications such as disengagement from physical reality and disrupting human connections. Finally, we offer reflections on using first-person research to engage with emerging technologies, highlighting its capacity to surface subtle, embodied insights in the wild.

5.1 Full Reality Mode

I am primarily engaged in real-world activities in many everyday situations where I live in MR. Immersion in fully virtual environments typically occurs only in limited scenarios, such as sitting on a train. MR technologies must therefore detect whether the user is engaged in real-world activities or immersed in a digital environment.

Seamless Transition Inspired by Full-Screen Mode: When users actively participate in real-world tasks, such as navigating, walking, or shopping, the system should transition into a "Full Reality Mode". This mode minimises digital overlays, allowing users to focus on their physical surroundings with fewer distractions. The concept is inspired by the "full-screen mode" in video players, where interface elements disappear to prioritise content.

Triggering Full Reality Mode: A typical transition to Full Reality Mode occurs when the user moves from a static to a dynamic state — for instance, standing up and beginning to walk. In this mode, menu bars and user interfaces seamlessly auto-hide, ensuring an unobtrusive, immersive real-world experience.

Task-Relevant Digital Enhancements: Only actively used and relevant applications to the main task remain visible. These apps provide embedded, in-situ content or lightweight animations, such as highlighting nearby shops or displaying an arrow for navigation. Such elements are naturally integrated into the real-world environment and support task continuity without visual overload.

Peripheral UI for Contextual Apps: These main-task applications are represented by subtle icons in the user's peripheral vision. These representations allow users to maintain awareness of active apps while still immersed in the real world.

Transparent Interfaces for Functional Apps: When interface elements are necessary, such as in the case of a payment application, they should employ transparent backgrounds to minimise obstruction and ensure the real world remains visually accessible.

Managing Secondary Tasks: Users may engage in secondary tasks such as watching YouTube. These applications typically feature content-heavy interfaces. In Full Reality Mode, they may either follow the user from behind or remain fixed in the left or right peripheral vision, depending on user preferences and customisation.

Minimisation of Non-Essential Apps: All other active background applications, such as messaging or browsing apps, are either minimised into icons in the peripheral UI or fully hidden to ensure minimal cognitive and visual interference.

Gesture-Based Recall: A pinch gesture is equivalent to a "mouse move" in video players. It recalls all full-featured interfaces previously in view. Additionally, eye-tracking may support this interaction: dwelling on the peripheral UI icon can trigger the corresponding app to reappear in full view.

5.2 Peripheral UI

Due to the limited peripheral vision in head-mounted displays from my lived experiences navigating with mixed reality, I reflected on what types of information should be presented in the peripheral areas of the display, and how critical different regions within the peripheral view are in supporting situational awareness and safe navigation while on the go. The peripheral display should balance awareness support with non-intrusiveness, helping users stay engaged with their environment while offering subtle contextual cues.

Inspired by the work of Zhang et al. [102], who visualised out-of-view traffic in mobile AR, we propose using lightweight peripheral overlays to represent out-of-view elements such as people, vehicles, furniture, and obstacles. These overlays can be positioned along the left and right edges of the display to enhance spatial awareness without capturing or diverting focused attention.

Spatial Hierarchy of Peripheral Regions:

Bottom Region: In real-world usage, the bottom of the MR display typically overlaps with the user's central physical view (e.g., the path or ground in front of them). For safety and clarity, this region should remain mostly empty while the user is on the move. Only extremely critical information could be displayed here, and even then, with reduced textual elements and minimal visual noise.

Top Region: The upper part of the field of view is less critical than the bottom. It can show active app icons or minimal status indicators, such as battery life or connectivity. These should remain small and low-contrast unless they require user interaction.

Left and Right Regions: As we proposed, the side regions can act as natural extensions of the physical world by dynamically displaying out-of-view content (e.g., approaching people or objects) to enhance spatial awareness. Alternatively, inspired by Apple's Stage Manager [4], users can pin secondary task apps to the sides in a dock-style layout. These apps remain fixed in the peripheral space and can be quickly re-accessed. The left and right regions should be customisable based on user preferences.

5.3 Four Layers of Context-Awareness for Mixed Reality

We encourage designers to develop context-aware and adaptive systems by providing scaffolding for exploring design possibilities, encompassing spatial, activity, social, and cognitive considerations.

5.3.1 *Spatial Layer.*

The spatial layer proposes location-based context awareness for mixed reality, meaning the system knows where the user is going and adapts accordingly. For example, when the user enters a spacious park, the system may lower the priority of safety-related overlays. In contrast, in high-risk environments such as stairways, crosswalks, or escalators, the interface can proactively simplify or suspend UI layers, transitioning to "whisper mode" using subtle auditory cues to maintain awareness without distraction. Features like the "Obstacle Enhancer" can softly blend in to support safer navigation. When the user enters the office, the system can proactively suggest shifting interaction modes, such as entering a "Focus Mode" — much like how smartphones switch to focus settings when entering a workplace.

5.3.2 *Task/Activity Layer.*

Task and activity awareness requires the system to recognise both real-world and digital activities, as well as understand user priorities, such as distinguishing between *primary tasks* and *background utilities* (e.g., calls or messaging apps). When the system identifies the user's current primary activity (e.g., navigation) and any secondary tasks, it can dynamically adjust the UI by repositioning or resizing elements, initiating Full Reality Mode, or providing contextual support such as safety overlays.

Besides, users can have *customisable reality modes*, allowing the system to transition between them fluidly. *Traverse Mode* (while walking) features a minimal UI, while *Anchored Mode* (while seated) displays the main home screen. In this mode, the menu bar can appear at the bottom, with some apps arranged in a Stage Manager layout and central apps brought into focus.

5.3.3 *Social Layer.*

The social layer is about social awareness. When the user approaches another person and begins a conversation, the system should recognise the interaction and automatically fade or hide the UI, avoiding sensory barriers between people, similar to removing earphones when talking to someone. This should also be communicated through design to alleviate concerns that the user wearing the headset may not be fully attentive or using an app behind the HMD. By responding to voice, proximity, or posture cues and indicating social mode, the system aims to minimise interference with real-world social connections.

5.3.4 *Cognitive Layer.*

The cognitive layer monitors the user's mental load by interpreting physiological signals such as pupil dilation, blink rate, and speech cadence. When signs of stress or cognitive fatigue are detected, particularly after extended VR use, the system can respond by simplifying the interface, dimming the content, or gently suggesting a break. Cognitive overload may also arise from poor camera quality and can be evaluated alongside attention indicators like eye dwell time. In scenarios like shopping, where users need to read product labels or tags, the system can enhance these elements digitally, making them sharper or larger to support better readability and ease of understanding.

5.4 Techno-Positivism: A Divided Path Forward

From my initially excited perspective as a techno-positivist [82], I approached mixed reality with the belief that it held endless possibilities for improving our lives. I saw MR as a tool for heads-up computing [103], allowing us to multitask [12], augment reality, and enhance productivity on the go [48]. However, after living with the technologies and deploying them in real-world environments, my mindset shifted — not only due to the technical challenges and limitations I experienced, but also due to broader societal concerns about disengagement from reality and deteriorating human connections, which I will elaborate on in Section 5.5 and Section 5.6.

Like many techno-positivists, MR researchers have envisioned a future where MR/VR technologies will become integral to our daily lives. This vision has generally diverged into two distinct paths forward: Some advocate for pervasive augmented reality, where users maintain direct engagement with the physical world while digital content seamlessly integrates into their environment. This approach preserves natural eye contact and facial expressions, crucial elements of human interaction and authentic experiences. Others focus on mobile VR/MR [46], emphasising seamless transitions between physical and virtual realities through advanced video pass-through headsets. These technologies enable users to fluidly shift between levels of immersion and blend various real-world information into VR based on their context and needs. While both technological paths present compelling arguments, my extensive experience with MR headsets in diverse situations has clarified which future I would prefer and the best use cases for each technological path. Mobile VR/MR proved valuable during moments when virtual content was the primary focus, and the physical environment offered limited engagement, such as during monotonous train travel. However, pervasive AR would be more suitable in situations demanding direct real-world engagement and authentic human connection. For example, my experiences revealed reduced enjoyment of a meal or the beauty of Paris when viewed through colour-inaccurate, low-resolution displays.

5.5 *"Reality is Broken"*: Disengagement from Reality

Even though MR technologies are imperfect and the user experience presents significant challenges, there's a growing trend toward increased time spent in mixed and virtual reality environments. As Jane McGonigal argues in *"Reality is broken"* [57], virtual worlds can prove more engaging than physical reality, a phenomenon already evident in cases where individuals maintain long-term VR engagement, spending thousands of hours in virtual spaces [51] - even sleeping and living in VR. This trajectory toward deeper integration with MR technologies also aligns with the conceptual imaginary of hyperreality [54], in which every aspect of the physical world is visually highlighted, gamified, and digitally augmented. It also recalls Stephenson's concept of the metaverse [87], where individuals inhabit an entirely alternative virtual reality. These imaginaries raise critical questions about the kind of future we are collectively building.

Through this autoethnography, I frequently experienced a reduced connection with the physical world, whether through VR-immersive tasks, a narrowed field of view, or digital overlays isolating me from my environment, all of which made it easier to become engrossed in the virtual world and disconnect from physical surroundings. Moreover, and perhaps more concerning for the future of ubiquitous MR adoption, the lack of transparency often made people around me feel uncertain and distrustful, reducing their willingness to engage. The mere presence of the headset already creates social barriers [74] and influences the face-to-face communication quality. These findings align with research on how digital technologies absorb our attention and impact real-world awareness [22], with MR potentially amplifying these effects due to its more immersive nature than smartphones.

Studies on digital escapism and psychological effects raise significant concerns about our relationship with virtual spaces. Digital escapism, particularly through video games and online platforms, is a prevalent phenomenon where individuals seek to escape from real-life stressors and challenges [52]. The negative consequences of this escapism include reduced engagement in real life [68], weakened ability to adapt to real-world challenges [68], and decreased overall happiness and well-being [93]. As MR technologies become more sophisticated and ubiquitous, they could open new channels for escapism beyond traditional gaming and smartphone media, potentially amplifying these effects through even more immersive experiences.

This raises fundamental questions about whether such a mediated reality aligns with our desired future. While technological advancement seems inevitable, we must critically examine its impact on our fundamental human experiences and connections. As Newport argues in *"Digital Minimalism"* [64], perhaps we need to intentionally reduce technological noise to maintain focused, meaningful lives. The challenge lies in balancing the potential benefits of MR technologies with preserving authentic human experience and connection.

5.6 *"Alone Together"*: Broader Implications for Human Connection

We are more plugged in than ever, yet paradoxically more alone. Turkle's concept of being "alone together" [5] captures an intriguing situation: even when physically co-located, we are increasingly "absent-present", absorbed in our digital devices. We break eye contact, disrupt social interactions, and forget the presence of others around us — that mirrors my experiences during the study. Digital technologies can create psychological distance even when people are physically close. This may only intensify through mixed reality technologies, as predicted by The Simpsons [94] - a world where users live in their own dreamy, personalised realities, while the real world remains chaotic and devoid of genuine interpersonal interaction.

Perhaps most striking is that people are increasingly lonely despite our ability to connect with millions online. This paradox prompts us to reflect on the growing need to maintain meaningful human connections in our rapidly evolving digital society, which might be the ultimate hack for combating the epidemic of loneliness.

5.7 Autoethnography and Imperfect Technologies

Through my autoethnographic study, I experienced firsthand the numerous challenges of using MR technologies in chaotic, real-world situations — challenges that significantly hindered their functionality. I often found myself frustrated, revealing that these devices are not yet equipped to manage the messy, non-linear scenarios of everyday life. This underscores the importance of living with emerging, imperfect technologies in real-life settings before deploying them at scale. Too often, we envision technological futures without first pre-living them and examining the lived experiences that could reveal critical implications and broader societal impacts. By engaging with these experiences before such futures materialise, we can better prepare ourselves and more intentionally shape technological development.

Additionally, as HCI researchers, immersing ourselves in technologies across various aspects of life — and testing their limits in complex, unpredictable environments — yields invaluable insights. My experience deploying MR in the wild [36, 77], intimately embedded in daily routines, surfaced the nitty-gritty details and numerous edge cases often overlooked. This includes navigating in the dark or multitasking during physical activities — scenarios that test the robustness and adaptability of MR systems. Such experiences offer a more systematic understanding of MR in everyday contexts and help identify pathways for improving its design and real-world applicability.

6 CONCLUSION

This paper presents an autoethnographic study that uncovers the complexities and challenges of living with mixed reality technologies in real-world, everyday environments. The findings are organised into four key themes: ergonomic challenges and safety concerns, personal struggles in daily scenarios, disruptions to connections with the physical world, and diverse social reactions during interactions. From these experiences, we emphasise the safety, social, and ethical implications, and encourage more resilient solutions to address the usage in unpredictable and complex real-world contexts, based on deploying the technologies in the wild. We question whether the envisioned future of pervasive and ubiquitous computing aligns with what we truly desire, calling for deeper reflections on broader implications for society and advocating for integrating real-world lived experiences into the design and development of these technologies.

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