IPPSO – Transdisciplinary Research on Legal, Public Policy, and Design Perspectives for Immersive Phygital Public Spaces in Smart Cities

Project Findings and Policy Recommendations

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1. Introduction

In an era where technological innovations blur the lines between physical and digital realms, spatial computing and its derivative—smart glasses—emerge as a transformative force, poised to redefine interaction with technology and human relationships. This marks a departure from traditional screen-based interfaces to a world where digital and physical realities converge. Smart glasses are expected to replace screens with an infinite canvas, while AI-powered spatial computing will enable machines to interpret the world, creating a new paradigm of human-computer interaction. This shift will inevitably affect the social sphere and our day-to-day lives, altering how we communicate and how we perceive reality.

Our project focuses on smart glasses that allow users to access layered information within public spaces, which we refer to as *Phygital Spaces*. These glasses represent more than a new gadget—they herald a fundamental shift in how we experience our environment. *Phygital realities* may emerge beyond specific devices, signaling a broader transformation where digital layers increasingly mediate our relationship with the world, fundamentally shaping our perception and interaction. The eyes may be just one of many sensory organs through which these digital layers manifest. Whether in parks, shopping malls, or bus stops, users can access added digital layers that transform their interactions with public spaces. While some call this technology *spatial computing*, we use the term *Phygital Reality* to emphasize interaction with reality itself rather than its computational underpinnings.

In an era marked by rapid technological advancements, democracies face unprecedented challenges that transcend political institutions and reach into the fabric of everyday life. Emerging technologies, such as smart glasses and immersive digital layers, are reshaping public spaces, influencing social norms, and redefining human interactions. These transformations raise critical questions about power, inclusion, and participation—fundamental pillars of democratic societies. A resilient democracy is not only about laws and institutions but also about the relationships, dialogues, and frictions that emerge within shared spaces. Exploring these new forms of interaction, understanding their impact on societal cohesion, and addressing the power imbalances they may create are essential steps to ensure that technological progress strengthens rather than undermines democratic values.

Our project, which explores Phygital Public Spaces through speculative design methodologies, contributes to the broader discourse on democracy in the digital age. By examining how technologies like smart glasses mediate human interactions in public spaces, we confront pressing questions about privacy, autonomy, and inclusivity—issues central to democratic life. Through our interdisciplinary workshops, which brought together academics and practitioners, we fostered a dialogue that reflects the essential pluralism and openness for democratic societies.

In alignment with the Volkswagen Foundation's mission to promote transdisciplinary collaboration on societal challenges, our project exemplifies how research can bridge the gap between theory and practice. Like the Foundation's *task forces* initiative, we combined academic rigor with participatory engagement to produce actionable insights for public policy. Our speculative design approach, which blends legal, technological, and societal perspectives, demonstrates how interdisciplinary methods can uncover new dimensions of democratic participation and public space governance, while inspiring structural changes in the discourse around technology and democracy.

As devices like Apple Vision Pro and Meta's Ray-Ban smart glasses increasingly permeate public spaces, the conceptual ambiguity of Privacy/Human Rights by Design (*P/HRbD*) leaves decision-makers, regulators, and civil society players without a functional framework. Our research aims to bridge this gap by reconceptualizing *P/HRbD* through an interdisciplinary approach, combining expertise from legal studies and interactive and spatial design to develop a practical framework that integrates *HRbD* as both a legal and design concept.

2. Chapter One: Smart Glasses – Technology, Products, Markets

2A. Understanding Spatial Computing

Spatial computing is an evolving form of computing that blends physical and virtual experiences, enabling new forms of human-machine interaction while giving machines the capability to navigate and understand users' physical environments.

The term was academically introduced in Simon Greenwold's 2003 MIT master's thesis, where he defined *spatial computing* as *"human interaction with a machine in which the machine retains and manipulates referents to real objects and spaces."* Since then, leading tech companies have developed their own interpretations: Apple describes it as technology that *"seamlessly blends digital content with the physical world while allowing users to stay present and connected to others,"* while Microsoft emphasizes the devices' awareness of their surroundings and their digital representation.

At its core, spatial computing integrates **Computer Vision**, **Natural Language Processing (NLP)**, and **Voice Recognition** (in the format of large language models, *LLMs*) in a multimodal framework—both for sensing and understanding the environment, as well as for generating content and enabling extended reality. The goal is to break free from traditional screens and introduce more intuitive, immersive interactions.

These capabilities are powered by technologies such as:

- **Depth sensors** and **LiDAR** for environmental mapping
- **Computer vision** for object detection and recognition
- **Visual positioning systems (VPS)** for real-time spatial orientation

In a robust spatial computing experience, almost any surface can serve as a screen or a touch-sensitive interface. The technology functions through an interaction loop composed of multiple inputs and outputs:

Key Inputs:

- **Hand tracking** through cameras and sensors for gesture recognition
- **Body tracking** for movement and location awareness, as well as facial expression analysis
- **Voice control** for natural command interpretation
- **Eye tracking** for anticipating user intent and focus
- **Biometric inputs**, such as heart rate and body temperature, for real-time user-state analysis

Key Outputs:

- **AR/VR displays** with opacity control and focal depth for immersive overlays
- **3D audio** for localized, spatialized sound experiences
- **Haptic feedback** for tactile sensations, enhancing interaction realism

As the technology evolves, spatial computing holds the potential to transform a wide range of sectors, fundamentally reshaping how we experience and interact with the world around us. By seamlessly integrating digital content into any environment, it enriches real-world interactions with contextual overlays—allowing users to see additional layers of information, guidance, or entertainment embedded within their surroundings. Physical spaces themselves become more dynamic and responsive, as real-time, data-driven digital information enhances environments such as classrooms, museums, and urban landscapes, making them more interactive and personalized.

Moreover, spatial computing revolutionizes how we process and interpret information by enabling advanced data visualization directly within real-world contexts. Complex datasets, from medical imaging to architectural models, can be projected into the physical space, offering users new ways to explore, analyze, and understand information intuitively. Beyond sight and sound, the technology introduces multi-sensory experiences that blend visual, auditory, and tactile elements into immersive interactions. With features like 3D spatial audio and haptic feedback, digital overlays feel more tangible, creating richer and more engaging user experiences that blur the line between the physical and virtual worlds.

2B. Smart Glasses: Overview

Smart glasses are wearable devices that integrate advanced technologies into eyewear, enabling users to access information, capture media, and interact with digital content within their field of vision. These devices incorporate cameras, microphones, speakers, and heads-up displays, providing functionalities such as real-time navigation, hands-free communication, and extended reality (XR) experiences. With advancements in artificial intelligence (AI) and spatial computing, smart glasses are evolving from niche gadgets into mainstream technology.

Unlike smartphones, which rely on flat-screen interfaces, smart glasses prioritize immersive experiences within a spatial context. While smartphones depend on touchscreens, smart glasses utilize eye tracking, voice commands, and gesture controls. This shift marks an evolutionary leap from static devices—confined to walls, desks, or hands—to devices that merge with our sensory organs, becoming less detached from us and fading into the background. As a result, users can focus on their physical surroundings, with digital information seamlessly overlaid based on their position, orientation, and proximity to objects and surfaces.

In the spectrum of human-technology interaction, the digital world lies at one end and the physical world at the other. The digital extreme includes devices such as computer screens, smartphones, and virtual reality (VR) headsets, which fully immerse users in digital experiences. Conversely, the physical extreme features humanoid robots and tactile interfaces, designed for tangible interactions with minimal digital overlays. Wearable technologies, such as smartwatches, occupy a middle ground but still primarily engage users through small screens.

Smart glasses, however, represent a unique middle ground, bridging physical and digital realms. They herald a *phygital* revolution where these realities become intricately intertwined, transforming physical spaces into canvases for digital innovation. Unlike other devices, smart glasses act as gateways to an enriched world experience, offering a hybrid reality enhanced by digital intelligence.

Smart glasses enable several transformative capabilities. They extend physical spaces by overlaying real-time information directly onto the environment without diverting the user's attention. Through layered perception, they superimpose digital elements directly into the user's field of vision, merging digital and physical contexts. Additionally, they enhance social interaction by maintaining engagement with the physical world while adding real-time features such as translation and contextual cues. Finally, their lightweight, unobtrusive design provides mobility and freedom, ensuring digital connectivity without compromising physical awareness.

2C. Operational Model: A Three-Layer Framework

Smart glasses operate on a layered framework similar to that of smartphones, comprising three key layers: hardware, operating system, and application ecosystem. Each layer plays a distinct role in enabling the advanced functionalities that define spatial computing experiences.

The **hardware layer** encompasses essential components such as micro-OLED displays, cameras, microphones, and a variety of sensors—including gyroscopes, accelerometers, and eye trackers—along with connectivity modules. These components collectively facilitate real-time interaction with the environment. Prominent examples include Apple Vision Pro's dual 4K displays and Meta's Ray-Ban smart glasses, which integrate cameras directly into the frame for seamless content capture.

The **operating system layer** serves as the technological backbone, enabling sophisticated spatial computing capabilities. Systems like Apple's *visionOS* and Meta's Android XR version are optimized to manage complex processes such as eye tracking, hand tracking, and augmented reality (AR) overlays. These operating systems are designed to seamlessly integrate hardware functionalities, providing users with fluid and immersive experiences.

The **application ecosystem layer** provides users with a wide range of functionalities, from navigation tools and fitness trackers to gaming applications and productivity tools. Platforms such as the Vision Pro's App Store and Meta's Quest Store offer diverse applications tailored to smart glasses, fostering a rich and expanding digital ecosystem.

As this technology matures, several emerging trends are shaping its evolution:

- A shift from voice-based interfaces to display-integrated systems that incorporate hand tracking for more intuitive interactions.
- The integration of continuous AI assistance, enhancing environmental awareness and providing contextual information in real time.
- The development of shared memory systems that enable seamless interaction and data exchange between devices and AI models.
- A growing convergence between smartphones and smart glasses, creating a unified digital ecosystem.
- Early explorations of brain-computer interface-like experiences, where combined sensor data could enable thought-driven interactions with digital environments.

However, the distributed nature of smart glasses technology introduces significant challenges in liability allocation. Responsibility for regulatory compliance spans multiple players, including hardware manufacturers, software developers, and content providers. This complexity raises concerns about privacy, security, and data governance.

Auki Labs CEO Nils Pihl warns that the spatial computing industry is building *"a massive surveillance apparatus that will be able to see the world through our eyes."* His observation becomes particularly relevant when considering how companies like Apple utilize biometric data in their human-centered design strategies for products such as the Vision Pro.

Beyond mere biometric data collection, smart glasses are also advancing into the realm of affective computing, where devices interpret and respond to users' emotional states. This capability allows smart glasses not only to assess physiological signals, such as pupil dilation or heart rate, but also to infer users' moods and predict their needs.

As EMTEQ founder Strand stated in *Wired* magazine's article, *These Smart Glasses Will Read Your Emotions and Watch What You Eat*:

"Fundamentally, we're collecting data. It's unusual that glasses are actually looking in as opposed to looking out. We're looking in and measuring what's going on with your face. And from your face, we can get all kinds of interesting information about your emotional wellness, about your eating and diet habits, your focus, your attention, the medical applications, neurological stuff."

This shift—from observing the external world to analyzing the internal states of users—raises profound questions about privacy, consent, and the ethical boundaries of human-machine interaction.

3. Chapter Two: The "Phygital Public Spaces" Project

3A. An Introduction to Our Methodology: Translating the Concept of 'By-Design'

Our objective was to transform the legal concept of *'by-design'* (as seen in *Privacy by Design* and *Human Rights by Design* within EU digital legislation) into practical interaction design principles, and then translate these back into legal frameworks. This created a feedback loop between abstract legal principles and tangible design applications, aiming to foster a dialogue between real-life and abstract concepts—between designers' intentions and legal responsibility.

Our interdisciplinary team developed a speculative design methodology to create a new vocabulary that redefines current regulatory approaches (*"P/HR/E by Design"* and *"Responsible AI"*). Through collaboration with German and Israeli partners and with the generous support of *VolkswagenStiftung*, we integrated perspectives from EU policy, law, and immersive technology design.

Our research methodology unfolded over a year-long timeline, structured into three distinct phases:

3B. Basic Worldbuilding and Initial Scenario Definition

Our methodology aimed to promote critical thinking about technology through speculative design and participatory frameworks. Drawing from literature on urban technology design and human rights integration, we challenged deterministic narratives about smart glasses by engaging participants in imagining alternative futures. The approach was particularly influenced by the work of *van Rijshouwer* and *van Zoonen* on citizen engagement in smart cities, as well as *Maria A. Wimmer* and *Melanie Bicking*'s research on collaborative scenario-building for policy development.

The initial phase focused on constructing a near-future world where smart glasses technology is ubiquitous. We developed a short-story scenario set in a specific location—a shopping mall—to contextualize the technology within broader socio-political and cultural frameworks. This preliminary scenario allowed us to examine how smart glasses might transform common public spaces and affect social interactions.

The first scenario (*"The Phygital Shopping Mall"*) appears in **Appendix A** of this document.

3C. Analysis of the Legal Foundation

The foundation phase established our analytical framework through a comprehensive examination of the EU's digital legislation package. By focusing on the *EU Charter of Fundamental Rights*, *GDPR*, *DSA*, and *AI Act*, we developed a robust framework to address the complex challenges posed by smart glasses in public spaces.

The European Union's digital legislation package offers a comprehensive approach to regulating various aspects of smart glasses deployment. The *GDPR* establishes fundamental frameworks for data usage and protection, particularly concerning biometric data processing. The *DSA* addresses operating systems and app store operations, creating guidelines for content moderation and platform responsibility. Meanwhile, the *AI Act* specifically regulates AI-based products and services, with strict provisions regarding manipulative practices and biometric identification systems.

Together, these regulations confront critical questions about privacy, autonomy, dignity, equality, control, and sociability in public spaces. For instance, the *GDPR*'s rules on biometric data processing directly impact how smart glasses collect and process personal information, while the *AI Act*'s requirements for high-risk AI systems influence technical documentation and interoperability standards.

In the first phase of our analysis, we employed familiar legal concepts such as privacy, autonomy, and equality, adapting them to the European digital legislative package. Our analysis revealed several significant challenges in applying these regulations to smart glasses.

For example, real-time biometric processing raises complex questions about facial recognition deployment in public spaces, particularly concerning law enforcement use. The cross-border nature of data collection creates jurisdictional challenges, as smart glasses gather information across national boundaries. Additionally, traditional consent mechanisms become problematic in augmented reality environments, where the boundary between public and private spaces blurs.

Platform and app store responsibilities present another layer of complexity. The *DSA* imposes specific obligations on intermediary services, while the *AI Act* establishes requirements for both AI system providers and deployers. Age verification systems become crucial for protecting minors from inappropriate AR content, necessitating robust technical solutions that balance accessibility with protection.

The collection of sensitive personally identifiable information, as well as vast amounts of surrounding data, raises significant security concerns. Persistent questions include:

- How will the data be stored?
- What security measures will be in place to prevent breaches?
- How will cyber protocols be enforced to protect users from misuse?

During the second stage of our analysis, and using this legal foundation, we developed detailed scenarios exploring various smart glasses applications. Through conceptual investigations, we identified gaps in current legal frameworks and analyzed potential value conflicts.

The complete two-stage legal analysis table appears in **Appendix B** of this document.

3D. Collaborative Scenario Generation via Workshops

Possibly refer to Micaela's public spaces internal workshop, a preliminary stage that took place in Israel, Finland, and Germany.

The walking workshop helped us map out possible interactions in specific urban spaces and identify the types of interactions different public spaces afford, which are shaped by distinct social codes and locations. To establish common ground, our team created a workshop employing speculative design tools, embodiment techniques, and legal definitions of public space to examine everyday surroundings through multiple layers. This workshop experience helped our team better understand public spaces through concepts such as thresholds, friction spaces, circulation zones, and grey zones.

We mapped out daily technology-mediated interactions between users and spaces, using terms such as actors, actions, and mediating objects. This process was central to identifying user needs and desires as forces driving mediated interactions, an understanding that significantly shaped the public workshop design.

We developed a *"Speculative Role-Playing Workshop"* format to engage various stakeholders in co-developing and imagining detailed scenarios involving phygital interactions. Two workshops were held—one in Jerusalem (September 2024) and one in Berlin (October 2024)—engaging approximately 60 participants from diverse backgrounds, including government officials, private sector representatives, NGOs, designers, lawyers, former police officers, former judges, political scientists, technologists, and tech journalists.

We scripted, recorded, and illustrated four location-specific scenarios designed to immerse stakeholders in policy exploration. Guided role-play, board game elements, and active facilitation enabled stakeholders to contribute using natural language and share insights from their real-life experiences. This experimental and innovative approach provided unique insights into complex public-space interactions that would be difficult to capture through traditional methods. The workshops focused on identifying conflicts, frictions, and clashing interests to map out potential blind spots.

The workshop experience consisted of several key elements:

- **Illustrated maps** of four locations: a shopping mall, a train station, an elderly home overlooking a public beach, and a town square. These locations were designed to feel familiar to participants from both Israel and Germany, yet were deliberately non-representative of any specific geographic region or existing site.
- **Four recorded scripts** depicting scenarios unfolding in the aforementioned locations. The scripts served a dual purpose: to introduce the presence of smart glasses within the scenarios and to raise open-ended questions about how smart glasses might support or influence the players' actions in various encounters.
- **Role-playing exercises**, where participants created characters within the scenarios and explored various interactions under the guidance of facilitators.
- **Group reflection and discussions** on policy implications following the role-playing sessions.

The workshops employed specific tools to broaden participants' imaginations and reveal potential friction points in existing legal frameworks. For instance, we used:

- **Pre-recorded narrative introductions** to create an immersive experience and set the stage for exploration.
- **"Phygital Layer" cards**, each presenting an amalgam of two words representing fictitious phygital functionalities, such as *"social blocking"*, *"object filtering"*, and *"imagination bridge"*. These cards, deliberately ambiguous and open-ended, were designed to support the participants' thought processes regarding "unknown unknowns"—interactions and frictions that may emerge unexpectedly.

The workshop methodology encouraged creative exploration while maintaining a focus on practical policy outcomes. Participants contributed through various formats, including sketches and textual descriptions, envisioning smart glasses technologies as flexible systems that should reflect diverse public values.

This collaborative approach transformed speculative scenarios into concrete policy recommendations while building a shared vocabulary for discussing the future capabilities of phygital spaces. The process illuminated both opportunities and challenges in implementing smart glasses technology in public spaces, particularly regarding social interactions and human rights protection.

4. Chapter Three: Key Learnings and Observations

4A. The Need for a New Regulatory Approach

The workshop process highlighted the malleable nature of phygital reality. While public space infrastructures may appear fixed, they can be reimagined to align with diverse public values. The role-play scenarios moved beyond simple utopian or dystopian narratives, revealing nuanced possibilities for future implementations. Moreover, the workshop enabled us to experience the socio-ethical challenges of smart glasses in public spaces and understand that traditional approaches often neglect societal context, stakeholder perspectives, and the juxtaposition of conflicting uses and intentions—resulting in insufficient solutions.

Thus, our primary recommendation is to develop a new regulatory approach, which we call **"Ethics of Interactions"**.

The process of translating from a regulatory language that focuses on applying abstract rights and values to a speculative design language that deciphers social cues in a contextual way led us to understand that smart glasses pose challenges to existing legislation and regulatory approaches. These devices fundamentally alter human-to-human relationships.

For instance, when smart glasses users can manipulate their perception of reality or access personal information about others in real time, the concerns extend beyond traditional privacy issues into uncharted territory involving mediated social interactions. This raises profound questions: *Who or what manipulates an individual's perception? To what extent is it the user?*

Existing regulations, such as the EU *AI Act*, aim to address concerns surrounding autonomy and privacy but fall short of adequately tackling the challenges posed by smart glasses and similar technologies.

1. **Focus on Biometric Data Only:** The *AI Act* primarily addresses biometric data, overlooking other forms of non-biometric data that can be equally potent in influencing emotions and behaviors. For instance, data inferred from user interactions, preferences, or contextual information can also be used to manipulate individuals, yet these forms of data remain outside the current regulatory framework.
2. **Narrow Scope of Contexts:** The regulation is limited to specific contexts, such as workplaces, educational settings, or for medical and safety purposes. This narrow focus leaves a significant gap in addressing manipulation and emotional AI applications in other critical environments—such as public spaces, private homes, or commercial areas—where the potential for misuse remains high.
3. **Overly Narrow Definition of Manipulation:** Current legislation often defines manipulation in strict terms, focusing on explicit exploitation of vulnerabilities, such as age or socioeconomic status. However, this approach fails to account for the broader human experience of vulnerability. Emotional AI can influence individuals in subtle and pervasive ways that do not meet the conventional definition of manipulation but still distort decision-making or exacerbate emotional states. For example, an individual in a state of grief or stress could be nudged through extended content designed to exploit their emotional condition, even if unintentionally.

4B. A Call for a New Framework: "Ethics of Interactions"

Translating back from the language of interaction-based design to public policy led us to recognize the need for additional regulatory frameworks that go beyond existing concepts such as *Privacy by Design* and *Responsible AI*, which are reflected in current regulations.

To address these gaps, we propose a new term and approach: **"Ethics of Interactions"**, designed as a complementary layer to current regulations.

This approach emphasizes the need to consider not only the data being used—whether biometric or non-biometric—but also the nature and context of interactions between humans, AI systems, and their environments. By focusing on the ethical dimensions of how technologies mediate and influence our interactions with others and with reality itself, this approach offers a more holistic framework for safeguarding human autonomy and dignity in the age of smart glasses and AR technologies.

4B1. Core Principles of the "Ethics of Interactions" Framework:

- **Context-Dependent Public Policy:** The framework views public policy as inherently context-dependent, acknowledging that different circumstances and experiences shape how technology affects various communities. This approach particularly addresses the gap in current *Responsible AI* frameworks, which often overlook the nuanced ways AI impacts human relationships and behavior in hybrid physical-digital spaces.

- **Socio-Cultural Implications:** The framework specifically considers the socio-cultural implications of phygital reality, addressing both users and non-users of smart glasses. It recognizes that these technologies will establish new social norms and potentially create power imbalances in public spaces.

- **Focus on Relationships and Interactions:** By focusing on relationships and interactions rather than solely on individual rights, this approach provides a more comprehensive foundation for regulating emerging technologies in ways that preserve human dignity and social cohesion.

4B2. Applying the "Ethics of Interactions" Lens to Regulation:

The framework suggests that regulators should adopt an "*ethics of interaction*" lens when evaluating AI's societal implications and determining appropriate regulatory responses.

While this evaluation process may initially appear less structured than traditional regulatory approaches, it offers the flexibility needed to address the complex and evolving nature of human interactions in phygital spaces. This approach balances innovation with protection, ensuring that technological advancements align with societal values and ethical principles.

The *"Ethics of Interactions"* framework represents a departure from traditional policy-making processes, which often rely on linear, top-down approaches centered on abstract legal principles, risk assessments, and stakeholder consultations. Conventional regulatory frameworks tend to address technological impacts retrospectively—only after technologies are deployed and societal frictions emerge. In contrast, our approach, which integrates speculative design and participatory methodologies, proactively explores potential societal impacts before they materialize.

This process stands apart by fostering **iterative dialogue** between designers, policymakers, and the public. Rather than treating policy as a static set of rules, it encourages continuous exploration of how emerging technologies shape human behavior, relationships, and public spaces. It recognizes that technologies like smart glasses are not just tools but *social actors* that mediate power dynamics and redefine human interactions in public spheres.

The added value of this approach lies in its ability to surface **"unknown unknowns"**—emerging risks, opportunities, and ethical dilemmas that conventional regulatory models often overlook. By simulating real-world interactions through scenario-building and role-play workshops, policymakers gain insights that cannot be derived from theoretical assessments alone. These embodied experiences help identify points of friction, potential conflicts, and opportunities to embed human dignity, inclusion, and autonomy into technological ecosystems from the outset.

Moreover, this approach promotes **co-creation between designers and policymakers**, breaking down disciplinary silos that often hinder the translation of ethical concerns into actionable regulations. Designers bring a unique capacity to prototype complex societal scenarios, visualize abstract policy outcomes, and present alternative futures. This collaboration empowers policymakers to craft regulations that are not only legally sound but also socially responsive and forward-looking.

Funding policy design processes that incorporate speculative design and participatory methods is not just an investment in technology regulation—it is an investment in democratic governance. It ensures that emerging technologies align with public values and social norms, thereby enhancing societal resilience and trust. By integrating design methodologies into policy-making, regulatory frameworks become more adaptive, inclusive, and capable of navigating the evolving complexities of phygital public spaces.

4C. Key Learnings and Observations: "Ethics of Interactions" Applications to Various Interactions in Phygital Public Spaces

Imagine a scenario in which a tourist wearing smart glasses attempts to navigate a train station using AR-guided directions. However, his glasses overlay inaccurate navigation instructions, causing him to repeatedly bump into a hurried commuter, who grows increasingly frustrated. The commuter's glasses, equipped with facial recognition, tag the tourist as "inattentive" based on prior behavioral data, further escalating the tension between them.

This scenario illustrates why an interaction-based analysis is valuable for uncovering *“unknown unknowns”* and exposing regulatory deficiencies within phygital environments. It highlights how subtle technological mediations can shape social interactions, trigger biases, and amplify conflicts—dimensions that are often overlooked in traditional regulatory frameworks.

Through our research, we identified **five types of interactions** that require special attention under the *Ethics of Interactions* paradigm:

- **Person-to-Person (P2P)**
- **Person-to-Space (P2S)**
- **Person-to-Reality (P2R)**
- **Person-to-Machine (P2M)**
- **Person-to-Platform (P2PL)**

Below, we explain the uniqueness of each interaction type, highlighting why they raise new questions that remain unanswered under existing regulatory paradigms.

4C1. Person-to-Person Interaction:

Smart glasses gather information through three distinct layers of interaction.

The **first layer**, referred to as *"two eyes looking outward,"* involves the familiar notion of outward observation. The glasses utilize AI and computer vision to analyze and interpret the physical world in real time, identifying objects, recognizing faces, and understanding environmental contexts. By augmenting human vision with digital intelligence, this layer enhances situational awareness and provides the wearer with immediate, contextual insights about their surroundings.

The **second layer**, *"two eyes connected to a billion others,"* emphasizes connectivity by linking the smart glasses to vast databases and networks. This capability enables cross-referencing of observed data with external sources—such as social media profiles, public records, or real-time analytics—creating a seamless bridge between personal observation and collective intelligence.

In contrast, the **third layer**, *"two eyes turned inward,"* focuses on introspection by monitoring the wearer's physiological and emotional states. By analyzing signals such as pupil dilation, heart rate, or micro-expressions, the glasses can infer emotional reactions and provide tailored feedback or interventions.

Each layer, distinct in its function, demonstrates the profound potential of smart glasses to integrate the physical, digital, and personal realms into a unified, phygital experience.

However, the regulatory challenges posed by these layers are uneven. While the **third layer**, which collects data about the wearer's behavior and physiological responses, can be addressed within existing privacy paradigms (despite the sensitive and biometric nature of the data), the **first two layers** present a more complex challenge.

Traditionally, privacy laws and frameworks have been designed to protect individuals in private spaces, while public spaces have been perceived as areas where privacy is limited or nonexistent. However, the capabilities enabled by these two layers disrupt this assumption, creating a new frontier of privacy concerns that current paradigms struggle to address.

The combination of the **first and second layers** illustrates this problem vividly. On the one hand, the glasses' computer vision (first layer) can identify who is walking past me on the street. On the other hand, the connectivity layer (second layer) can reveal additional personal details about that person—whether they are vaccinated, Jewish, single, angry, or even where their shirt was purchased.

This creates an unprecedented ability for one private individual to deeply invade the privacy of another private individual in a public space—a power previously reserved for public authorities using tools like street cameras for purposes such as maintaining public order. Now, this invasive capability is available to individuals, highlighting a critical gap in existing privacy frameworks. Traditional paradigms were not designed to address such tools in the hands of private citizens, demanding a reevaluation of how privacy is conceptualized and protected in public spaces.

Insights from Workshops:

During our workshops, participants surfaced numerous examples of potential conflicts arising from person-to-person interactions with smart glasses:

- **Privacy Intrusion:** Participants identified common privacy issues, such as a person with smart glasses accidentally recording a private conversation in a park, raising consent concerns in public spaces.
- **Invasive Interactions:** More extreme scenarios emerged. For instance, café or restaurant staff could automatically know what a customer wants to order through facial recognition and behavioral patterns. While efficient, this raised fears of surveillance and overanalysis, blurring the line between helpfulness and intrusion.
- **Etiquette Conflicts:** Even seemingly mundane situations, such as a café patron wearing smart glasses, sparked discomfort, as others felt uneasy about the possibility of being recorded or analyzed without their consent.

- **Surveillance Abuse:** Participants raised concerns about law enforcement using smart glasses to track individuals in real time without sufficient oversight, creating a chilling effect on public behavior and expression.

- **Reality Manipulation and Public Safety:** Another significant concern was the ability to manipulate reality by blocking elements, people, or public nuisances (*מטרד לציבור*). For example, participants imagined a scenario where broken sidewalks could be visually replaced with flowers through AR overlays, creating a hazardous situation by concealing real-world dangers and increasing the risk of accidents.

- **Misunderstandings and Emotional Toll**

Some examples highlighted more complex interpersonal conflicts. One participant described a scenario involving a man replaying a past argument with a coworker using his glasses' memory feature. When confronting the coworker with the replay, the coworker claimed that the glasses had misinterpreted the conversation due to algorithmic bias. This incident sparked a workplace-wide debate about the ethics of using augmented memories as evidence, raising questions about trust, context, and the fallibility of AI in interpersonal relationships.

In another scenario, a tourist using AR-guided glasses misidentified a police officer as a "tour guide" and approached her with questions about the area. The police officer, using her own smart glasses to monitor crowd behavior, received an alert marking the tourist's behavior as suspicious due to the unusual interaction. This innocent misunderstanding escalated into an awkward and tense moment.

Another important question that was surfaced is how does machine vision affect interpersonal interactions and reduce natural friction points? When approaching someone to ask, "How are you, and what do you do?", a seasoned police officer uses subtle cues—like body language and emotional signals—to gauge the person's state and determine whether to escalate the interaction. Machine vision, while powerful, lacks the human intuition that gives experienced professionals an edge. The increased agency of a skilled human observer over the machine was a key point raised in the discussion.

- **The Uncertainty of Boundaries**

A recurring theme was the emotional impact on individuals who are unsure about what others know about them through these devices. For example, one participant highlighted an app called *"Undress the Waitress"* that creates a deepfake of a waitress appearing without clothes. The actress playing the waitress in the workshop described this not only as deeply offensive but also emphasized the uncertainty surrounding the boundaries of knowledge others possess about her. This lack of mutuality amplified her discomfort.

Another recurring theme in the discussions was the anxiety caused by not knowing what actions others are taking with their glasses. For example, sitting on a train and noticing someone staring at you through their smart glasses could provoke fears of being secretly recorded.

Other scenarios included:

- A beggar using smart glasses to identify "generous faces," selectively targeting individuals deemed more likely to donate.

- People of color experiencing uncertainty, unsure if someone is watching them suspiciously because of their race—or if others are using augmented reality features to "erase" them from view altogether.

This uncertainty about boundaries led to a broader regulatory question: *What should people be prohibited from doing with these devices, and where must the rules be drawn?*

- **Social Isolation and Forced Interactions**

Another aspect involved social isolation, where users become so engrossed in augmented overlays that they disconnect from real-world relationships. Some participants described smart glasses as *"heaven for extroverts and hell for introverts,"* enabling overly sociable individuals to extract personal information to initiate unwanted conversations. This forced engagement was seen as intrusive, creating a conflict between technology-enabled openness and personal boundaries.

4C2. Person-to-Space Interaction:

Humans are inherently spatial beings, naturally understanding and engaging with the world volumetrically. Smart glasses hold the potential to restore spatial thinking, which often diminishes with age or through the habitual use of flat, two-dimensional screens. By leveraging natural interfaces—such as touch, gestures, eye-tracking, and even brain-computer input—smart glasses minimize hardware abstractions, enabling interactions with virtual content to more closely mimic those of the physical world. This seamless blending allows virtual objects to coexist with real objects and spaces, creating opportunities for more immersive and intuitive interactions.

- **Spatial Transformation and Its Implications:**

Interactions between humans and their surroundings through smart glasses will inevitably lead to significant changes in physical environments. For example:

- Will traffic signs or crosswalk markings remain necessary in a world where smart glasses provide real-time guidance and navigation?
- What will retail environments, such as store shelves in malls, look like when price tags and inventory details can be overlaid digitally?
- How might classrooms evolve into hybrid spaces where virtual and physical elements seamlessly coexist?

Additionally, the multimodal capabilities of smart glasses could replace non-physical cues—such as public announcements in train stations or malls—with personalized visual overlays tailored to each user.

- **Concerns About Inclusivity and Cultural Preservation:**

However, these advancements raise a critical concern: *Should we preserve the physical environment as a fallback for instances of technological failure or for those who do not have access to smart glasses (the "haves and have-nots")?*

Participants in the workshops expressed fears of cultural erosion. They noted that augmented reality (AR) layers, if used to replace physical signage, could inadvertently erase local languages and cultural identifiers in public spaces. This highlighted the need to balance innovation with inclusivity and cultural preservation.

Another significant concern raised in the workshops was the potential for **spatial exclusion**—where access to certain places could be restricted based on data retrieved from the glasses. For example, AR systems could limit entry to spaces based on factors such as social behavior profiles, turning public areas into gated digital zones. Participants noted that this scenario approaches the realm of *social scoring* systems, where digital reputations could determine physical access to services or spaces.

On the other hand, participants discussed the personalization aspect of smart glasses, which, while beneficial, could create problematic experiences. For instance, a user on a diet might configure their glasses to blur or hide candy stores entirely. While seemingly harmless, such capabilities raised questions about autonomy, self-regulation, and the potential for technology to mediate or manipulate human choices in public spaces.

- **Body Movement and Spatial Awareness**

Smart glasses also reshape how we interact with our surroundings through body movements and gaze direction. For instance, where do people look when information is delivered directly through their glasses rather than via billboards or announcement systems?

One workshop participant shared an example of walking alone in a dark parking lot: Would the additional layers of information provided by smart glasses—such as a detailed description of the parking lot—reassure her, or would they heighten her anxiety?

- **Intimacy and Proximity:** Smart glasses introduce new dimensions to how people perceive and navigate physical closeness. For example, will AR overlays that reveal personal details about nearby individuals change our sense of personal space or disrupt social norms?
- **Edges and Peripheries:** Augmented reality may alter our perception of boundaries within physical spaces. For instance, would virtual "no-entry" zones or warnings that only appear through AR affect how people move through public areas?
- **Navigating Control, Expression, and Overload**

This issue extends to public spaces where augmented reality becomes a medium for expression. In one of the game scenarios, an activist projected AR messages advocating for environmental action in a train station waiting area. A security officer's smart glasses flagged this display as a potential disruption, prompting intervention.

This raises a fundamental question: *Who controls the phygital space that surrounds us?* Who has the right to add layers of information, publish content, and decide where it can appear in the physical world? Should any individual or organization be allowed to overlay virtual advertisements or messages in physical spaces, or must these actions be regulated?

The issue touches on boundaries of free expression and advertising but also raises concerns about content overload. If the physical environment becomes saturated with overlapping layers of virtual content, our ability to function effectively in real-world spaces may be compromised. For example, essential signage—such as safety instructions or wayfinding cues—could be obscured or lost amidst a flood of digital messages, creating confusion and even endangering public safety.

Participants also raised concerns about the potential for *selective access control* in public spaces based on data retrieved from smart glasses. For instance, what if AR systems restricted entry to a venue based on a visitor's profile or behavioral history—effectively creating invisible barriers to access? Participants noted that this scenario dangerously approaches the realm of *social scoring* systems, where digital profiles determine real-world privileges.

Conversely, some participants discussed the personal autonomy that smart glasses offer. For example, a user could configure their glasses to block certain locations based on their preferences, such as hiding the view of a candy store while on a diet. While this capability may seem empowering, it sparked a debate about technological mediation of human behavior:

Does the ability to "erase" temptations or distractions help users maintain control, or does it create dependency on technology to manage choices and impulses?

- **The Complexity of Digital Expression in Shared Spaces**

The ensuing debate highlighted complex questions about free expression, the boundaries of AR content in shared spaces, and whether digital graffiti should be viewed as vandalism or as legitimate expression.

The complexity deepens when digital graffiti appears over a physical bulletin board in a mall or train station, blending virtual content with a real-world medium. In such cases, the act raises additional questions:

- Does the virtual overlay interfere with the intended function of the physical space, such as conveying important announcements or advertisements?
- Who has the right to control or curate the AR content displayed in these semi-public or private environments?
- What is the status of *phygital protests*—should they be protected as free expression or regulated as disruptions to public order?

Participants also emphasized that public spaces should prioritize the right of individuals and civil society organizations to express themselves, particularly in areas where civic discourse should take precedence over commercial interests. The fusion of physical and virtual layers creates a gray area where both property rights and freedom of expression are challenged, requiring new frameworks to navigate these interactions.

- **The Power to Modify the Physical Space**

Smart glasses introduce unprecedented capabilities for modifying surroundings, allowing users to alter or even erase elements of their environment. These modifications can include enhancing neglected spaces or covering up unwanted features, such as turning an unkempt backyard into a lush garden.

While appealing, such capabilities raise safety concerns: *What happens if someone hides hazards—such as sharp objects, stones, or trash bins—and subsequently trips over them?*

This power also raises moral and ethical questions.

- Could users erase people from their surroundings, such as homeless individuals or even an ex-partner walking toward them on the street?
- Could a user replace the ex's face with a cartoon character?

Such features challenge existing frameworks for responsible AI and current regulations, as they allow users to manipulate their perception of the physical world in ways that may conflict with societal norms or safety requirements.

- **Collaborative and Shared Spaces**

The ability of smart glasses to synchronize shared access, movement, and states across multiple simultaneous users will be essential for collaborative spatial computing applications.

For example, understanding physical environments through sensors, computer vision, and visual positioning systems enables advanced features such as:

- **Real/virtual occlusion**, where virtual objects are realistically hidden behind real-world objects or vice versa.

- **Photorealistic rendering**, which enhances these interactions, making the blending of physical and virtual environments seamless.

However, these advanced features create complex scenarios:

- What happens when one user's personalized modifications to a shared space conflict with another's? For instance, an individual might find comfort in overlaying a peaceful virtual landscape, while another might see the same space as a public environment requiring transparency and accessibility.
- How should conflicts between personalized AR views be resolved to ensure that augmented environments remain inclusive, equitable, and safe for all users?

Managing these conflicts will require sophisticated solutions and cooperative frameworks to ensure that shared augmented environments balance personal autonomy with collective accessibility and safety.

- **Emotional Manipulation and Digital Overload**

Another significant concern raised in the workshops relates to the potential for emotional manipulation through smart glasses. The integration of **emotional AI** and **affective computing** enables these devices to *"see into"* the user's emotional state and influence it, either deliberately or negligently.

For instance, AR advertisements subtly overlaid on real-world objects can nudge users toward specific purchasing decisions without their conscious awareness. Imagine walking through a grocery store and seeing a virtual "glow" around a product that aligns with your emotional state, encouraging you to buy it—even if you hadn't planned to.

Unlike traditional digital targeting, where users are increasingly aware of ads and have developed cognitive defenses—such as skepticism toward online recommendations or the use of privacy settings—interactions within the physical world present a distinct vulnerability.

In digital spaces, users have learned to navigate and filter persuasive content. However, in physical spaces, our cognitive defenses are weaker. Human perception has evolved to trust sensory experiences in the real world—what we see, hear, and touch—because physical reality has always been a reliable anchor for decision-making.

Smart glasses exploit this inherent trust. By blending digital overlays with the real environment, they bypass the skepticism users apply to digital screens. This seamless merging of the virtual and physical undermines natural cognitive defenses, making users more susceptible to subconscious influence. The result is a form of manipulation that is more pervasive and harder to detect than traditional advertising methods.

Participants also highlighted the potential for broader psychological impacts.

- **Digital Overload and Cognitive Fatigue:** Over-reliance on augmented data can lead to digital overload, causing cognitive fatigue that diminishes users' ability to engage with the unaugmented physical world. When users become dependent on their glasses to interpret their surroundings—such as relying on overlays for navigation, product choices, or social cues—they risk losing their ability to process their environment independently.
- **Increased Vulnerability to Manipulation:** This vulnerability is compounded by cognitive fatigue, which lowers users' critical faculties and heightens their susceptibility to subtle persuasive techniques. Individuals overwhelmed by digital

stimuli may become more reliant on their devices for decision-making, inadvertently allowing AI-driven suggestions to shape their preferences.

4C3. Person-to-Machine Interactions

Exploring the interaction between humans and machines in the context of smart glasses is essential for designing systems that move beyond traditional screens and keyboards. To become true partners in our work and play, these devices must integrate seamlessly into the physical world, operating on the same objects and environments as their users.

Smart glasses not only understand the wearer's physical space but also make it interactive and updatable in real time. By enabling more natural, verbal, and intuitive interactions, these devices can better map and navigate the environment while seeing and learning about the world through the wearer's perspective. The question of *"recommending"* certain modes of behavior is an ethical one: *To what extent should wearers of smart glasses retain autonomy, agency, and freedom in their choices?*

Smart glasses also act as a bridge between devices disconnected from the body—such as personal computers or mobile phones—and more advanced neural interfaces. For instance, prototypes like *Meta's Orion* wristband illustrate how companies are beginning to explore the integration of AI into brain-computer interfaces.

This development highlights the potential of smart glasses to transform interactions with technology, making them more intuitive and immersive. Yet, it raises another critical question: *Who decides what kinds of incentives these glasses will promote, and to what ends will they guide their wearers?*

- **Accessibility and Economic Disparities**

Participants in the workshops raised concerns about operational challenges that could undermine the effectiveness of smart glasses and deter their adoption, particularly among marginalized populations.

While the shift from typing to voice- or gesture-based interfaces was seen as a potential enabler for older adults and others with accessibility needs, participants voiced fears of economic segregation. Advanced features of smart glasses might only be available to premium users, creating disparities in how public spaces are experienced.

This could lead to a scenario where wealthier individuals disproportionately benefit from augmented reality, while others remain excluded from these new layers of information. As a result, AR could unintentionally deepen social inequalities, further marginalizing those unable to access its capabilities.

- **Trust and Reliability: Can We Count on the Machine?**

Trust in technology was another significant theme. Workshop participants questioned whether they could rely on smart glasses, especially in critical moments.

For example, they discussed the potential dangers of facial recognition errors, which could lead to serious consequences, such as misidentifying individuals and resulting in discriminatory actions or profiling.

One participant shared a scenario involving a parent in a crowded station, trying to balance tracking their child while attending a virtual work meeting through their smart glasses. A stranger, using enhanced visual filters on their own glasses, mistakenly identified the child as lost and approached them—creating confusion and alarm for both the parent and the child.

Participants also expressed concerns about what happens when technology fails. One participant imagined an elderly individual attempting to navigate a busy urban square using AR directions provided by their glasses. Suddenly, his navigation overlay was overridden by a promotional AR campaign, guiding users to a nearby café. Confused by the conflicting layers, he accidentally walked into a restricted area, triggering an alert in a police officer's glasses.

While the officer intervened to assist, the incident revealed a deeper issue: How subtle manipulations in AR advertisements can interfere with users' ability to navigate safely and independently. This scenario underscored the potential for commercial interests to disrupt essential functions of AR, such as navigation and safety, raising important questions about regulatory safeguards and ethical design.

- **Striking the Balance: Usability Versus Vulnerability**

Despite these challenges, there were optimistic voices in the workshops advocating for the transformative potential of smart glasses. The transition to natural interfaces—such as voice commands and gestures—was seen as an opportunity to reduce barriers for populations who might struggle with traditional devices, particularly older adults.

However, balancing usability with vulnerability remains a key concern. Participants emphasized the need for fail-safes and mechanisms that prevent the exploitation of users, especially those less familiar with the technology or unable to afford its advanced features.

- **The Concept of "Liquid Agency"**

The concept of *"liquid agency"* emerged as a crucial lens through which to understand human-machine interactions in the context of smart glasses.

Liquid agency suggests that control and decision-making are fluid, shifting dynamically between the user and the device depending on the context and the nature of the task. For instance:

- In safety-critical situations, such as detecting an oncoming vehicle, smart glasses may take the lead by providing real-time alerts.
- Conversely, for more subjective decisions—such as selecting a route based on personal preferences—the device would relinquish control to the user.

This interplay requires a careful balance: while empowering users to retain autonomy, systems must also adapt responsively to their cognitive and emotional states.

Participants highlighted the importance of designing for this fluidity, ensuring that smart glasses act as *partners* rather than passive tools or overly dominant systems. This approach would foster a more collaborative and intuitive interaction model, where decision-making dynamically shifts according to situational needs while preserving the user's sense of control and agency.

4C4. Person-to-Platform Interactions

Workshop participants, echoing scholars like Goodman, highlighted the dangers of *"platformization"* and the increasing dominance of private tech companies in urban governance, particularly in the context of smart glasses. A recurring concern was the profit-driven nature of these platforms, which often prioritize revenue over individual well-being or societal needs.

- **Conflicts Between Platform Influence and Personal Autonomy**

One example raised in the workshops illustrated a conflict between a parent and their child. The child, wearing smart glasses, received tailored recommendations to purchase unhealthy food. The parent, attempting to enforce healthier choices, found their authority undermined by the platform, which held the child's attention and trust. This scenario underscored how platforms, by leveraging behavioral data, can disrupt familial dynamics and personal authority.

- **Commercial Manipulation of Public Spaces**

Another example involved the integration of spatial mapping systems provided by smart glasses with targeted advertising. As users navigate a city, their AR overlays are influenced by advertisers who pay the platform for prominence.

This raises ethical questions about how public spaces are manipulated for commercial gain, as individuals may unknowingly be directed toward businesses or locations that paid for visibility rather than those that best serve their needs. Participants expressed concern that such practices could blur the line between navigation and advertising, eroding trust in digital guidance systems.

- **Historical Distortion and Control of Narratives**

A third scenario highlighted concerns about historical distortion. One participant suggested a scenario in which a tourist exploring a historic district while wearing smart glasses, instead of receiving accurate historical information, experiences an altered narrative. In this scenario, the local government pays the platform to present a revised version of history that aligns with its political agenda.

This creates a conflict between the authenticity of cultural heritage and the platform's control over how history is presented and consumed in the physical world. Participants stressed that this type of narrative manipulation could shape public memory and collective understanding, raising critical questions about the role of platforms in curating history.

Several participants advocated for preserving historical layers in augmented reality experiences—for example, marking where a cemetery once stood before a skyscraper was built. They argued that such digital annotations could honor collective memory and maintain a connection to the contested layers of a society's past.

However, others raised concerns about cognitive overload: *Does every space need to carry its entire past?* Too many historical layers could overwhelm users navigating public spaces, turning AR into a chaotic stream of competing narratives rather than a tool for meaningful engagement.

- **Governance Challenges in Public Spaces**

Another significant theme in the workshops was the governance of public spaces and the transitions between different types of environments. Participants noted that governance dynamics vary significantly between spaces such as schoolyards, playgrounds, senior living facilities, privately owned malls, city hall buildings, train stations, and open public streets.

- **Conflicts Over Control of XR Layers**

One example involved a conflict between the management of a train station and the operating system of a major tech company controlling the XR layers users experience. The management sought to limit certain content, such as intrusive ads or targeted promotions, within the station's boundaries.

However, the platform prioritized its profit-driven algorithms, leading to disagreements over who has the right to regulate these digital layers in physical spaces. This scenario underscored the tension between private platform control and local governance rights in shared environments.

- **Data Collection Boundaries and Contextual Governance**

Another participant raised the issue of data collection boundaries. For instance:

- Should the level of information collected and analyzed by smart glasses differ between a schoolyard and a busy main street?
- Should privacy expectations change based on the type of public space?

While digital data-sharing challenges are well-known from traditional online platforms, the physicality of these environments introduces additional complexities. Governance frameworks must consider not only digital regulations but also the physical management of these spaces. This creates a need for integrated policies that effectively balance both dimensions—digital and physical.

- **Balancing Profit, Privacy, and Governance**

The workshops underscored the need to address the dual challenges of platform control and physical governance in environments mediated by smart glasses.

While the influence of private platforms over digital interactions has been long debated, the intersection of physical and digital layers requires new approaches to governance. For example:

- How should regulators balance the demands of advertisers, municipalities, and governments with user rights?
- How can historical accuracy and the integrity of public spaces be preserved while accommodating commercial AR overlays?

- **Rethinking Governance for Phygital Spaces**

Ultimately, participants emphasized that governance in this new era must account for the blending of physical and digital realities. The traditional boundaries between public and private spaces are increasingly blurred, necessitating regulatory frameworks that address not only the digital economy but also the *lived, physical experiences* of users navigating augmented environments.

This redefinition of governance calls for a hybrid approach—one that integrates digital rights with real-world management practices, ensuring that public spaces remain accessible, equitable, and inclusive within the expanding phygital landscape.

5. Chapter 4: Recommendations

5A. Introduction

If the uses of smart glasses are not properly regulated, they might lead to a decline in the standard of both human-to-human and human-to-machine interactions. The *responsible AI* approach ensures transparency and autonomy for the user but neglects the user's dependency on human connection and AI's ability to infringe on existing and potential relationships.

Addressing these gaps will require platforms, developers, and municipalities to adopt certain responsibilities toward individual users' well-being and social cohesion, as well as safeguard society's democratic standing.

In cases where regulatory approval is not required for the device, we propose implementing internal control mechanisms not only for the products themselves but also for the physical spaces in which they operate.

- Vulnerability should be considered an ongoing human experience, and guardrails must be established to ensure it is addressed appropriately.
- Mechanisms should be implemented to detect risk factors ahead of time and mitigate them.
- Additionally, the design of AI tools must prioritize strengthening human connections, emphasize the importance of tailored, personalized settings, and enable human intervention where necessary.

5B. Emphasizing the Concept of "Phygital Spaces"

We recommend using the term *"Phygital Spaces"* instead of *"spatial computing"* to emphasize the complex, multidimensional reality being created, rather than the computational aspects behind it.

This terminology shift can contribute to a deeper understanding of the concept and serve as an introduction to an epistemology of the possible.

5C. Adopting Our Novel "Ethics of Interactions" Approach

Rather than replacing *Privacy by Design (PbD)* and *responsible AI* principles, we recommend that the *"ethics of interactions"* framework serve as a complementary mechanism.

- This framework should broaden developer responsibilities, particularly in sensitive areas of interactions, and establish standards for professional interactions.
- Over time, as technology and phygital products evolve, these interaction-based principles may develop into more structured regulatory requirements.

Expanding the Interaction Typology

We suggest continuing to refine the typology of interactions proposed in this project while exploring additional interaction types and subtypes.

- Clearly defining these interactions makes it easier to imagine and understand their implications.

Mapping Interactions Across Contexts

We recommend mapping sub-interactions in specific physical environments, such as indoor and outdoor spaces and various types of public spaces.

- The design of interactions must consider the type of service provided, the characteristics of the space, and the specific impact on users.
- Age, locality, accessibility needs, and emotional states should all be part of this comprehensive mapping effort.

Competence and Responsiveness in Interactions

Effective interactions require competence and attentiveness to others. Developers must design systems that meet the interaction needs of both *"interaction givers"* and *"interaction receivers."*

- **Human Support:** Add a layer of human support for cases where technology alone cannot address the interaction need.
- **Monitoring User Feedback:** Developers should actively monitor users' responses to interactions and use the feedback to improve the systems.
- **Responsibility for Privacy and Safety:** Recognize the ability of users to impact others' privacy and security in public spaces and implement mechanisms to acknowledge and address these concerns.

Interaction Transparency

Unlike traditional algorithmic transparency, we suggest adopting the notion of *"interaction transparency,"* which focuses on the transparency of human-machine communications and interactions. This approach ensures that exchanges and interfaces are more understandable, allowing users to know what to expect from their interactions.

Interoperability and Longevity of Systems

To address the risks of technological obsolescence and closed ecosystems, we recommend that developers prioritize interoperability in their systems:

- **Preventing System Obsolescence:** Systems should be designed with upgradability in mind to prevent premature obsolescence of devices and platforms.
- **Cross-Platform Compatibility:** Promote interoperability between different AR and smart glasses platforms to ensure users can seamlessly interact across different devices and services.
- **Open Standards:** Encourage the adoption of open standards to prevent vendor lock-in and facilitate future integration with emerging technologies.

Recognizing and Addressing Vulnerability

The *ethics of interactions* framework acknowledges that vulnerable populations may require special considerations in their interactions. Recognizing these needs can be challenging, as they differ from person to person and may change over time.

- **Life Cycle Responsibility:** Developers and companies should be responsible for ensuring their systems provide appropriate interactions throughout the product's life cycle. This includes delivering outcomes that enhance user well-being while mitigating risks.
- **Incorporating Emotional Needs:** Systems should accept and reinforce emotions rather than ignore them. Vulnerability should be identified and addressed with appropriate responses, guided by a broad understanding of its meaning.

5D. Dual Governance in Phygital Spaces

- **Addressing Power Imbalances**

The power relations that have enabled the emergence of smart glasses must be critically examined. The significant influence held by a few companies—operating solely for profit without adequate regulatory oversight—raises ethical concerns. Developers, regulators, and civil society must collaborate to address these imbalances and ensure that user rights, privacy, and autonomy are protected.

Recognize the parallel governance systems that exist in phygital spaces: the digital operating systems and the authorities managing the physical spaces.

- **Shared Responsibility:** Municipalities and local stakeholders must play an active role in setting boundaries for AR content and interaction mechanisms. For example:
    - **Regulating AR Advertising:** Set limits on how AR advertising can influence users, particularly in sensitive environments like schools, religious sites, or medical facilities.
    - **Preventing Manipulative Uses:** Prohibit AR overlays that steer users toward commercial destinations under the guise of navigation assistance.
- **Promoting Localized and Inclusive Solutions:**
    - **Adapting AR Layers to Local Contexts:** Platforms should ensure that AR content respects local traditions, languages, and community standards.
    - **Customizable AR Settings:** Provide tools for users to personalize their AR experiences in ways that align with their values and identities.
    - **Public AR Infrastructure:** Introduce public AR systems funded by governments or non-profits to reduce reliance on commercial platforms for critical services and promote bottom-up content creation by civil society and non-profit creators.

5E. Recommendations: The Workshop Process

The workshop process revealed two key insights that can shape the development of technology policy and stakeholder engagement:

- **Expanding the Feedback Process**

We suggest expanding this section with a more detailed description of the feedback process, incorporating some of the responses received as participant testimonials.

Additionally, we recommend referencing the survey we conducted, which indicated that most participants were unfamiliar with the concept of *phygitality* and encountered it for the first time during the workshop. This highlights the importance of workshops in raising awareness and closing knowledge gaps about emerging technologies.

- **Learning Through Play**

Role-playing emerged as a highly effective tool for uncovering legal and social blind spots in current frameworks. While the scenarios often sparked laughter—somewhat freeing participants from the constraints of their natural thought processes—they also prompted serious and thoughtful discussions about the readiness of existing systems for emerging phygital interactions. Participants found the process both engaging and illuminating, as it provided a deeper understanding of the interpretative and subjective nature of smart glasses.

To enhance the effectiveness of role-playing in future workshops, we recommend the following:

- **Select empathetic and relatable characters:** Choosing roles that evoke curiosity and empathy encourages participants to engage more deeply with the scenarios. It is also important to select characters that participants can identify with while predefining roles that contribute to the narrative and allow for a deeper exploration of potential conflicts and interactions.
- **Introduce nuanced and dynamic characters:** Incorporate a wider variety of characters with relevant traits or more fluid identities to better reflect the diversity of interactions in phygital spaces.
- **Promote ownership and authority roles:** Assign one participant to play an authority figure—such as a facility care manager, police officer, or lifeguard—to ensure system-level thinking is carried out throughout the game.
- **Gamification techniques:** Use tools such as shuffled character cards or randomized assignments to make the process more interactive and engaging.
- **Include computer-based participants (NPCs):** Incorporate AI-driven non-player characters to simulate interactions and demonstrate the nuances of machine-mediated engagements.
- **Address blind spots in participant understanding:** Many participants were unaware of what capabilities the technology enables or what questions they should be asking. It is important to guide participants in imagining possible futures and identifying gaps in their understanding during the role-playing process.

5F. Digital Literacy Challenges

Technology policy development faces several common challenges, including complexity, opacity, and limited stakeholder engagement. The rapid evolution of technology further compounds these issues, particularly due to significant gaps in digital literacy among decision-makers.

The workshops demonstrated how gamified, experiential learning helps participants think critically about technology and better understand its challenges, conflicts, and opportunities. This approach not only fosters awareness of emerging technologies like smart glasses but also equips participants with the tools to approach other technological environments with similar rigor and creativity.

5G. Recommendations for Expanding the Workshop Model:

  - **Use role-playing for broader technological exploration:** Extend the role-playing methodology to explore other phygital technologies and environments. This approach can generate valuable insights across different domains, such as smart cities, AR-based education, or workplace AI systems.
  - **Incorporate speculative design and role-playing to explore social dynamics:** Speculative design and role-playing can help participants understand the nuances of the social fabric—dilemmas, frictions, and cases that challenge societal norms. This approach prompts players and policymakers to grasp the subtleties of everyday life in democratic societies and reinforces tolerance through exposure to diverse perspectives.
  - **Foster cross-cultural collaboration:** Our Israeli-German collaboration highlighted the importance of incorporating diverse cultural perspectives into decision-making. This diversity enriched discussions and emphasized the value of stakeholder-informed approaches.
- **Invest in digital literacy for decision-makers via speculative design workshops:** Allocate budgets to improve digital literacy among policymakers, regulators, and stakeholders. Enhancing their understanding of complex technologies will enable better regulatory frameworks and more informed decisions. We emphasize that digital literacy is a *prerequisite* for policymakers' ability to maintain democratic governance and uphold societal stability. In an era where digital technologies increasingly shape public discourse, influence elections, and mediate public spaces, decision-makers without sufficient digital literacy are at risk of failing to regulate technologies effectively or of being manipulated by opaque technological systems.

  Workshops that build digital literacy not only enhance policymakers' understanding of specific technologies, but also cultivate their ability to:

  - Identify digital threats to democratic processes, such as disinformation and algorithmic bias.
  - Evaluate the societal impact of emerging technologies on privacy, freedom of expression, and human rights.
  - Develop inclusive technology policies that balance innovation with public interest and equity.

  Thus, digital literacy should be viewed not merely as a technical skill but as a *core competency* essential for democratic governance in the digital age.

6. Conclusion

The *"Ethics of Interactions"* framework introduced in this project offers a groundbreaking perspective on navigating the challenges of phygital spaces. Unlike traditional approaches that focus solely on *Privacy/Human Rights by Design* or *Responsible AI*, this framework emphasizes the nuanced and multifaceted nature of interactions between individuals, machines, platforms, and environments. It underscores the importance of addressing social, cultural, and emotional dimensions in technology design, particularly as these systems mediate how we perceive and engage with reality itself.

The speculative design workshop proved to be an essential tool for exploring these complex dynamics. Through game-like interactions and role-playing immersive scenarios, participants uncovered hidden blind spots in legal and ethical frameworks, sparking important conversations about our readiness for emerging phygital technologies.

The workshop also highlighted the importance of context-specific design, as requirements for interactions vary across socio-political and cultural settings. It is through multi-disciplinary collaboration—bringing together ethicists, technologists, designers, and policymakers—that we can begin to address the intricate challenges posed by smart glasses and similar technologies.

As one participant observed: *"The human is not what they think they are, nor what others think they are. The human is what language models think they are."*

This quote encapsulates the transformative power of AI to reshape identity and perception, demanding thoughtful frameworks to guide its evolution. As the world becomes increasingly saturated with smart glasses, we must embrace this moment as an opportunity to redefine how we design and govern augmented experiences. In the words of British statesman and polymath John Lubbock: *"What we see depends mainly on what we look for."*

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