The Pervasive Multiverse

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THE PERVASIVE MULTIVERSE, an interconnected web of diverse and dynamic digital landscapes, promises to redefine our understanding of computing's reach and impact. Hereby, it extends beyond the traditional boundaries of pervasive computing: digital ecosystems seamlessly intertwine with the physical, creating an immersive and interconnected experience across devices, contexts, and users.

The Pervasive Multiverse holds transformative potential for our society at large. Imagine a world where information seamlessly flows between devices, personalized experiences adapt to our preferences and abilities across multiple realities, and the boundaries between the physical and digital realms blur harmoniously.

The demand for dedicated research in this field is essential. Challenges such as interoperability, interaction, security, privacy, and ethical considerations loom large. How do we ensure a smooth exchange of information across diverse digital landscapes? How do we create novel interaction techniques? How can we guarantee the privacy and security of individuals traversing the Pervasive Multiverse? These questions demand the attention of researchers and practitioners alike.

Past research has played a fundamental role in shaping the future of the pervasive multiverse. Fundamentally, Rauschnabel et al. contributed the XR framework [1], providing a common terminology and clear delineation of concepts such as AR and VR. Furthermore, researchers created novel devices and concepts, redefining how people will interact and experience these dynamic realities. For example, Mai et al. [2] implemented the illusion of a transparent head-mounted display by rendering eyes on an outward-facing display; Pfeuffer et al. [3] early integrated eye gaze and hand gestures for intuitive and versatile interaction in mixed realities; or, Knierim et al. [4] who addressed the challenge of text input in Virtual Reality by blending a physical keyboard within the virtual experience. These examples helped push the boundaries and are, to a certain extent, embedded into commercial products such as the Meta Quest 3 or Apple Vision Pro.

The objective of this special issue is to surface novel approaches to and examples of applications for the Pervasive Multiverse. The accepted articles address a variety of topics, ranging from privacy and interaction challenges in the metaverse to more speculative views on how the metaverse will shape future societies, focusing on the potential harms and benefits of the metaverse. The authors of the manuscripts featured in this special issue come from three continents (Asia, Europe, and North America) and represent a variety of fields, including computer science, information science, security and privacy, and psychology.

This special issue begins with an article by

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Tatsuya et al. [**?**] in which the authors highlight the potential privacy risks associated with sharing unrestricted spatial data. They proposed a visual privacy control method to empower users to define or automatically assess protection levels for spatial objects based on their inherent semantics. We invite all readers interested in XR-related security and privacy research to consider this article and build upon the idea of adaptive obfuscation techniques to balance privacy risks while maintaining the realism of the metaverse.

The next article delves into hands-free augmented reality interaction techniques. Korkiakoski et al. [**?**] explored the nuances of gestures and voice commands, considering them as potential gateways to the Metaverse. Despite the similarities in usability and user experience, distinctive individual preferences emerged. Users favored voice commands for their efficiency but acknowledged a lack of excitement compared to gestures. Based on the provided guidelines, future Metaverse interaction techniques can be refined with tailored techniques based on specific contexts and applications.

The last two articles explore the metaverse concept and its implications on society through a detailed analysis of various aspects such as structural descriptions, use cases, privacy, health, ethics, inhabitants, and philosophies. Both articles contribute insights to the development of the metaverse by addressing not only its promises and potentials but also its risks and societal impacts. To that end, Hohendanner et al. [**?**] studied peoples' reflections on fictitious metaverse scenarios and offered valuable insights into societal, ethical, and technical challenges surrounding the metaverse. The speculative and sometimes provocative nature of the study sparked occasionally extreme reactions, emphasizing the need to engage with the public to shape the future of the metaverse. Finally, Butz et al. [**?**] shed light on the pervasive multiverse from technological, psychological, and partly philosophical perspectives in the last article of the special issue. In their essay, they highlight the responsibility of the research community and propose a research agenda that addresses social and individual concerns alike. They emphasize the necessity for thoughtful interdisciplinary research to navigate the complex construct of the pervasive metaverse and make this paradigm valuable to society.

The collection of articles in this Special Issue illustrates the wide range of ways in which computing technology can contribute to the pervasive multiverse. The articles contribute methodological insights, deliver tools, provide reflections on the challenges, and illustrate provocative new views. We hope they will inspire new work, spark novel ideas, and help establish new directions in thinking about how technology can support research on the pervasive multiverse.

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