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A Review of Security and Privacy Challenges in Augmented Reality and Virtual Reality Systems with Current Solutions and Future Directions

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Abstract: *Augmented Reality (AR) and Virtual Reality (VR) systems offer immersive experiences by integrating virtual elements into the real or simulated world, enabling applications in navigation, gaming, healthcare, military, and education. However, these technologies pose significant security and privacy challenges due to their reliance on sensor data, real-time processing, and shared virtual environments. AR systems face risks such as deception attacks, input validation issues, and data misuse, while VR systems contend with concerns around user tracking, motion data security, and immersive feedback manipulation. This review explores these challenges across single and multi-application systems, highlighting risks related to output conflicts, input accuracy, and data access control. Current solutions, such as robust input validation, access control models, and conflict resolution frameworks, are examined. The study concludes by identifying future directions, including the development of advanced interface designs, collaborative sensing applications, and novel privacy-preserving techniques to ensure secure and ethical deployment of AR and VR technologies. The study emphasises that in light of the continuous evolution of AR/VR technologies, it's of extreme importance to take proactive measures to prevent risk from increasing.*

Keywords: Augmented Reality, Virtual Reality, Security, Privacy, Authentication, Neuro-cognitive Threats, Encryption, Zero-Trust Algorithm (ZeTA), Data Protection, User Consent..