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A Qualitative Review of Zero-Knowledge Proofs and Biometrics in Decentralized Identity Systems

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This paper presents a qualitative review on the integration of Zero-Knowledge Proofs (ZKPs) and biometrics in Decentralized Identity (DID) systems. It explores how these technologies address key challenges in digital identity management, including privacy preservation, security enhancement, and regulatory compliance. Guided by three research questions, the study systematically reviews recent literature to identify the problems these technologies solve, the sectors where they are applied, and the standards that govern their implementation. The review further reveals that ZKP-DID is the most widely adopted method, dominating fi-nance and governance applications, while Bio-DID focuses on healthcare and education under GDPR, and BioZK-DID combines biometrics with ZKPs for enhanced security but with limited regulatory guidance. The findings reveal that ZKPs enable privacy-preserving verification, while biometrics offer robust user-specific authentication. Their integration within DID systems is particularly relevant in sectors such as finance, healthcare, governance, and education. However, challenges remain in scalability, interoperability, and regulatory alignment. This paper contributes new insights by proposing technical guidelines, policy recommendations, and future research directions to support the ethical and effective deployment of ZKP-biometric-enabled DID systems.

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