Abstract

The Industrial Internet of Things (IIoT) is revolutionizing industries by enabling smart automation, real-time monitoring, and seamless connectivity. However, the rapid proliferation of IIoT devices has introduced critical security challenges, including unauthorized access, data breaches, and rogue device infiltration. Traditional centralized security models struggle to provide the necessary resilience against cyber threats. To address these concerns, this study proposes a **blockchain-based security framework** that ensures secure, decentralized, and tamper-proof data management for IIoT networks. The framework leverages **blockchain encryption** and **immutable storage** to safeguard device communications, preventing data manipulation and unauthorized modifications.

Additionally, **data science techniques** are integrated to detect and mitigate security threats in real-time. These techniques enable **anomaly detection**, identifying rogue devices, message tampering, and unauthorized access attempts. A **coordinator device** is employed to establish trusted communication pathways, authenticate device identities, and prevent network vulnerabilities. The combination of blockchain's transparency and data-driven threat analysis significantly enhances the overall security posture of IIoT systems.

To validate the effectiveness of the proposed framework, **Python-based simulations** are conducted to assess key security parameters such as **false authentication probability, message integrity, and resilience against cyberattacks**. The experimental results demonstrate that the system effectively mitigates unauthorized activities, ensuring reliable and secure IIoT operations. By eliminating reliance on centralized authorities, the proposed approach enhances trust, transparency, and network resilience.

This research contributes to advancing **IIoT security** by integrating blockchain and data-driven intelligence, offering a scalable and robust solution to combat evolving cyber threats. The findings suggest that industries adopting this framework can significantly **reduce security risks, prevent data breaches, and fortify IIoT ecosystems** against sophisticated attacks, thereby fostering a secure and efficient industrial environment.