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Thesis Title: **An Intelligent IOT Framework for Industrial Applications in Cloud Environment**

Keywords: *Industrial IoT, Machine Learning, Blockchain Technology, Cloud Computing, Predictive Maintenance*

Abstract

This thesis provides an exhaustive review of the integration of Machine Learning (ML) in the industrial Internet of Things (IIoT) within cloud environments, underscoring its transformative role in Industry 4.0. It highlights ML's impact on predictive maintenance, fault detection, and smart energy management while exploring fog, edge, and cloud computing frameworks for enhancing real-time analytics and decision-making. The findings in this study also address challenges such as data privacy and system interoperability, offering insights into future research directions. It illustrates how ML is poised to revolutionize industrial practices, boost operational efficiency, and drive innovation. This thesis presents a framework integrating the IIoT, ML, and BTs to optimize cloud-based industrial systems. The proposed multi-layered approach enhances real-time data collection, predictive maintenance, and operational efficiency through IIoT devices. ML algorithms are employed for data-driven decision-making, while blockchain ensures secure and transparent data transactions. The framework addresses key challenges such as scalability, data privacy, and system interoperability. A smart manufacturing use case demonstrates the framework's practical benefits, emphasizing its transformative impact and the complexities involved in implementing this advanced technological integration in industrial contexts.

Furthermore, this thesis presents an integrated ML framework to enhance predictive maintenance and demand response in IIoT environments. Utilizing data from interconnected sensors, the framework employs algorithms such as gradient-boosted decision trees (GBDT), random forest (RF), and logistic regression to accurately forecast machine failures and optimize energy consumption. The research synthesizes approaches from unsupervised learning for early failure

detection and predictive modelling for demand response management. The results demonstrate significant improvements in operational efficiency, maintenance cost reduction, and energy optimization, providing a comprehensive solution for ensuring reliability and efficiency in modern smart manufacturing environments. Moreover, the thesis presents a framework that integrates a private blockchain system with a microcontroller and smart devices to enhance food traceability in supply chains. The system addresses challenges such as lightweight processing, evaporation, warehousing, and shipment time by ensuring secure and reliable data flow. ML is applied within the blockchain to improve accuracy and extend product shelf life. The research explores the combined benefits and applications of blockchain and ML, demonstrating their potential to optimize supply chain operations and ensure data integrity in modern food traceability systems. Finally, the thesis proposes a novel cyber security framework for IIoT that integrates random subspace methods and blockchain technology. Addressing the distinct security needs of IIoT compared to consumer IoT, the framework uses Principal Component Analysis (PCA) for data preprocessing and employs blockchain to secure communication and node details. This approach enhances attack detection efficiency and overall security, offering a significant improvement over existing ML techniques. By combining these technologies, the proposed methodology provides a robust solution to safeguard IIoT systems and ensure the safety and privacy of industrial operations.

In conclusion, this thesis has demonstrated the profound impact of integrating IoT, ML, and BTs on industrial IT applications, marking a significant advancement in Industry 4.0. By examining various frameworks and methodologies, the research highlights how these technologies collectively enhance operational efficiency, security, and automation. The proposed frameworks for cloud-based industrial systems, predictive maintenance, and demand response showcase their potential to optimize real-time data processing and decision-making while ensuring data integrity and transparency through blockchain.