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AI-Enabled Smart Contracts for Reliable Traceability in the Industry 4.0

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Abstract : The manufacturing industry was collecting vast amounts of data for monitoring product quality thanks to the advances in the ICT sector and dedicated IoT infrastructure is deployed to track and trace the production line. However, industries have not yet managed to unleash the full potential of these data due to defective data collection methods and untrusted data storage and sharing. Blockchain is gaining increasing ground as a key technology enabler for Industry 4.0 and the smart manufacturing domain, as it enables the secure storage and exchange of data between stakeholders. On the other hand, AI techniques are more and more used to detect anomalies in batch and time-series data that enable the identification of unusual behaviors. The proposed scheme is based on smart contracts to enable automation and transparency in the data exchange, coupled with anomaly detection algorithms to enable reliable data ingestion in the system. Before sensor measurements are fed to the blockchain component and the smart contracts, the anomaly detection mechanism uniquely combines artificial intelligence models to effectively detect unusual values such as outliers and extreme deviations in data coming from them. Specifically, Autoregressive integrated moving average, Long short-term memory (LSTM) and Dense-based autoencoders, as well as Generative adversarial networks (GAN) models, are used to detect both point and collective anomalies. Towards the goal of preserving the privacy of industries' information, the smart contracts employ techniques to ensure that only anonymized pointers to the actual data are stored on the ledger while sensitive information remains off-chain. In the same spirit, blockchain technology guarantees the security of the data storage through strong cryptography as well as the integrity of the data through the decentralization of the network and the execution of the smart contracts by the majority of the blockchain network actors. The blockchain component of the Data Traceability Software is based on the Hyperledger Fabric framework, which lays the ground for the deployment of smart contracts and APIs to expose the functionality to the end-users. The results of this work demonstrate that such a system can increase the quality of the end-products and the trustworthiness of the monitoring process in the smart manufacturing domain. The proposed AI-enabled data traceability software can be employed by industries to accurately trace and verify records about quality through the entire production chain and take advantage of the multitude of monitoring records in their databases.

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