Strukturierte Zusammenfassung der Dissertation

Digital quality assurance system for additive manufacturing based on artificial intelligence methods and blockchain technology

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The number of additively manufactured functional parts is increasing, making special quality aspects, such as a predictable and reproducible manufacturing process that leads to high-quality results, are becoming more and more important. In this context, traceable and digital quality management (QM), process-integrated and fast quality assurance (QA), and suitable process monitoring are key elements for additive manufacturing (AM). However, the effective implementation of corresponding quality-relevant aspects is hindered by a lack of process understanding and immature networking of the additive process chain, so that innovative technological potential in these areas is not recognized. Instead, conventional processes that have been established for years and which are generally complex, slow and expensive, are used without restriction as the standard without regard to technological innovations.

Therefore, the aim of this work is to investigate technological innovations in the context of process digitization and to develop a digital quality assurance system for additive manufacturing based on specific artificial intelligence (AI) methods and blockchain technology to enable more reproducible as well as predictable AM processes and parts. To this end, this cumulative work considers the implementation of special quality assurance methods based on AI algorithms, the development of a digitalized quality management system based on blockchain, and the conceptual combination of these aspects into a real-time capable digital quality assurance system for AM as three main areas of investigation.

The research investigations show that complex machine learning (ML) algorithms are capable of automatically detecting and classifying defects and irregularities based on image and sensor data from selected AM processes. Detailed analyses and comparisons of different algorithms have also demonstrated the effectiveness of the data-based methods and their suitability as fast, non-destructive and process-integrated alternative to conventional QA methods. Further investigations show that a blockchain-based QM can digitally map the value chain of a complex AM process. This also enables a cross-company digital QM of data along the entire supply chain, including data from conventional and data-based QA methods. Analyses based on specific evaluation criteria have shown that a corresponding digital quality assurance system can fundamentally improve quality in AM.

Waren (Müritz), 31.08.2023