The system enables reliable segment orientation and joint angle estimation without needing wired sync or proprietary interfaces. It is compatible with standard Android devices and supports long-term data acquisition for out-of-lab settings.

Conclusions. The developed platform demonstrates precise temporal alignment and motion tracking using only BLE and IMU modules, without hardware synchronization. Its modular design supports scalability and portability. In addition to gait analysis, the system has great potential in rehabilitation, telemedicine, and prosthetic control. In addition, its flexible architecture supports the integration of additional sensor types, such as torque sensors or force sensors, expanding the scope of application to complex biomechanical studies. These capabilities open the door to future use in sensory-enhanced lower limb prostheses, providing adaptive control strategies and patient-specific feedback mechanisms.

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USING ARTIFICIAL INTELLIGENCE IN RESEARCH AND IMPROVEMENT OF THE TECHNOLOGY OF ROLL FORMING OF BENT 3D-TYPE PROFILES

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Abstract. The research explores the application of artificial intelligence (AI) to optimize the roll forming process for bent 3D-type profiles. AI-driven algorithms are used to predict deformation behavior, optimize process parameters, and enhance production efficiency. The study aims to improve precision, reduce material waste, and accelerate industrial adoption of advanced roll forming technologies.
Key words: Artificial intelligence, roll forming, bent 3D profiles, optimization, predictive modeling, machine learning, production efficiency.

Introduction

Topicality. Roll forming is a widely used manufacturing process for producing bent 3D-type profiles in industries such as automotive, aerospace, and construction. However, the complexity of forming intricate geometries often leads to inefficiencies, defects, and material waste. Traditional methods rely heavily on physical prototyping and manual adjustments, which are resource-intensive. Artificial intelligence offers a transformative approach to address these challenges by enabling predictive modeling, process optimization, and real-time decision-making.

The object of the research is the roll forming process for bent 3D-type profiles.

The subject of the research is the integration of AI algorithms into roll forming technology to improve precision and efficiency.

The goal of the work is to develop AI-driven methods for optimizing the roll forming process of bent 3D-type profiles, ensuring higher accuracy, reduced waste, and enhanced production efficiency.

The tasks of the study include:

1. Analyzing deformation mechanics and identifying key parameters affecting roll forming.
2. Developing predictive AI models to simulate the roll forming process.
3. Implementing optimization algorithms for process control.
4. Validating AI-driven solutions through experimental and simulated data.

The novelty of the research lies in the application of advanced AI techniques to address the specific challenges of roll forming bent 3D-type profiles, which have not been extensively explored in existing studies.

Methodology

The research employs a combination of computer modeling, finite element analysis (FEA), and machine learning techniques to study and optimize the roll forming process. FEA simulations are used to generate data on deformation behavior, material properties, and process parameters. This data serves as the foundation for training machine learning algorithms, such as neural networks and generative algorithms, which are designed to predict deformation patterns and optimize roll forming parameters.

A key aspect of the methodology is the development of real-time AI-based control systems that monitor process variables such as roll pressure, material thickness, and deformation rate. These systems dynamically adjust parameters to minimize defects and ensure consistent quality. Experimental validation is conducted using physical prototypes and industrial roll forming equipment to test the accuracy and reliability of the AI-driven solutions.

According to the recent studies, the researches could successfully develop predictive AI models capable of simulating the roll forming process for bent 3D-type profiles with high accuracy. These models have demonstrated their ability to forecast deformation behavior and springback effects, allowing for precise adjustments to process parameters. Optimization algorithms have been implemented to reduce material waste by up to 15% and improve geometric accuracy by 20%. Additionally, the integration of AI-driven control systems has significantly enhanced production efficiency, reducing downtime and defect rates.

Discussion

This research aligns with the principles of the New European Research Paradigm by addressing sustainability, promoting human-centered approaches, and fostering impact-oriented innovation.

Sustainability (Economic-Ecological-Social):

The AI-driven roll forming process reduces material waste, energy consumption, and production costs, contributing to economic and ecological sustainability. Socially, it supports responsible manufacturing and resource efficiency, aligning with global sustainable development goals.

Human-Centered – Wellbeing:

By automating complex tasks, the research improves workplace safety and reduces physical strain on operators. It also enhances product quality, benefiting end-users in industries like construction and automotive, while fostering skill development in advanced manufacturing technologies.

Impact-Oriented – Multi-Agent/Sector/Disciplinary Co-Creation:

The study bridges expertise from manufacturing, AI, and materials science, fostering interdisciplinary collaboration. Its outcomes are applicable across multiple sectors, enabling innovation in industries such as aerospace, automotive, and renewable energy, while encouraging partnerships between researchers, manufacturers, and technology developers.

In summary, this research contributes to sustainable, human-centered, and collaborative advancements in manufacturing, aligning with the goals of the New European Research Paradigm.

Conclusions. The application of artificial intelligence in the roll forming process represents a significant advancement in manufacturing technology. By leveraging AI for predictive modeling, optimization, and real-time control, the research has demonstrated improvements in precision, efficiency, and sustainability. The developed methodologies and algorithms provide practical solutions for industries seeking to produce bent 3D-type profiles with higher accuracy and reduced costs. These findings contribute to the digital transformation of the roll forming industry, paving the way for future innovations in intelligent manufacturing systems.

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STUDY OF THE KINETICS OF THICKNESS FORMATION AND PHASE COMPOSITION OF COATINGS ON DEFORMABLE ALUMINIUM ALLOYS DURING MICROARC OXIDATION

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Abstract. The study deals with the processes of coating formation on deformable aluminium alloy AMg6 by microarc oxidation (MAO). The kinetics of coating thickness growth and changes in its phase composition depending on electrolysis conditions have been investigated. The main regularities of the influence of oxidation modes on the morphology and phase composition of the obtained coatings have been established. The mechanism of formation of various phases in the process of MAO and their influence on the properties of coatings have been studied. The obtained results can be used to optimize the technology of formation of protective coatings on aluminium alloys used in various industries.
Keywords: aluminium alloy, microarc oxidation, coating thickness, phase composition, X-ray tensometry, hardness.

Introduction. The development of technologies for surface modification of metals and alloys is an urgent task of modern materials science. One of the most progressive methods of formation of wear-resistant and protective coatings on aluminium alloys is the method of micro arc oxidation (MAO). This method allows to obtain coatings with high hardness, corrosion resistance and wear-resistance, which makes it in demand in the aerospace, automotive and machine-building industries. Despite the widespread use of MAO technology, the issues related to the kinetics of coating thickness growth and formation of their phase composition remain unresolved so far.

The object of research is multilayer MDO coating on deformable aluminium alloy AMg6.