Gliwice, 29.09.2024

Abstract

Modern industry constantly strives to increase the efficiency and accuracy of technological processes, driven by growing demands for the quality of manufactured components and the optimization of production costs. SMHydro Ltd. from Katowice, specializing in the production of satellite hydraulic motors, faces the challenge of optimizing the wire electrical discharge machining (WEDM) process, which, despite its precision, generates high operational costs.

The aim of this doctoral dissertation was to develop and implement solutions that enable the optimization of the WEDM process at SMHydro through the application of artificial intelligence methods. The research involved analyzing the impact of technological parameters on key quantities characterizing the WEDM process, such as material removal rate, erosion gap width, surface roughness of the machined surface, and process continuity. WEDM process models were developed using artificial intelligence methods, including Support Vector Regression (SVR) and the XGBoost algorithm, which allowed for predicting these quantities based on technological parameters.

Subsequently, software for dynamic, multi-criteria optimization of the WEDM process was developed, utilizing a Genetic Algorithm (GA) to adjust technological parameters according to specified quality and performance criteria. This software was implemented at SMHydro, enabling practical application of the tool in production conditions.

The research results confirmed that the application of artificial intelligence methods in modeling and optimizing the WEDM process brings significant benefits compared to traditional statistical methods. The Genetic Algorithm proved to be the most effective in optimizing technological parameters, allowing for flexible adjustment of the process to the current needs of the enterprise.