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ANN-based ensemble model for predicting micro-EDM responses and machining variability

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Abstract

Micro-electrical discharge machining (μ EDM) requires high precision, quality and efficiency, yet machinists rely heavily on expertise and heuristics due to the complexity of the process and the use of machining different materials. This article introduces the use of artificial neural networks (ANNs) and ensemble models to predict key μ EDM

responses, such as machining time (MT), tool wear rate (TWR), overcut (OC) and taper angle (TA). The model incorporates material properties like thermal conductivity, melting point and electrical resistivity, along with input factors, including capacitance, voltage, feed rate, tool speed, tool diameter and workpiece type. Experimental data, collected using an I-optimal design of experiments (DOE) technique, was used to train the ANN models and optimized through grid search. The model's accuracy, evaluated across training, testing and validation sets, showed mean accuracies between 76.84% and 86.62%. Deployment results revealed strong alignment between experimental and predicted outcomes, with predictions within a four standard deviation (4σ) range. A user-friendly graphical interface (GUI) facilitates the prediction process, improving precision and decision-making in μ EDM for various workpieces.

Keywords:

ANN grid-search-optimization machining variability micro-EDM model averaging

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Authors' contributions

Dr. Tanveer Saleh (T.S) is the PI of the research project. The main idea of this article is from him. M.M.H is the main PG student involved in carrying out the experimental and modeling work related to this project. He also compiled, analyzed the data and wrote the

manuscript. T.S commented and corrected the manuscript. A.S is the co-supervisor of M.M.H. He also commented about the manuscript.

Use of the AI tool

During the preparation of this work the author(s) used Grammarly and ChatGPT in order to enhance the language and readability of the manuscript. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

The corresponding author can share the data validating the conclusions of this study upon request.

Additional information

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